

Cotton breeding and seed production.

Textbook.

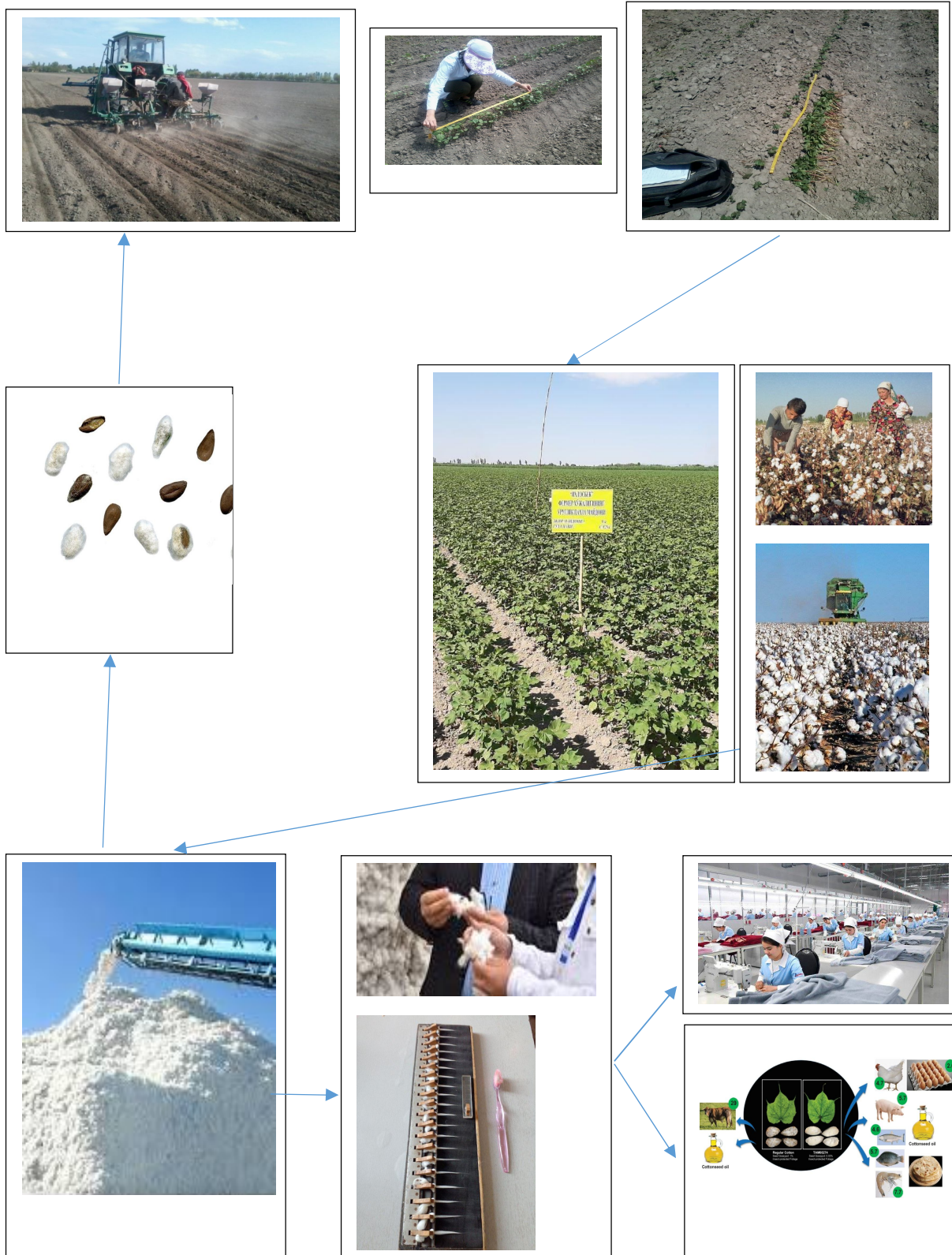
M.E. Ashurov, G. A. Narmatova, N. Yakubjanova.



Cotton breeding and seed production.

Textbook.

M.E. Ashurov, G.A. Narmatova, N. Yakubjanova.



UDK:631.517

KBK:41.3

C-11

M.E. Ashurov

Cotton breeding and seed production. / G.A. Narmatova

N. Yakubjanova/ Textbook. – Tashkent: “NIF MSH”, 2024, 415 p.

The textbook “Cotton breeding and seed production” is targeted to use for bachelor students of agricultural establishments.

It also can be used by masters, research assistants, teachers and cotton breeders.

Reviewers:

P.Sh. Ibragimov

*doctor of agricultural science, the Scientific-Research Institute of Cotton Breeding,
Seed Production and Agrotechnologies.*

J.B. Khudaykulov

*doctor of agricultural sciences, professor of the department of plant growing and
oil bearing crops, Tashkent State Agrarian University.*

The textbook was approved to publish by the decision № 391 of Ministry of Higher Education, Science and Innovations of the Republic of Uzbekistan on August 25, 2023.

ISBN 978-9910-785-83-2

M.E. Ashurov and others., 2024.

“NIF MSH”, 2024.

Contents	4
Introduction.	7
Part I. Cotton plant.	10
Chapter 1. Cotton plant, origin of cultivating species and economic importance.	10
Chapter 2. Pre-historic cotton grown in Uzbekistan.	16
Chapter 3. The history of <i>G. hirsutum</i> L. varieties and its evolution in Uzbekistan	22
Chapter 4. History of development of <i>G. barbadense</i> L. varieties in Uzbekistan.	39
Part II. Classification of cotton plant.	48
Chapter 1. Genus <i>Gossypium</i> , origin and classification of cotton.	48
Chapter 2. Cotton plant classification developed by G.S. Zhaytsev.	53
Chapter 3. Cotton classification created by J.B. Hutchinson.	57
Chapter 4. Cotton classification composed by F.M. Mauer.	61
Chapter 5. Cotton genome classification by J.H. Saunders.	66
Chapter 6. Classification evolved by A.C. Dariev and A.A. Abdullaev.	68
Chapter 7. Biological features of cotton plant.	72
Part III. Cotton plant breeding.	80
Chapter 1. Cotton breeding process.	80
Chapter 2. Conception about cotton variety.	119
Chapter 3. Cotton varieties must meet certain requirements.	128
Chapter 4. The initial materials.	142
Chapter 5. Hybridization.	165
Chapter 6. Selection and its kinds.	176
Chapter 7. Evaluation of breeding material.	186
Part IV. Methods of cotton breeding.	198
Chapter 1. Scheme of the cotton breeding process in Uzbekistan and abroad.	198
Chapter 2. Plant breeding scheme based on intraspecific hybridization.	217
Chapter 3. Scheme of plant breeding by the use of remote geographic and interspecific hybridization.	227

Chapter 4. Scheme of plant breeding by the using of induced mutation.	237
Chapter 5. Scheme of cotton breeding by the using of heterosis in the cotton forms.	245
Chapter 6. Using of untraditional methods in cotton breeding.	254
Chapter 7. Using biotechnological methods in cotton breeding.	275
Chapter 8. Preliminary reproduction of varieties in plant breeding institutes.	283
Part V. Cotton variety trial.	286
Chapter 1. Station testing.	286
Chapter 2. Competitive variety testing and criteria of the new varieties submitted to the state variety trial.	289
Chapter 3. State variety testing and commercialization of the cotton varieties.	295
Chapter 4. Genetic uniformity of new cotton lines.	301
Chapter 5. Agro-practices, field observations, selection, and harvest in the cotton breeding plot.	303
Chapter 6. Copyright for the cotton variety.	316
Part VI. Cotton seed production.	319
Chapter 1. Cotton seed, its economic importance in the seed production.	319
Chapter 2. History of cottonseed production in Uzbekistan.	324
Chapter 3. Theoretical basis of seed production.	330
Chapter 4. System and scheme of seed production.	335
Chapter 5. The method to produce elite seeds and successive reproduction seeds of cotton plant.	339
Chapter 6. Approbation procedures of stock cottonseed plantations.	356
Chapter 7. Harvest, provision of stock seed raw cotton, documentation and provision of seed to sow.	363
Part VII. Raw cotton and cottonseed marketing.	374
Chapter 1. Cotton textile-clusters in Uzbekistan.	374
Chapter 2. Cotton fiber and cotton seed marketing.	377
Chapter 3. Extra payment to the raw cotton and stock seed.	382

Chapter 4. Briefly about cottonseed production abroad.	383
Chapter 5. Achievements of cotton breeding and seed production in Uzbekistan.	386
Glossary.	393
Appendixes.	402
References.	413

Introduction

Cotton plant has been a unique crop forever in its sort in regard to demand by the whole people of Central Asia and glorified by them as the main source of wealth.

Not only were cotton-planted fields used to support peasants and their families, but fiber, seed, dried stalks, and pods extracted from cotton plants after harvest were also converted into long-awaited goods to meet family needs or social trade exchange relations for the Ancients who once lived in modern-day Uzbekistan.

Cotton plant, within the development of the Renaissance, had begun to attract the attention of primary industrial manufacturers for its multi-purpose dignity. It has become the first vital crop in both social and industrial spheres as the cotton plant and its burst open bolls can be seen depicted everywhere and everything, beginning with the insignia of the republic and on the posters of squares, streets, parks and festive decorations. Because overall products derived from cotton plant could prove themselves as easily gaining natural treasure in the promotion of the development of a new national economy in the periods of historical progress that took place in the 20th century.

The true values of cotton plant structural components in the appearance of raw or reprocessed materials have been discovered since the development of science and industrial processing technologies. As a consequence, nearly 300 commodities designated for widespread consumption with technical and special demand have begun production and utilization by local manufacturers. On average, no less than 35-36 kg of textile fiber (which is enough to produce 3000 m of fabrics), 6-8 kg of lint, 11 kg of plant oil, 2,5 kg of soap, 2,2 kg of cake, 13,6 kg of husk for the hydrolysis industry or food for animals and 3-4 kg of other products are obtained from 100 kg of first grade raw cotton.

Cotton fiber is the main source for spinning and yarn or thread producers to use in the textile and other fields of the light industry. Various fabrics (linen, muslin, print, batiste), cotton wool, artificial silk, fishing supplies, different technical goods (electric windings, card threads applied in the auto industry, filters, driving straps, hand-made leathers) and many others are produced from cotton fiber.

Cotton seed constitutes plant oil and its percentage share with regard to seed weight ranges from 20 to 28% depending on cotton varieties and species. This product is being extracted from cotton seeds at oil refining plants and has remained for ever and a day, a traditional first ingredient in cooking daily culinary meals by the indigenous residents of the republic. Its quality was in no way inferior to the best grades of natural olive oil. Besides this, cotton seed oil is used to manufacture other high-demand items like margarine, toilet soap, glycerin, stearin, drying oil, and technical oil. The flour gained from cotton seed pulp is another unique source for getting a valuable protein with high fitness to feed infants. Cellulose, linoleum, lacquers and other manufactured goods are obtained from the residues of cotton ginning and oil extracting industries (appendix 2).

The leaves and stems may be reprocessed to gain acetic, malic, and other acids, and cake remained after removing gossypol, which is used to feed the agricultural animals.

But, in its biology, the cotton plant is an extremely capricious crop and demands daily attention, the expenditure of all necessary resources in agriculture and great effort on the part of the farmers. Every cotton boll responds to great effort, time and adequate sunshine and water to form fluffy raw cotton in it. That is why cotton was called figuratively by the peasants "a child of the sun and water." Of course, the weather and available irrigation water are the primary decisive factors for a good cotton crop.

It is known that Uzbekistan was a leading producer of cotton in the former Soviet Union. According to the literature, at that time, our republic accounted for two-thirds of that country's raw cotton output. There was a steady increase in the yields and the overall production of this important technical crop. This increase came as a result of developing new land for irrigated farming, raising per hectare yields through improved farming methods and introducing integrated mechanization, large-scale use of chemicals and broad land reclamation measures.

The products driven out of its reprocessing truly deserved the other historic name of "White Gold" given to cotton in Uzbekistan.

All above mentioned achievements in the republic have partly been the results of pioneer cotton breeding and the organization of a properly seeded production system in our republic. The overwhelming majority of grown varieties possessed high genetic potential derived from the local cotton populations and historically introduced overseas cotton varieties.

Moreover, Uzbek cotton breeders and seed producers constantly conduct purposeful researches to improve further the newly released cotton varieties and seed reproduction methods under the guidance of advanced theories by world-famous scientists like Ch. Darwin, I.V. Michurin, N.I. Vavilov and others. Consequently, they could evolve and introduce cotton varieties into agriculture that had productive possibility at the level of the world's highest yield of raw cotton 3,7-3,9 tons per hectare on average.

In regard to cotton fiber, due to how cotton plants are generally planted, the variety S-4727 also achieved the highest rank of fiber output at 37-38%.

The progress in cotton plant breeding at the turn of its history can be explained by two factors: successfully crossed breeding ways and the initial materials used. On the one hand, local cotton populations were remarkable for their genotypes, with wide adaptation to local soil conditions, distinguished by harsh and unstable extreme temperature fluctuations. On the other hand, introduced overseas varieties are often exposed to genomic splitting under strange cultivation conditions resulting in their genomic responses. The emerging diversities of plant genotypes with different genomes could be the best chance for the creation of a background full of genome combinations. Moreover, our genetics and breeders could discover innovative scientific techniques to transfer desirable traits of distant and wild cotton species into the genomes of cultivating cotton varieties. These

advances were great opportunities to select plants with desirable genomes of traits, those that the breeders would like to see at the end of their deliberately breeding researches.

Some of the local cotton varieties, F-108, C-4727 and Tashkent-1 (*G.hirsutum* L.), developed by our breeders have demonstrated superior genetic potential, which enabled them to spread planting areas even in the neighboring republics and up to the Caucasus regions. But this kind of progress in the history of agriculture in our republic step by step has resulted in a single dominance on the account of the cotton plant. And vast cotton plantations that have already attained more than 3 million hectares demand great water resources and human efforts, which, in general, lead to the loss of plant diversity and even the exhaustion of soil fertility. Overall, cotton production has gradually become a mighty burden on the government and is one of the most inefficient crops not only for the country but for farmers as well.

The government of the republic, just after the acceptance of independence in the year of 1991, as the major initiator, launched wide scale economic and organizational reforms across the country covering all internal and external national spheres of activity. Obviously, it has been concerned with cotton breeding prospects also.

Diversification and efficiency are involved in major strategies of our government for the growing of agricultural crops. Because of substantial reforms, the land planted to cotton plant before the advent of reforms has decreased by half and the vacated lands went under cereals and other agricultural crops.

Part I. Cotton plant.

Chapter 1. Cotton plant, origin of cultivating species and economic importance.

Cotton plant grown in the fields of farmers is an annual plant to get mainly plant fiber. Beside fiber its different parts are raw source to reprocess in the various industries of the countries of the world to produce numerous demanded products. Taxonomically, it belongs to the domesticated hibiscus species of plants and has a relationship with its wild, natural species. According to the information presented from the last results of botanical research, more than 50 domesticated, semi-wild, and wild species of the genus *Gossipium* have been discovered. In the next parts of the textbook, we will learn more detailed about their taxonomic definition and their regions of formation.

The varieties of five domesticated species: *G.hirsutum* L. (photo 1), *G.barbadense* L., *G.herbaceum* L., *G.arboreum* L. and *G.tricuspidatum* are commercially grown by the farmers of the world. In general, historical domestication of cotton plant has facilitated the extend its area to the north of 45 degrees and to the south of 35 degree and its fiber has occupied about 31% of the world's textile market currently. The native lands of these species are often reflected in their names. Two species, *G. herbaceum* L. and *G. arboreum* L., in terms of their genetic characterization, represent diploids ($2n = 26$) and are considered old world cotton plants. They also known as the Asiatic cottons because of their cultivation mostly meet in Asia. The other two species are characterized as the tetraploid cottons ($2n = 52$), and it is well known that they are referred to as the



Photo 1. *General view of the plants of G.hirsutum, G.barbadense and their structural parts.* "New World Cottons."

Scientifically, *G.hirsutum* L. has many names: American cotton, Upland cotton and Middle staple cotton. *G.barbadense* L. in Uzbekistan is commonly called a fine staple cotton and, scientifically, Egyptian cotton, Sea Island cotton, or Peruvian (or Pima) cotton. *G. tricuspidatum* is a West Indian, known as "three teeth."

Generally, all cotton breeders and cotton geneticists acknowledge that the old world (diploid) cottons are characterised by a high degree of resistance to biotic and abiotic stresses, whereas the new world (tetraploid) cottons have a high yielding capacity and fine fiber quality.

World statistics figured out the varieties of *G. hirsutum* L. species, which alone produce about 90% of the total global production. Plants of these varieties are distinguished by phenotype: the data for 33 commercialized cotton varieties reveal the range in the height of plants; from 70 cms (variety of Omad and S-8284) up to 140, or 150 cms (varieties of Sultan and Jarkurgan). Plant architecture varies between varieties, and can be classified as limited branching or non-limited with a four-sup-type branching canopy. The absence of a spot at the base of the flower's petal is the most distinguishing feature of this cotton variety (photo 1). The fiber of these varieties is relatively shorter than the fiber of *G. barbadense* varieties, but has a high demand in the Uzbek national and worldwide textile industries.

Out of the photo it is obvious that bracts of **G. barbadense** are very large than bracts of the other species. That is why, when you see the flower, the later bolls are completely covered with bract teeth. But they are developing alone, not united as the branches of diploid species. This is one of the remarkable traits with large fat, dark-green leaves and characteristic red spot on the base of flower petals. Bolls are usually longer with a sharp tip and are deeply pitted with black oil glands. The structures of the plants in the cultivating varieties can be described: zero branching, limited branching, and spread branching.

As we noted above, its fiber is the extra-long-one. That is why, its fiber is used to manufacture the finest fabrics in the world. It is very soft but quite strong. Its fabrics, which bear the brand "Pima," are highly sought after for use in apparel and bedding. By the way, it is the second –most produced a type of cotton and comprises about 8% of global cotton output.

G. herbaceum is also known as Levant cotton (photo 2), it is native to southern Africa and Arabian countries. Its share in the world cotton production is comprises less than two percent. Levant cotton's fiber is primarily spun into yarns to make a variety of natural fiber fabrics. The varieties of this cotton are widely spread in the countries of India, China, Japan, Middle Asia, and the Caucasus. It is the most dwarf (herbaceous), and the most resistant because of its cultivation further north than others.

Bracts of its diversities and varieties flare widely from the square (bud), flower and boll. They have 6–8 sharp teeth. The flower has a yellow color with a red spot on the base of the petal. Their bolls are usually round and rarely have prominent shoulders. The immature bolls have a smooth surface with a few shallow pits and oil glands. However, when bolls are ripe, they do not fully open. Fiber—the white, short, and coarse variety—is often called woolen fiber.

G. arboreum—three cottons, perennial, with red and yellow flowers depending on the species and sub-species, and naturally the tallest cottons of 4.5-6.0 meters. The domesticated, annual varieties are grown widely in Pakistan and

India. The amount of fiber produced from this cotton accounts for less than 2% of the global market.



Photo 2. A general view of the plants of *G. herbaceum*, *G. arboreum* and their structural parts.

Bracts of cultivating varieties closely invest bud and flower and have 4-5 teeth. Bolls are tapering and have pitted oil glands. At the time of ripening, the bolls open fully, and the raw cotton even hangs down. The seeds are naked, black, and small, with yellow fiber of high quality. That is why, it is known as the source for the manufacture of gauzy fabric that offers immense breathability while maintaining its form over time.

G. tricuspidatum (photo 3). Despite its similar phenotype to *G. hirsutum*, cotton classification expert A.A. Abdullaev did not include it in domesticated cottons. On the basis of research studies, it was retained in the list of cotton sub-species. It is grown by tropical peasants on the shores of rivers in the southern hemisphere.

All other sub-species and wild species are found primarily in their natural habitats around the southern regions of the world. Their existence is the great source for all cotton breeders' economic traits and biological properties. Because, they survived, developed under the conditions of natural selection, and genetically had to continuously recombine more effective genotypes and phenotypes that were needed to save the next generation: those that were more resistant or tolerable to biotic and abiotic stresses.

Historically, many plant geneticists and cotton breeders have devoted their research to the analysis of genetic makeup and the use of wild cotton species in crossbreeding to determine problems that occur in the cotton breeding process and its seed production. Gradually, geneticists and breeders have achieved remarkable achievements in terms of their genetic descriptions and initial resource importance. They, due to their unique traits and biological properties, have attracted breeders' attention more purposefully to use them to improve the economical traits and biological properties of cultivating crops. Furthermore, cotton sub-species and wild species have become natural, initial sources for SRI cotton breeders. In this regard, introduction or collection departments to save their seeds and green houses to grow

perennial cottons have been established at all SRIs of the republic where breeders engage in agricultural crop plant breeding. These advancements have allowed our breeders to operate more efficiently all year. In particular, owing to the availability of these collection departments and green houses, our cotton breeders have demonstrated world-important achievements in regard to creating economically efficient cotton varieties.

Recently, scientists: Dr. V. Gotmare, Dr. P. Singh, and others from the Central Institute for Cotton Research, Nadpur, presented their report about "Wild and cultivated species of cotton". This is the most vital literature for the cotton genetic scientists and breeders looking for donors to improve all farm valuable traits and biological properties of cultivating cotton varieties. For example, *G.anomalum* (photo 3.) which has the best, genetically held traits and properties, has traits like: yield, length, strength, and fineness of fiber; resistance to boll worms, jassids, mites, bacterial blight, and drought.



Photo 3. Cotton species of G.tricuspidatum, G.anomalum and their parts.

The wild species presented in this report have the donor potential to improve nearly all traits and properties of growing cotton varieties.

Today, the newly developed cotton varieties should meet the requirements of international standard indexes, have high productivity, and be resilient with regard to local growing practices and conditions. The quality of cotton fiber should be at maximum competence levels with advanced textile etaloning to enable them to manufacture splendid textile goods according to export demands. Furthermore, the newly released varieties should have high reliability across all inputs of production technologies and adequate profitability for farmers.

Unfortunately, not only indigenous but also internationally published data on the current cotton production potentials of the world's cotton producing countries indicate that the productivity of our cotton varieties has considerably decreased in comparison to our historic achievements with former homegrown varieties. More important is our cotton varieties' potential at the international ranks in productivity and fiber quality, which would be a significant tool in the enhancement of both

market demand shares by the international prestige of our cotton production and farmers' interests in the result of benefit increasing (table). The data figured out in the table clearly exhibits the ranks of cotton growing countries in the productivity of seed cotton yields in kilograms per hectare. On the other hand, the reader can imagine the productive potential of the planted varieties along the cotton-growing countries of the world. According to their productivity indices, Australia, Israel, Turkey, China, and Syria are contenders for the world's first five countries with cotton varieties with superior productivity potential. Their productivity accounts for 44,077;43,272; 42,936; 42,098 and 36,905 kilograms per hectare, respectively. The table 1 presents the data brought together from 14 out of 45 prestigious cotton growing countries acknowledged by the ICAC (International Cotton Advisory Committee) and can show the rank of our country in cotton productivity.

Table 1. Seed Cotton Yield by Country

Seed Cotton Yield					
Rank	Country	Kg\ha	Rank	Country	Kg\ha
1	Australia	44,077	8	Greece	33,333
2	Israel	43,272	9	Nigeria	33,333
3	Turkey	42,936	10	Kyrgyzstan	27,353
4	China	42,098	11	South Africa	26,609
5	Syria	36,905	12	Uzbekistan	25,650
6	Brazil	36,507	13	The U.S.	24,428
7	Mexico	34,847	14	Peru	24,090
Source: FAO Data\Food and Agriculture Organization, viewed 31 st January, 2017					

Our country occupies the 12th place in cotton productivity among the 14 countries in the world. Producing raw cotton (seed cotton yield) consists of 25,650 kilograms (or 2,6 tons) per hectare. This index is even lower than in South Africa, where it is widely known that African countries generally plant imported varieties of cotton seeds. Furthermore, African countries' agriculture is still in its developing stages compared to Uzbekistan's. Our republic is characterized as one of the world's most developed agrarian countries in many aspects of agriculture. Cotton growing is also without exception. The index in the table belongs to our country's productivity, which means there is no real potential for cotton varieties developed and grown in the recent past. As above mentioned, they have an average of more than 3,5 tons per hectare across the republic. So, based on natural cotton growing conditions and the achievements reached by cotton breeders and seed producers, we can be sure that our republic, with its resources in terms of scientific research centers provided by up-to-date techniques and highly qualified researchers, can rank among the top five world countries.

Generally, cotton plants are planted for their fiber. Cotton varieties with high output are regarded as the world's achievement in cotton breeding research, and cotton production is primarily measured by cotton (fiber) yield (table 2).

Table 2. Cotton yield by country.

Cotton Yield					
Rank	Country	Kg\ha	Rank	Country	Kg\ha
1	Turkey	1,884,00	16	The USA	955,00
2	Australia	1,814,00	17	Sudan	907,00
3	China	1,787,00	18	Kyrgyzstan	871,00
4	Brazil	1,675,00	19	Pakistan	726,00
5	Israel	1,633,00	20	Egypt	726,00
6	Mexico	1,598,00	21	Iran	704,00
7	Venezuela	1,234,00	22	Bangladesh	668,00
8	Greece	1,200,00	23	Ecuador	653,00
9	Syria	1,132,00	24	Vietnam	653,00
10	Tunisia	1,089,00	25	Myanmar	635,00
11	Bulgaria	1,089,00	26	Korea	630,00
12	South Africa	1,031,00	27	Azerbaijan	620,00
13	Peru	1,025,00	28	Argentina	599,00
14	Spain	1,005,00	29	Uzbekistan	599,00
15	Columbia	968,00	30	Ethiopia	586,00
Source: United States Department of Agriculture. Year of estimate: 2018					

And here also, our government and breeders face much work and deliberate research to be done ahead.

The government of our republic was and remain to date as the first initiator with the challenges of improving cotton production and dignity of local varieties. Everywhere, the nets of cotton at scientific research institutes (SRI) and their regional selection stations and state variety test plots function. An enlarged cotton germplasm depository is being built at the SRI of Cotton Breeding, Seed Production, and Agro-Technologies. It maintains seeds of locally released varieties, semi-wild, wild species, and introduced seeds from all the well-known cotton research centers in the world.

About twenty cotton varieties are listed annually in the state register, which recommends cultivation in the regions of our republic. They present a great achievement as a result of cotton breeders' and seed producers' activities. There are varieties that have been recognized by international experts as having the potential to be used as the world's etalons, depending on the fiber quality.

Chapter 2. Pre-historic cotton grown in Uzbekistan.

The history of the cotton plant in pre-historic times can be traced to its domestication. Cotton plant domestication coincides with the development of agriculture by primitive man, and it is regarded as one of the oldest crops. Its evolution can be considered as the result of the conjunctive effect of environmental conditions, natural and artificial selection. The last one was implemented by a man, initially unconsciously and then in a systematic process, that involved the adaptation of a cotton plant to the needs of a man.

The original cotton plant was cultivated as a yard crop by primitive man, then gradually transformed into an annual plant and, finally, a field crop. Cotton plants and their products played an important role in that time period for people's existence and continue to be an important crop and commodity.

The word "cotton" has Arabic origins, derived from the Arabic word قطن (*qutn* or *qutun*), and it was the usual word for cotton in medieval Arabic. They say, that this word entered the Romance language in the middle of the 12th century and English a century later.

In the opinions of historians and cotton scientists, it is obvious that the history of domestication is very complex and not known chronically. Several long-lived civilizations in both the old and new worlds gradually domesticated cotton plants, grown in their surrounding nature and their fiber converted through ginning, spinning, and weaving into necessary fabrics. The innovative tools, such as wooden gins (photo 4, 5),

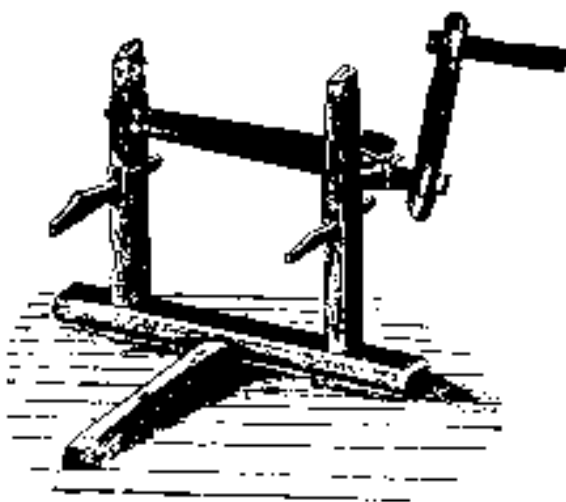
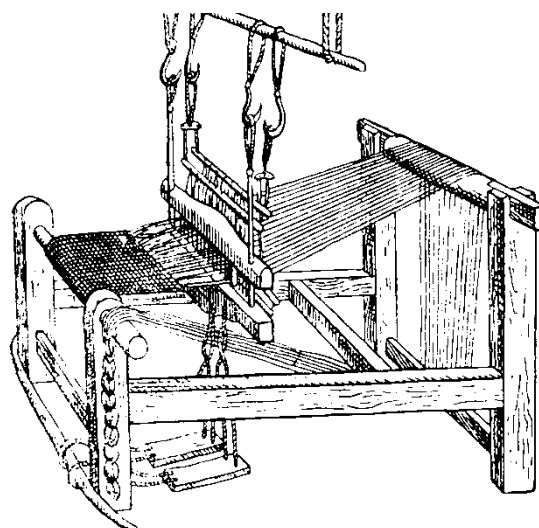


Photo 4, 5.



Wooden gins and some looms.

Combs, bows, hand spinning devices and looms were invented by the people's craftsmen of that period, who had played a great role in the development and simplification of primitive cotton production and cotton fiber reprocessing (Appendix 1).

The first archeological information referring to the oldest cotton textiles was found in graves and city ruins of civilizations from the regions of dry climates,

where the fabrics did not decay completely. They have 3-5 thousand years' standing.

Cotton plants had penetrated into Central Asia through Iran, most probably in the first thousand years of B. C. Excavations of grave edifices near Chust (Namangan region) have proved that people in the Fergana valley were engaged in cotton growing in the first century A. D. *G. herbaceum* L. spread widely in the third and fourth millennia A.D.

Some amounts of raw cotton have been discovered at the archaeological excavations executed in 1933-1934 near the city of Samarkand. The scientific staff of the former Sous NIKhI's central breeding station could establish that this raw cotton belongs to Asian guzi *G. herbaceum* L. (photo 6) based on the analysis of



Photo 6. Locally grown guzi at the time of harvesting.

those findings, which were referred to the year 720 by archeologists. The word "guzi" has an Arabic origin from the word "goz" which means a soft substance (*Gledhill, D., 2008*).

There is another report (Bartold V.V., 1924) which contains Arab geographers' compositions from the century X, where there are indications about the production of cotton-paper fabrics in the villages of Bedar and Zindany. These villages were located 12-14 km north-west of Samarkand and near Bukhara. Except for these, there were often mentions of Mary, Khoresm, Shashy (Tashkent) and other neighboring towns as the centers of fabric manufacture.

It is possible that Asian varieties of cotton plant *G. herbaceum* L. existed in the Fergana valley, along the Zarafshon, Khorezm, Amu-Daria, and Murgab for a long time before the beginning of our era and continuously over the course of successive centuries.

The complex effect of natural conditions and local growers on the cotton plant's formation was immeasurably great. In particular, the early maturing forms of Asian guzi, adapted to short vegetation periods and tolerant of the severe dry climates of certain regions, were created as a result of people's multi-century selective breeding activities in Central Asia.

Cotton growing in Central Asia reached its pinnacle in the X-XI century A.D, and it then began to decline as a result of ruinous wars. With the unification of Central Asia and Russia, cotton growing has started to gain good features. Fiber and yarn were regularly exported to Russia in the XVIII-XIX centuries. In that period, only national bred varieties of Guzi developed as a result of the associated effects of natural and artificial selections were grown in Central Asia. All the varieties of Asian cotton of that period were historically grouped under one general name, "Local or Asian guzi," but they distinguished each other with especially remarkable diversities depending upon their agro-ecological regions. Moreover, Guzi has territorial biologic and morphologically different properties owing to the consequences of the long-lasting, regionally disparate conditions of present Turkmenistan, Bukhara, Tashkent, Khiva, and Karakalpak, which had an enormous effect on the stabilizing of the heritable characteristics related to precocity and economically valuable traits.

It is more important to note that cotton plants have herbaceous types with more light-colored stems and leaves. The height of the main stem reached up to 1–1,2 m and was covered with short hairs. The leaves are comparatively small and have 3-5 or seldom 7-lobes, with a heart-shaped outlook at the base. Lobs are egg-shaped, narrowed at the base, and they are spearheaded against the top edge and not prolonged. Bracts are prolonged at the bases to a similar length as the boll, sometimes with short 5-to-9 teeth.

Calyx is short, with a scarcely noticeable five teeth. Petals are yellow with purple spots on the base and turn rose at the end of blooming. Bolls are small, circle-shaped with four to five sections, each with 5-7 seeds.

The seeds are oval shaped with corn kernels. The sharp edge ends with thorns and is covered by the rough white fibers (sometimes the fiber has the color of camel wool), measuring 22 mm in length on average, except that there is a grey, greenish or light-yellow fluff.

Matured bolls are semi-opened or even up to full unexposed (typical guzi) and treated with specially developed tools guzi breakers. First the bolls are broken, then raw cotton free from barks is handed to fiber separating gins for removing the fiber from seeds. Seeds of yellow or grey guzi and white or light guzi were sown, preferably separately, and cultivated exclusively by hand. The white guzi within them was specially differentiated by its productivity (up to 1,650 kg per hectare) and remarkable precocity.

The Russian empire's occupation of Central Asian territories for 31 years in the second half of the nineteenth century (1864–1895) had a new and progressive effect on the enhancement of early established trade relations between Russia and Central Asia. The majority of them represented textile manufacturing, which had been streamlined in response to the availability of cheap raw cotton produced by local cotton growers.

Technical development occurred in the Russian textile industry with the equipment of contemporary technologies, which has made it possible to increase the consuming potential and selection of quality of raw sources, in particular for cotton fibers. That is why export-directed manufacturers were more interested in producing fabrics of superior quality in order to maintain their competitiveness in the world markets. There is a lot of intent on the part of Russian weaving mill owners, who invested in local cotton growers to cultivate a certain type of guzi with the necessary fiber qualities and to offer ever enlarged sizes.

But often, the local producers could not meet the new broad-based demands of Russian consumers because of the productive potential of guzi varieties and their fibers, which had become weakened in comparison with up-to-date weaving looms' requirements.

Overall, cotton growth based on the guzi has been low productive, with fiber gained characterized by short, coarse indexes, forcing people to consider alternative options. As a result, attempts to introduce American cotton species were made until the end of the nineteenth century. These species have been represented as the very ancient crops on the American continent. According to the textbook published by the authority of N.G. Simongulyan (1987), inhabitants of Mexico, Columbia, Peru, and the West Indian Islands (progenies of various ancient nations like the Aztecs and Maya) already had highly advanced cotton growing and were possessed of the art of weaving cotton fiber at the time of the discovery of America by the explorer Christopher Columbus (1492). *G.hirsutum* L. (Mexico mountain cotton or upland) was grown in Mexico in various forms. *G. barbadense* L. varieties (around the sea or Sea Islands) were cultivated in Peru.

Bred cotton varieties developed by people's plant breeding were already in America at the time of the introduction of American cotton to Central Asia. Academician N.I.Vavilov wrote: "Many of the best cotton varieties—upland, cultivated in the United States of America and here in our country—are the results of the creative activities of introducers and peasants in the old Mexican villages; these varieties were exposed further through splitting selection and seed multiplication. Undoubtedly, they trace their roots back to the time of Maya

civilization, which existed before the advent of Europeans. Such cotton varieties as Acala, Big-Boll, and Durango were developed by "unknown cotton breeders."

Today, *G. hirsutum* L. varieties are planted in our republic on almost all cotton fields. This upland cotton was entered into Uzbekistan in the 1870s from America. The first introduced cotton in 1870, unfortunately, was the very late ripening sea-island (*G. barbadense* L.), non-adapted to the local growing conditions. This attempt at the growing of overseas cotton in Uzbekistan has ended in failure. This outcome may have a negative impact on the continuation of the entering process. The new seeds of imported overseas varieties of *G. hirsutum* L. were distributed 12 years later, through the agricultural department, to the landed property of Kaplanbek, located 20–25 km from Tashkent. Following that, such seeds, primarily from the United States, were distributed to the Fergana valley. The successively introduced varieties, King, Russels, and Kliveland, ripened relatively early, and by 1884, the area planted to their seeds had grown to 300 hectares. Imported seeds were also planted in 1907 and 1908 in the Khoresm oasis. At the turn of the century, the total area planted to seeds of *G. hirsutum* L. varieties was 200–220 thousand hectares.

The following main types of local variety diversities of Asian cotton were differentiated at the beginning of the 20th century:

Guza of Bukhara-more enlarged bolls in comparison with others, wool fiber with a length of 22–24 mm.

Guza of Kokand is a shorter wool fiber than guza of Bukhara.

Guza of Khiva: has more remarkable fine and long fibers (24–26 mm).

Guza of Tashkent and Khorezm shares characteristics with Guzi of Bukhara.

Malla guza is made from brown fibers.

Hereinafter, the gradual forcing out of local guzi by the American varieties has begun. Since then, these varieties have proven to be unrivaled in terms of productivity, fiber length, and fiber quality. However, due to the complete absence of seed production works, the spread of American cotton has continued on its own. The owners of cotton ginning plants, cotton-fiber manufactures, and individual people got seeds of different varieties through the agricultural department without any plan. These seeds were mixed with each other in cotton jinning plants after harvesting of the crop. Spontaneous reproduction, mechanical mixing of the seeds of American varieties in the cotton jinning plants, and crossing of plants have led to the establishment of mixed plant populations historically called "Plant Mixes". This population of cotton plants has indefinitely adapted to their regions of cultivation. The plant mixes differed significantly in terms of morphologic and economic characteristics, particularly precocity. Northern Turkistan and the

Chimbay region produced a more early ripening and small boll population. The plant mixes from Ferghana, Bukhara, and Turmenia are distinguished by their too late maturity and enlarged bolls (table 3).

The more famous "plant mixes" planted in 1910–1917 are given in the table. A general feature of plant mix diversity (S.S. Kanash, 1948; and B.P. Straumal, 1974).

Table 3. **Characteristics of cotton "plant mixes".**

Plant mixes	Productivity of 1 plant, g.	Maturity, days.	Fiber output, %.	Length of fiber, mm.	Weight of raw cotton per boll, g.	Region of cultivation \ removal from production
Ferganskaya	93	118	28,7	25,0	4,6	-\\-
Tashkentskaya	71	117	28,9	25,7	4,3	-\\-
Khorezmskaya	-	-	29-30	27-29	4,0-4,5	-\\-
Chimbayskaya	-	-	31-32	27-28	4,0-4,5	-\\-\1935
Kok-chigit	113-125	130	29-30	25-27	4,5-5,0	Namangh.
Ok-chigit		129	30-31	25-27	4,5-5,0	Andijan
Qora-chigit		130	30-32	24-26	4,6-5,0	Tashkent

Pedagogic technology – “BBB” technology.

Read the text under the topic of “History of *G.hirsutum*”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Navrotsky			
2	Variety 8517			
3	108-F			
4	S-4727			
5	Tashkent-1, 175-F, ...			

Chapter 3. The history of *G. hirsutum* L. varieties and its evolution in Uzbekistan.

The network of agricultural experimental establishments like Turkestanskaya, Andijanskoy, and Golodnestepskaya stations were organized in the year 1900 by the former agricultural department to improve the cotton production in the territory of Turkistan. Mainly, they functioned to work out optimal agro-practices for cultivating varieties. Exceptions were that, from 1901 to 1902, they implemented comparable variety tests. After 10 years of variety trials, they have offered recommendations on the practical use of better *G. hirsutum* L. varieties like King, Russels, and others. They were more early ripening and had superior productivity by 50-100% and more in comparison to local plant mixes.

Plant breeding departments were set up at the main experimental stations Turkestanskoy, Andijanskoy, and Golodnostepskoy in 1909-1910.

The beginning of scientific cotton breeding in the former territory of our republic refers to 1910-1913. M.M. Bushiev and G.S. Zhaytsev in the Golodnostepskoy, R.R. Shreder in the Turkestanskoy and Ya.L. Navrotskiy in the Andijanskoy stations started to plan breeding works to develop new cotton varieties through individual selections.

"Plant mixes" and imported varieties were the major initial materials used widely by the above-mentioned breeders.

The first native cotton varieties were: Navrotskiy (photo), Triumf Navrotskiy, 182 (Djura), 508 (Batir) and 169 (Dekhkan) which were released in 1914-1915.

Navrotskiy (photo 7) was developed by the breeder Ya, L. Navrotskiy from the population of American variety Russels at the cotton breeding station "Pakhtalik-kul" nearest to Namanghan city in 1913.

According to the data of C.C. Kanash (1928), the variety of Navrotskiy has superiority on the productivity than plant mixes of Tashkent and Ferghana by 20-25%, has more fiber output (4.9-5.1%), more weight of raw cotton per boll (1.2-1.5 g), but matures 3-4 days later.

Triumf Navrotskiy was evolved by the breeder Ya, L. Navrotskiy from an imported variety population of Triumf.

The 169 and 182 were developed at the Golodnestepskoy station, by the breeder G.S. Zhaytsev. These varieties have been selected from local "plant mixes" and possess remarkable precocity. These varieties ripened 10 days earlier than variety Navrotskiy and were primarily grown in northern regions.

The varieties of Navrotskiy, 182 and 169 had very short fiber lengths of: 26-28 mm and did not meet the requirements of the textile industry.

Reproduction of these varieties took place very slowly and could not spread to enlarged areas due to the absence of adequate seed production facilities there.

The Turkistan cotton breeding station, located 10 km from Tashkent, was organized by G.S. Zhaytsev in 1922 in the light of the fulfillment of the decree on

restoration of plant growing in Turkestan and Azerbaijan signed by V.I. Lenin (1920). The decree has been the land mark for further development of our cotton breeding industry during the first period of its development. In one paragraph of that decree, it was remarked that "restore formerly existed, organize new experimental fields and breeding stations".



Photo 7.

Navrotskiy cotton variety

That station played a great role in the coordination of regional breeding stations and considerably improved cotton breeding and seed production activities across the newly established Uzbek Soviet Socialist Republic in 1924.

In 1929, the Turkistan breeding station was renamed to "Central breeding station" and entered into the system of the newly formed All Union Scientific Research Institute of Cotton Growing (SousNIKHI).

From 1921 to 1931, the first strain changes took place all over the former cotton-growing republics of the former Soviet Union. The varieties of Navrotskiy, 169, and 182 were the major varieties that fully replaced the old low-productive and short-fiber plant mixes in the territories of Uzbekistan.

In the 1930s, the mean length of varieties was achieved at 27.5 mm in a combination of lower quality of fiber (19-21 rupture length). The problem, on the

side of industrial consumers, was the creation and introduction of varieties with long and high-quality fiber into production.

For the short period of cotton breeding activities, the breeders evolved new varieties with long fiber: 8517 (Kolkhoznik), 36M2 and 2034. All of these varieties were developed by the method of analytical breeding from American variety populations.

Variety 8517 (photo 8) was released (1928) in the Turkistan breeding station of Souz NIKhI by S.S. Kanash from sample Acala 0278. This variety has complex but good traits such as fiber length of 31-32 mm, high fiber output (37-38%) and high yield.



Photo 8. Cotton variety 8517

Variety 36M2 was selected from other collection samples of Acala 036 (1929) by P.V. Mogilnikov in the Fergana station, which had been organized in the years of 1924-1926 as a branch of the Turkistan cotton breeding station. The breeding of the variety took place in wilted environments. Due to this factor in the process of selection, the developed variety has been distinguished by its high resistance to wilt and other traits such as fiber length and productivity, which have also been significantly improved.

The variety 2034 was selected from the American variety Express Vebbera by G.S. Zhytseva and Ya.D. Nagibin.

The second strain change took place in the years of 1934-1937. The extension of cotton varieties with a positive complex of high productivity, fiber length of 31–33 mm, and higher fiber output were the major directions of this strain's change.

The historic feature of this period was the rapid multiplication of the seeds of new varieties, owing to the arrangement of a severely mapped out system of seed production. This system involved a five-year scheme of renewing the seeds, a widened net of elite-seed production farms in the kinds of collective farms and state farms, and setting up republican seed stations and seed laboratories at the cotton clearing plants. The variety of 8517 has got the most distribution in the strain changing. It has a fiber with a length of 30-32 mm and a fiber output of 37–38%. The total area planted to this variety consisted of 736,040 hectares. The variety of 2034 has more fiber length (33-34 mm) with very high-quality fiber, which reaches 28–29 km of rupture length. The second strain change has facilitated the increase of productivity by 15–19% across the republic, mean fiber length by 27–30.5 mm, and fiber output by 28.4–33%. sharply enhanced the grade of variety (up to 87%) and planting seed quality.

Unfortunately, the main commercialized varieties of cotton in the second strain change were not resistant to wilt disease caused by *Verticillium dahliae*. This disease began to spread rapidly through major cotton planting regions and, by the end of the 1940s, had reduced productivity by up to 10%–20%. The spread of this disease is explained by the absence of proper crop rotation, which is monoculture with cotton plants, and either the lower resistance of varieties to disease-spreading pathogens. This has resulted in the accumulation of wilt infections in the soil. The resolution of the state about "The measurements for further rise of cotton growing in Uzbekistan" dated 1939 has committed to carrying out the next and fourth (1941-1946) strains changing to 1944 on the introduction of highly productive and resistant to wilt varieties into production.

The new more wilt-resistant varieties S-460, S-450, and 18819 released by breeder S.S. Kanash at the Central Cotton Breeding Station have come to replace strongly prone to verticillium wilt varieties 8517, 2034, and 8196.

Variety S-460 (photo..) is the result of crossing varieties 8517 x 36M2 and has higher productivity in raw cotton, particularly in fiber output, which can reach up to 40%, as well as being longer and stronger. But it has a single scarcity, and that is its late maturity. This variety has occupied more than half a million hectares. The early-ripening variety 18819, with long fiber and high-quality fiber, has replaced the strongly susceptible to wilt variety 2034. The introduction of new resistant varieties into production sharply decreased infection of plantations by wilt, enhanced the raw cotton crop by 15–18%, and fiber output by 20–22. The average percentage of fiber output over the republic was raised by 33 to 35.5% and the mean length of fiber by 30.5 to 32.5 mm.

In spite of the positive combination of fiber quality of the main variety S-460 in the third strain changing, its late maturity has considerably appeared in the periods of successive years with high fertilization rates. The variety started to

develop a mighty vegetative mass of plants, which has resulted in a decrease in pre-frost yields, especially the first crops. So, the question of changing the variety of S-469 with more precocity has emerged. The fourth strain change (1947-1970) was carried out since 1947 with the extension of the variety 108-F, which had an earlier ripening (147 days), which is 7-10 days earlier than its predecessor (photo 9).

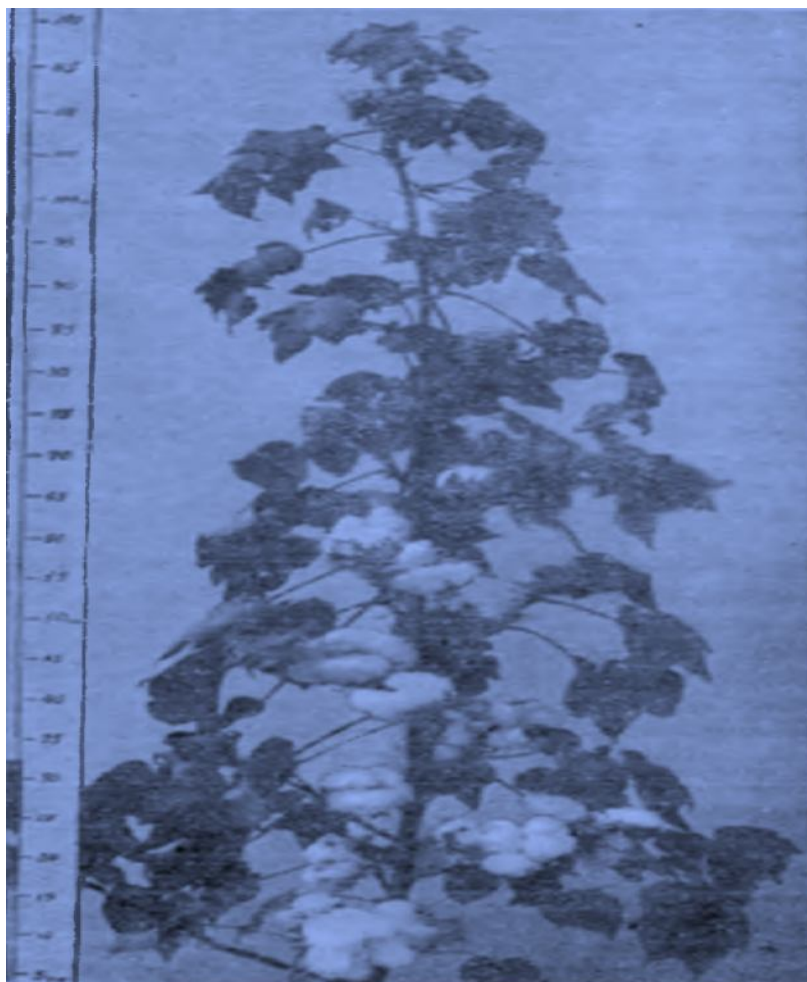


Photo 9.

The variety of 108-F

This variety was evolved by breeder L.V. Rumshevich at the Andijan station from the materials of natural hybridization of samples Acala and Cook (strain 17687). Since 1947, this variety has rapidly occupied the main cotton growing areas of the republic. In 1976, the area planted to this variety attained 1.6 million hectares in Uzbekistan and in the neighboring cotton growing republics. It was one of the longest (more than 50 years) planted cotton varieties in the history of cotton growing in our republic. Its long-lasting properties were related not only to its high productivity and fiber quality, but also to the vast adaptive potential of its good resilient properties to various soil, climate, and agro-practice conditions.

Other varieties, such as 138-F, 149-F, and S-4727 (photo 10), were commercialized in the meantime. The long fiber variety of 138-F was regionized in the beginning of the 1950s. This variety, as well as 149-F with fiber of IV textile type, were grown primarily in the republic's southern regions.



Photo 10. The variety of S-4727.

S-4727 was evolved by the breeders B.P. Straumal and A.I. Tishin through crossing of varieties 137-F and S-1470. It was regionized in 1961. The area of the variety S-4727 was extended a few later to northern part of the republic. Its growth also lasted for a long time, mostly in the region of Karakalpak. The variety was earlier (7-8 days) than the variety of 108-F. The enlarged bolls and high fiber output were notable distinguishing characteristics of this variety from others.

In 1960, the SousNIKHI established the central breeding station as a branch for cotton and alfalfa breeding and seed production.

Because of the destructive spread of wilt infection in 1960 and the adaptation of the fungus to main variety 108-F, its resistance to wilt has decreased, and the question of replacing it with a more resistant race of fungus has become an everyday reality. The Andijan station's 152-F and 159-F varieties eventually supplanted it. But these varieties did not solve the problem, even for the short term. At the end of the 1960s, wilt resistant varieties of Tashkent 1 (photo 11) were evolved by breeder S.M. Mirakhmedov and others at the Institute of Experimental Biology of the Academy of Science of Uz.SSR.

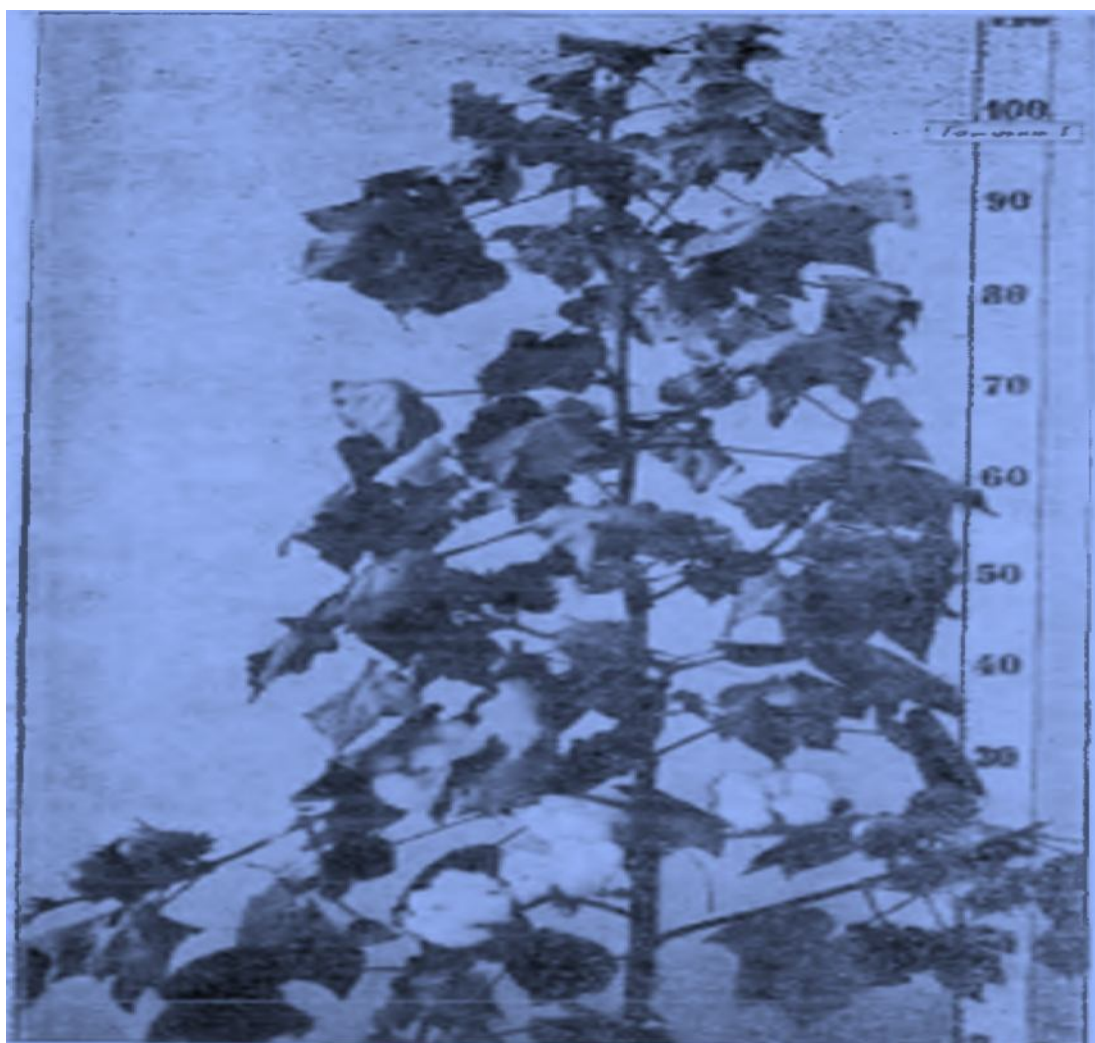


Photo 11. Variety of Tashkent -1.

It was specially recognized by the broaden circle of scientists that the varieties of Tashkent (Tashkent-1, Tashkent-2, Tashkent-3 and Tashkent-6) created by the method of remote hybridization between the variety S-4727 and wild subspecies of *ssp. mexicanum* in combination of backcross with S-4727 again in the third generation present a great achievement of the former soviet cotton breeding. It is sufficient to remark that in the period of regionizing, the variety 108-F was infected by as much as 90% and more, the variety 159-F -50-60%, while the varieties of Tashkent have only 5 to 6% infected plants. So, at that time, these varieties for their resistance to wilt were superior to any world variety of cotton plants.

Tashkent-1 became the most famous of the Tashkent varieties. In 1969, it was tested in the state variety trial plots and, in 1971, it was introduced into production. Extension of the variety of Tashkent-1 into production took an extraordinarily short time. In 1976, the area under plantations in Tashkent-1 had already reached 1 million hectares. It ripened 5-6 days earlier than the variety 108-F. The architecture of plants has a spreading form, leaf setting is mean, and the height of the main stem attains to 90-100 cm. highly resistant to wilt. Every plant has 1-2 growing (vegetative) woods, with fruiting branches involved in the first

half, and the first fruiting branch is set on the 5-6th node in the second type, which is greener and less haired. Leaves have 3-5 lobes; the green, middle lobe has a triple corner shape. Bolls are medium in size, circled, and have smooth, green surfaces; they open easily, and the raw cotton does not fall out of the boll. The seeds have residual hair. The weight of 1000 seeds are 120-140 g. The weight of raw cotton per one boll consists of 6.5-7.5 g. Fiber output is equal to the fiber output of the variety 108-F (35-36%). Fiber length of 32-33 mm, metric number - 5100, micronaire -5.0 and rupture length -26.1 km. Wilt infection accounts for 1-2% of the total.

Deserving of being the major cotton plant breeding organization in Uzbekistan, the cotton and alfalfa breeding and seed production branch of SousNIKHI has been reformed into independent Scientific Research Institute on Cotton Breeding and Seed Production in 1965 and, in the years of 1977 and 2014, correspondingly to the Coordination Center on Cotton Breeding at the rate of all Union SRIs and the Uzbek Scientific Research Institute of Cotton Breeding, Seed Production and Agro-technologies.

Historically, in introduction of the varieties Tashkent played an important role in the cotton growing of Uzbekistan. But the fiber of the variety Tashkent -1 didn't respond the normatives of fifth industrial type. That is why, the further necessity is to create the new varieties appeared into republic and are evolved and regionized in the production such varieties as: AN-402, 175-F, Samarkand-3, Kizil-Ravat, Uychi, and others with excellent qualities of fiber to compensate the demand to the fifth fiber type.

AN-402 was the result of radio-phosphorus treatment of wild Mexican cotton by the breeders of N. Nazirov and others in 1974. Widely growing it in the plantations of the republic took place since 1978 after its registration. It was 2 days earlier than the variety of Tashkent-1. Weight of one boll (7.5g), fiber output (40.7%) and fiber rupture strength (4.7g) were its remarkably distinguishing features.

The most aggressive race (2nd) of wilt pathogen injuring the variety of Tashkent-1 and above-mentioned varieties created by the participation of wild subspecies of mexicanum but (kpome) variety 175-F which was extended to the end 1970s. These varieties also differentiated with insufficient high fiber outputs. This trait has an important significance in the light of transferring of crop planning in account of fiber. The new varieties, which will come to replacing these growing varieties should have complexes of resistance to different races of fungus and on the precocity, productivity, fiber quality surpass any up to date standards.

175-F (photo 12) was released by the breeders A.N. Tribunskiy, Kh. Egamov, and A.V. Kim in the Andijan branch of CGSRI (Cotton Growing Scientific Research Institute) and entered into the State register in 1980.

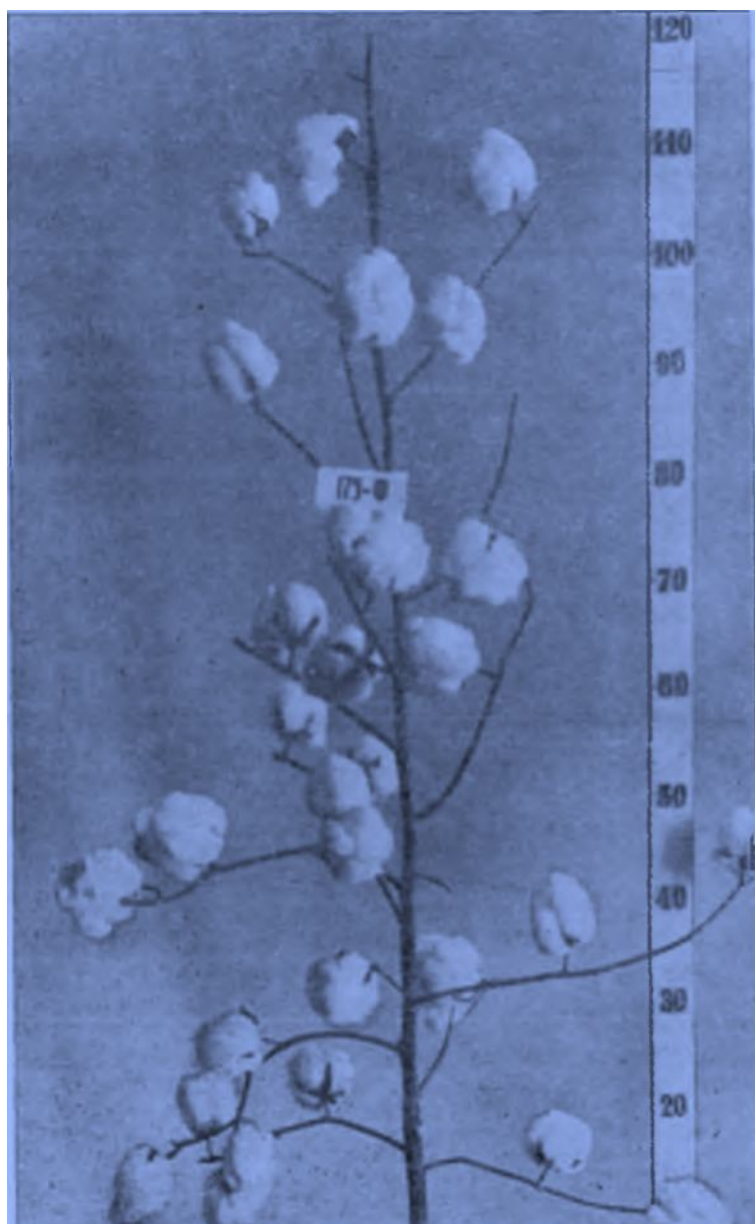


Photo 12.. 175-F cotton variety.

This variety was created using a more complicated hybridization method [(156-F x 2795) x (L-204 x 06422)]. It is a middle-ripening variety, with the weight of one boll equating to 5.2-5.6 g. resistant to wilt. Fiber output: 33-34%, length of fiber: 35-36 mm, relative rupture power: 26.4–27.9 gktex. Textile fiber indexes correspond to the IVth type.

Samarkand-3 was developed by the breeders O. Jalilov, D.M. Babaev, and N. Asriyan through hybridization of varieties (108-F x AN-401). This variety was introduced into production in 1981. One boll weighs 5.5 g, with a fiber output of 36-37. The fiber length and rupture length are 34-35 mm and 4.7 g, respectively.

Hereinafter, the varieties of An-Bayaut-2 (photo 13), C-6524, Bukhar-6, Akdariya 6, and others were developed. In particular, these varieties have occupied more than 60% of the cotton plantations in the republic.



Photo 13.. Cotton variety An-Bayaut-2

The An-Bayaut-2 variety was developed by the breeders S.S. Sadikov and others at the Uzbek Academy of Science, SRI of Plant Experimental Biology, through the selection method of changed forms from the variety Tashkent-1. It was included in the State Register in 1983. The precocity is 114–118 days. The plant architecture has a height of 90–100 cm, with a pyramid shape. Branching belongs to the 1-2 type. The stem is strong, middle-haired, and not prone to lodging. The leaves are medium-sized and middle-haired; the first fruiting wood emerges from the 5th to 6th node.

The bolls have 4-5 capsules. The weight of raw cotton per boll consisted of 4.5–6.4 g. 1000 seeds have 120 g. The fiber output is 34.7–35.5% and the fiber quality refers to the fifth type: mironire-4.5–4.9; UHML-1.07–1.11 inch; code-34–36; relative rupture length–27.6-30.4 gtex.

This variety has some advantages in the soil-climatic conditions of the Djizzakh, Navoiy, Syrdarya, and Tashkent regions of the republic, and therefore it has been recommended to grow in these regions.

Cotton variety S-6524 (photo 14). V.A. Avtonomov and others are the authors of this variety.



Photo 14. *Cotton variety S-6524.*

It was developed through the method of hybridization between variety 159-F and a semi-wild *G. hirsutum* ssp. *punctatum* sample at the SRI of cotton breeding and seed production. It has been included in the state register since 1988. It takes 125 days to get ripe.

It has a canopy like conus, with branching referring to 1-2 types, and a height that attains 100-110 cm. The main stock is strong and not prone to lodging. The leaves are medium-sized; the first fruiting branch appears on the 5–6 nodes.

The bolls have 4-5 capcules. The weight of the raw cotton from one ball is 5.5–6.5 g, the weight of 1000 seeds is 125–135 g, and the fiber output is 33.5–34.5%. The quality of the fiber belongs to the IVth textile type: microcire -4.3-4.6; UHML-1.12-1.15-inch, code-33-35; relative rupture strength-27.7gtex.

Another cotton variety, Yuldus, developed by the breeder O.J. Jalilov at the SRI of experimental biology of plants of the republic of Uzbekistan, was registered in the state register in 1989 to cultivate in the republics of Karakalpak and Bukhara, Kashkadaria, Surkhandaria, Syrdaria, and Khorazm regions.

Cotton variety Bukhara-6 (photo 15). A.M. Batalov and M. Barakaev are the authors of this variety.

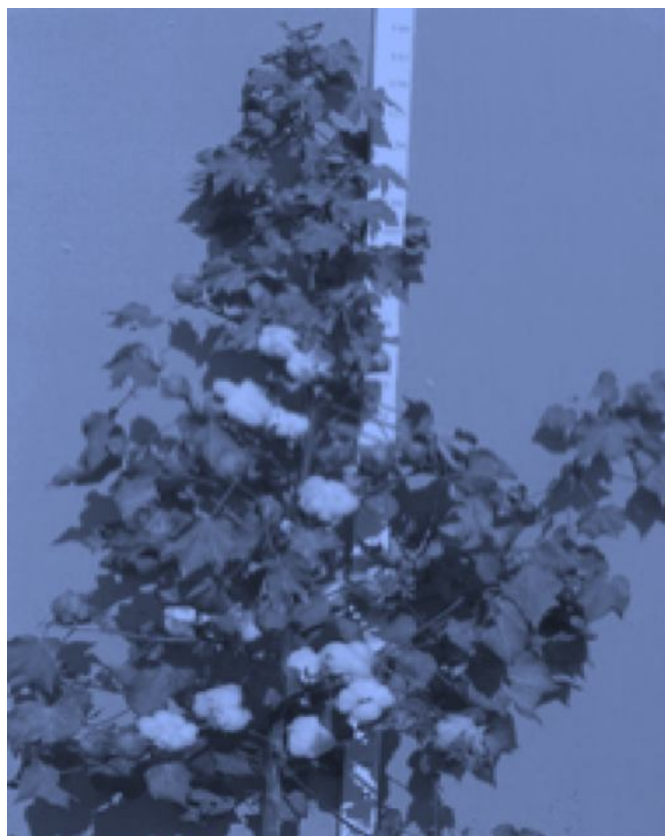


Photo 15. *Cotton variety Bukhara-6.*

This variety was created by the method of interspecies hybridization (Tashkent-1, *G. hirsutum* L. and 9647-I, *G. barbadense* L.) at the Bukhara branch of the Uzbek SRI of cotton growing. It was included in the State Register in 1990. Its age is equivalent to 119–127 days.

The canopy of the plant has a pyramid shape, the branching refers to 1-2 types, and the height of the main stem attains 80–110 cm. The stems are strong and not subjected to lodging. The leaves are medium-sized, and the first fruiting wood sets on the 5th or 6th node.

The bolls have 4-5 capcules. The weight of raw cotton taken from one cotton boll weighs 5.9–7.4 g., the weight of 1000 seeds is equal to 122-123 g., and the fiber output is 35.5–36.3%. The fiber quality belongs to the Vth type: micronire-4.2–4.6; UHML-1.09–1.13-inch, code-33–35, and relative rupture strength of 25.6-32 gtex.

This variety was recommended for growing in the regions of Bukhara, Kashkadaria, Navoiy, and Surkhandaria.

In 1990, another variety, S-9070, was registered to be cultivated in the regions of Bukhara, Jizzakh, Navoiy, Samarkand, and Syrdarya of the republic. P.V. Popov and others were its authors.

The variety S-6530 was registered in 1993 to grow in the regions of Kashkadaria, Namangan, Samarkand, Surkhandaria, Tashkent, and Ferghana regions of the republic. Its authors were V.A. Avtonomov and others. It was the SRI Cotton breeding and seed production variety.

In 1994 was registered another cotton variety, the more famous Namanghan-77 (photo 16). Vad.A. Avtonomov, M. Saidakhmedov, A. Shermatov, and A.E. Egamberdiev were the authors of this variety.

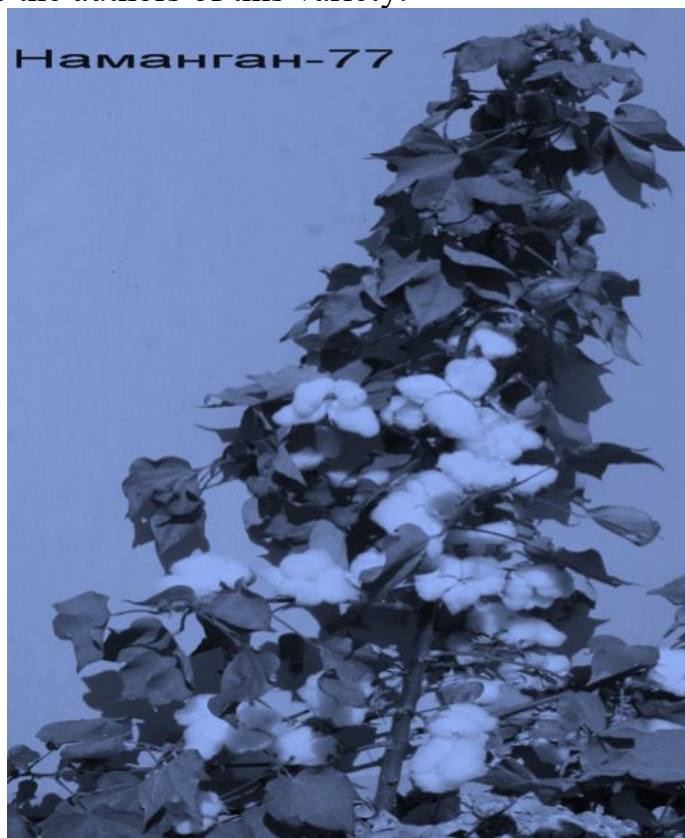


Photo 16. *Cotton variety Namanghan-77.*

Selection of an individual desirable plant from natural pollinated plants of the variety S-6526 was applied in the Kizilrabot experimental farm of the Uzbek SRI of Cotton Breeding and Seed Production to develop the new variety. This new variety was included in the state register in 1994. Its precocity consists of 120-124 days. Canopy has conus shape, branching refers to 1-2 type, the height attains up to 100-110 cm. The stem is strong, middle haired, and not prone to lodging. The leaves are medium sized, middle haired. The first fruiting wood sets on the 5th or 6th node.

weight of raw cotton from one boll made of 4,5–6,4 g, weight of 1000 seeds – 100–110 g, fiber output-37.2–38.9%, quality of fiber refers to fifth type, UHML-1.08–1.12-inch, code-35–36, relative fiber rupture strength of 26.5–30.7 gtex.

In 1997, another more famous cotton variety, Omad (photo 17) was entered into the state register.



Photo17.. Cotton variety Omad.

The authors of this variety were R.G.Kim and others. It was developed on the basis of collection number 02 at the Uzbek SRI of cotton breeding and seed production. Precocity is made up of 110-123 days. The canopy has a shape like a pyramid, branched into the types of 1–2, with a height of 70–90 cm. The stem is strong, straight standing.

The leaves are medium-sized; the first fruiting wood is set on the fifth node.

The bolls have 4-5 capsules, the weight of raw cotton per boll is 6-7 g, 1000 seeds weigh 130-135 g. The fiber output is 37,2-38,9%. The fiber quality belongs to the fifth textile type: micronire -4.3-4.5, UHML-1.07-1.15-inch, relative rupture strength -26.2-32.4 g\text.

The yield index was achieved at 55-60 percent after developing early maturing varieties Namanghan-77, Omad, Andijan-35, and Namanghan-34. This means that raw cotton accounts for 55-60% of total biological mass, whereas earlier developed varieties such as 108-F, 175-F, and Tashkent varieties have yield indices of no more than 40-45 percent.

Since 2000, more than 20 new varieties of *G.hirsutum* L. have been created by our breeders and successfully introduced into production to meet the farmers' and industry's demands.

Cotton variety Akdariya-6 has been included in the State register in 2000 to cultivate in the regions of Karakalpak republic, Andijan, Namanghan, Navoiy and Samarkand regions. Khorezm-127 was included in State register in 2002; Andijan-35 in 2005; Bukhara-102 and Mekhnat in 2006; Chimbay-5018 and Bukhara-8 in 2007; Khorazim -150, S-6541 and Namanghan-34 in 2009; Beshkakhramon in 2010; Sultan and Dustlik-2 in 2011; Kupaysin and Gulbakhar in 2012; Jarkurgan, Navbakhar-2 and S-6775 in 2013; S-8284, Parloq-1 and Parloq-2 in 2014 and the varieties S-6550, Namanghan-102 in 2015 and others.

According to the decree of the Cabinet Ministry dated December 22nd, 2018 under number 1037 on the distribution of cotton varieties for the cotton crop year of 2019, there were 15 registered and 4 perspective cotton varieties with a total sowing area of 1 033.6 hectares. On the basis of the the share of planted area, the more leading varieties were Sultan-184.1; Bukhara-102 -92.7; Andijan-35 -57.8; Namanghan-77 -54.1 and An-Bayaut-2 -47.8 thousand hectares.

Sultan, Bukhara-102 and Andijan-35 are exceptionally new varieties developed after 2000.

Sultan (photo 18). This variety was developed at the SRI of Cotton Breeding and Seed Production by the breeders of Sh.E. Namazov and others. The method of complicated interspecies hybridization F5 (*F1G. thurberi* Tod. X *G. raimondii* Ulbr.) x Acala sj-5 selection was used during its breeding process. Since 2011, it has been registered in the state register. Precocity is equivalent to 115–120 days.

The architecture of the plants is conus shaped, branching (first type), and the plant height is 130-140 cm.

The leaves are finger-shaped and medium in size, with the first fruiting wood appearing on the 6th and 7th nodes. The stem and leaves have less hairiness, are strong and not prone to lodging. The bolls: the weight of raw cotton per one boll is 6.0–6.5 g., 1000 seed weighs 130–135 g., and fiber output is 34–35%. The qualities of fiber refer to the fifth type: micronire 4.5-4.6; UHML-1.12-1.15 inch; relative rupture strength of 26.4gtex.

Cotton variety Bukhara-102. This variety is the result of hybridization of the variety Bukhara-6 with [(1-4380 -7097)] by the breeders S.I. Maksudov, B.O. Muslim, and E. Mavliyanov in the Bukhara branch of the Uzbek SRI of cotton growing. The breeding process was prolonged with continuously directed selections on the traits of hybrid populations. Precocity lasts 115-124 days.

Plant architecture consists of a pyramid shape, branching refers to 1-2 types, and height attains 100-110 cm. The stem is strong, middle haired, and not liable to lodging.

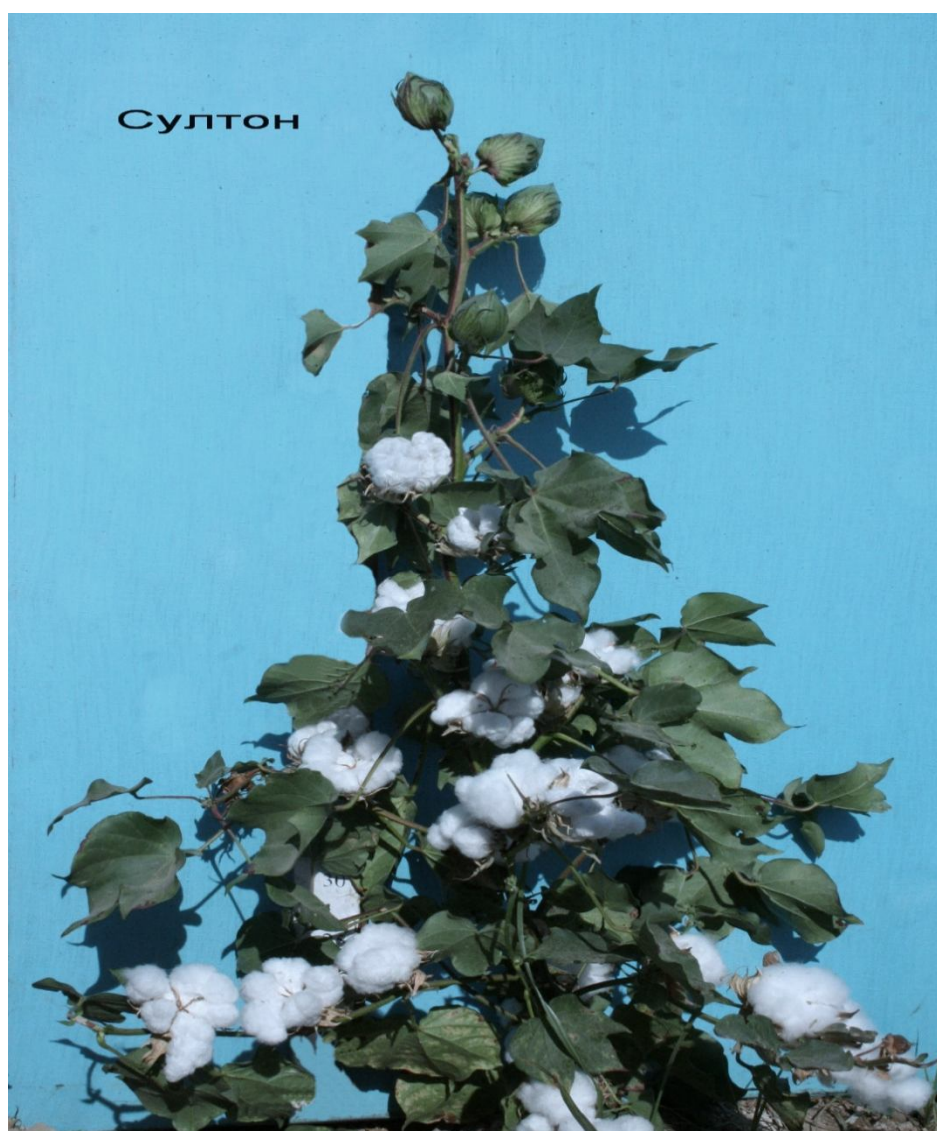


Photo 18. Cotton variety Sultan.

The leaves are medium sized, middle haired; the first fruiting branch appears from the 5th to 6th node. The bolls: weight of one boll is 7.4 g., weight of 1000 seeds consist of 123-130 g., fiber output -36.8%, fiber quality corresponds to fourth textile type: micronire -4.3-4.4; UNHL-1.08-1.12-inch, code -34.1; relative rupture strength -26.5 g\text.

Andijan-35. The authors of this variety are T. Komilov and others. It was developed at the Andijan branch of the SRI of cotton growing. Pair hybrids of [(An-402 x Line of-90th), (Mustelinum x Andijan-13)] were the initial material for developing of this new cotton variety. It was included in the State Register in 2005. Precocity is made up of 122-125 days. The plant architecture is similar to a cylinder shape, with branching likes 2nd type, and the height attains 100-110 cm. The stem is strong and not liable to lodging. The leaves are medium sized, and the first fruiting branch sets on the 6-7th node. The bolls have 4-5 sections, weight of raw cotton from one boll makes of 6,0-6,2 g., weight of 1000 seeds equals to 119-125 g., fiber output-36.0-37.0%. The quality of the fiber corresponds to the fifth

type: micronaire-4.7; UHML-1.08-1.12 inch; code-33.5-34.5; relative rupture strength-28.6 g\text.

Today, our cotton breeders at the mapping out of breeding works, by taking into account climatic conditions pay a special attention not only to high productivity but also to fiber quality enhancing, increasing resistance to salinity, diseases and pests, extremely high temperatures and either a lot of attention is to pay the enhancing of tolerance to soil moisture deficiency. This related to the fact that, agriculture of the republic is based on irrigation. Here, 90 percent of agricultural products and cotton fiber either are getting from watered lands.

Moreover, since 1992, Uzbekistan has become a member of the ICAC (International Cotton Advisory Committee). This predicts that the newly released cotton varieties have to be created in coordination with international market demands and to meet both internal and external quality standards.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “History of G.hirsutum”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Navrotskiy			
2	Variety 8517			
3	108-F			
4	S-4727			
5	Tashkent-1, 175-F, ...			

Chapter 4. History of development of *G. barbadense* L. varieties in Uzbekistan.

The catalog (a list and characteristics) for all cotton varieties was created by our cotton breeders from 1913 to 2012 in the republic. It was published periodically (the 3rd issue in 2012). According to this catalog, 586 of *G. hirsutum* L. and 81 of *G. barbadense* L. varieties (scientifically called as "middle staple" and "fine staple" cotton varieties) have been released. The varieties of 70 middle staples and 18 fine staples were successfully zoned into production to be cultivated in different regions of the republic.

Primarily, batches of imported seeds of *G. barbadense* L. from Egypt in 1871 were sown in the frontier areas of Tashkent in the former Turkistan. But the fiber and seeds were not mature in the conditions of Tashkent, and the experiments were discontinued.

In 1912–1914, the Egyptian variety Afify was grown on the farm "Malik" in the Fergana valley on approximately 300 hectares. The crops consisted of 0.4-0.6 tons per hectare.

The tests on the study of fine staple cotton were conducted in 1910 by M. Bushiev in the Golodnostep experimental field. But the results of these experiments were also not successful, and future attempts at its cultivation were delayed until the 1930s. The main reasons for the failure of these experiments were concluded to be the occasional choosing of experimental plots and the use of non-accumulated seeds for local soil-climatic conditions.

The epoch of the 1926–1930s was known for its all-national industrialization plans, and the state had initiated to expand cotton plantations and provide the growing light industry with native, high-quality raw materials, including cotton fiber.

Scout cultivation of the imported seeds from Egypt was revived in the fields of the neighboring republics of Tajikistan, Turkmenistan, Turkistan and the Caucasus. In the beginning, the cultivation of this cotton plant was implemented through the sowing of seedlings in 1929-1930; their plantations have been grown up to 5 thousand hectares. Apart from this, the seed reproduction of Pima and Maarad varieties was continued. The peasants of collective farms in the Fergana valley and Surkhandaria region of Uzbekistan also had an initiation to accustom themselves to cultivating this crop. So, the collective farms named after Bauman in the district of Kuva and Voroshilov in the district of Fergana harvested 1.6 tons of raw cotton per hectare in 1933. More surprisingly, the yields obtained in the Fergana valley were higher than those in the Surkhandaria region.

With the aim of creating a high-quality seed material, the net of elite-seed production farms in the former Soviet cotton growing republics was organized in 1933. This measurement secured the taking of high-quality seeds even in 1935 and 1936. As a result, the grade index of fine staple cotton plantations has reached to 95-98%.

A.I. Avtonomov was the first scientist, who studied the *G. barbadense* L. diversities in the territories of Uzbekistan. He began to engage (1924-1926) at the Turkistan cotton breeding station (later called SRI of Cotton Breeding and Seed Production, named after G.S. Zhaitzev) with fine staple cotton breeding and continued up to 1933. His research results enabled him to release a wide range of fine staple cotton varieties, including Maarad (1938), 35-1, 35-2, (1939), (photo 19, 20), 2836, 2850, 10964, S-6002, S-6022, and others, which were planted to significant areas in various regions of Uzbekistan at various times in cotton growing history.

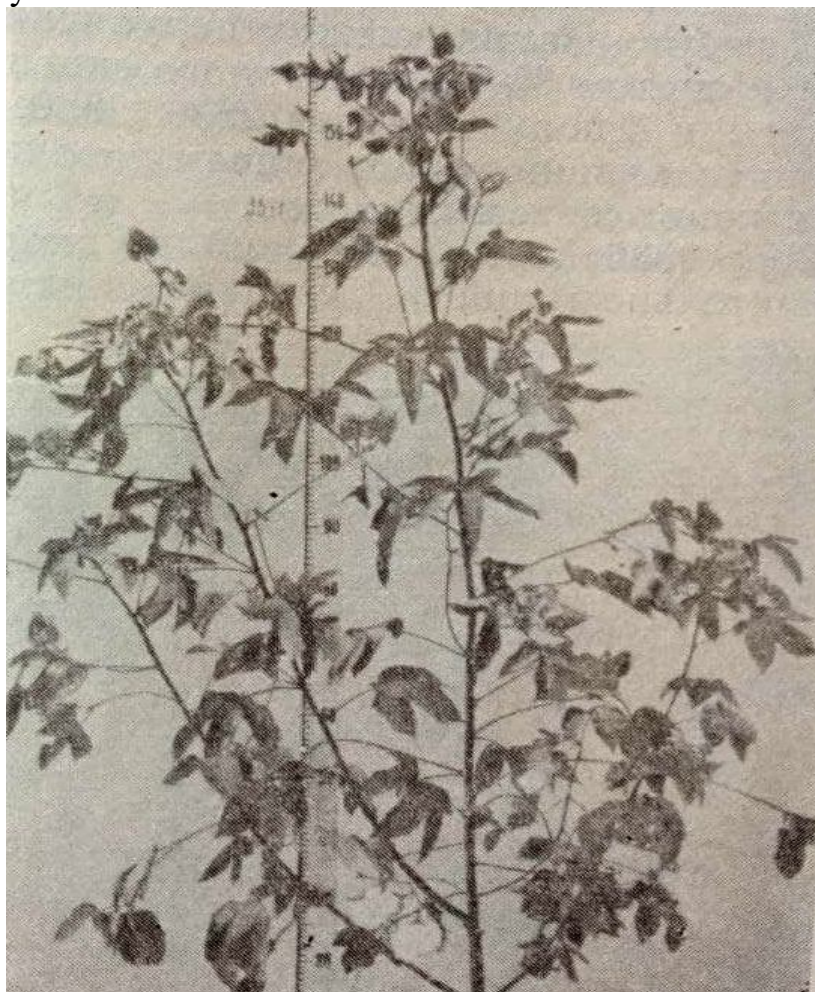


Photo 19. Fine staple cotton variety 35-1.

Late ripening, original Egypt varieties planted primarily in Asian soil-climatic conditions were often exposed to splitting their genotypes into different offspring plant genotypes. The plantation of these plants could be valuable to breeders as it could provide the background to select an ancestor plant with desirable traits that breeders would like to see. So, A.I. Avtonomov gave a chance to select a plant in 1931 within the plantation of the original Ashmuny, which gave the start to developing the new, locally adaptable fine-staple cotton varieties.

L.A. Turks (1951y.) conducted plant breeding studies on fine staple cotton varieties at the Fergana experimental station (later the Andijan branch of the Sous

NIKHI). She developed a series of varieties like 123-F and 155-F. Later, the work on the development of fine staple cotton varieties was discontinued.

Variety 35-1 has a friable, strongly spread bush with 120–160 cm of height. In the spring, the stem is thin, stable, not lodging, naked, and strongly sunburnt. In the autumn, up to two vegetative woods are developed. Fruit-bearing woods have the longer first between-node lengths of the fourth type. The rest of the internodes are more short, naked, and in the autumn get sunburnt; additional fruiting branches appear on the 6th through 8th shoots.

The leaves are three to five lobbed, leathery, dark-greened, and naked; the main lobe of the leaf is triangular and prolonged. The flower is enlarged, the petals are lemon-yellow with a raspberry spot on the base, the pollen is yellow, and the bracts are medium-sized with not more than nine to eleven thin, sharp teeth.



Photo 20. *Fine staple cotton variety 35-2.*

The bolls are small-sized, 2.8-3.2 g., circle-cone imaged with a slightly prolonged bow, usually with three locules – seldom with four locked bolls. The seeds are small, almost naked, with weak downy ends. The weight of 1000 seeds are 120-130 g.

Fiber has a weak creamy color and a length of 35–37 mm. Fiber output is 32–34.0%; rupture strength of fiber is 5.5–5.9g; metric number is 5500–5900; rupture length is 31.0–35.0 km.

The variety 35-1 was strongly affected by the disease of fusarium wilt. To replace it, a disease-resistant variety, 35-2, has been zoned. Its reproduction began in 1936 in the state farm "Kizil Ravat" on an area of 0.7 hectares, and in 1937, its

reproduction continued in the state farm "Surkhan" on an area of 16 hectares. The rate of reproduction was very high, and in 1940, its plantation grew by more than 5.5 thousand hectares. Its origin, precocity, productivity, and main morphological characteristics were similar to the variety of 35-1. It is distinguished from it by the higher technological qualities of its fiber: length of 40-41 mm, metric number 7200-7400, rupture strength 4.9-5.3 g, rupture length 35-36 km. Fiber output was 3.0% less on average than 35-1 and 35-2. It was planted in large areas of Uzbekistan and neighboring republics between 1942 and 1946.

In the above mentioned periods of history, A.I. Avtonomov has evolved the varieties of 2836 (photo 21), 2850, 10964, S-6002, and others through the method of remote hybridization between samples 0876 (Peru cotton) and 35-1 variety and repeated crossing with fine staple cotton 2 and 3 varieties (variety driven from Egypt variety Yanovich in Turkmenistan).

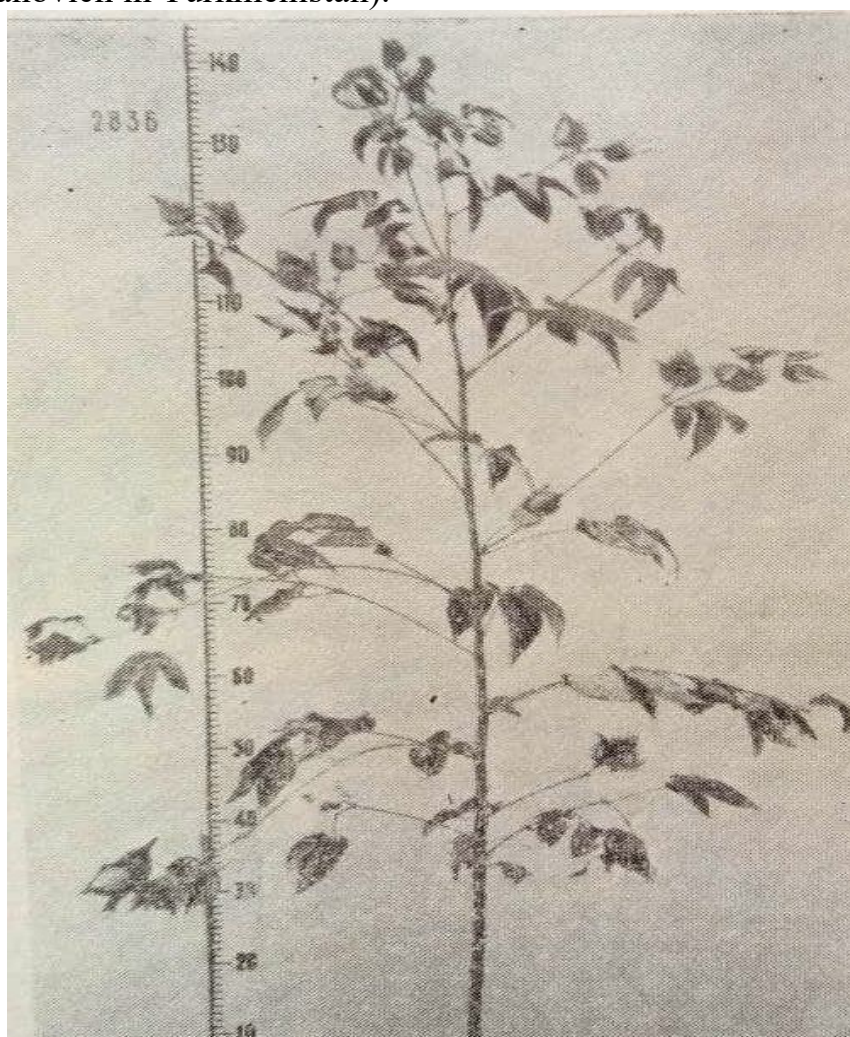


Photo 21. Fine staple cotton variety 2836.

Fine staple cotton 2836 is closely related to the variety 35-1 in precocity. The bush is comparatively powerful, with a middle spread and a height of 120–140 cm. The setting of leaves is mean. The stem is strong, stable, and almost naked. From the autumn when it gets strongly sunburnt, the fruiting woods are long and naked, getting off from the main stem at an obtuse angle; the ends of the woods are

hanging. From the end of autumn when it becomes dark red, the length of the first between nodes is 20–25 cm, and usually is more than 2–2.5 times longer than successive between node lengths; appendage fruiting organs are set usually out of 6–10 sympodials.

The leaves are enlarged, 3–5 lobbed, dark-green, and naked; the main lobe is lancet-shaped; the flower is also enlarged; the petals are lemon-yellow with a raspberry spot on the base; pollen is yellow; and the bracts are medium-sized with 11–13 teeth.

The boll is enlarged with a cone-oval outlook and has 3–4 locules with a long nose. The surface is slightly uneven with clearly observable glands; the glumes of the boll are well split open at the mature time. The weight of raw cotton per one boll is equal to 4.0–4.5 g. The seeds are large, bald, with light-grey and slightly green fuzz. The weight of 1000 seeds is 140–155g.

The fiber is a little creamy with 35–37 mm of length, fiber output of 33–34.0%; rupture strength of 4.9–5.2 g; metric number -6200–6500; rupture length of 31–34 km. The variety 2836 was one of the more commercialized varieties of this species of cotton. The variety was zoned in 1946.

The variety was highly resistant to fusarium wilt. It was cultivated in a comparatively small area (up to 25 thousand hectares) in Uzbekistan in the 1942–1948 period.

Cotton 2850 is a fine staple cotton variety. The origin, precocity, and main morphological characteristics were similar to the variety 2836. distinguished from 2836 by its increased productivity and textile quality, which has 2 mm longer fiber, but fiber output was less by 1%. It was also grown in the 1942–1948s on an area that extended up to 20 thousand hectares annually.

10964 has a wide range. The bush of this variety is friable, spreads at a height of 120–140 cm. The stem is stable, it does not fall, naked and strongly sunburnt at the end of autumn. One or two fruiting woods are longer and refer to the 4th type, naked, and at the end of autumn they get sunburnt. Additional fruiting branches are set on the 5–7th simpodies.

The leaves are medium sized, three-lobbed, dark green, and naked. The main lobe of the leaf is three-angled and long. The flower is medium sized. The petals are lemon-yellow with a raspberry spot on the base; the pollen is yellow; and the bracts are medium sized with a few teeth.

The bolls are enlarged, cone-oval shapes with 3–4 glumes, with a large nose gland available with 3.8–4.2 g. The seeds are middle-sized, bald, and have two types of seed fuzz: grey and slightly green. The weight of 1000 seeds is 130–140 g.

The fiber has a light creamy color and has a length of 37–39 mm; fiber output of 32–33%; fiber strength of 4.8–5.0 g; metric number of 6800–7300; rupture length of 33–35 km.

This variety was highly resistant to fusarium wilt, microporous and black root rot. It was commercialized in 1946 and occupied the main parts of the area in the Surkhandaria region in the years of 1947–1955.

The variety of S-6002. The bush of this variety has a low height (up to 0.9-1.0 m) and is compact and round-shaped.

The stem is stable, isn't lodged, naked, and at the end of autumn gets a few sunburns; the fruiting wood is naked, green, and the second type of branching, at the end of autumn, turns into weak antosian sunburn.

The leaves are 3-5 lobed, light greenish, and naked. The flower is large, the petals are lemon-yellow with an antosian spot on the base, the pollen is orange-yellow, and the bracts are small with 11-13 teeth.

The bolls are medium-sized, egg-prolonged shapes with 3-4 glumes, with a large nose and glands that weigh 3.6-4.0 g. The seeds are bald in the middle; the seed fuzz is light-grey with a greenish tint. The weight of 1000 seeds are 120-130 g.

The fiber has a white color and is 38-40 mm in length. Its output is 33-34%; fiber strength is 4.8-5.2 g; metric number is 7200-7500; rupture length is 35-36 km.

The vegetation period of this variety consists of 156 days, and it is highly resistant to fusarium wilt, but considerably prone to microporous at the high rate of soil moisture. As a consequence of this, the variety has been cultivated in the elevated southern areas of the Surkhandaria region since 1958.

Fine staple cotton variety S-6030 (photo 22). This variety was released by the breeders Yu.P. Khutornoy, Sh.I. Ibragimov, and A.A. Abtonomov.

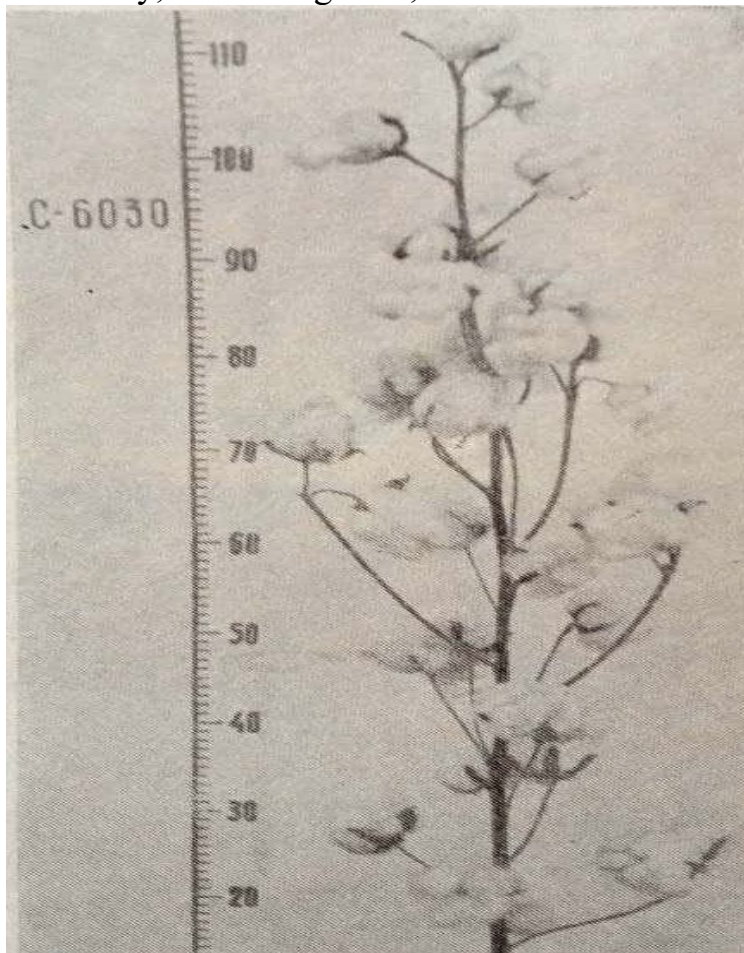


Photo 22.. Fine staple cotton variety S-6030.

The methods of inter-variety crossing (S-6002 x S-6015) and directed individual selection were used in the breeding process. The variety was exceptionally early-ripening. Its bushes were like cones shaped with a height of 110-120 cm. Branch setting refers to zero type. The stem was stable; it didn't lodge, naked, and at the end of the fall, it turned slightly sunburnt.

The leaves are 3–5 lobbed, light-green, naked, and fleshy. The flower is large, the petals lightly lemon-yellow with an antosian spot on the base. The pollen is orange-yellow, and the bracts are large with 13–15 teeth. The bolls are large, egg-prolonged shapes, with 3–4 locules with a nose and gland available, weighing 3.8–4.2 g. The seeds are medium in size and have a blade-like seed fuzz that is light brown in color of 1000 seeds is 125–135 g.

The fiber is white, 39-41 mm; fiber output: 29-31%; fiber strength: 4.6-4.8 g; metric number: 8000-8300; rupture length: 37-38 km.

This variety was resistant to fusarium and verticillium wilts, but considerably susceptible to the leaf form of microporous.

Since 1971, the variety has been zoned to Surkhandaria, Karshi, Fergana, Andijan, and Namangan.

In successive years, fine staple cotton varieties such as S-6037, Karshi-8, T-24, Termiz-31, Surkhan-9, Surkhan-14, and others were developed and registered.

Their characteristics are given in the table 3.

In the meantime, cotton plantations in the republic have considerably decreased in connection with reforms implemented in the country since the 1990s, in particular in agriculture. The reductions in the cotton areas in 1990, 2002, 2015, and 2018 result in: 1832.6, 1387.9, 1298.0, and 1170.0 thousand hectares. Owing to these changes, the former area of fine staple cotton in the republic decreased significantly in 1995 and left 50.3 thousand hectares under the varieties Katshi-8 (6.7), Ash-25 (3.8) and T-24 (40.1) in the regions of Kashkadaria and Surkhandaria. In the 2001 crop year, these indexes decreased even more (22.5) and consisted of only 20.4 on the varieties Termiz-31 and Karshi-8, 2.1 thousand hectares in those regions.

The 8.9% of all produced cotton fiber in the republic in 2015 was involved in the 4th textile type, and the rest, 16.1%, refers to the 5th textile type. Fine-stripped cotton varieties which give the best I-III textile fibers were not grown at all.

But, since 2020, according to the correspondence of the resolution of the Ministers' Chamber of the Republic dated January 30, 2020, "About the introduction of mechanisms of stimulation of effective organization in the production of fine staple cotton and increasing new varieties," Uzbekistan has resumed cultivation of fine staple cotton varieties on an area of 50.5 thousand hectares.

The varieties of fine staple cotton created in the last decades of cotton breeding and listed in the table clearly exhibit that our breeders could release world-compatible varieties. It was possible to produce a high yield in the southern regions of Uzbekistan with the fiber meeting the first three textile types. And they

are valuable resources with tremendous potential to promote the contemporary development of cotton growing in the republic.

Review questions:

1. What do you know about the cotton plant?
2. Can you describe the origin of cultivating species of cotton plant?
3. Do products of the cotton plant have economic importance in the lives of people in our republic? If yes, how?
4. What was the growth of the cotton plant in the pre-historic period?
5. Does cotton plant differ in its species?
6. In general, what does it mean by cotton species?
7. Can you distinguish the genus from the species?

Table 3. Economical and textile characteristics of fine staple cotton varieties registered (1977-2009) for planting in Uzbekistan.

Cotton varieties	Authors	Method of breeding	Year of register	Vegetation period,	Weight of raw cotton per boll, g.	Length of fiber, mm.	Fiber output, %.	Fiber strength, g.	Metric number.	Rupture length, km.	Textile type
S-6037	Yu.P.Khutornoy and others.	(S-6022xS-6015)	1977	141	4.1	40-42	30-32	4.8	7900	38.0	I-II
Karshi-8,	A.R.Tyaminov	ML-112, ML =(ML-104 x ML-107)ML-107 = (ML-101 x7318-V)	1992	134	3.5	33.3	39.2	5.1	7150	36.2	III
Surkhan-8	M.I.Iksanov, M.Ashurov, Kh.Khusanov	[S-6041 x Ash-25]	1993	133	3.2	38.9	31.2	5.1	7630	38.9	I
T-24	E.G.Gavrilov and others	9647-Ix (9647-I x T-7)	1995	140	2.8	33.0	39.7	4.7	7390	36.2	III
Surkhan-10	M.I.Iksanov, M.Ashurov, Kh.Khusanov.	[S-6041 x Ash-25]	1996	127	3.7	38-40	33.5	4.5	7700-8700	35-36.0	I
Termiz-31,	A.A.Tvorogova and others.	(6608-V x Termez-11)	1998	115	3.2	34.2	38.5	4.8	6950	33.3	III
Surkhan-12	M.I.Iksanov, M.Ashurov, Kh.Khusanov.	[S-6037 x Ash-68]	1999	135	3.2	39.3	35.7	4.9	7600	37.2	I
Surkhan-14	M.Iksanov and others.	Ash-53 x Karshinskiy-6	2003	122-124	3.6-4.0	1.30	37.6	Mic 3.6	Cod 40-42	40.5	Ib
Surkhan-9,	Vad.Avtonomov and Vik.Avtonomov	(ML-101 x 07630)	2004	119-121	3.3-3.5	34-34.5	37.7-37.5	4.5	7500	33.7	II
Termez-202	Kh.Chorieva and others.	[Karshinskiy-8 x 7603]	2007	114	3.4	36.2	38.5	4.3	7610	30.3	III

Part II. Classification of cotton plant.

Chapter 1. Genus *Gossypium*, origin and classification of cotton.

It is widely known that all existing diversities of cotton involving wild and domesticated species belong to the genus of *Gossypium* in the family Malvaceae. About 50 species are widely known in the sciences, and new species of *Gossypium* continue to be discovered (Simongulyan N.G. et al., 1987). The major direction of evolution in the species was the reduction of the life cycle, related to the changing of surface stock organs of plants, simplification of branching types, and conversion of trees into small herbaceous perennials and domesticated shrub types. Primary reduction of the life cycle of the plant has happened in connection with reclaimed practices in the regions of tropical zones. The shrubs, as natural plant forms, are mostly more resilient to xerophyte conditions than the trees. For the last thousand years, the huge diversities of forms—from ephemeron, extraordinary early to comparatively late ripening have been established as the movement of plants to more cold zones of moderate climate, where they mature for one vegetation period. Truly wide cotton forms present themselves as the strictly short day forms; reducing of the life cycle accompanied with harsh weakening of photoperiodic reaction.

Cotton plant evolution must be considered as a whole process, as the result of the combined effect of natural and artificial selections implemented by man, beginning in ancient times (15–30 thousand years ago), initially unconsciously and then as a systematic process of plant adaptation to man's needs.

The transformation of the cotton plant into an annual crop plant under the influence of natural and artificial selections has suddenly increased the seed productivity, the areas of domesticated species have extended and it has been profitable as the biological prosperities of the species increase and so in the point view of economic values of plants. The cotton plant transformed into a precious agricultural crop.

Currently, wild-perennial cotton and ancient forms have been preserved in Mexico, Brazil, Peru, Sudan, Tanzania, and other tropical and subtropical countries. Genus *Gossypium* unites enlarged number of wild and domestic species, meeting in different extents of relationship.

Archaeological records show that *Gossypium* fiber has been used since 6000 BC. C.W. A *Gossypium* thread, used to string copper beads, from Mehrgarh in Pakistan has been dated to the 6th millennium BC (Moulherat et al., 2002). It is unknown whether this is from a domesticated cotton species, but it suggests that cotton fiber was known and used at this time.

On the basis of discoveries implemented by different scientists and relevant experts, we can now know about the origin of domesticated species of cotton. For example, the geographic center of origin for *G. hirsutum* is North and Central America and Mexico, and for *G. barbadense*, it is South America. In the meantime, *G. hirsutum* was probably first domesticated by pre-Columbian people of the

Yucatan peninsula. These early semi-domesticated forms dispersed into the rest of Mesoamerica as well as northern South America and into the Caribbean.

According to the analysis of W.H. Kidir (2019) of the literature about the genus of *Gossypium*, the place of its origin was not known, but west-central and southern Mexico (18 species), north-east Africa and Arabin (14-species), and Australia (17-species) are confirmed as the primary centers of cotton diversity involved in this genus. The majority of the species originated in the third period from tropical and subtropical regions of the old (Africa and Asia) and new worlds (American continent countries) 5-10 million years ago.

Selection occurred on the side of that people for reduced seed dormancy, an annualized growth habit of plants, and photoperiod independent flowering, resulting in genotypes more similar to modern cotton cultivars. Interestingly, modern North American *G. hirsutum* has very limited genetic diversity compared to ancient cotton, thought to be due to a genetic bottleneck resulting from the artificial selection pressure of domestication. This is hypothesized to partly result from the Kekchi Indians of Guatemala intercropping cotton with capsicums and harvesting the cotton as soon as the first bolls developed to prevent competition with the capsicums, thus resulting in rigorous selection by men for early maturity along with reduced seed dormancy and annual growth. A doubling of seed size occurred as well, resulting in a threefold increase in lint index (g. lint/100 seeds) and an 80% increase in mean fiber length during domestication (photo 23). This increased fiber length has been achieved by a prolonging of the fiber elongation period and a greater growth rate early in fiber development in modern cultivars compared to wild *G. Hirsutum* (Kidir W. H., 2019).

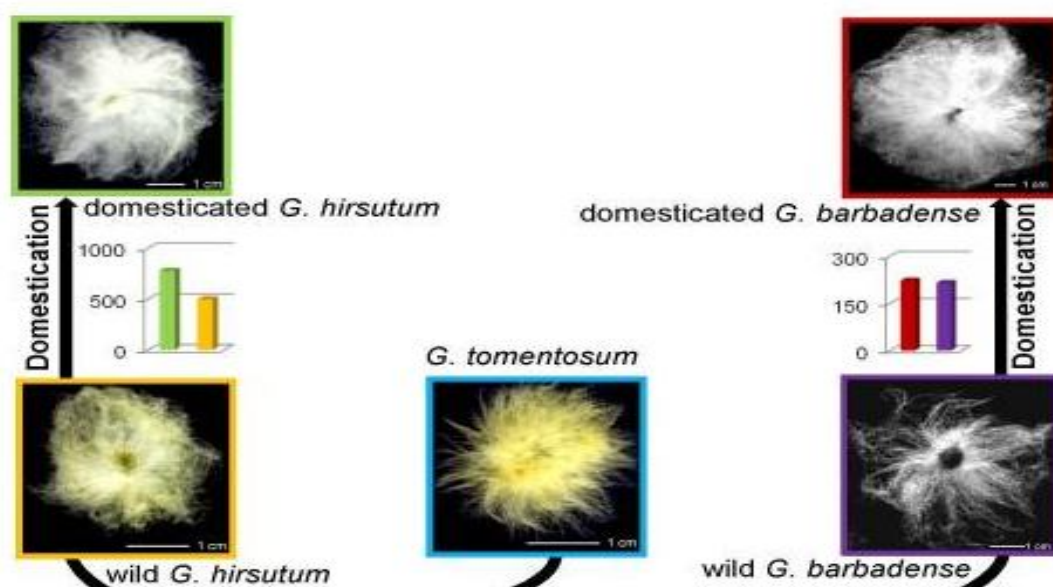


Photo 23.. Cotton fiber length changes at a glance during domestication.

Gossypium has remained in the form of cloth, string, assorted bits of fiber and boll fragments and was found in different layers of soil in caves in the Tehuacan valley in Mexico (Smith Jr. and MacNeish, 1964). Analysis of relevant experts proved their rise from tetraploid *Gossypium*, with the earliest bolls dating

from approximately 5800 BC. Stephens and Moseley (1973) believed that archaeological remains of scrapes of fabrics and cords, unprocessed fibers formed into plugs, and cotton boll segments from a site in Peru are the earliest forms of domesticated *G. barbadense*. Smith (1995) supposes that cotton was probably used as wadding, packing or for dressing wounds prior to being used by the ancient inhabitants for spinning into yarn. Moreover, these findings indicate a trend of increasing seed size and fiber diameter from the earlier (2500 BC) to later (1000 BC) levels.

Consequently, the knowledge about genus classification, worked out by the account of species' cytogenetical and morphological features, their ecological-geographic distribution, and phylogenies, has important significance for plant breeding, widely using the method of hybridization between different species and ecologically remote forms.

The first information about the classification of cotton refers to XVII-XVIII centers. The famous classifier K. Linney in 1763 described five species of cotton, including four domesticated species: *G. hirsutum* L., *G. barbadense* L., *G. arboreum* L., *G. herbaceum* L.

In XVIII and in the second half of XIX century with the classification engaged Rohr J.Ph.B. (1791), Parlatore F. (1866) and Todaro Aug. (1877), and in XX century – Alliota A. (1903), Gammie G.A. (1907), Watt G. (1907-1927), Leak H.M., Prazad R. (1914), Zaytsev G.S. (1928), Harland S.C. (1939), Hutchinson J.B. (1945, 1947), Mauer, F.M. (1954), Brubaker C.L. et al. (1999), Abdullaev A.A. and others.

Classification proposed by the first authors, can be named artificial, so the morphological traits were used as the quality of systematic indexes which do not have any serious evolutionary importance.

For example, J.Ph.B. Rohr has systematized cotton on the characteristics of seed fuzzy. J. Watt also systemized the cotton species on the basis of such traits as the existence of fuzzy on the seeds, the character of bracts, the expression of flower nectars, and the forms of leaf lobes. That is why such far-distant species like *G. sturtii* from Australia, *G. barbadense* ssp. *Darvinii* from America, *G. stocksii* from Africa, and *G. tomentosum* from Hawaii were referred to in one section by G. Watt. The closer they form as ssp. *Peruvianum*, the ss. *Vitifolium* turns out to be in different sections. H.M. Leak and R. Prazad suggested that the long existence of above land organs and the type of branching are the main principles in cotton systematics and have divided all species into monopodials and simpodials. Now, it is perfectly clear that within one species, there can be available perennial forms and the forms of annual cotton crops with monopodial, simpodial, and zero-type branching. For example, the species of *G. barbadense* involves subspecies of three types (ss. *Vitifolium*), simpodial type (ssp. *Eubarbadense*) – varieties 10964, S-6002, and others, and zero types – varieties S-6030, S-6037, and others.

As a result, the morphological method could not be used to build natural classifications of cotton species without taking into account historical, geographic,

and cytogenetic factors. The new stage in the development of cotton systematics has been related to the progress of cytogenetic research on remote hybridization and the creation of world collections, which enabled study of cotton not on herbarium materials but on alive samples.

Even in the 1970s in the territory of Uzbekistan, the world collections numbered over 4000 samples, which were created by the force of the All Union Institute of Plant Growing (AUIPG)—as a result of expeditions by Vavilov, Zhukovskiy, Uzeychuk, Bukasov and others. N.I. Vavilov deserves special recognition for his expedition to Ethiopia, Afghanistan, northern China, and Mexico, where he collected valuable samples of African, Asian, and American cotton. In particular, in the 1930s, he introduced the seeds of cotton *Acala* from America and Mexico, and the Mexican people's breeding represented itself as a complicated population of biotypes. They have given rise to the majority of Soviet and American cotton varieties over the years.

The first large-scale research on the study of world collection has reached its extension in foreign countries—at the Trinidad station in the USA, India, Africa and other regions of cotton growing. On the basis of this research, they worked out the system of cotton classification in the genus of *Gossypium*. This research has resulted in the creation of the next classification proposed by S.C. Harland (1939), which was based on the chromosome number of different species. He divided the cotton into two sections depending on the chromosome number: $2n = 52$ and $2n = 26$. And further, his division was related to the geographic principle as well as morphological and physiological principles. As it was considered by the most systematic scientists, S.C. Harland has revalued the role of cytological differences—in one section, all wild diploid species from all continents occurred. He also revalued the role of photoperiodic reaction and overall plant architecture, as much as (осколку) one species may be presented by the forms that are sharply distinct in these traits. This also confirms the natural character of the classification created by G.S. Zaytsev.

F. Jonathan, Wendal and E. Corrinne Grover (2005) have either highly emphasized that the cotton taxonomy and classification (appendixes 2 and 3) of the genus *Gossypium* has been well studied by J.H. Saunders (1961), P.A. Fryxell (1979, 1997), T.A. Seelanan et al., (1997), R.C. Cronn et al., (2002). Meanwhile, the classification composed by P.A. Fryxell is considered the most modern and widely followed. In this treatment, species are grouped into four subgenera and eight sections (table 4).

Table 4. Diversity and geographic distribution of the major lineages of *Gossypium*. Genomic placements and taxonomic status of species enclosed by parentheses are yet to be validated by cytogenetic and other means.

Genome (no. of species)	Recognized species	Geographic distribution
A (2)	<i>G. arboreum</i> , <i>G. herbaceum</i>	Africa, Asia
B (3–4)	<i>G. anomalum</i> , <i>G. triphyllum</i> , <i>G. capitis-viridis</i> , (<i>G. trifurcatum</i>)	Africa, Cape Verde Islands
C (2)	<i>G. sturtianum</i> , <i>G. robinsonii</i>	Australia
D (13–14)	<i>G. thurberi</i> , <i>G. armourianum</i> , <i>G. harknessii</i> , <i>G. davidsonii</i> , <i>G. klotzschianum</i> , <i>G. aridum</i> , <i>G. raimondii</i> , <i>G. gossypoides</i> , <i>G. lobatum</i> , <i>G. trilobum</i> , <i>G. laxum</i> , <i>G. turneri</i> , <i>G. schwendimanii</i> , (<i>Gossypium</i> sp. nov.)	primarily Mexico, with range extensions into Peru, Galapagos Islands, Arizona
E (5–9)	<i>G. stocksii</i> Mast., <i>G. somalense</i> (Gurke) J.B. Hutch., <i>G. areysianum</i> Deflers, <i>G. incanum</i> (O. Schwartz) Hillc., <i>G. trifurcatum</i> , (<i>G. benadirensis</i>), (<i>G. bricchettii</i>), (<i>G. vollesenii</i> Fryxell), (<i>G. trifurcatum</i>)	Arabian Peninsula, Northeast Africa, Southwest Asia
F (1)	<i>G. longicalyx</i>	East Africa
G (3)	<i>G. bickii</i> , <i>G. australe</i> , <i>G. nelsonii</i>	Australia
K (12)	<i>G. anapoides</i> , <i>G. costulatum</i> , <i>G. cunninghamii</i> , <i>G. enthyale</i> Fryxell et al., <i>G. exiguum</i> Fryxell et al., <i>G. londonderriense</i> Fryxell et al., <i>G. marchantii</i> , <i>G. nobile</i> Fryxell et al., <i>G. pilosum</i> Fryxell, <i>G. populifolium</i> (Benth.) F. Muell. ex Tod., <i>G. pulchellum</i> (C.A. Gardner) Fryxell, <i>G. rotundifolium</i> Fryxell et al.	Northwest Australia, Cobourg Peninsula, Northern Territory, Australia
AD (7)	<i>G. hirsutum</i> , <i>G. barbadense</i> , <i>G. tomentosum</i> , <i>G. mustelinum</i> , <i>G. darwinii</i> , <i>G. ekmanianum</i> , <i>Gossypium</i> sp. nov.†	New World tropics and subtropics, including Hawaii, the Wake Atoll, and the Galapagos Islands

† J.F. Wendel, C.E. Grover, J. Jareczek, and J.P. Gallagher, unpublished data, 2014.

Recently by Kidir W. H. (2019) informed that cotton is a woody perennial shrub and taxonomically categorized within the family Malvaceae and genus *Gossypium*. Family Malvaceae comprises about 100 genera and 1500 species split across two ploidy levels (Brubaker et al., 1999), 45 - diploids ($2n=2x=26$) and at least five allo-tetraploids - ($2n=4x=52$), whose aggregate geographic ranges encompasses most tropical and subtropical regions of the world.

Chapter 2. Cotton plant classification developed by G.S. Zhaytsev.

As far back as the 1920s, the Soviet wild and domesticated cotton collections had been significantly enriched. For the first time, the Soviet cytologist A.G. Nikolaeva (1922–1923) was able to count the number of chromosomes in the cultivating cotton species and identified that New World domesticated cotton species have a diploid number of chromosomes of $2n = 52$ and Old World species have a diploid number of $2n = 26$. This and other relevant achievements gathered in the sciences of cotton cytology, genetics, and physiology have caused a sharp change in the idea of the phylogenetic relationship of cottons.

G.S. Zaytzev, the founder of Uzbek cotton growing and working in the Turkistan plant breeding station, developed the first natural classification of the genus *Gossypium* based on these discoveries. In the 1925-1928s, G.S. Zaytsev published his cotton classification scheme (figure 1). In his "classification"

Botanic cotton classification of G.S. Zaytsev

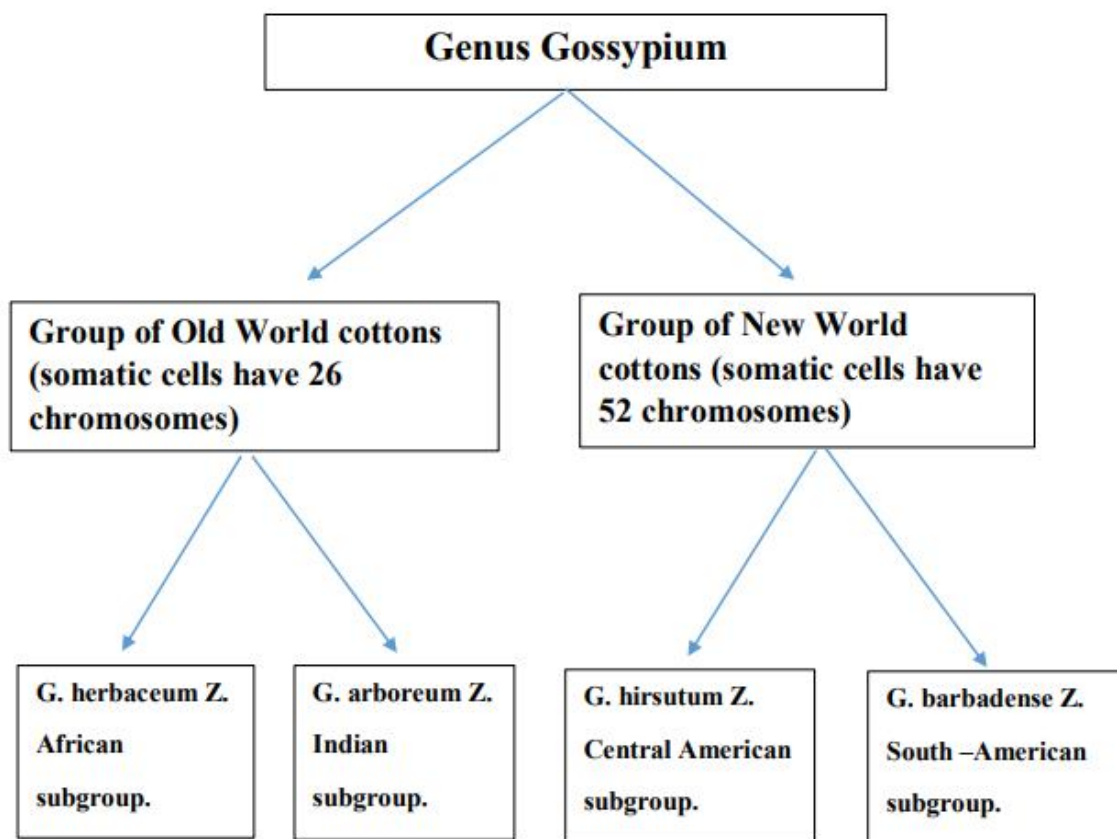


Figure 1. Two main groups of *Gossypium*.

For the first time, in his "classification" of the genus *Gossypium*, G.S. Zaytsev clearly differentiated the domesticated cotton species into two main groups: Old World and New World, which, first of all, are differentiated on the number of chromosomes. Furthermore, the Old World cottons are divided into two subgroups: *G. herbaceum* and *G. arboreum*, which originated in Africa and India, and the New World cottons—*G. hirsutum* and *G. barbadense*, which originated in

Central and South America, respectively. Division of the Old World cottons was the special merit of G.S. Zaytsev, because no systematic scientist before him had been able to do it. He discovered that these groups were distinguished not only by morphologic but also by physiological characteristics.

At the same time, G.S. Zaytsev, by thoroughly studying morphology and biology of development, has carried out since 1923, the great works on hybridization picked out by him groups and identified that the crossings between the old world groups and new world cottons occur easily, the progenies are fertile, but the furious splitting by appearing feeble, freak forms in the future generations, which has evidenced the genetic and physiological exclusivity of these groups.

He defined the extent of physiological exclusivity of main groups and subgroups for the first time in clear and critical forms, and in particular, he identified that "subgroups" of the Old World are distinguished almost as deeply as "subgroups" of the New World. Aside from that, he could correct some significant errors made by his forefathers – F. Parlatore, G.A. Gammie, and G. Watt. He has exposed the essence and reason of those mistakes and pointed out the artificial character of G. Watt's classification, which had been built by the use of one-sided and incorrect morphologic criteria.

Thus, the main items dealt with and enlightened by G.S. Zaytsev are:

1. He clearly categorized domesticated cotton into two major groups: old and new world. Though, this demarcation had been fixed earlier, the full clarity of this item had not been (Mauer F. 1954). Contrarily, other points of view have been widely disseminated in the literature, admitting, namely: *G. hirsutum*, *G. punctatum*, *G. microcarpum*, and others are from the old world (Watt G., 1907; and others).

2. In the same way, he has clearly separated cotton from the old world into two independent subgroups, and the exclusive primary area or elementary inhabited region for each of them has been established: *G. arboreum* – in Asia and *G. herbaceum* – in Africa.

The separation of domesticated Old World cotton species, undoubtedly, as mentioned above, is a great merit of G.S. Zaytsev. Before him, the full demarcation of them had not been turned out by anyone: neither F. Parlatore (1866), nor Aug. Todaro (1877), G.A. Gammie (1907) nor G. Watt (1907-1927). Because of the availability of a large number of *G. arboreum* forms, they resemble *G. herbaceum* forms morphologically.

Regarding Zaytsev's investigations apart from the great similarity, the forms of the first subgroup can be distinguished from those of the second subgroup along the series of resistant features, as well as by the numerous smaller characteristic morphologic traits. In particular, he has finally set the large diagnostic significance of the character of the boll surface-smooth and small pit occurrence (photo 24) for the difference between herbaceum species from arboreum as well as *hirsutum* from *barbadense*.



Photo 24. Cotton bolls with their surface characteristics.

G.S. Zaytsev, simultaneously with thoroughly studying the morphology of species, with the participation of Belova A.I., Podyapolskogo S.P. and other colleagues. Beginning in 1923, there were a number of experiments on the hybridization of various forms of four cultivating species of cotton. The result of this research has shown that, independently of the rate of morphologic similarity of the parental forms, the hybrids *herbaceum* x *arboreum*, as well as hybrids *hirsutum* x *barbadense*, in the first offspring are powerful and fertile, but in the successive progenies they will produce extremely diverse forms on the rate of fertility, as well as various new formations, defects, and other appearances characteristic of the remote interspecific hybrids. So, the identified morphological criteria by him were verified experimentally with regard to the physiological side.

3. He established that the species of *G. herbaceum* originated in Africa, and the species of *G. arboreum* originated in Asia, whereas it was previously accepted that all cottons of the Old World originated in Asia. Also, despite of the clarity and incontestability of the new situation set by G.S. Zaytsev, until nowadays, it was not recognized by some foreign scientists. J.B. Hutchinson (1945), for example, attempts to defend the old point of view, though even G. Watt, in one of his later works (1926), was forced to express a supposition about which – all cottons of the Old World originated not from Asia, but from Africa. Although this supposition was expressed by G. Watt more uncertainly and in this form that is as much a misinterpretation as his old point of view.

Cultivating cottons of the New World have also been divided by G.S. Zaytsev into two subgroups: Central American and Southern American, and he determined their primary areas, as well as gave them clear morphological criteria for their division.

Regarding the opinion of F. Mauer (1954), the issue of the origin, distribution, and classification of these cottons was strongly confused by Aug. Todaro (1877) and G. Watt (1907-1927). They divide this cotton into a series of

non-existent "species" and assign these "species" to various artificial "sections" of their own system.

G.S. Zaytsev does not have time to deepen his studies of world cotton diversities and has not created the unfolded classification. His final work (1928) was only a preliminary report on some existing results of his cotton systematic research.

Some critical errors were found in G.S. Zaytsev's researches, which were caused by incorrect theoretical views on the one hand and a lack of relevant studies on cotton diversities on the other.

One of his errors was the exception of a wild species group, which made up the first section of the system of G. Watt called "non-genuine cottons" from the genus *Gossypium*.

As emphasized by N.G. Simongulyan et al. (1987), G.S. Zaytsev was not able to give an unfolded classification, because cotton world diversities had not been studied by him. As a consequence of this, he excluded all the wild species from the *Gossypium* genus. But, in spite of this, the classification of G.S. Zaytsev was the first natural cotton classification recognized throughout the world.

The research on the cyto-genetics of interspecies hybridization and continuation in the biological development of world collection samples has been started in successive years, which has facilitated working out the new, more complete systems of cotton classification.

Table of Insertion of the Pedagogical Technology

The rule of filling in the table of insertion. They themselves systematized the information acquired during the study – "they insert" in the columns of the table according to the marks noted in the text:

"V" – relevant to the information that I knew;

"-" - contrary to the information I know;

"+" - new information for me;

"?" - it is not clear to me or information needs to be clarified.

V	+	-	?

Chapter 3. Cotton classification created by J.B. Hutchinson.

Working out the new, more perfect systems of cotton classification has been made possible as a result of consistent studies on the cytogenetics of interspecies hybrids and the biology of the development of the world cotton collections.

As mentioned above, the classification suggested by J.B. Hutchinson (1939; 1949) was based mainly on the number of chromosomes and, consequently, cotton was divided by him into two sections: $2n = 52$ and $2n = 26$ (figure.). And further, the principles of geography, morphology and physiology were also taken into his consideration.

In spite of many scientists who worked out their classifications, the classification of J.B. Hutchinson, R.A. Sillow, and S.G. Stephencs published in 1947, was the most successful, widely followed, and gained worldwide recognition.

In this classification, the genus *Gossypium* is divided into 8 classes according to their regions of growth and cytogenetic relationships. The first class involves wild diploid Australian cottons, *G. sturtii* and *G. robinsonii*. The most widely distributed species of *G. sturtii* is an inhabitant of the Australian deserts.

Diploid American cotton refers to the second, third, and fourth classes. Integration into classes has been based on the rate of genetic relationships and the regions of inhabitation. The sections are distinguished by morphological characteristics such as stem pubescence, leaf and bract shape, and fruiting branch type. *G. aridum*, *G. armourianum*, and *G. harknesi* are involved in this class. These species have naked stems, intact leaves, falling bracts at the time of maturity, and reduced fruit branches. They are found in southern California and Mexico.

Kolotzschanum, *G. davidsonii*, and *G. raimondii* were taken to the third section. These plants are characterized by naked stems, intact leaves, and tooth bracts. They are found in Mexico, Peru, and the Galapagos Islands.

G. thurberii and *G. gossypoides* were taken to the fourth class. The deeper split leaves, weakened pubescence of the stem, and intact bracts are characteristic of these species. *G. thurberii* is the most widely distributed, and it grows in the valleys of Arizona and northern Mexico.

Wild diploid cotton of the African and Asian continents is involved in the classes five and six. *G. anomalum* is the most widely spread. It is a xerophyte that lives in south-western Africa, including the Sahara, Sudan, and Somalia, where it is a common forage for camels. This section includes *G. triphyllum* and *G. ayresianum* species.

The cottons of the sixth section are spread across the deserts of Arabia, Sudan, and Tanzania. *G. stoksii* has a genetic isolate species which is the typical representative of this section and hardly crosses with other cottons as well as with *G. somalense*.

Cultivating species of *G. herbaceum* and *G. arboreum* of the African and Asian continents were taken by J.B. Hutchinson to the seventh class. All the above listed cottons have a double set of chromosomes equal to $2n = 26$.

Tetraploid cotton containing 52 chromosomes in the somatic cells was taken to the class eight. This class involves three species: *G. tomentosum* (endemic to the Hawaii archipelago) and two cultivating species—*G. hirsutum* and *G. arboreum*—with diversities.

According to the conclusions reached by N.G. Simongulyan et al. (1987), J.B. Hutchinson, prior to his classification, discussed the question of the origin of tetraploid cotton in detail. So, A. Skovsted (1937), for the first time, explained that half of the chromosomes of the tetraploid cotton is homology to the chromosomes of the Old World diploids and the other half is homology to the genome of New World diploids. The difference is especially observable in the size of chromosomes and is confirmed by the chromosome conjugation character in the hybrids F_1 from crossings of tetraploids with Old World and New World diploids.

J.O. Beasley (1942) created the first artificial allopolyploid through the doubling of the chromosome set of sterile *G. arboreum* x *G. thurberii*. This artificial allopolyploid was used for such things as cultivating New World cotton. These findings have earned their place as the foundation for the theory of allopolyploid origins of cultivating American species.

S.G. Stephens (1944), on the basis of genetic research of progenies from the crosses of tetraploid species with various American diploids has identified that wild Peru diploid *G. raimondii* has a closer relationship with cultivating tetraploid species than *G. thurberii* or any other American wild species.

J.B. Hutchinson, in the consequences of his analysis on the crossings between two world cottons and their progenies' behavior and in the point view of phylogenetic relationships of Old World diploid species, he supposed that species *G. herbaceum* was the grandparent of tetraploids as being more ancient than *G. arboreum*. J.B. Hutchinson hypothesized that species *G. herbaceum* was introduced by African aborigines via the Pacific Ocean to the western shores of America, in the district of Peru, where wild species *G. raimondii* grows. Natural crossings and spontaneous doubling of the chromosome number are what gave the initiation to the grand parent of the modern tetraploid species. The expedition of Tura Higherdala approved the possibility of contact between American and African aborigines by using papyrus vessels across the Pacific Ocean, which has suggested a hypothesis about the seeds introduced in America by men, which is entirely real.

The classification of the genus *Gossypium* was a result of a group work which has been elaborated and written by J.B. Hutchinson. The author divided the genus *Gossypium* as mentioned above into eight classes:

Wild species of cotton

Wild Australian species

Class I. *Sturtiana*

1. *G. Sturtii* F. Mull.
2. *G. Robinsonii* F. Mull

Wild species of New World

Class II. *Erioxyla*

Wild species of Southern California and Pacific Ocean shores of Mexico.

3. *G. aridum* (Rose et Standl.) Skovsted
4. *G. Armourianum* Kearney
5. *G. Harknessii* Brandg.

Class III. **KlotZschiana**

Wild species of Western Mexico, Galapagos Islands and Peru.

6. *G. Klotzschianum* Anderss.
- 6b. *G. Klotzschianum* var. *Davidsonii* (Kell.) J.B. Hutch.
7. *G. Raimondii* Ulbr.

Class IV. **Thurberana**

Wild species of Arizona and Mexico

8. *G. Thurberi* Tod.
 9. *G. trilobum* (DC) Kearney
 10. *G. gossypioides* (Ulbr.) Standl.
- Wild species of Old World

Class V. **Anomala**

Wild species of South –west of Africa, Sahara, Eritrea, Somali and Southern Arabia

11. *G. triphyllum* (Harv.) Hochr.
12. *G. anamalum* Wawra et Peyr.
13. *G. areysianum* Defl.

Section VI. **Stocksiana**

14. *G. Stocksii* Mast.
15. *G. somalense* (Gurke) J.B. Hutch.

Cultivating species of cotton

Class VII. **Herbacea**

13 – chromosomes species

In the wild and cultivated states everywhere in tropics and subtropics of the Old World

16. *G. arboreum* L.
17. *G. herbaceum* L.
- 17b. *G. herbaceum* var. *africanum* (Watt) J.B. Hutch. Et Ghose
- 17c. *G. herbaceum* var. *acerifolium* (Guill. Et Perr.) Chevalier

Class VIII. **Hirsuta**

The wild and cultivated states of New World, introduced into all cotton growing countries of the world.

18. *G. tomentosum* Nutt. Ex Watt
- 19a. *G. hirsutum* L.
- 19b. *G. hirsutum* var. *punctatum* (Schum. Et Thonn.) J.B. Hutch.
- 19c. *G. hirsutum* var. *Mari-Galante* (Watt.) J.B. Hutch.
- 20a. *G. barbadense* L.
- 20b. *G. barbadense* var. *brasiliense* Raf.

20c. *G. barbadense* var. *Darwinii* (Watt) J.B. Hutch.

In total, the system of J.B. Hutchinson has 20 species and seven diversities (F. Maur, 1954).

This attempt by J.B. Hutchinson was to find the most correct classification of the genus *Gossypium* and although it attained some achievements, all the same, it does not correspond to modern knowledge in the sphere of evolution and cotton systematics.

Review questions:

1. What is the age of cotton plant growing?
2. In what countries can be found the first forms of the cotton plant?
3. What role had cotton fiber played in the development of the first cultivated cottons in the world?
4. Does classification of cotton effect on the cotton breeding?
5. Do you know the names of the scientists who were engaged to compose the cotton classification?
6. What is the genome of the cotton plant and its kinds?
7. Has our country played any role in the formation of the local cotton varieties?

Chapter 4. **Cotton classification composed by F.M. Mauer.**

A cotton classification organized by Soviet botanist F.M. Mauer was published in 1954. This classification was based on the study of an enriched world cotton collection brought together at the All Union Institute of Plant Growing and presented in the stations of the Azerbaijan Institute for the Scientific Research of Cotton and SousNIKhl. The analyses of results on the crossing potentials of species, the character of F₁ development, the rate of their fertility, as well as cytological research on the morphology and sizes of cotton chromosomes, It is recognized by a wide range of experts from cotton-growing countries around the world as the most perfected cotton classification after the classification of G.S. Zaytsev (1928). His classification is either based on experiments to study the living plants. These experiments soon showed him and his colleagues that the expelled species by G.S. Zaytsev, but one *G. Kirkii* Mast, undoubtedly belong to the *Gossypium* genus, otherwise they are genuine cottons. He proved that this error by G.S. Zaytsev had prevented him in his time from correctly interpreting the course of cotton evolution and correctly understanding its ecological nature. It was the most perfect and detailed system of classification in its time.

F.M. Mauer has concluded that the division of cultivating cotton species by G.S. Zaytsev was both incorrect and systematic. Because he considered that there were two polyploidy subgroups in the New World that were parallel to two diploid subgroups in the Old World. The similarity of these subgroups was distinguished by him with the availability of some important common traits (pits on surface, shape and locule numbers of boll, and sharp, color of leaves and others), on the one hand in the Indo-China and Southern American subgroups, and on the other hand, in the African and Middle American subgroups. Further research showed that this morphological similarity of the "subgroups" is not an index to any close phylogenetic connections, as the cotton of the old and new worlds were isolated in space and inhabited on different continents for long geological periods.

He also showed that the understanding of G.S. Zaytsev with regard to biologic species had not been defined. In spite of some of his expressions where he underlined the identity of his subgroups with certain species, namely: the African subgroup with species of *G. herbaceum*, Indian-China with *G. arboreum*, Middle American with *G. hirsutum*, and South American with *G. barbadense*. Here, it was obvious that items about species, in particular, what can be considered as a species and how the species are made up in the genus of *Gossypium*, had forced G.S. Zaytsev to stay in difficulties. Consequently, he was limited in his understanding of groups and subgroups. For example, forms of species *G. purpurascens* (*G. tricuspidatum*) on the basis of morphological traits of vegetative organs, G.S. Zaytsev incorrectly included in the Middle-American and South-American subgroups. *G. mustelinum* Miers, from South America, is unquestionably part of the Middle American subgroup, which includes *G. hirsutum*, despite the fact that this species is independent and well separated from the latter.

By mistake, multi-chromosome organisms such as *G. tomentosum* Nutt. (endemic to the Hawaiian Islands) have good crossing with all New World multi-

chromosome forms that were previously excluded from the genus *Gossypium*. In nature, he did not study this cotton and even did not see it. By precise mistake, he excluded the original form of *G. Darwinii* Watt (endemic of the Hawaii Islands) from the genus because it had not been studied by him in the experimental conditions. In the consequences of the study by F. Mauer and his colleagues, it was identified that this is a truly wild form of the species *G. barbadense*.

Furthermore, further research by F. Mauer and his colleagues revealed that the species' make up of the genus and relative treatments amongst cotton species turn out to be considerably more complicated than what G.S. Zaytsev stated. The species composition of the genus has turned out to be incomparably enriched in terms of both the number and the diversities of cultivable and wild species. In the New World, they turned out not only two multi-chromosome species (*G. hirsutum* and *barbadense*) but five: *G. hirsutum* L., *G. tricuspidatum* Lam. (*G. purpurascens* Poir.), *G. barbadense* L., *G. mustelinum* Miers, and *G. tomentosum* Nutt. The first three species are cultivated, and the last two are wild cottons.

There were also found and described several less-chromosomal wild species. Following that, F. Mauer and other scientists identified them as the considerable diversity in the morphological and other biological features of plant species, sharply distinguishing from multi-chromosome ones, frequently crossing easily with them, and the hybrids resulting from these remote crossings are very vigorous and often fruit-bearing.

On the basis of collected data, F. Mauer and others supposed that in the Old World there existed not only two closely related cultivating species but three: African *G. herbaceum* L., Asian *G. arboreum* L., and either an independent (original) Madagascar species, *G. Perrieri* (*G. soudanense* Watt.).

Either it was identified that the cultivating species of the Old World were related more or less to some wild species of the Paleotropic regions, Experimental research on them demonstrates that this is the species of *Gossypium*.

As a result of his study on the cotton groups of endemic Australian species, Mauer came to the conclusion that this group, in spite of their peculiarity and more strongly isolated status, should be included in the genus of *Gossypium*.

So, the conception of F. Mauer on the cotton classification consists of further comprehensive substantiation that the genus *Gossypium* makes up not only four cultivating species, which was limited by G.S. Zaytsev, but about 35 sufficiently substantiated species. Five of them are widely used in agriculture; two can be cultivated but in smaller quantities, and the rest are wild cottons. As a result of that, it was suggested by F. Mauer that the genus *Gossypium* makes up three strongly substantiated groups (subgenus): Paleotropic, Neotropic, and Australian, and each of them includes up to ten or more species. Though he was not in the field of vision mentioned above about the allopolyploidy origin of cultivating species in cotton evolution.

A Classification of the Genus *Gossypium* was made by F.M. Mauer (1954).

Subgenus I. *Eugossypium* Tod. Ampl. Mauer.

Section I. *Indica* Tod. Ampl. Mauer.

Subsection. *Indica* Tod. Em Mauer.

1. *Herbaceum* L.

Subspecies: *africanum* (Watt) Mauer, *pseudoarboreum* Mauer, *frutescens* (Delile) Mauer, *euherbaceum* Mauer.

2. *Arboreum* L.

Subspecies: *obtusifolium* (Roxb.) Mauer, *Perenne* (Blanco) Mauer, *neglectum* (Tod.) Mauer, *nanking* (Meyen) Mauer.

3. *Soudanense* Watt

Subsection: *Gurtiloba* Mauer

4. *Somalense* (Gurke) J.B. Hutch.

5. *Ellenbeckii* (Gurke) Mauer

6. *Bakeri* Watt

Subsection: *Anomala* Tod. em Mauer

7. *Anomalum* Wawra et Peyr.

8. *Capitis – Viridis* Mauer.

9. *Triphyllum* (Harv.) Hochr.

Section II. *Pseudopambak* Prokh. Ampl. Mauer

10. *Stocksii* T. Mast.

11. *Areusianum* Defl.

Subgenus II. *Karpas* Raf. Ampl. Mauer

Section III. *Integrifolia* Tod. Ampl. Mauer

Subsection. *Integrifolia* Tod.

12. *Davidsonii* Kellog

13. *Klotzschianum* Anderss

14. *Raimondii* Ulbr.

Subsection: *Ingenhousia* (Moc. Et Sesse ex DC) Mauer

15. *Trilobum* (Moc. Et Sesse ex DC) Scovsted

Diversity: *arizonicum* Mauer, *emasculatum* Mauer

16. *Aridum* (Roze et Standley) Scovsted

17. *Gossypoides* (Ulbr) Standley

Subsection. *Caducibracteolata* Mauer

18. *Armourianum* Kearney

19. *Harknessii* Brandg.

20. *Californicum* Mauer

Section IV. *Magnibracteolata* Tod. Em. Mauer

21. *G. Hirsutum* L.

Subspecies: *mexicanum* (Tod) Mauer, *punctatum* (Schum. et Thonn.) Mauer, *paniculatum* (Blanco) Mauer, *euirsutum* Mauer

I. Middle Asian group

Subgroups: southern zons, middle zons, northern and submountain zons

II. Cavkasus group

Subgroups: nothern cavkasus; ukrainen

22. *Tricuspidatum* Lam. ex Tussas

Subspecies: *rupestre* (Raf) Mauer, *purpurascens* (Poir) Mauer, *glabrum* (Lam) Mauer

23. *Barbadense* L.

Subspecies: *darwinii* (Watt) Mauer, *ruderae* Mauer, *vitifolium* (Lam.) Mauer, *eubarbadense* Mauer

Subgroups: eastern, western

Azerbaijan group

24. *Mustelinum* Miers ex Watt

25. *Tomentosum* Nutt. ex Seem.

Section V. *Thespesiastra* Tod.

26. *Thespesioides* (Benth.) F. Mull.

27. *Flaviflorum* (F. Mull.) Tod.

Section VI. *Hibiscoidea* Tod.

28. *Sturtii* F. Mull.

29. *Costulatum* Tod.

30. *Cunnighamii* Tod.

31. *Populifolium* (Bengh.) F. Mull.

32. *Timorensis* Prokh.

33. *Australe* F. Mull.

34. *Robinsonii* F. Mull.

35. *Bickii* Prock.

All scientists related to cotton growing in the former Soviet Union followed this classification. The author divided the genus *Gossypium* into 3 subgenus:

Eugossypium, *Karpas*, and *Sturtia*. All Old World cottons belong to the subgenus *Eugossypium* and are united into 2 sections: section *Indica* and section *Pseudopambak*.

Section 1 involves cultivating cottons from the Old World (sections 1 and 2) and African wild species *anomalum* and *soudanense* (sections 3 and 4). The species included in these sections belong to genomes A and B and cross each other rather easily, producing chiefly fertile progeny. *G. stocksii* is genetically differentiated from other afro-asian cottons, making crossing within them very difficult. It was picked out in section 2. In one section with *G. stocksii* (genome E), they united *G. ayresianum*, which is taken to genome B along with the genome system. Further studies into the phenologic relationship between these species are required.

All New World cottons are taken from the second genus, *Karpas*, which has been divided into 2 sections.

All of the wild diploid American species originated in section 3, while the tetraploids originated in section 4. The tetraploid species have been considered in great detail. Mauer picked out three cultivated species instead of two on the

Huchinson: *G. hirsutum*, *G. barbadense*, *G. tricuspidatum*, and two wild species *G. tomentosum* and *G. mustelinum*.

4 subspecies have been selected out in the bound of species *G. hirsutum*:

G. hirsutum L. ssp. *Mexicanum* (Tod) Mayer

- \- ssp. *punctatum* (Shum et Thonn) Mayer

- \- ssp. *paniculatum* (Blanco) Mayer

- \- ssp. *euirsutum* Mayer.

Subspecies *mexicanum* – a truly wild form, growing in South Mexico, in Ukatán, on the islands of Taity and Fidgy. Three diversities: var. *nervosum*, widely used in cotton breeding as a donor to wilt resistance; var. *microcarpum* and vat. *Taitense* belongs to this subspecies. Ruderal and semi-cultural forms are taken from subspecies *punctatum*. Cultivated tropic forms belong to subspecies *paniculatum* from which selected varieties of subspecies *euirsutum* are widely distributed in cotton plantations in both hemispheres. All modern cotton varieties are taken from subspecies *euirsutum*, which presents annual sympodial bushes.

F.M. Mauer also picked out the species *tricuspidatum*, the independence of which is disputed by many systematic scientists. He also involved the wild form *rupestre*, primitive cultivating form *purpurascens*, and cultural tropic form *glabrum* in the species *tricuspidatum*. They were used as annual and perennial cultures.

The species *barbadense* has four subspecies: the wild subspecies *darwinii*, which is represented by primitive cultures and ruderal forms; the subspecies *ruderales*, which is represented by primitive cultures and ruderal forms; the subspecies *ruderales*, which is represented by primitive cultures and ruderal forms; and the subspecies *ruderales*, which is

Highly cultural tropic cottons belong to subspecies *vitifolium*, which gave initiation to the Egypt varieties. Cultural, sympodial, early ripening fine staple cottons taken to subspecies *eubarbadense*. They were subdivided into groups: Sea-Islands (group of West-India), Egypt varieties, American-Egypt varieties (group of Arizona), and Soviet fine staple varieties.

By Mauer eight instead three taken to Australian cotton subspecies *sturtii*. Totally, genus *Gossypium* on the classification of Mauer has included 35 species.

Constantly, the new forms of cotton have been discovered by the scientists and botanists of the world. Their registration in the cotton classification was regularly required. Consequently, after F.M. Mauer (1954) were continued the creation of new cotton classifications and they have been built by J.H. Saunders, (1961), P.A. Friksel (1968, 1979, 1992), R.C. Cron et al. (2002), and others.

Chapter 5. Cotton genome classification by J.H. Saunders.

Although lacking in detail, the classification proposed by J.B. Hutchinson, R.A. Sillow, and S.G. Stephens (1947) is better substantiated cytogenetically and corresponds with the genome system, the basics of which was developed by well-known cytogenetic researchers H. Brown (1936), A. Skovsted (1937), J.O. Beasley (1942), S.G. Stephens (1944), and others. These scientists have conducted multiple crosses between cotton species and studied them with a method of cytogenetic analysis. The consequence of this research was the groups into which the cottons comparatively easily cross each other and produce fertile offspring. Such cottons have close genotypes and make up one genome.

Crossings of species with different genomes can be successful or unsuccessful, and even the progeny can be sterilized. This points out that the genetic individuality of the genomes emerged in the process of adaptive evolution of species in various ecological and geographic conditions.

Like the above mentioned research and other more recent achievements relevant to genome connected crossings among different cottons, they have been promoted to make up the genome classification by J.H. Saunders and published in 1961 (table 5).

Table 5. Genomic classification of genus *Gossypium*.

Species	Genome	Species	Genome	Species	Genome
Asian and African species (n=13)		Australian species (n=13)		New World Cultivating species (n=26)	
<i>G. herbaceum</i>	A ₁	<i>G. sturtii</i>	C ₁	<i>G. hirsutum</i>	(AD) ₁
<i>G. arboreum</i>	A ₂	<i>G. robinsonii</i>	C ₂	<i>G. barbadense</i>	(AD) ₂
<i>G. anomalum</i>	B ₁	<i>G. austral</i>	C ₃		
<i>G. triphyllum</i>	B ₂			Wild species of Hawaii Islands (n=26)	
<i>G. stocksii</i>	E ₁	American species (n=13)		<i>G. tomentosum</i>	(AD) ₃
<i>G. somalense</i>	E ₂	<i>G. thurberii</i>	D ₁		
<i>G. auranum</i>	E ₃	<i>G. armourianum</i>	D ₂₋₁		
<i>G. incanum</i>	E ₄	<i>G. harknessii</i>	D ₂₋₂		
<i>G. longcalyx</i>	E ₅	<i>G. klotzschianum</i> , <i>G. klotzschianum</i>	D _{3-K}		
		var <i>dauidsonii</i>	D ₃		
		<i>G. aridum</i>	D ₄		
		<i>G. raimondii</i>	D ₅		
		<i>G. gossypoides</i>	D ₆		
		<i>G. lobatum</i>	D ₇		

According to the interpretation of N.G. Simongulyan et al. (1987), six genomes: A, B, C, D, E and AD have been brought to light within the bounds of the Genus *Gossypium*.

The table shows that cultivating Old World species like *G. herbaceum* and *G. arboreum* takes genome A.

Wild African cottons of group *anomalum* (section V) taken to genome B.

The Australian species united by Hutchinson into section I has been taken to the genome C.

All wild American diploid cottons of sections II, III and IV are taken to genome D.

Wild African cottons of the group *stocksii* (section VI) were subjected to genome E. This genome is the most isolated from other genomes of the Afro-Asian continent.

Tetraploid species of *G. hirsutum*, *G. barbadense* and *G. tomentosum* belong to the genome AD as far as cytological studies on the tetraploid cottons have shown that in the karyotype, they comprise two sets of chromosomes. The second set of chromosomes is identical in morphology and size to genome A of Old-World cottons and the second set, with genome D, of wild American cottons; the chromosomes of this genome are noticeably smaller.

In the figure 2, have presented the native geographic lands of cotton species, while indicating their correspondent genomes on the system of Saunders. As noted by N.G. Simongulyan and others (1987), they additionally added three new species to the classification of Huthchinson, which were discovered in the 1950s. They are: *G. incanum* from Southern Arabia, *G. longicalyx* from Africa and *G. lobatum* from Mexico.

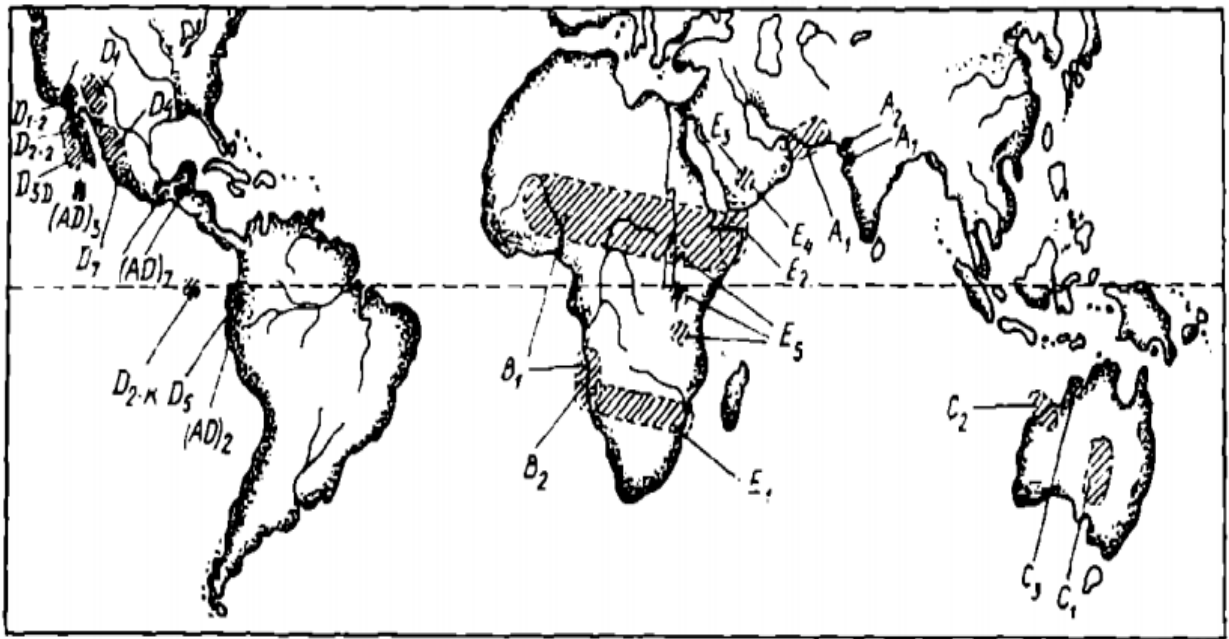


Figure 2. The geographic distribution of species and genomes of the genus *Gossypium*.

Chapter 6. Classification evolved by A.C. Dariev, A.A. Abdullaev.

In more than 100 years of history, botanists have tried to prove the intimacy of the relationship of some species in the tribe Hibisceae Reichenb with the genus of *Gossypium* within this tribe.

A.C. Dariev, A.A. Abdullaev (1985) have supposed that the genus *Gossypium* has the highest number of species (37) in the tribe Gossypieae. According to their suggestion, there were 23 systems (classifications) of genus *Gossypium* developed by the scientists of the world. And on the basis of the latest data concerning all aspects of cotton species study, together with other scientists, they also underlined that the classifications composed by Mauer (1954) and Fryxell (1969b) were historically the more substantiated and completed.

Notwithstanding the intensive research in the genus *Gossypium*, some of the Australian, African-Asian, and American species have not been sufficiently studied. For example, four new species: *G. pilosum*, *G. nelsonii* in Australia, *G. laxum*, and *G. thurneri* in Mexico, were discovered after the last classification.

This circumstance, and the availability of the 23 above mentioned classifications, has initiated A.C. Dariev and A.A. Abdullaev to investigate the morphology and anatomy of seeds, leaves, wood structure of lively forms, geography, as well as the evolution ages of 10 species in the tribes Adansonieae, Hampeae (family Bombacaceae) and 78 species (table 6) of the tribe Hibisceae (family Malvaceae).

Therefore, the wild species are highly valued as the quality of genetic source that is necessary to use in the development of more productive and early maturing cotton varieties. Some of them are resistant to fungal diseases, others to pests, drought, extreme temperatures and cold. For example, *G. armourianum*, *G. thurberi* with reduced bracts is used to develop varieties without bracts, which would contaminate raw cotton at mechanical harvesting in the USA or *G. harknessii* with early falling bracts; *G. trilobum* is applied to evolve varieties with strong fiber. Dr. McCarty (2016) recently discovered a wild gene pool from *G. hirsutum* race stocks that can genetically improve upland cultivar germplasm against nematode. reduction in upland cotton due to nematode infection is substantial and approaches 200 million dollars annually in the U.S.

Table 6. The list of investigated species.

№	Family Bombacaceae Kunth	№	Genus Lebronnecia Fosc.
	Tribe Adansonieae Reichenb	62	<i>Lebronnecia kokioides</i> Fosc.
	Genus <i>Adansonia</i> L.		Genus <i>Gossypioides</i> Skov.
1	<i>Adansonia digitata</i> L.	63	<i>Gossypioides Kirkii</i> (Mast.) Skov.
	Genus <i>Bombax</i> L.		Genus <i>Gossypium</i> L.
2	<i>Bombax costatum</i> Pellegr. Et Vuill		Section <i>Sturtia</i> Tod.
3	<i>B. albidum</i> Cagner	64	<i>Gossypium sturtianum</i> J.H. Willis
	Genus <i>Ceiba</i> Mill.	65	<i>G. robinsonii</i> F. Muell.
4	<i>Ceiba pentandra</i> Gaerth		Section <i>Hibiscoidea</i> Tod.
	Genus <i>Pachira</i> K. Schum.		Subsection <i>Grandicalyx</i> Fryx.
5	<i>Pachira aquatica</i> Aubl.	66	<i>Gossypium populifolium</i> (Benth) F. Muell. ex Tod.

	Genus <i>Chorisia</i> Kunth	67	<i>G. pilosum</i> Fryx.
6	<i>Chorisia insignis</i> HBK		Subsection <i>Hibiscoidea</i>
	Tribe Hampeae Reichenb.	68	<i>Gossypium austral</i> F. Muell.
	Genus <i>Hampea</i> Schlecht.	69	<i>G. bickii</i> Prokh.
7	<i>Hampea integerrima</i> Schlecht.	70	<i>G. nelsonii</i> Fryx.
8	<i>H. nutricia</i> Fryx.		Subgenus <i>Houzingenia</i> Fryx.
9	<i>H. trilobata</i> Standl.		Section <i>Houzingenia</i>
10	<i>H. mexicana</i> Fryx.		Subsection <i>Houzingenia</i>
11	<i>H. sphaerocarpa</i> Fryx.	71	<i>Gossypium trilobum</i> (Moc et Sesse ex DC) Skov.
12	<i>H. platanifolia</i> Standl.	72	<i>G. thurberi</i> Tod
13	<i>H. rovirosa</i> Standl.		Subsection <i>Selera</i> (Ulbr.) Fryx.
	Family <i>Malvaceae</i> Juss.	73	<i>Gossypium gossypioides</i> (Ulbr.) Standl.
	Tribe Hibisceae Reichenb.		Subsection <i>Erioxylum</i> (Rose et Standl.) Fryx.
	Genus <i>Hibiscus</i> L.	74	<i>Gossypium aridum</i> (Rose et Standl.) Skov.
14	<i>Hibiscus greviiifolius</i> Hassk.	75	<i>G. lobatum</i> Gentry
15	<i>H. toruosum</i> Roxb.	76	<i>G. laxum</i> Phill.
16	<i>H. tiliaceus</i> L.		Subsection <i>Caducibracteolata</i> Mauer
17	<i>H. floccoccus</i> Mast.	77	<i>Gossypium armourianum</i> Kearn.
18	<i>H. rosa-sinensis</i> L.	78	<i>G. harknessii</i> Brandg.
19	<i>H. furcatus</i> Wall.		Subsection <i>Integrifolia</i> (Tod.) Tod.
20	<i>H. syriacus</i> L.	79	<i>Gossypium klotzschianum</i> Anderss.
21	<i>H. sterculia</i>	80	<i>G. davidsonii</i> Kell.
22	<i>H. sturtii</i> Hook.		Subsection <i>Austroamericana</i> Fryx.
23	<i>H. coulteri</i> Harv.	81	<i>Gossypium raimondii</i> Ulbr.
24	<i>H. micranthus</i> L.		Subgenus <i>Gossypium</i> .
25	<i>H. pusillus</i> Thunb.		Section <i>Gossypium</i>
26	<i>H. pedunculatus</i> L.		Subsection <i>Gossypium</i>
27	<i>H. ferrugineus</i> Cav.	82	<i>Gossypium herbaceum</i> L. ssp. <i>africanum</i> Mauer
28	<i>H. panduriformis</i> Burm.	83	<i>G. arboreum</i> L. ssp. <i>obtusifolium</i> Mauer
29	<i>H. canescens</i> Heyne		Subsection <i>Anomala</i> Tod.
30	<i>H. splendens</i> Fras. ex Grah	84	<i>Gossypium anamalum</i> Wawta et Peyr.
31	<i>H. laciocarpes</i> Cav.	85	<i>G. barbosanum</i> Phill.
32	<i>H. cucurbitaceus</i> St. Hil.		Subsection <i>Triphylla</i> Prokh.
33	<i>H. heferophyllus</i> Wenty.	86	<i>Gossypium triphyllum</i> (Harv.) Hochr.
34	<i>H. surathensis</i>		Section <i>Pseudopambak</i> Prokh.
35	<i>H. palustris</i> Thore		Subsection <i>Pseudopambak</i> .
36	<i>H. militaris</i> Cav.	87	<i>Gossypium stocksii</i> Mast. ex Hook.
37	<i>H. grandiflora</i> Mienh.	88	<i>G. areysianum</i> Defl.
38	<i>H. trionum</i> L.	89	<i>G. incanum</i> (Schwartz) Hillc.
	Genus <i>Lagunaria</i> G. Don	90	<i>G. somalense</i> (Gurke) Hutch
39	<i>Lagunaria patersonii</i> G. Don		Subsection <i>Longiloba</i> Fryx.
	Genus <i>Julostylis</i> Thwait.	91	<i>Gossypium longicalyx</i> Hutch. et Lee
40	<i>Julostylis angustifolia</i> Thwait.		Subgenus <i>Karpas</i> Rafin
	Genus <i>Dicellostyles</i> Benth.	92	<i>Gossypium tomentosum</i> Nutt ex Seem.
41	<i>Dicellostyles axillaris</i> Benth.	93	<i>G. hirsutum</i> L. ssp. <i>tricuspidatum</i>

	Genus <i>Kydia</i> Roxb.	94	<i>G. darwinii</i> Watt
42	<i>Kydia calycina</i> Roxb.	95	<i>G. barbadense</i> L. ssp. <i>brasiliense</i> Mauer
43	<i>K. jujubifolia</i> Griff.		Genus <i>Cienfuegosia</i> Cav.
44	<i>K. glabrescens</i> Mast.		Subgenus <i>Articulata</i> Fryx.
	Genus <i>Decaschistia</i> Wight et Arn.		Section <i>Articulata</i>
45	<i>Decaschistia trilobata</i> Wight.	96	<i>Cienfuegosia hildebrandtii</i> Garcke
46	<i>D. harmandii</i> Pierre		Section <i>Garckea</i> Fryx.
47	<i>D. crotonifolia</i> Wight et. Arn	97	<i>Cienfuegosia welschii</i> (T. Anderss.) Garcke
	Genus <i>Senra</i> Cav.	98	<i>C. somaliana</i> Fryx.
48	<i>Senra Arabica</i> Webb.	99	<i>C. hearnii</i> Fryx.
49	<i>S. nubica</i> Webb.		Section <i>Dioica</i> Fyx.
50	<i>S. incana</i> Cav.	100	<i>Cienfuegosia heteroclada</i> Sprague
51	<i>S. zoes</i> Volkens et Schweinf.		Subgenus <i>Cienfuegosia</i>
	Genus <i>Thespesia</i> Sol. ex Corr.		Section <i>Cienfuegosia</i>
52	<i>Thespesia grandiflora</i> DC	101	<i>Cienfuegosia</i>
53	<i>Th. Cubensis</i> (Britt. et Willis) Hutch	102	<i>C. jucatanensis</i> Millsp.
54	<i>Th. Populnea</i> (L) Sol. ex Corr.	103	<i>C. rosei</i> Fryx.
55	<i>Th. Populneoides</i> (Roxb.) Kostel	104	<i>C. heterophylla</i> (Yent.) Garcke
56	<i>Th. garckeana</i> F. Hoffm.	105	<i>C. tripartite</i> (H. B. K.) Gurke
57	<i>Th. danis</i> Oliv.		Section <i>Robusta</i> Fryx.
58	<i>Th. lampas</i> Dalz. ex Dalz. et Gibs.	106	<i>Cienfuegosia sulfurea</i> (Juss) Garcke
59	<i>Th. garckeana</i> x <i>Th. populnea</i>	107	<i>C. drummondii</i> (A. Gray) Lewt.
	Genus <i>Kokia</i> Lewt.		Section <i>Friesia</i> Fryx.
60	<i>Kokia rockii</i> Lewt.	108	<i>Cienfuegosia argentina</i> Gurke
61	<i>K. drynarioides</i> (Seem) Lewt.		

Studies by scientists have made it possible to identify the tribes *Adansonieae* and *Bombacaceae* – trees (up to 25 m height) with palmated, gipostomated leaves, wood with too long than other cottons, xylem components, with numerous fibrous tracheids and heavy metatracheid parenchymas forming the dense net.

Species of genus *Hampeae*, tribe *Hampeae*, family *Bombacaceae* differs from tribe *Adansonieae* with availability of gossypol conceptacles in the organs of germ, thin membrane cells of external and internal epidermis of outward integument, absence of sorrel calcium crystals in the cells of internal epidermis of this integument, intact or weakly three-laminal, hipo or amphystomat leaves shorter than xylem components of *Adansonieae*, absence of fibrous tracheid parenchyma and less plentiful metatracheal parenchyma which establishes comparatively rare net.

In Genus *Hampeae*, with the traits of spermoderm and germ, the genetic relationship with *Gossypium* and a close relationship with it from the family *Malvaceae*. This confirms the opinion of Fryxell (1968) about the genus of *Hampea*, which does not belong to the family *Bombacaceae*. It undoubtedly belongs to the tribe *Gossypieae* Alef.

As well as the most characteristic traits of the genus *Hampea* have been revealed.

The tribe Hibisceae family of Malvaceae species differ from Adansonieae species by having more or less short xylem components, the absence of fibrous tracheids, and so on. This and other specific differences have allowed it to be acknowledged that tribe Hibisceae has achieved a higher rank of evolution than tribe Adansonieae family Bombacaceae, which agrees with Takhtadjyana's (1966) opinion about Malvaceae's great progress in comparison to Bombacaceae.

The authors of this system have come to the conclusion that the availability of gossypol conceptacles in parenchyma with conducting bundles in the external integument of spermoderma is a constant trait. So, studied genera of tribe Hibisceae on the traits of spermoderm structure and germ have also helped to divide them into two clearly distinguishable groups: Hampea, Thespesia, Cephalohibiscus, Kokia, Lebronnecia, Gossypioides, Gossypium, and Cienfuegosia, characterized by the availability of gossypol conceptacles in the organs of germ and adult plant and either parenchym with conducting bundles in the external integument of spermoderms.

On the basis of the above listed two traits, A.C. Dariev, A.A. Abdullaev, tracing the conclusions of Alefeld (1861) and Frexell (1968), have divided Hibisceae Reichenb into two tribes – Hibisceae Reichenb and Gossypieae Alef. And by them, we presented some of the characteristic traits of these two taxonomies.

The representatives of the tribe Gossypieae were clearly divided into two groups by the type of spermoderm: Hampea, which included species of the genus Humpea and two woody species of the genus Thespesia – Th. grandiflora and Th. cubensis; and Gossypium, which included all other Gossypieae taxonomies. They are also divided into two groups based on the sharpness of their leaves: the genera Hampea, Kokia, and Lebronnecia, which have woody leaves, and two species of Thespesia, Th. grandiflora and Th. cubensis, which have hypostomate leaves (table).

The independence of genera Thespesia Sol. ex Corr, Hampea and others have been identified by traits such as seed fuzzy, length of fiber, epidermal cells, external integument, conducting bundles, geographical distribution, evolution age of development.

The genus Gossypium L. was determined to be very enlarged in terms of species and polymorphism of traits: it makes up, in the last system of Fryxell (1969), out of 4 subgenera, 6 sections and 15 subsections, including 36 species, 32 of which have been studied by A.C. Dariev and A.A. Abdullaev.

These scientists described in detail the subgenera Houzingenia and Karpas—brushes that are likely small trees. Species of subgenus Karpas polyploidy ($2n = 52$), while other subgenera have diploids ($2n = 26$).

Species of subsection Erioxylum of subgenus Houzingenia G. aridum, G. lobatum, G. laxum – trees 6-9 (15) m height with unique traits. More probably these three species are the most primitive. And other related forms of cotton listed in the table..were deeply studied and pointed out their natural place in the modern taxonomy.

Chapter 7. **Biological features of cotton plant.**

In general, cotton plant has acquired a global importance because of its fiber which has a high commercial value. According to ICAC's information, cotton plants are currently grown in 45 prestige cotton producing countries in the world. Moreover, some other published literature informs us that cotton plants are cultivated in over 70 or even in about 80 countries worldwide. Most of its plantations occupy temperate and tropical regions of Asia, America, Australia and Africa. Its outlook differs from trees to shrubs until they eventually get to an annual domesticated shape, depending primarily on the conditions of growing and plant breeding. The northern boundary of cotton growing areas spreads up to 38–44° of northern latitude (n.l.). At this point, it has stretched up to 38 n.l. in the U.S. and up to 44° in China. In our republic, the northern part of the Karakalpak Autonomous Republic was displaced approximately 43 n.l.

Nearly 25 million tons of total cotton are produced worldwide annually. The top ten producing countries are India, China, the USA, Brazil, Pakistan, Uzbekistan, Turkey, Greece, Mexico, and Argentina, which sum up 93% of the annual produced cotton. In 2019/2020 their cotton production consisted of: 6423; 5933; 4336; 2918; 1350; 762; 751; 365; 342 and 305 thousand metric tons.

Cotton plants are highly valued in Uzbekistan and have historically been recognized by our nation as "white gold" since its time when it started to become a multi-purpose raw material for the national economy. All parts and reprocessed products of the cotton plant are used by a wide range of fields in the country, such as farms, plants, light and heavy industries, chemistry, medicine, transport and export enterprises. Subsequently, the development of our republic, in particular, depends on the development of new varieties of cotton plants and their resilience in the different conditions across the regions of the republic. Resilience, high productivity and precocity of the grown cotton varieties make of their biological features and concludes that a certain cotton variety has optimal factors to get a normal performance. As a result, any created variety of cotton plant can only perform its genetic potential in terms of productivity, precocity, and product quality if complex factors such as temperature, moisture, nutrition, and light are available.

Relation of cotton plants to the temperature. According to the classification and origin of cotton, all forms of the genus *Gossypium* were imported from the tropical belt of the globe where the very cold temperature of the air does not get below of 18°C. Consequently, temperature has a special impact on the development of cotton plants from their time of seeding until the harvesting of new seed cotton yield. In general, our cotton varieties correspond with the geographic diversities of cotton planting regions: northern, central and southern are created respectively as early, middle and comparatively late ripening varieties. The multiyear averaged indexes of maximum and minimum temperatures have been illustrated in figure shown below (figure 4). But the climate of Uzbekistan in regard to agricultural crops is often characterized by its abrupt changes with the

coming of short-term frost temperatures in early spring and hot temperatures with drying winds in the middle of summer. It is commonly known that 10°C is the lowest effective temperature for agricultural crops in Uzbekistan. And 14°C is considered the initial temperature at which cotton seed starts to grow. Anyone can predict the approximate month to seeding of cotton seed by looking at the borders of maximum and minimum lines growing and lowering. Cotton plant seeds respond by maintaining a constant temperature of 14°C under 2–5 cm of soil prior to sowing. This depth requires some temporary corrections depending upon the soil type and moisture conditions of the regions.

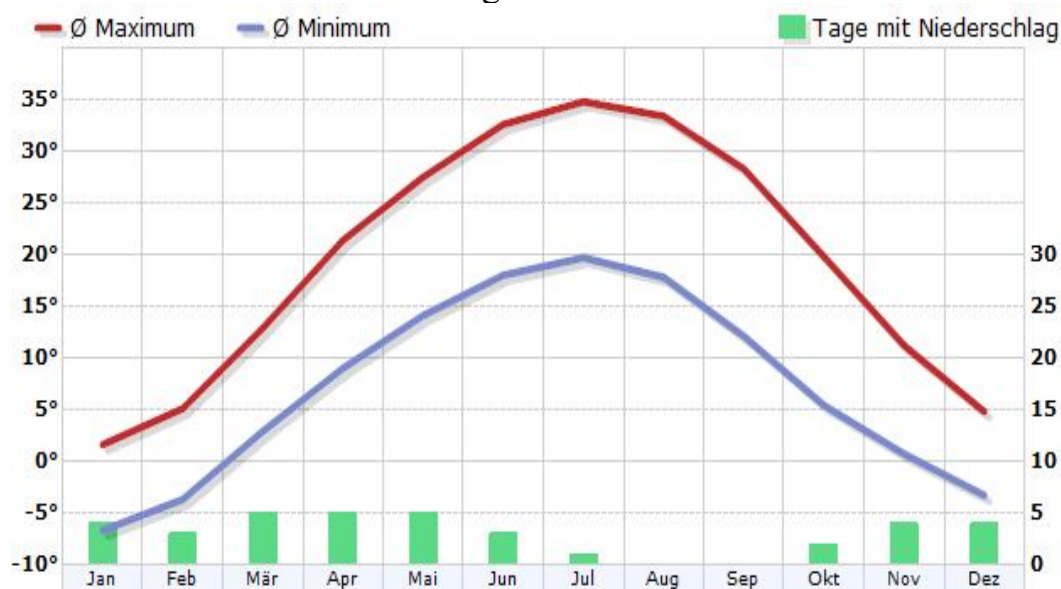


Figure 4. Image of averaged multiyear temperature in Uzbekistan.

It is generally accepted that a cotton plant in its life cycle is to pass through five main developing phases. 1.Stage of germination or cotyledons emerging; 2.Stage of true leaf formation; 3.Stage of budding; this is the establishment of fruiting (sympodial) branches; 4.Stage of flowering; 5.Stage of maturity (boll split opening).

The minimum temperature at which cotton plant seeds can grow is 10-12 °C, but sprouting does not occur. In order to raise the cotyledon's knee above the soil, it demands at least 16 °C. That is why, if the sowing is carried out too early, the seedlings are very sparse. A temperature of 25–30 °C is optimum for cotton plants, including seed germination. At a temperature below 25 °C, the development of cotton is slowing down. Lack of heat statistics, especially visible at temperatures below 20 °C, at temperatures of 17 °C and below, strongly delays the development of the plant. The temperature above 36-37°C causes overheating of the tissues of the cotton plant and 40 °C even conspicuously depresses it. Consequently, in the period with very high temperatures in the summer, it grows predominantly at night when the temperature has gone down.

The requirement of cotton plants for temperature within the period of certain development stages differs in various varieties. A definite heat tension not below the definite average daily temperature of air is demanded to pass through one phase

of development to another. At this, it was elucidated that the demand of different cotton varieties for heat tension to pass through and complete one development phase varies. The definite sum called "effective temperature" is necessary. The difference between the average daily temperature of air and the temperature below which one cannot pass a certain development phase is implied as the effective temperature. If you summed up all the average daily effective temperatures for the period of the passing of a concrete phase of development, it would be the effective temperature for this phase. The lower limit of temperature point required for passing one or more phases was known as constant V, and the sum of effective temperatures required to complete one or more phases was known as constant A. Approximately, the following sums of effective temperature are required by middle-stack cotton in the conditions of Central Asia (table 7).

Table 7. The sum of effective temperatures necessary for middle staple cotton varieties (Avtonomov A.I. et al., 1983).

Varieties	Sum of effective temperatures from seeding			Sum of effective temperatures from flowering to 50% of ripening.	Sum of effective temperatures from seeding to 50% ripening.
	Until germination	Until budding	Until flowering		
Early maturing	84	485	900	660	1560
Mid maturing	84	500	950	675-685	1625-1635
Late maturing	84	500	1050-1200	720-800	1770-2000

To count the effective sum illustrated in the table for emerging seedlings and passing of the stages of budding and flowering, the temperature limit (constant V) was set at a similar lower temperature limit (-10 °C) and for passing the stage of flowering at -13 °C. Thus, this kind of simplification is entirely applicable for originative calculations and is currently used frequently in practice.

Relationship of cotton plants to moisture. Aside from its drought resistance, the cotton plant establishes a strong and deeply penetrating root system into the soil. plant in a state of good security with water grows better and develops, establishing more fruitful branches with bolls on them to accumulate a bumper crop of raw cotton. The transpiration coefficient in the various varieties of cotton plants in the different conditions of Central Asia for the period of vegetation equals 600–700. This index typically ranges from 400 to 800, but it can reach 1000 or even 1.4-1.4 thousand depending on growing conditions. The less coefficient transpiration there is, the less expensive the water outlay. It is especially important in the handmade irrigation: irrigation water has a high value. Coefficient transpiration differs in certain periods of cotton development. It has the highest index just before budding, the lowest during flowering, and the lowest until the

beginning of ripening. Then again, it increases several times. The less there will be in July and August, the better. outlay of water by the cotton plant in the difference from the intensity of evaporation until the beginning of blooming is comparatively small in the period of budding, as at this time the general evaporation surface is not great, the temperature of the air is not the highest and it is not too dry. For example, 1 hectare in the phase of true leaves outlays to evaporation 10–12 m³ and in the phase of budding 30–35 m³ of water for a day and so on. The total consumption of water by the cotton plant for the vegetation period reaches 5–6 thousand m³ha.

In our republic and in other regions where the vegetation of cotton plants is discontinued by the coming of cold weather in the late autumn, the productivity of the cotton plant is defined by precocity, boll size, and economic fruit setting. These traits may vary considerably under the influence of environmental conditions, in particular with the security of water in the various periods and stages of development. Water's effect on precocity, boll size, and economic fruit setting can vary greatly depending on genetic characteristics of different varieties and environmental conditions such as soil fertility, ground water level, agro-technical practices, and weather.

Cotton plant nutrition relationship According to the data of scientists from the Cotton Growing Scientific Research Institute (the CGSRI), nutritional substances in the amount of N 50 kg, P₂O₅ 10 kg, and K₂O 50 kg are needed to produce 1 ton of raw cotton in the condition of Central Asia. Other micronutrients include calcium (50 kg), sulfur, magnesium, and sodium (10 kg), iron (up to 2 kg), boron (up to 200 g), copper (at least 50 g), and chlorine (1.5 kg).

At the time of the cultivation of cotton plants in the salt-exposed conditions of soil, the normal utilization of nutritious substances breaks down and hereinafter increases the supply of chlorine, magnesium, sodium, and other elements. The number of consuming elements consumed by cotton plants can vary significantly depending on their amount, which is required to form various organs, and the correlation of raw cotton yield and above-soil mass of the plants (including raw cotton). The share of raw cotton in the above soil mass can fluctuate in Central Asia by approximately 25–30 and up to 50–60% depending upon the environmental conditions and physiological and biological features of cotton varieties and species.

S.A. Kudrin determined the following sizes of variation in the assimilating of nutritious elements by middle staple cotton to establish 1 ton of raw cotton with a corresponding amount of above soil vegetation mass: 30 to 70 kg of nitrogen, 10 to 20 kg of phosphorus, and 30 to 80 kg of calcium.

Fine-stripped cotton plants in the conditions of Central Asia assimilate several times more nitrogen, phosphorus, and calcium than middle-stripped cotton. To a great extent, this is explained by the fact that fine staple cotton, possessing small bolls, powerful plant architecture, and too late vegetation in comparison with middle staple cotton in the conditions of Central Asia, produces relatively less raw cotton yield in regard to whole mass than middle staple.

According to the data of American researchers, 3 to 5% of nitrogen, 5 to 7% of phosphorus, and 7 to 10% of calcium out of the general quantity of these substances going to the formation of above soil mass are expended to form root systems.

Consumption of the most deficient nutritious substances (nitrogen and phosphorus) in Central Asian soils is closely related to increasing indexes of dried plant mass during the vegetation period. In its turn, depends upon the availability of nutritious elements, water and many other factors in the various stages of development. It is commonly known (figure 5) that the absolute assimilation of nutritious substances by the cotton plant in its different stages is unequal.

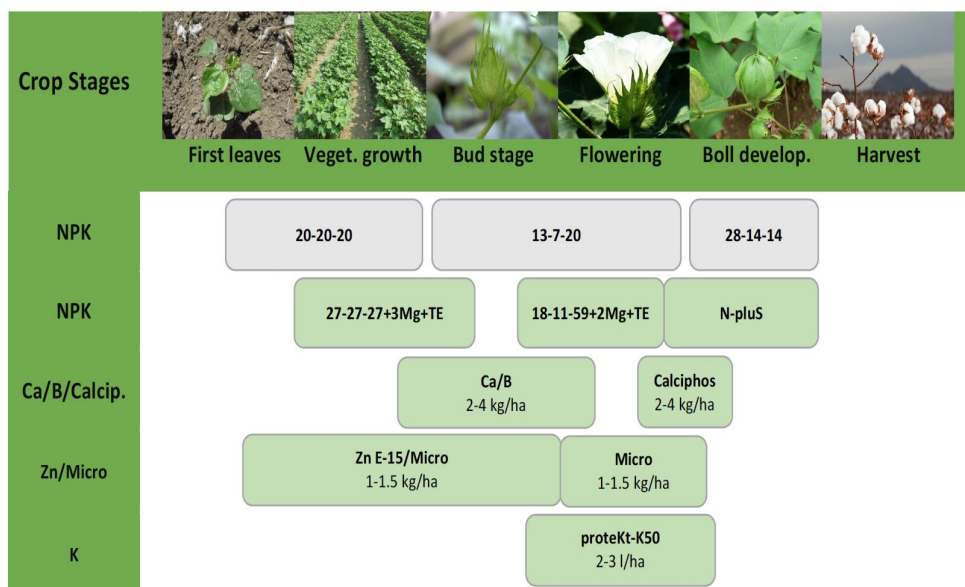


Figure 5.

Development stages and fertilizer application.

The consuming index of nitrogen and phosphorus is not very large in the stage of germination. It slowly increases from seedling to budding and abruptly increases from budding to boll development and ripening. After that, it drops significantly.

Relationship of cotton plant to the light Cotton plants develop best only in open, lightened by the sun, places. Leaf plates of plants strive to take up the state during the day that their surface is perpendicular to sunny rays and always changes their state, following the sun; at night the leaf plates get down. This changes the state of emerging cotyledons during the day. For example, when there is a lack of light, for example, cotton plants develop slowly under the shades of trees or under prolonged thick cloudiness, and they intensively shed buds and young bolls after their introduction in the period of reproduction.

According to A.V. Blagoveshenskogo's (Tashkent region) data, 1 hour of assimilation on 1m² leaf surface of a middle-ripening cotton variety on a sunny day yields 1.46 g, while early ripening yields 1.45 g. The next day, in the condition of a cloudy day, it abruptly lowered: in the middle ripening it consisted of 0.0073 g. and in the early ripening it was up to 0.06 g. Durability of lighting in the day has a great effect on cotton development and, other wise, it means durability of light in

the day. Under the conditions of a long day, it slows down the development and belatedly transitions into the reproductive stage. Handmade shortening of the day durability accelerates cotton development and its transition into the reproductive stage in the regions of Central Asia where the day is long in the period of vegetation. Various forms have different photoperiodic reactions on short days. According to the data of N.N. Konstantinov, especially strong photoperiodic reaction on the handmade shortened day is remarked in the three like forms of cotton, though some of them almost do not react. Early ripening forms, used as annuals, for example, cultivating fine staple cotton and middle staple cotton closer to it on the precocity, react weakly to day lengthening. ripening forms react still weaker or almost do not react. The different degrees of reaction of different cotton forms to handmade shortening are directly related to geographic origin and all phylogenetic development of all forms. The closer the cotton form is to its geographic origin near the equator, where the day is very short (approximately 12 hours), the more strongly it reacts to the day shortening. The more favorable durability of handmade short days facilitates the great acceleration of cotton development in the condition of Tashkent, accounting for 9–12 hours. It varies for different forms, depending upon their place of origin and particular phylogenetic developments. The height of first simpodial branch setting is lowered under the effect of short days. That is why blooming and maturation start earlier. But the rate of blooming, according to the data of N.N. Konstantinov, does not change at the different durability of (up to 8-12 hours) every day light. For example, during the strongly decreased period of lightening, for example, up to 6 hours, the rate of blooming is decreased. Aside from the foregoing, photoperiodic reaction at the handmade short day has resulted in changes to some morphological cotton components. For example, the height of the main stock, the size of the leaf plate, and the stipules can all be changed, though the last one is not always possible. As previously stated, the more strongly photoperiodic reactions at the shorter day occur primarily in the tree form of cotton. Seeding them in the soil conditions of Tashkent not only gave mature bolls but even prevented them from getting into the budding stage. The effect of the shortened day abruptly lowered their height of first simpodial setting (from 30-35 to 9-11th node). As a result, such forms flower almost simultaneously with our cultivating fine staple cotton, allowing us to use three similar cottons in breeding works to cross with our cotton varieties. Historically, it was used by the famous breeder A.I. Avtonomov in his research and he created new large boll varieties of fine staple cotton.

Relation of cotton plant to soil. Cotton plants can grow in a very diverse range of soil conditions, but not all of them are similarly suited for them. That is why labor expended and material invested will be unequal to obtain a high raw cotton yield. The relationship of cotton plants to soil in the conditions of artificial and rain-fed cultivation is differentiated. In irrigation conditions, it succeeded in heavy and light soils, and the floor was usually not deeply covered with shingle or sand, if only there were enough nutritious substances. Such are the results of centuries of irrigation in Central Asia, established by the rich nutritious substances

(except nitrogen) of forest deposits. The soils from light sand to clayey are suitable to cultivate cotton, but light loamy soil is better in both irrigation and rain-fed conditions. Heavy loamy soils are less favorable, but high yields can be obtained by expending a comparatively large amount of resources and treatment. Sand-loam soils have less fitness than light loamy soils, so as a consequence of their little moisture capacity and too much air and water penetration, they dry very rapidly. The meadow soils of Central Asia together with powerful serozems are one of the best for cotton planting. It is necessary to improve. Salted soils, depending on their grade of salinization, are almost not fitted or less fitted. But through the removal of harmful salts from ploughed and under ploughed horizons, we can obtain good yields in such soils. It needs to be kept in mind that an especially sensitive cotton plant to saline soil is in its younger periods. Chlorine salinization is more toxic in the same concentration of salts than sulfate.

The harmful effect of salts on the development and productivity of cotton plants starts at the content, correspondingly in the amounts of tight residue, chlorine and SO_4 in the soil horizon 0-50 cm in the period up to budding (5): 0.4-0.5, 0.01 and 0.2-0.3. The availability of tightly residue 1.4% chlorine 0.12-0.14 and SO_4 0.5-0.6% results in a very strong oppressive and, in particular, plant destruction. Soaking and germination of seeds in the salted soils is belated, and in the strongly salted soils, seedlings will not sprout. Besides this, it destroys the development of the root system, delays the starting of successive stages—budding and flowering—increases the shedding of fruit establishments and decreases the growth of plants. All these reduce the productivity and worsen the quality of fiber. The depth of ground water has great significance to cotton development. Its closeness to the soil surface (at least 3 m) in the condition of irrigation is undesirable, especially at salinization. The very near level of ground water to the surface of the soil intensifies vegetation growth, which inhibits the beginning of maturity and the rate of boll splitting. But in some cases, cotton can be grown without irrigation in the near absence of ground water.

So, in the desirable combinations of the main factors (temperature, moisture, nutrition, light, and soil), cotton plant growth occurs with the germination of the seed as moisture enters into the embryo. And newly germinated seedlings emerge from the soil just five to six days after the root tip arises from the seed, completing the first development stage. Once above the surface of the soil, the young cotton seedlings take five to seven weeks for the blooming stage to begin. At this stage of development, younger plants start to blossom from their buds into white flowers. At the beginning, as the flowers start to open. On the first day of this stage, only one or two buds will bloom per day. The first flower appears on the lowest fruiting branch of the plant, closer to its main stem. Once the plant grows along the upcoming stages of development, they will open more rapidly in both directions: higher on the plant and farther out on the plant's branches. The duration of interphase development increases significantly from the first true leaves to budding, flowering, and maturing (figure 6).

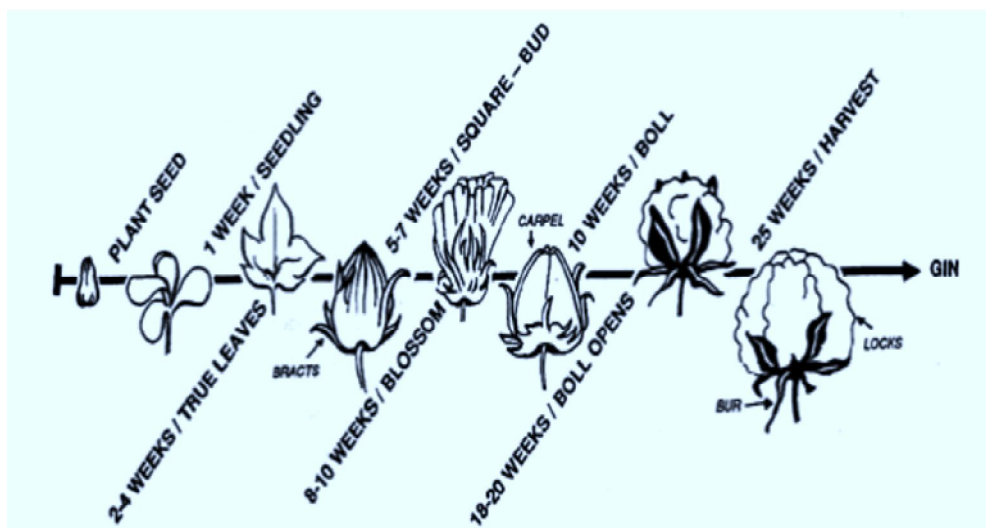


Figure 6. *Development phases of cotton plant.*

Here, the flowers have very short lifespans, as they open at midmorning with the start of sunshine and begin slowly to wither by the afternoon of the next day. In general, cotton flowers have little open-day time to be pollinated. Cotton flowers predominantly engage in self-pollination, but outcross can occur in the availability of intensive insect pollinators' activities. Sooner, as the cotton flowers wither, the little fruit called cotton bolls will be left behind in their places. Cotton bolls start to form cotton fiber in their locules. The number of locules consists of 3-5 depending on the cotton species. Boll development in its phase of development takes 45 to 60 days for the boll of the cotton plant to reach its complete maturity. Most of the cotton bolls are approximately the size of an egg, with different tips and green in color. At the stage of maturity, the bolls gradually form cracks starting from the tip top to downward, and eventually, the bolls split open, exposing locks that contain a grouping of seeds with their own fibers attached to them. Each cotton plant may bear up to 100 fruit bolls, but depending upon the plants' biological and genetic potential and the availability of the optimal combination of environmental factors listed above, only a few of them come to the state of full maturity. Once cotton fibers from the boll fruits are completely exposed, they start to dry. Then the bolls dry out, and they are referred to as a bur (figure). Mainly, the vegetation period for growing varieties of middle staple cotton in the conditions of Uzbekistan is divided into three groups: early maturing varieties with 100-110; middle ripening varieties with 110-120; and late ripening varieties with up to 140 days to reach full maturity. By their biologic features, cotton plants are characterized as natural perennials with their non-stop flowering. However, they have been transformed into true annuals and are cultivated for economic reasons by cotton producing industries all over the world.

Part III. Cotton plant breeding.

Chapter 1. Cotton breeding process.

Uzbekistan has produced 2,845,000 tons of raw cotton in 2019. In the global share of producing fiber, it ranks sixth place (762 thousand tons) after leading cotton producing countries: India-6,423; China-5,933; United States-4,336; Brazil-2,918; and Pakistan-1,350 thousand tons (Statista 2020). This is also the merit of our cotton plant breeders and seed producers in the development of new cotton varieties and the efficiency of the used techniques, which encompass the breeding processes in the republic.

The development of elite cotton varieties with superior fiber quality, resistant to various plant diseases and pests, tolerant to environmental stresses, and adapted to various extreme growing conditions across the republic has always been a major issue eternally standing before our breeders and seed producers. To solve this issue, they mapped out the breeding process at the Scientific Research Institutes (SRI). Depending on the breeding process, breeders use conventional breeding methods like individual selection, mass selection, hybridization and one of its diversities: inter-variety, intra-specific, interspecific, backcross, heterosis, induced mutation, untraditional selection and cotton biotechnology progress, in particular, gene transformation using DNA markers to accelerate breeding programs in Uzbekistan.

The annual State register for 2020 on the disposition of agricultural crop varieties figures out that 33 (18-early ripening; 5-middle ripening; and 10-promising varieties) cotton varieties were grown in the regions of the republic. These varieties have been developed through one of the above-mentioned traditional breeding methods with some of their inconsiderable modifications, but three (Parloq-1, Parloq-2, and Parloq-4), which have been released on the basis of biotechnological methods. Even so, most breeding work with these varieties will take place in field conditions.

Cotton breeding in our republic is generally characterized as a scientific research experiment conducted in the field under optimal irrigation, nutrition, and inter-row mechanical soil loosening conditions. Laying out of this field experiment to fulfill the cotton breeding process and statistical treatment of the experimental data is mainly guided by the Methods of Field Experimentation (MFE) described by B.A. Dospechov (1985) and others.

Experimentation to develop the new cotton variety in the breeding process is implemented by such successive research proceedings as: creating a space plan for a field experiment (figure 7), laying out the breeding nurseries to prepare for selected seeds for seeding, chemical treatment of seeds, sowing, phonological observations, measurements, and statistical treatment of data, hybridization, study of productivity, and station testing.

Creation of a space plan for the field experiment. Preliminarily, the space scheme of the future experimental plot with its structural components is drawn in the register of experiments (appendix 3) with round table decisions and decisions of the senior and other scientists of the department by taking into account the

amount of all introduced and selected seed materials in the result of the last cotton breeding process fulfilled by them. The senior scientist bears the full responsibility for the accuracy of this work in the mapping out of the field experiment and efficiency of the coming breeding process.

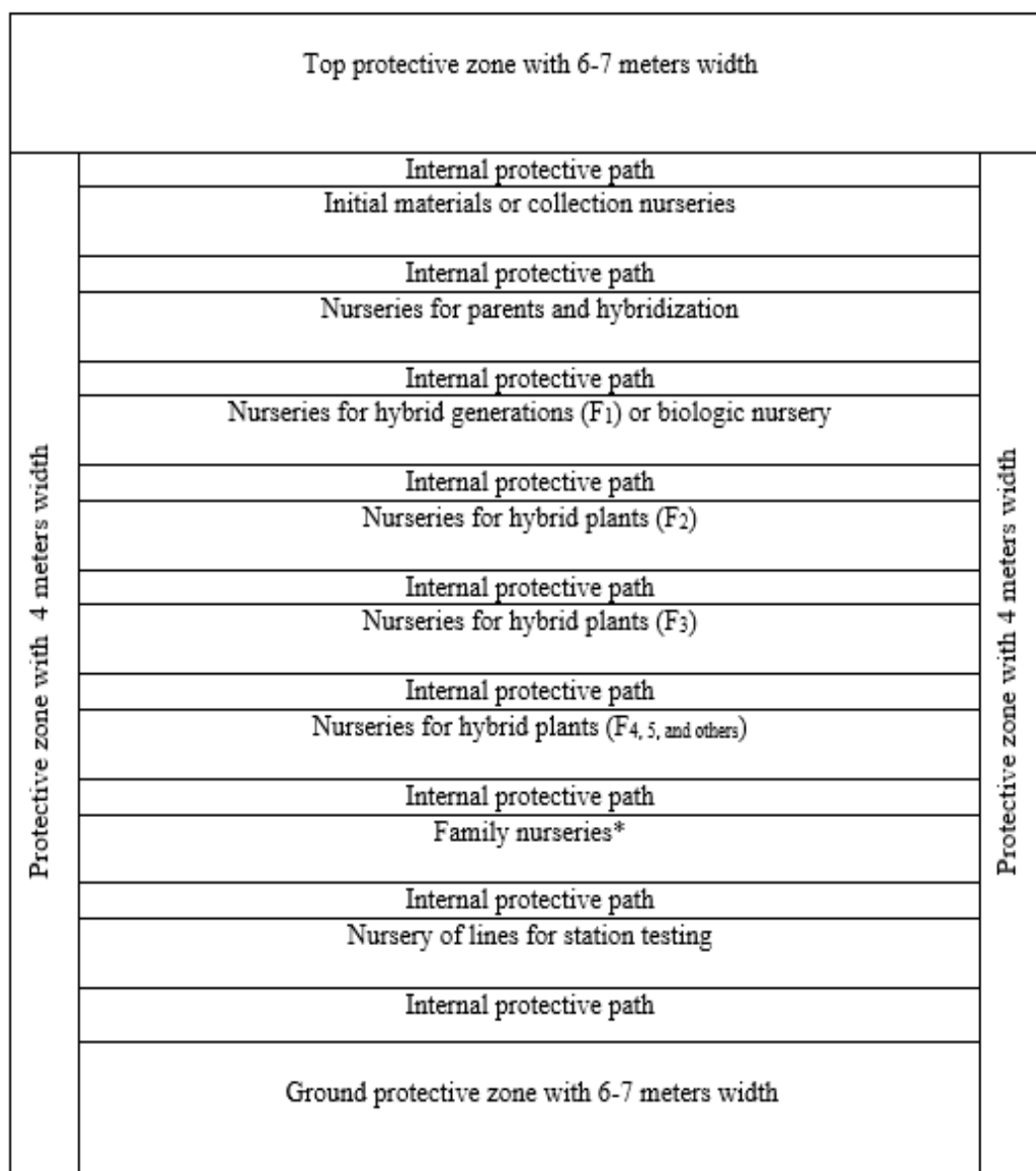


Figure 7.. Exemplary space plan of the breeding plot of the department for the release of fine staple cotton varieties headed by the breeder Y.P. Khutornoy, State Prize Laureate at the former SRI of Cotton Breeding and Seed Production named after G.S. Zhaytsev.

Its success primarily depends on the creative endeavors of the scientists of the department, the value of the initial materials, the precise selection of parental forms for the combinations of hybridization, hand pollinations in time and all other successive cotton breeding techniques involved in the breeding process. The SRI's breeding department, like other breeding departments of the SRI, has a set of working instruments (look at the appendix 3) to lay out the breeding nurseries' displace scheme in the soil surface prior to seed planting in the spring.

All protective zones of the breeding plot in 1985-1993, when the author of this text book was still a younger scientific researcher under the direct scientific

guidance of senior scientific employee M.I. Iksanov, who was the follower of Y.P. Khutornoy in the department, were sown by the seeds of the standard varieties S-6037- 0 type of branching and Ash-25 with non-limit branching.

The nurseries of the plot consist of recording rows with a size of 5 to 0.9m. Besides external protective zones to prevent outcross pollination and to separate the belts of the nurseries from each other, there are internal protective paths with a 1 m width. Every nursery in the plot is built by severely observing the order fixed in the field experiment register and later in the list for seed planting (appendix 4). The first row of every breeding nursery is marked with a wooden peg with the order number written in pencil, and it is set on the land at the beginning of the row, aside from the internal protective path. The pegs will help researchers and lab assistants find a certain row with needed plants in it in any nursery fixed in the list of plantings at the time of phonologic monitoring.

Often, the seeds of the definite generations are sown and studied in the conditions of a greenhouse to speed up or reduce the period of new variety release. The greenhouses enable the scientists to equip a special chamber for research on the resistance of their own initial materials and their hybrid progenies to different abiotic and biotic stresses at any time of the year. This feature of modern greenhouses is ideal for conducting experiments with disease and pest infection in enlarged fields isolated from main experiment fields. This part of the experiment also has a corresponding scheme enclosed in the experiment register.

The area of the plot (figure 7) accounted for approximately 2.0–3.0 hectares and in which 8 scientific staff were engaged annually: one senior scientist (breeder) who guided the overall breeding program and presented an annual report at the convention of the scientific council of the SRI. This senior breeder carries full responsibility for the perfection of the breeding process and the efficiency of expenditures, and to correct research strategies according to the state's policy in the field of agriculture. The next scientific activities are to be done annually by the breeders of the department. In order to find necessary initial materials, they look study all available collections of cotton germplasms deposited in the collection department of own SRI and related SRIs, to renew the scheme for the new breeding process and seeding the seeds in the nurseries of the experimental plot. In particular, placing order for nurseries, separating a half of family seeds to sow in the specially infecting plots in the isolated field of the SRI; and to choose the seeds of best developed lines for a competitive variety testing in the associated plots of the SRI on the conducting of competitive variety testing; assorting of parental samples for crossing in the future crossing combinations; mapping out phonological monitoring on the studying of experimental plants; making up and control the agro-practices for cultivation, feeding; accuracy of hand pollination in the nursery of hybridization; remarking of individual plants and assessment of new families and lines; harvest of individual and row crops; harvest of raw cottons on the new families; control the transportation of harvested materials into depository; supervise in organizing of lab analyzes on the collected material and discarding of inferior materials on the base of field and lab analyzes; separate fiber samples from

individual, family raw cottons and put them in the registered packages for transfer to the central lab of the SRI, where will be analyzed and identified textile qualities of fibers; to receive the data on textile qualities testing, data from isolated infection plot and from the plot of competitive variety testing and expose them to statistical treatments; to do trustworthy conclusions in regard of studied cotton forms in the breeding process and to present necessary recommendations; making up the registering documents and dispatch the selected seeds to preliminary seed reproducing farms and elite farms from the seeds out of department's new variety, which recently passed successfully through competitive variety and state variety testing plots. Except above listed obligations, the senior breeder must: guide the scientific research of young scientists of his department on the basis of counseling and mentoring; take continuous control of their experiments; ensure accuracy in the plant assortment and tagging them to monitor and measure plants in time; statistical data treatment and sum up; prepare current and annual reports with progressing results; and then present reports by them at the scientific council conventions. To be supervisor of junior scientists until successful protection of their dissertation work.

The young scientists of the department, since the time of protection of their dissertations, have united their scientific research with the department's program to expand the breeding process in practical and theoretical aspects, incorporate plant genetics, physiology, biochemistry, advanced breeding methods, and attract rare cotton species. They facilitate a great potential to develop not only new cotton lines and varieties but perfect plant breeding methods, which has made the department program possible to raise the efficiency of the breeding process at its modern stage of development.

Furthermore, about 5 or 8 lab assistants are available to help breeder-scientists in terms of practical work to be done in the implementation of the breeding process. Preparing various documents in the form of different lists and experimental registers used in the breeding process; fulfilling lab analyses; assortment of selected seeds after lab analyses; preparing seed garlands; assisting in the creation of new nurseries in the experimental plot; conducting field observations and measurements; hand hybridization; preparing different breeding bags, numbering them for seed storing and individual sample bag garlands, transport all bags into breeding repository and to help their proper storage until lab analyzes and transportation to the gin houses, ginning of selected raw cottons and transporting them back to their places of storage.

According to figure 7, the main breeding parts of the plot are surrounded by top and ground protective zones depending on the water flow direction. The width of these zones is equal to the needed width for the mechanical cultivator to turn back after reaching the end of the plot. Besides these, necessary protective zones on either side of nurseries which have a width equal to one direction's passing way size for mechanical cultivators. And the grown plants in the nurseries for initial material, nurseries for parents and hybridization, nurseries of early hybrid generations or biologic nurseries, nurseries for evolved families (breeding

nurseries of 1st and 2nd years), and line nurseries to conduct station testing encompass the whole experimental plant nursery in the breeding process.

Laying out the breeding nurseries. The breeding process in the field experiment independently which one of the above mentioned methods of cotton breeding is being planned to use is implemented in the following breeding nurseries:

- nursery of initial materials;
- nursery of parental forms;
- the nurseries of hybrids;
- nursery of the F₂ generation;
- nursery of the F₃ and successive generations;
- breeding nurseries of the 1st and 2nd years.

Nursery of initial material. This nursery is established mainly on the basis of materials mainly taken from the collection department functioning at the own SRI or other related SRIs or plant breeding stations. We purposefully introduced a number of valuable overseas cotton forms, but to our great regret, they will not serve and reproduce in our natural conditions. They present themselves as perennial, three, bush or photoperiodic short-day cotton forms (appendix 5). To provide them with their native growing conditions, SRI has complexes of greenhouses and other supplementary field constructions functioning year-round. Except for them, they operate their field nurseries on an annual basis, with new cotton forms and samples introduced by various local and international plant breeding and botanic organizations. Moreover, all newly introduced samples are preliminarily inspected in the distant quarantine nursery for the absence of diseases and pests. It is known that one-third of the seeds from each introduced sample are preserved as their original germplasm. Furthermore, all samples from the collection department are studied in two environments: naturally infected and artificially infected with disease-causing pathogens. As long as the seeds of collection samples reach a sufficient dimension and for restoration of the planting qualities, they are replanted annually 1/4 part of the collection seeds. The nursery is seeded in single replication with 10-12 seed lots, the number of seeds at each plant stand varying. The samples are united into individual groups in regard to their biological features and to create optimal agro-practice conditions for them to enable normal plant development and exhibit traits. When necessary, a short day is created to the forms of short-day photoperiodic reactions, which do not reproduce in the relatively long days of Middle Asia with the help of special light-impenetrable photoperiodic houses called "carriages" and based on rail movement. Plants are covered from 6 -7 in the afternoon to 8 - 9 a.m. in the morning of the day with 9 hours. That is the creation of the day with 8 -10 hours.

The introduced samples are examined in the collection nursery, their adaptability, biological and economic properties, resistance to diseases, and entire characteristics of the samples. But breeders are interested in studying the unique particularities of overseas cotton accessions and often study them in their plots. And it seemed that not essential darkening of all parts of plants in the

photoperiodic house to get the effect of a shortened day. Finally, it was shown by N.G. Simongulyan and Y. Uzakov that darkening the top parts of plants with growth points and 4 - 5 young leaves by putting on light-impenetrable black bags from 6 - 7 p.m. to 8 - 9 a.m. is enough. Thus, local exposure to short days on the growth point of plants ensures a short-day effect and even promotes the better accumulation of fruit components than under "Carriages" (take a look at the textbook of N.G. Simongulyan, 1987).

Later, the method (photo 25) of growing some photoperiodic plant samples and their hybrids under black-white oil paper has been worked out by Y.I. Ikramov. The artificial short day created by the help of black plastic paper and white plastic paper enables it to rise even to the essential temperature. Their combined effects have become the most favorable for photoperiodic cotton forms. All those forms and their unique studied traits serve as the initial parental forms for plant breeding departments of the SRI with established similar live cycles (appendix 5). These cotton forms bloom all year round, and the breeding departments' breeders use them for hybridization with their own materials grown in natural field nurseries. The other recommended seeds of annual cotton forms from the department of collection which are possible to grow in the condition of open nature are seeded directly in the initial material nurseries of the breeding departments. They are cultivated similar to the collection department up to reproducing the necessary dimensions of seeds, studying their typicality and using them in the breeding process.

Nursery of parental forms. The varieties according to the previously fixed plan of crossing are placed in this nursery. To seed, elite seeds or, if available, genetic uniform material derived from multiyear self-pollination (at least 4-5 years) are typically used. The material, self-pollinated for 1-2 years, is not yet ready to be considered genetically uniform as self-pollination leads to heterogenesis of the material, segregating it into different individual genotypes. Every variety occupies several rows in the nursery in order to be able to conduct crossings according to the fixed plan. In the nursery, the best agricultural practices are used to minimize squire shedding. Tops of plants are chopped. Removing exceeded buds on the plants is necessary, especially on the fruiting wood where the crossing has been done. All off-type plants are removed until flowering.



Photo25. Outlook of one of the similar light black-white oil paper constructions to grow photoperiodic cottons proposed by the scientist Y.I. Ikramov.

The nurseries in which hybrids of earlier generations (since F_1) are to be seeded are called hybrid or biological nurseries. The seeds from crossed bolls, united in the combinations or individually on the bolls, are sown in the nursery of the first hybrid generation. In the first case, the number of rows and their lengths depend on the quantity of the hybrid seeds. Usually, 20–40 seed nests are placed in the row. If every generation of crossed bolls is seeded separately, the rows have 5–10 seed nests. If the standard is needed, its seeds are accepted to sow in nine rows (1, 11, 21, 31, and so on) or rarely. Breeders don't prefer to sow standard or parental varieties around because of the crossings with them, which cause biological spoiling of the material. It has been made to do self-pollination of the hybrids. Seeding of parental varieties is used to point out the combination ability of varieties on the economic traits and the heterosis level of hybrids. That is why they are sown in 3–4 replications, involving both parents and standard. In those cases when initial material is genetically uniform (elite varieties, self-pollinated lines), the selection of plants within hybrid combinations is not conducted and the yield of all plants is united. All of the differences between plants in the F_1 hybrid combination are considered Para typic and are not inherited. If the initial material is not uniform, the usual discarding within hybrid combinations is conducted in the offspring of backcrosses. It is obligatory to cultivate the hybrids of the first generation on the highest agro-background in order to get the maximum possible dimension of seeds with high planting quality and correctly characterize the population. Field surveys are carried out in the nursery of F_1 , where the character of dominance traits is defined. The entire characteristics of economic traits are presented on the basis of phenologic observations, raw cotton crop, and probe sample analysis.

The nursery of the F_2 generation. The seeds of total harvests of individual selections from hybrid combinations of F_1 are seeded in this nursery. The standard is planted in nine rows in the row of tenth if we continue the need to watch the combination abilities of parents in this generation. In all other situations, this nursery will be free of all other materials to prevent biological spoiling. One of the most important things in this nursery is to provide as many F_2 plants as possible in each combination. At least 1000 hybrid plants should be grown out of every crossed combination. The breeder approaches the crucial task of identifying successful recombinant hybrid plants with a favorable combination of parental traits. According to the law of inheritance and experiments of outstanding breeders, it is well known that the chance to catch that plant the breeder would like to see increases in the population of possibly enlarged numbers of hybrid plants in this progeny. For this, the plants of the second generation are scrutinized by the breeders on the basis of the abovementioned principles. Not less than 2 or even 3 field observations are carried out by the breeders for the vegetation period. Moreover, the selection works as well as being guided by focusing on the

environment and developmental factors, which may cause considerable variations in the segregation of desirable hybrid plants.

Plant productivity of plants, number and size of bolls, number of boll lobules, number of seeds in a lobule, earliness, length and strength of fiber (visually defined), maturity and fiber output, plant architecture, suitability of crop to machine harvest (plant structure), rate of foliage, the height of the first fruiting branch, the character of stickiness of fiber to boll glumes and the pappus of each other are taken into consideration at the time of individual selections. The plants fixed to individual selection should be perfectly healthy. The plants neighboring the next combination and the plants developed in the sparse rows do not fit into selection. A cruel discarding of the morphological traits of F_1 . It means that only zero-type forms with desirable trait recombination is selected according to the main breeding plan as a result of a crossing combination "simpodial X zero" by excluding all other hybrid forms, regardless of their desirable trait recombination. The same principle is to be guided by the breeder when the selection is implemented within hybrids originating from the crossings of naked and downy seed cotton varieties. Here, in accordance with the breeding program, only that form of seed was selected as what was accepted in it. All hybrids of downy seeds, even with weakened pubescence, are discarded.

Only white fiber forms in the F_2 remained as the result of crossing cotton forms which have greyish-brown and white fibers as the example of cultivating varieties and the wild wilt resistant form of Mexicanum with greyish-brown fiber. In short-day conditions, the wild short-day subspecies of Mexicanum has a high setting of first simpodial wood (from extra-axillary bud of 13–14th true leaf). By the arrival of short fall days in Tashkent's natural long day condition, the first simpodia can be anticipated later from the extra-axillary bud of the 25th–30th leaf. The lowered setting of the first fruiting wood (in the 3-7 node) is partially inherited in the F_1 at the crossings between cultivating varieties, and splitting is observed in the F_2 . Besides, most plants have a lowered or intermediate setting of the first simpodia. All plants from F_2 with simpodia disposed above 9–10 are discarded. As it was noted above (Simongulyan N.G. and others, 1987), the more attentive discarding is conducted with such traits as fiber length, fiber output, productivity, and so on, which are under the control of polygenes and considerably vary under the effect of growing conditions on account of genetic control peculiarities, their inheritance, and correlative relations. It is especially remarked that the lowered productivity may be conditioned by inadequate agricultural practices and not by the genotypes; not enough fineness and length of fiber in some combinations can be the consequences of the traits that are governed by the recessive genes; low fiber output has a negative correlation with fiber length; and so on.

Ample knowledge of the genetic principles of trait inheritance and also practice, attentiveness, and erudition of the breeder play a decisive role. Individual selections taken from the nursery of hybrid F_2 were exposed to supplementary study and discarding in the laboratory conditions. Fiber output is defined through the weighing of raw cotton of individual selection prior to separation of seeds and

successive weighing of fiber and seeds. The weight of fiber converts into a percentage in regard to raw cotton weight (photo 26). The length of fiber is determined in the technological laboratory. For this, six papus (seeds with fibers) are singled out from the middle part of cotton locks. The data is entered into a special form (appendix 6). If the individual selection has a paper with the number of bolls on the plant, there can be found an average weight of one boll by dividing the weight of raw cotton of the individual selection by this number of bolls. Following additional discarding based on laboratory analysis data, the material is being prepared for sowing in the nursery of the third hybrid generation, according to the seeding list.



Photo 26. Analyzing individual selections by assistants Sobirova Shokhista and Allashova Gulbakhor from the laboratory for the creation of cotton plant varieties resistant to salinity and water deficiency (2021).

F3 nurseries and subsequent generations. If the breeding process is carried out on a healthy background, the seeds of individual selections taken out of the hybrid F_2 are divided into two parts. The first part is intended to be sown in the nursery of F_3 in the main plot. The second part of the seeds is sown in the nursery of verticillium and fuzarium wilts for testing the resistance of the families. These nurseries are laid out in a separate plot where the soil is infected artificially by the pathogens of the diseases.

Hybrid seeds of F_3 in the healthy background are seeded as the individual families in the rows of 30-50 seed nests depending on the seed quantity. If necessary, standard is disposed of in every 9 rows as usual.

There is a **common idea** that the families of F_3 drive from homozygote hybrids of F_2 on the individual morphological traits are genetic and phenotypic uniform. As it is known that 50% of plants in the second generation are homozygote on the polygene traits, 25% of plants are homozygote on the traits controlled by two gene pairs, 12.5% of plants are homozygote on the traits controlled by three gene pairs, and so on. The plants of the F_3 generation are genetically uniform in certain traits. Either way, we note that the probability of discovering genetically uniform offspring of homozygote plants in F_3 on the more complete economic traits is significantly less than on the phenotypic.

Field observations were carried out in the nursery of F_3 , which remarked the best families and discarded the bad ones. Phenological observations on the blooming and maturation are implemented in the best, more phenotypic uniform families. The date of blooming and maturation initiation, the date of flowers' arising and the boll opening on 50% of the plants are determined in the families.

Testing of half of the individual selections in the artificially infected background gives the opportunity to judge the resistance of every family to disease. If the family was prone to wilt in the infected background, its half in the normal background will be discarded regardless of its other traits.

The best plants in F_3 are remarked for individual selections after the taking of probe samples. Such individual selections taken from the most uniform families of F_3 with elite complexes of economically valuable traits are intended to be sown in the breeding nursery of the first year; all other selections harvested from splitting families are sown in this hybrid nursery as successive generations. They are improved continuously in this hybrid or in the biological nurseries until the end of the splitting in them and are not transferred to the breeding nurseries. The most prolonged splitting is seen in the interspecific hybrids.

All data of field measurements, phenotypic observations, the results of analysis of probe samples, and records of family crops are included in "the main database of breeding (biological) nursery including the data of standards" to elucidate the best families in comparison with standards intended to be transferred in the breeding nursery. The raw cotton crop is defined via the addition of the weight of the probe sample, individual selection, and family harvest. The indexes of the families on all traits are compared to the half sums of neighboring standards.

Breeding nurseries for the first year the best materials selected in the hybrid nurseries are improved, evaluated, and reproduced in these nurseries. As the pathogens of wilt lay out hybrid nurseries in healthy and infected backgrounds, breeding nurseries are laid out. The agro-practices for caring for plants are considerably high. Every family occupies one row with 30-50 seed nests with single plants in them. The disposition of the standard is the same as in the hybrid nurseries in the case of necessity. The breeding nursery conducts a particularly detailed study on the families, their phenotypic distinctness, uniformity on economic traits, and crop stability. Field observation in the vegetation period is implemented three times. The second observation is carried out up to flowering, and off-type plants are removed from the families. If the off-type plants get more

than three plants, the family is discarded entirely. Phenological observations on the initiation of 50% germination, flowering and maturation are compulsory in the breeding nursery. Repeated discarding of families which contain off-type and disease-infected plants is carried out again just before harvesting. The family in the healthy background is discarded if its half-seeded in the artificially infected background demonstrates weak resistance to wilt. 25-50 boll probe samples are taken from all non-discarded families for analysis of cotton boll length, fiber output, and size. The technological quality of fiber is determined selectively. Individual selections are remarked in the non-discarded families by taking into account trait complexes. Total productivity of families is defined by analyzing the weight of probe samples, individual selections, and family harvests. Yield is calculated per plant.

[illegible]

The breeding nursery of the 2nd year is collected and set by the seeds of the best selections and family harvests of non-discarded families. Progenies of individual selections occupy one row lot, and several row lots are occupied by the seeds of family harvests depending upon the seed quantity. The same measurements and records as in the 1st breeding nursery are carried out in the breeding nursery of the 2nd year.

To prepare selected seeds for seeding Prior to making the above mentioned plan in the real plot of the department, the lab assistants of the department get to prepare seeding bags on the basis of selected seeds from former breeding materials as a result of visual and lab discards. This work is usually done in the winter months according to the list of future seed plantings (appendix 4) to place selected seeds in them. Seeding bags are preferably new, sewn from simple fabric material in the sewing shop to the size of 15 x 18 cm and have their own circled strings (appendix 8). They are numbered with a special chemical pencil in order to not wash off their color at the time of soaking. So, the seeding bags have growing numbers according to the planting numbers on the seeding list, and all selected seeds are placed in them. They are grouped by 100 each into chains (garlands) by twisting their strings together. Then, every five garlands (each with 100 seed bags) are gathered and placed in jute sacks measuring approximately 50 x 90 cm. These garland sacks are tagged with wooden tags numbered with growing numbers written by those chemical pencils. Besides the garland sacks, there should be one additional sack with seeds of standard variety to sow in the protective zone surrounding the nurseries in the plot. Most of the experimental plot, except for some first hybrid seeds, is sown by mechanical drill. On one of the sunny days in the beginning of spring, all the staff of the department come together in the square equipped with disinfection baths and water reservoirs with running water to redistribute seeding bags for operational order of the seeding drill.

The lab assistants take the garland sacks with seed sacks of standard variety out of the depository and put them aside on the square. The seed drill presents itself as a special one (look at the manual for practical training) and considerably differs from farmers' seeding drills. Here, a square about 20 to 40 meters in size will be represented as a real breeding plot, but only in decreased size. And all of the seeding bags are taken from their garland sacks and placed one by one on the land under the supervision of a senior scientist with a seeding list. The order of putting the seed bags should coincide with the drill's movement, which has four-row seeding apparatus and moves across nurseries of the experimental plot. Accordingly, this order of work redistributed all seeding bags on the ground. In this order, all seeding bags will have their new place on the land, similarly to the nursery rows where the seeds of each seed bag will be sown by that mechanical drill. If a part of the nursery for initial materials is purposefully intended to be sowed by hand, here will be placed empty bags with the numbers of rows only. With the help of the seed planting list, the senior scientist and others randomly check the correctness of the redistribution of seed bags in both order of the drill's

movement and seed bags on their own rows in the nurseries of the experimental plot. Eventually, the redistribution order of the seed bags should ensure correctness with regard to the space scheme made in the experimental register also. This will be accomplished by performing repeated checks by comparing seed bag order with nursery disposition in the space scheme (figure..). And after that, all seed bags are sewn together with breeding awl using firm thread in the consistency of the drill's movement. And now each garland sack (smaller than sacks for seed bag garlands) has to contain four chains of seed bags sewn in parallel to the direction of four seeding apparatuses of the drill across the nurseries of the experimental plot up or down. The seed sacks, according to their numbers, are divided into two groups to provide the drill with uninterrupted functioning. The first group of sacks is for drill's movement up, the second is for drill's movement down across the nurseries. No need to forget that the sacks with empty seed bags in their garlands have one duplicate sack with the seed bags. Their seeds have to be seeded by hand after massive seeding with a drill. The tag of this sack bears the record "Hand seeding" and the order number following the major seed sacks' numbers.

Chemical treatment of selected seeds. Usually, seeding takes place in the middle of spring, when the soil has yet to get warm enough and the part of sown seeds is injured as a result of disease caused by soil microorganisms. In order to prevent the loss of selected bred seeds, breeders use treatment of seed materials one day before general seeding. For this purpose, a bath was installed near the water reservoir for soaking of seeds. The bath is filled with water up to 70% of its volume. Then, formalin at 40% is poured into this water in the ratio of 20 parts of available water. The solution is mixed with long sticks until the solution gets its constant specific color. The immersing of seed sacks in the solution is started with the immersing of four first sacks at the same time. The quality of treatment depends on the completeness of sinking the sacks under solution and the soaking of all seeds in the seed bags. For this, sacks will be kept under solution for 30 minutes. After that, the first four sacks were pulled out of the solution, letting the excess solution flow out of sacks and put with their numbers on top beside the fence of the water reservoir. About three meters long, strong strings are tied to the necks of sacks and the base of the fence while other groups of assistants start to fill the bath with solution until the initial volume level and sink the second four sacks according to their numbers. This work will continue until the last four seed sacks have been tied to the fence of the water reservoir after soaking (chemical treatment) with solution. The sacks will be allowed to stay in this state until sunset, and then all sacks will be dropped into running water in the reservoir for the night carefully without tangling their strings with each other. One of the assistants will come early before sunrise and pull out all the sacks from the reservoir one by one and put them in their former places for their exceeded water flow. After two or three hours, they will be ready for general seeding in the soil of the experimental plot.

Sowing. A seed drill used to seed bred seeds in the experimental plot (photo 27, 28) differs from all other serial seeding drills in production (see the photo 5 in

the practical training manual published in 2022). It has seats for lab assistants and a wooden long box mounted above the seeding apparatus to put seed sacks at the time of seeding (look at that manual for practical training).

All seed sacks at the beginning of the working day, after having flown down of exceeded water from them for about two hours, are ready for seeding in the experimental plot. They are loaded on a special floorboard near the seeding apparatus of the drill and transported to the top side of the plot. The sacks are then unloaded and distributed against each nursery row above the top boarder of the protective zone (figure 7). Only the seed sack of seeds for protective zones is left on the side of the drill's floorboard, because the seeds in this sack are sown regularly when the drill comes to every protective zone, moving ahead and back. The senior scientist, who bears full responsibility, is responsible for the order and accuracy of sowing the bred seeds into their intended rows. Under his control and checking, the drill stands with landed apparatus above the top protective zone and first four rows of the nurseries. The assistants take their places above the seeding apparatus. The first two seed sacks with the numbers 1 and 2 on their tags are loaded onto the long wood box. The box of drills has the little four boxes against every sitting assistant for a hand knife or blade to cut the thread of her garlands. One of the assistants sitting on the beginning side untied the sack for a protecting zone and the first sack with seed garlands. All four assistants take seeds with the help of empty seed bags from untied protective seed sacks and put them on the bottom of the wood box against themselves. The four garlands from the first seed sack are distributed to the assistants in the following order: 1, 2, 3, and 4. Each garland consists of an equal number of seed bags distributed across the different breeding nurseries from top to bottom of the ground protective zone. At the command of the senior scientist, the drill begins to move ahead. The assistants begin to seed the seeds picked out for the protective zone. At the command of another scientist who is going side by side with the drill, shows the signal to the drill operator to stop the drill when the seeding apparatus of the drill gets the first internal protective path. The assistants replace the seeds on the first garland. When all the assistants are ready to seed, the drill starts to move ahead until the next internal protective path and stops again. The senior scientist, armed with his register of experiments and seeding list, continues his control over the proper working of a drill operator, assistants, and junior scientist. Such work interruptions continue until the drill is able to exit the ground protective zone. And it turns back with raised drill apparatus and assistants. The second movement of the drill begins with the seeding of seeds for the ground protective zone until the first internal protective path (look at the figure). Another junior scientist was ready to restore the damaged pigs after passing a drill over them. If the pig breaks, he immediately replaces it with a new one, as well as rewrites its former number. Time by time, in different parts of the plot, the senior scientist examines the correctness of the sowing. He stops the drill and checks the numbers of seed bags with the numbers for the respective rows in the seed list and the nursery along the resister of experiment. At the end of the general sowing of all nurseries, the drill moves

through two side protective zones without stopping. They have 4 rows each, and it needs only one movement of the drill up or down. The assistants will sow only the seeds that remain for the protective zone. The three scientists together and attentively inspect the accuracy of seed sowing and the safety of all pigs along the protective zones, internal paths, and across the breeding nurseries just after the completion of all seeding work.



Photo 27, 28. Mechanical seeder to sow the seeds of selected cotton materials.

The part of the nursery for initial materials left for hand sowing is used for special experiments. Usually, one of the junior scientists in the department runs here his or her department's special experiment. All scientific staff and assistants come together with seed sacks in hand to start seeding along the internal protective path to the destination. Assistants brought hoes to hand seed, pegs, and hammers. The list of seeds has been approved by the responsible scientist over this nursery after hand seeding. He conducts a little lesson about the order of seeding rows, the number of seed bags in the seed sack, the number of seed nests per row, and the number of seeds per seed nest. The scientists and assistants have mostly multi-year experience and do not face any difficulties in the implementation of the hand seeding. The work starts with assistants who make nests of the said number along the rows. Others continue seeding by putting the definite seed units in the opened soil nests from seed bags in their hands (photo 29-32). And the third group of helpers have already become busy with closing the seed nests with soil and are going to mark the rows with wood pegs. While the pegs are numbered by the responsible scientist on the basis of his seeding list, After the end of these tasks, he will check the accuracy of the seeding and remark the seeded rows. This proper order of hand sowing enables easy and authentically conducted observation, especially focused on some of the studies like soil disease resistance of seeds and their field germination capabilities.

The next day, scientists from the department inspect the soil above the seeded seeds and its humidity over the experimental plot. If the moisture of the soil is inadequate for seeds to grow normally, the first irrigation has to be organized.

Phenological observations, measurements, and statistical treatment of data. Phenological observation and measurements are the most vital and responsible tasks in the cotton breeding process. It means studying all breeding

forms and their progenies throughout the nurseries of the experimental plot, selecting the best plant and reproducing its seeds due to economically important traits and properties the breeder would like to see at the end of the breeding process. By the way, successful selection relates to the breeder's intellectual ability in regard to the inheritance law of cotton plant traits. Most of the economic traits of cotton plants are characterized by their polygene heredity. Traits like productivity and fiber quality belong to the polygene-controlling traits. Breeders can see frequent non-stop variation within experimental plants during reproduction on the above-mentioned traits. This presents a certain difficulty to the breeder in the selection of a plant with constantly hereditary traits. Consequently, the breeder in the laying out of the experimental plants in the nurseries and monitoring them should observe some of the principles underlined in the sciences of genetics and statistics. They claim that the traits are handed down from parents to offspring on the basis of G. Mendel's principles of segregation as dominant or recessive. Genes (alleles) of chromosomes responsible for controlling the trait come in pairs and are inherited as distinct units, one randomly from each parent. Here, by keeping in mind the statistical principles, the breeder tries to make as many experimental plants as possible in order to increase the chance of catching desirable individual plants with valuable trait combinations. Multiplication of seeds after the first study and lab analysis results in either increasing the number of experimental plant genotypes bearing a complex of valuable hereditary traits or decreasing it. However, it is important to remember that the segregation of dominant and recessive traits occurs not only as a result of genetic influences, but also as a result of natural factors that, unfortunately, work against breeders' expectations. Morphological shapes of plants emerge which hide the progeny of those selected plants in the previous year. Meanwhile, the number of experimental plants in each of the hybrid combinations has increased to several hundred plants (population) since the second (F_2) generation and continues to grow in the elder generations. Scientific staffs of the department have to secure optimal and constant agro-technical conditions for all nurseries under which the desirable family plants and lines of plants have to be evolved and mentored from the generation of the first selected plants. By caring for plants in time, it is possible to provide an optimum background for experimentally selected and hybrid plants' development. Here, it is necessary to remember the valuable information presented by well-known cotton geneticist N.G. Simongulyan (1987) about the genetic substantiation of traits which give the indexes of heredity.



Photo 29, 30, 31, 32. Seeding order of cotton seed samples by hand.

Accordingly, morphological (phenotypic) variation of the trait in the population represents the result of genetic heterogeneity in the population and variation caused by the effect of environmental conditions (paratypic). That is why phenotypic dispersion of the trait may be pronounced by the following conception:

$$\sigma^2_{ph} = \sigma^2_g + \sigma^2_e$$

Where, σ^2_{ph} – phenotypic dispersion; σ^2_g – genotypic dispersion and σ^2_e – dispersion caused by environmental effect.

Attitude of genotypic dispersion to general phenotypic is called an inheritance of trait in the **broad sense** and pronounces via symbol.

$$H^2 = \frac{\sigma^2_K}{\sigma^2_{ph}} \quad \text{or} \quad H^2 = \frac{\sigma^2_g}{\sigma^2_g + \sigma^2_g}$$

Genetic dispersion of population makes of three components – additive dispersion, its effect will not lose in the progeny, and dispersion, substantiated by the effects of dominancy and interaction of allele genes:

$$\sigma_g^2 = \sigma_A^2 + \sigma_H^2 + \sigma_N^2$$

Where: σ_A^2 – additive variance; σ_H^2 – dominant variance; σ_N^2 – variance caused by non-allele interaction of genes.

These effects are looked at the splitting time. Attitude of additive variance to general phenotypic variance pronounces the hereditary in the **close sense**:

$$h^2 = \frac{\sigma_A^2}{\sigma_A^2 + \sigma_H^2 + \sigma_N^2 + \sigma_g^2}$$

The more paratypic variation of the trait caused by the effect of environment conditions (σ_E^2), the lower the indexes of inheritance, and contrary, the traits, the less altering under the influence of cultivation conditions, have the values of inheritance equal to one.

Heredity also depends upon the genetic substantiality of the trait. The more genetically complicated a trait is, the more genes it is controlled by, the lower the indexes of inheritance. This theoretic knowledge is vital to the breeders in the understanding of essentiality in the hereditary reforming of cotton plants. Breeders should observe such commonly accepted theories on the inheritance of cotton traits and their alterations in the cotton plants. They are necessary approaches in the breeding process to increase the efficiency of selection in spite of existing difficulties, growing from generation to generation of selected plants. Furthermore, some of the new initial parental forms of cotton are included in the initial material lists each year and are started to study in the collection (initial materials) nursery, and some of them are subjected to hand crossings, newly in the hybridization nursery.

Hybridization is usually carried out in the different directions of crossing combinations depending on the program accepted by the decisions of scientists and on the general or specific combining abilities of the included parental genotypes. To overcome existing difficulties, the scientific staff of the department make maximum effort to keep optimal developing conditions for plants and control the effective breeding process comprehensively without losing desirable plant genotypes. The optimal conditions of cultivation exclude the environmental effect on the phenotypic reforming of new hybrid plants and enable us to see the inheritance of traits by the anticipated genes.

Phenological observation (monitoring) means exploring and selecting the best plants in the progenies (in the F_3 and following generations) of plant populations. Since the start of plant development phases, the breeders have been exploring the plants in their nurseries. A special notice with respective records on all remarked plants is made in the last column of the planting list remaining for this purpose (see appendix ..). For example, two plants within plants of one parental form population in their nursery have considerable distinguishing in their outstripping for over 4 days at the time of blooming. If they are not remarked in

time, they will be lost at the time of massive ripening. It is concluded that the accumulation of fruit components and crop per individual plant depends, in particular, on the control of two genes: early starting of flowering and ripening. As a result, these two plants make it possible to accumulate even more crop than any other plants which have shown earliness only at the time of massive maturity of bolls. In similar cases, in the course of exploring, researchers are obliged to make respective records with the number in the last column of the planting list for notices and to attach tags on those plants with that number. For this purpose, special numbered tags with strings are planned to be carried in the planting list during phonologic monitoring and recording. life cycle and development phases of cotton plants compile breeders to carry out a range of phonological observations, measurements, and accountings.

Traditionally, the life cycle of a cotton plant is divided into five developing phases: germination, the forming of the first true leaves, budding (or squaring), flowering, and maturation. They present some of the important periods of the whole vegetation life of cotton plants, from cotton seed sown in the soil to the ginning of raw cotton, which produces new cotton seed (appendix).. At least the following kinds of phonological observations and accountings have to be conducted in the cotton breeding process:

- seed germination;
- forming of the first true leaf;
- bud (square) forming;
- height of plants;
- number of vegetative and fruiting branches;(appendix6)
- blooming;
- maturity and rate of maturation;
- account of bacterial blight and wilt;
- phonologic analysis of hybrids, bacterial blight, wilt, and productivity.

Depending upon the breeding program, some of them would be unnecessary or be added with modified changes. For example, records on the field seed germination or rate of boll maturation, which are proceeded up to 50% or 100% of the quantity of sown seeds, seed nests, or in regard to tagged plants' numbers (photo 33, 34). The second and following observations are conducted along the growing plants in the rows. Similarly, as the MFE, a certain plant quantity (10, 20 to 30 individuals) is picked out, preferably in the center of each row and tagged with order numbers. The data recording and measuring are carried out according to small sampling (non-grouped data) or large sampling (40 or more plants) of the grouped data. This order of picking out the experimental plants is continued up to four times (as the replications) along the identical plants' origins from other rows disposed in other parts of the nursery. They encompass three or four replications, as they were described by the MFE. To do these and other observations, measurements, and accountings in the nurseries closely related to the accepted program for every nursery.

Seed germination in the field conditions is one of the important and valuable traits of any studied cotton plant. It becomes even more important when the new initial cotton samples or newly developed cotton families are studied in the course of the breeding process. In a week after seeding begins, the first observation on the account of seeds' germination in order to subject the collected data from this observation to statistical treatments, accounting rows should have at least three replications. A field notebook (take a look at the manual for practical training or appendix...4) is needed to make records from observation. It is prepared by one of the junior scientists prior to the start of the first seedling's emerging. This notebook has a title: "Accounting of the Field Germination on the Samples Taken from Pakistan (for example). The blank table in it has columns with records: the dates of seeding, the names of sown samples, date of sowing, the quantity of seeds laid out in each seed nest, the numbers of rows. Accounting is done by the assistants after getting necessary tips from the responsible scientist. According to the program of study, it may be conducted in regard to all numbers of nests (first mode) or numbers of seeded seeds per nest (second mode). For example, in the first accounting, the number of nests per row is observed, and on every third day, the number of nests with emerged seedlings is noted. The numbers of nests with emerged seedlings are increasing day by day. Every row in the replications has 20 nests. Accounting is continued until 50 or 100% of nests have sprouted seedlings.



Photo 33, 34. Registered cotton row and plant tagging.

The day when the remark about the number of nests in the row gets its 50 (10 units of nests) or 100% (all nests), the last written number is circled and stops the further accounting on this row. The similar completion of accounts follows in

regard to other rows in the replications. Some of the rows are left at the different levels until 20. After completion or circling the numbers in all observing rows, the collected data in the notebook is carried by the responsible scientist to the first blank page of this note book. Carrying across of the date of the studied sample is done by pencil in order of: one after the other, as shown in the methods of B.A. Dospekhov. Let's assume the scientist carried across the data (in units) of the first experimental sample or standard variety in the following order: On the four replications of the variety S-6037 (standard): 16; 13; 20; and 17.

Sample 1 (from Pakistan): 13; 15; 10; 16 and other observed cotton samples followed as those order.

The scientist according to the statistical methods on the small sampling treatment calculates arithmetic mean ($\bar{m}$ or $\bar{x}$), variance (s^2), standard deviation (s), coefficient of variation ($v\%$), arithmetic mean error ($s_{\bar{x}}$), relative arithmetic mean error ($s_{\bar{x}}\%$) confidence interval for mean ($\bar{x} \pm ts$) and degree of freedom ($n-1$). The results of these statistical calculations helps scientist to compute arithmetic mean and standard deviation at the levels of 95 and 99% confidence. On the base of these statistical treatments scientist can easily explain the populations' particularities on studied cotton traits.

The second way (or mode) of accounting is more complicated and is usually used to study the progress of the variation lines on this trait in the studied samples and varieties and even to compare them with a standard variety's variation. Here, taking into account of seedlings' numbers per nest and per every row in replications, the collected results have made it possible to expose the collected data on a large sample of statistical treatments. Furthermore, as a result of this statistical treatment, breeders would be able to evaluate the genetic potential of studied materials in terms of **broad and close senses**.

Form of the first true leaves. The first true leaf forms 10-12 days after germination (appendix3); the second and third follow 4-6 days, and the following ones every 2-3 days. The rate of formation of the first and subsequent true leaves is determined by the genetic characteristics of the studied material as well as the environmental conditions. Environmental conditions of spring in Uzbekistan when cotton seed is seeded are often characterized by harsh lowering of the soil temperature and increasing soil humidity as a result of sudden rains, which adversely affect the seed germination and further development of the leaves. As a result, most cotton breeding programs plan to differentiate introduced new breeding materials based on their resistance to adverse environmental stress. This is also regarded as one of the preliminary evaluations of newly introduced materials for future hybridizations or other breeding intentions. This observation was carried out in the nursery of collections. Accounting is usually done by two assistants. They are instructed by the responsible scientists of the department and provided with a field notebook (appendix 4) which has a title about the observation and an empty table to be filled at the time of accounting. The accountings are conducted once every 2 days, on the third day after the previous accounting, until 50% of all grown seedlings in the row have first formed true leaves. It continues

for about 3 weeks. The accounting data is subjected to statistical treatment in the same way that seed germination data is. The results of this observation help the breeder to know the development progress of studied cotton samples after germination. Because, in the growth cycle studied, cotton samples begin to differentiate not only in the growing speed but as well as in the resistance to biotic and abiotic stresses. Assistances, who conducted this observation and accounting, remarks on the state of the first juicy and fragile leaves. Their abnormal state in per cents or in quantities is regularly recorded in the last column of the field notebook's table. For example, 5% of experimental plants were injured or wilted and fell off by the pest attack. Even so, this population of samples is entirely susceptible (about 90%) covered by the black aphid (sectorial) and trips (rodents). These kinds of values in regard to studied materials have great importance in the entire evaluation of all breeding accessions. Because the breeder searches for valuable plants or plants from their populations in his experimental plot with complex economic traits and biological properties gathered into one single genotype.

A bud (or square) is forming. Accounting of the plant stand (density) in the rows is carried out before every phonologic observation – bud forming, blooming, and maturation. The budding stage begins 25–30 days after the formation of the first true leaf. In general, cotton plants are grown to get a high yield of raw cotton and fiber. The setting of bud structure (photo 35) and remaining in the form of cotton

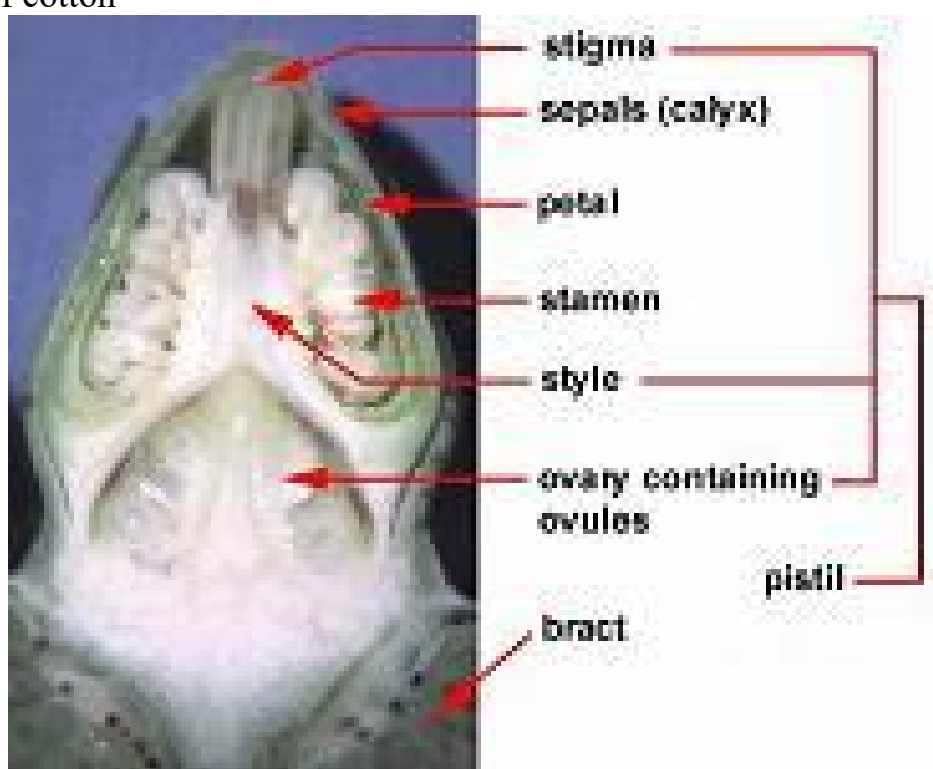


Photo 35. Cross section of square.

bolls until harvest is highly evaluated by the breeders. The safety of buds is related to the genetic features of the maternal plant and the influences of environmental stresses, which were minimized by the taking of necessary agro-technical measurements. Genetic scientists have discovered that the setting of buds on the

woods of cotton plants, which is characterized as a complicated trait based on gene complexes and some hybrid plants, in a particular generation show a complex of those genes gathered together in one genotype. That is why breeders planned to observe this in populations of newly introduced cotton samples and at the time of splitting generations ($F_2 - F_5$) in complicated or remote hybridizations.

Ten normally developed young plants are preferable in the central part of three rows as three replications per population are picked out and these 30 plants are tagged with respective numbers (photo 4). The necessary field notebook with its blank table is to be prepared until the first bud sets on the plants of this population. Sample names and the numbers of tags are recorded in the corresponding column of the table in the field notebook (appendix 9). The same organizational work is done for other sample populations to be observed for accounts of this trait in the experimental plot. There is no need for additional accounting training for assistants because they assisted in the selection of plant populations and plant tagging for this observation. Accounting is begun when one of the tagged plants in each replication of a sample begins to set the first normally developed buds. the first buds fall off and the first records in the column of the table are excluded with the sign of X. Next, the new date when the following bud emerges and forms normally, is noted in the table. Accountings are continued once every two days until all tagged plants have set normal buds. Since completing the accounting, the responsible scientist takes the field notebook to do statistical treatments. The statistical treatments were implemented on the pages of this notebook after the filled table. Transferred data is subjected to statistical treatment on the basis of a small sample. The obtained result merits drawing corresponding conclusions on the observed trait based on the phonological observations made above.

Height of plants. One of the characteristics of the cotton plant bush is its height. Plant trait accounting is done on a monthly basis. Every first or fifteenth of the month is designated for accounting on this trait. This trait is easily affected by environmental factors and has visible variations. For this reason, the number of experimental plants is increased to up to 60 or 100 plants. They are identified along the recorded rows by tagging two plants: the first and last on the rows, and measuring the lengths of their main stems. Their numbers are transferred into the tables of the next field notebook. This observation is often conducted on the valuable introduced varieties' samples or bred families. Such a large amount of data enables statistical treatment of the data using the large sample method. The lengths of the tagged plants are measured with the help of a special ruler (photo 36, 37) from the surface of the soil to the top growing points of the plants. Typically, data from the first months such as May, June, July, and August should be treated as a supplement to the main accounting conducted in September. The data from this last accounting are important because they coincide with the accountings of productivity traits. The statistical treatment should be implemented severely in the sequence of methodic order on a large sample as described by B.A. Dospekhov: all values on the plants' heights of the first population from the table's column are



Photo 36, 37. Variation of main stem heights at the time of cotton plant vegetation.

carried on the blank page of the same notebook in the same sequence as in the manual:

90	109	99	100	115	68	70	72	73	70
76	82	80	68	69	74	72	69	80	59
79	81	84	108	83	81	99	98	102	101
45	59	60	63	78	87	94	91	88	90
72	68	80	81	84	77	79	81	84	50
70	67	100	103	69	72	74	66	67	52
79	78	83	92	93	81	82	86	89	93
77	76	88	89	94	82	80	81	77	80
92	91	76	79	73	84	79	84	79	84
89	85	93	90	79	83	91	87	80	54

In reason of unsuitability of these values to characterization the height of first population, they are grouped with a certain interval. The interval should not be less 5 and more 20.

To find out the size of interval into which the variational series is divided by the formula:

$$i = \frac{X_{max} - X_{min}}{\text{Number of groups}} = \frac{R}{k}$$

The frequency of the variate in each group is determined by distributing the above-presented data between class intervals, as described in the manual as: "To avoid errors and minimize the time required to distribute the variates between groups, searching for and choosing similar variates in the population for each group is not advisable." It is preferable to separate the variates for groups one by one as they stand in the series. To do this, the scientist (analyst) uses one of the following methods. method of "strokes". The analyst crosses out the first data point in the original data and shows it in the appropriate row (group) in the working table with a vertical stroke. The first four data points in each class interval analyst are shown by vertical strokes, and the fifth by a diagonal stroke. method of "envelopes". The analyst shows the first four data in each class interval by points constituting the corners of a square; the next four data 5-8 are the sides of the square connecting the points shown earlier; the 9th and the 10th data he shows as diagonals. Thus, each of the ten data points are shown in the form of an "envelope" (table 8).

Analyst using manual order exposed the data to statistical treatment by the help of necessary formulas for large sample treatment. In the result he gets values of: arithmetic mean, variance, standard deviation (error of individual observation), coefficient of variation, absolute error of sample mean, relative error of sample mean, confidence interval for the universe mean at 5% level of significance for $n - 1 = 100 - 1 = 99$ degree for variation ($t_{05} = 1.96$).

Statistical treatment on the exemplary data, has result that the universe mean of studied trait at the 95% level of probability laid within 81.3 - 81.9 cm; the absolute error of sample mean is 0.132 cm; the relative error, 0.16%; the coefficient of variation of the technical stem length of population is 16.2%.

Then, a histogram or polygon of the distribution of 100 plants of the population on the stem length (figure 8) is constructed. The analyst lays group boundaries on the abscissa and frequency on the ordinate. This results in a stepped graph in the form of columns proportional in height to frequencies and having the width i .

In similar order, all collected data on the heights of other observing cotton samples should be treated. And the results of large sample treatments will be able to show the universal state of height in the cotton populations at the 95% level of statistical probability. This information would allow breeders to base future arguments about studying traits on facts.

Plant height accounting in the created families and lines is done in three replications. 10 plants are separated one after the other along the experimental row, beginning with the 5th plant and tagged with respective numbers (from 1 to 10). The other 20 plants were similarly picked out from the other 2 rows of the same population of plants. The specific feature of this observation is that measuring is always done at the same plants with the same tags and numbers. And great attention will be paid at the time of the next recordings in the field notebook in order to avoid entanglement of data from one plant with another one. Plant heights

are typically measured three times: in June, July, and at the end of August. And the total data is subjected to statistical treatment using the small sample method.

Table 8. Delivering of initial data on the groups.

Groups	Mode of “strokes”	Mode of “envelopes”	Frequency, F	Groups of variants
1. 40,0 – 48,9		•	1 45	
2. 50,0 – 59,9		• •	5 55	
3. 60,0 – 69,9		• •	11 65	
4. 70,0 – 79,9		• •	26 75	
5. 80,0 – 89,9		• •	33 85	
6. 90,0 – 99,9		• •	16 95	
7. 100,0 – 109,9		• •	7 105	
8. 110,0 – 120,0		•	1 115	
Sum			100	

Vegetative (monopodial) and fruiting (sympodial) branches. The formation of branches on the cotton plant has a key importance in the evaluation of initial materials and in the presentation of bred families or lines as a result of the breeding process. In general, any cotton material, depending upon origin and genetics, figures out one of the branching types: zero branching, limited branching, and unlimited (extreme) branching (appendix 10).

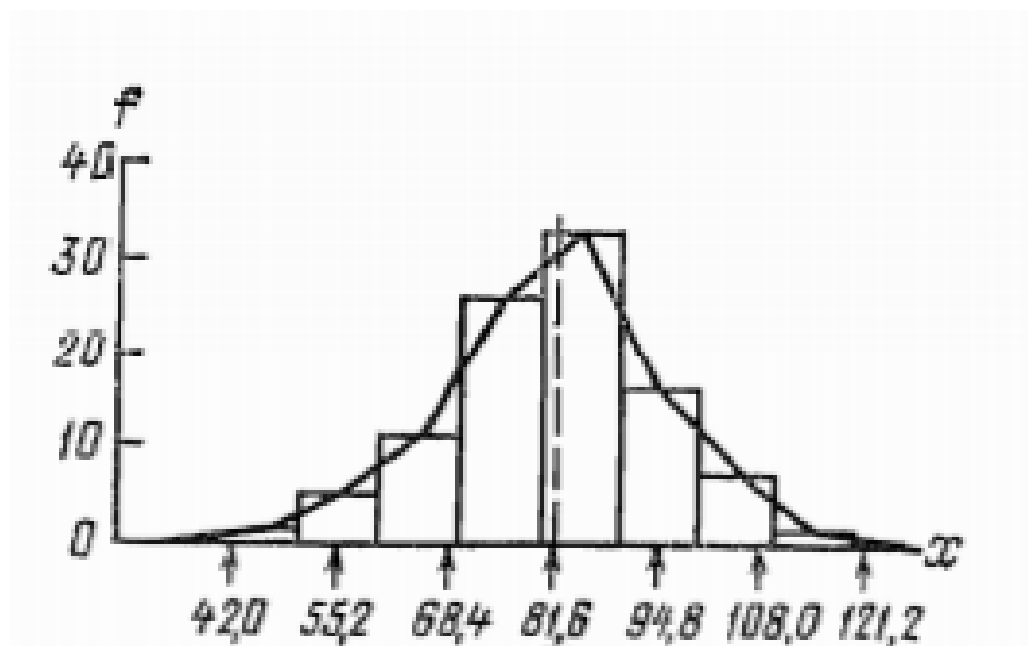


Figure 8. Histogram and polygon views of a distribution curve of 100 plants based on the height of the main stem.

Zero branching types have no vegetative or sympodial branches. Their fruit components form straightly on the nodes of the main stem. Most of the varieties of fine staple cotton are involved in this type of branching. Hereby, the above mentioned observations in the cotton population belong to the zero type of branching are conducted for determining the numbers of nodes with normally developed cotton bolls. Here, if the first node from where the first square (future boll) has normally been established is placed lower, this plant is highly emphasized and the accountings are targeted to define the heights of the first bolls on the plants. The observations need a separate field notebook. About 30 or 40 plants are picked out for three or four replications from the same cotton population. They may be from initial material, varieties, families, or a new line just developed at the department.

In the basic column of field notebook remarked the node number (4th, 6th or 7th) in regard of the trace of cotyledons. Collected data are subjected to the statistical treatment similarly to above listed observations and correspondingly by the method of small sample. And the result of statistical treatment 4 or 7 is figured out in the report table for every observed population under the column remarked "Height of the first sympodial branch (hs), m or $\bar{x} \pm s$ " (in which: $\bar{x}$ means arithmetic mean and s- standard deviation).

Determination of the height of first normally developed cotton bolls per plants of all studied cotton populations has made it possible to predict the earliness or late ripening and even the productivity of the studied populations, because between populations with 4th and 5th nodes on the accountings earliness on the flowering differentiated for 4-8 days and far more at the time of coming maturation. It is obvious that every cotton ball with raw cotton of 5 g formed 4 days before means a great yield contribution in the point view of 100 000 plants to

be cultivated per hectare. Contrary, the differences of studied populations on the productivity at the end of the year either can be grounded by their differences on the remarked height of the first node number from where the first boll formed and since the beginning of the vegetation.

The observation of this trait has its own unique characteristics with accountings in cotton populations with limited or unlimited branches.

The setting of fruit components occurs from the base of leaves settled on short fruiting branches, which were established from the base of the first leaf grown on the end of the first node of the fruit branch.

The unlimited type is characterized by the elongation of the distance between internodes, which is ranged from 5 to 10, 20 to 25, and even more than an average and marked in the first, second, third and fourth sub-types respectively.

The observations and accountings carried out in cotton populations belong to these branch types. Records in the field notebook are made on the number of the first node from which the first true fruiting branches were formed. However, in these cotton populations, vegetative rather than sympodial branches first emerged. So, in this case, the assistants who directly make accountings should have enough practice to recognize whether a newly emerged branch is sympodial or vegetative. Branch has to have a young bud at its growing point. If this growing point is completed with the young leaf, it would be a clear prediction that here exactly will develop a vegetative branch. Usually, plants of the best commercially grown cotton varieties begin to form the first fruiting branch after 3-6 growing branches (figure 9). These numbers are noted in the last column of the field notebook, where they should be recorded as "notes". Namely, the late ripening of the cotton plants is closely related to these indexes. Because the development of growing branches considerably inhibits cotton earliness. Unfortunately, single cotton plants with only sympodial branches occur rarely in cultivated cotton populations. Consequently, the breeders everywhere intended to select only cotton bushes with a lower number of growing branches. Growing branches also form fruiting components, but later as the second order.

As a small sampling, the selected plants are picked mostly from families and lines to study their dignity as the result of the plant breeding process. Besides this, all tables presented for the demonstration about the study of any initial cotton accessions or samples and the ongoing breeding process should have a table column "Height of hs". As a result, observation on the accounting of growing and fruiting branches is included in the program of all experiments on breeding material research.

Some of the report tables include a column for **"Number of sympodials"**. In this case, together with counting up the number of the node from where the first sympodial branch developed, the total quantity of sympodials formed for the vegetation period of the studied cotton population is calculated. Of course, the counting of them will be done at the end of the vegetation period. Collected data is subjected to the statistical treatment of the base of a small sample. The results obtained in the experimental plants of all studied populations assist the breeder in

conducting structural analyses on every bred material to determine their potential in terms of farm and biological yields.

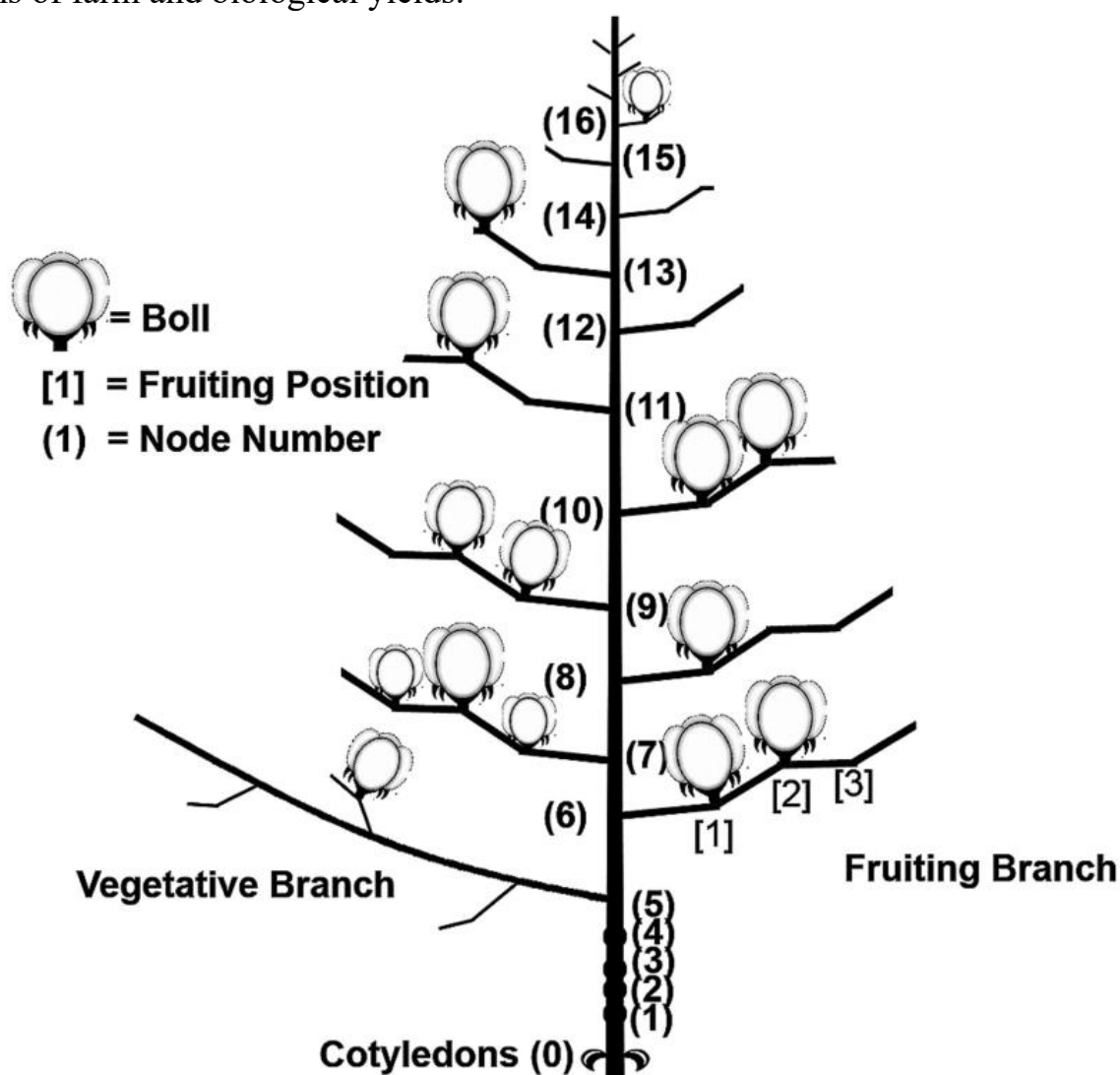


Figure 9. Location of some cotton plant structural components.

Blooming and its rate. Accountings on the blooming of flowers are carried out in all nurseries except the hybrid nursery of F_1 and F_2 . In the nurseries of the older generations they are conducted selectively, according to the intention of the breeder, mostly in morphologically uniformed families. Phenological observations on the blooming are compulsorily conducted in the elite families and lines studied in station variety trials. At this, plants in one row out of other rows are remarked with tags to account for the blooming. This row shouldn't have even one plant with a growing point damaged. The quantity of all plants in the row is counted. The first plant in the row is tagged, and the tag has to be kept until the accounting on the maturation in the fall. And the nursery's name and numbers of tags, row, and quantity of plants in the row are marked in the field notebook before accounting (appendix 4). Depending upon the earliness of the observing cotton populations, the accountings are conducted daily or in a day and the data is recorded in the respective blank table of the field notebook until the blooming gets up to 50 or 100% in regard to all numbers of plants in the row. The rate of blooming is

regularly marked on the tags of individual plants by writing the dates of the first and other successive flowers' emerging like: 20.06; 23.06; 26.06 and so on (figure 9). These tags should be kept on the plants until the maturity phase in order to continue the accounting of the data on the rate of maturation and eventually to pick them up for statistical treatments.

Maturation and its rate. The repeated counting of the plants is especially necessary prior to the start of maturation in order to correctly identify the date of maturation and later to calculate the productivity of raw cotton per plant. As a result, the quantity and states of plants in the rows, as well as their tags, are verified again just before the observation to collect data on maturation. If there were some plants damaged by diseases during vegetation or loosed native growing points on the tops of the remarked plants, they are excluded from the former quantity of studied plants. Maturation is defined first. We observed the course of emerging open bolls on plants along the rows. It is better to do an accounting of up to 100% of plants with opened bolls. The total quantity of observed plants per every population would enable the breeder to entirely analyze the genetic potential of the maturation. Accounting for the maturation rate is similar to accounting for the blooming rate. Correctness of the completed date of the observation may cause some difficulties for the assistant who is responsible for the observation. In some days of accounting above, of plant populations with opened bolls, it seems that their numbers became too much more than expected (50 or 100%). In that case, it is accepted to mark the date of the passed day.

By the way, the rates of blooming and maturation closely correlate with the duration of short and long sequences of blooming and maturation (appendix 11). The following works are done to define the rate of blooming: tags are tied on the flower stalks of forming flowers in sequences of 10 plants in a row. The date of blooming, the number of fruiting branches and their place on this branch are written on the tags; at the defining of the rate of maturation, the same records are repeated on the same tags (photo 37). In autumn, all the tags are brought together and calculated into the short and long sequences of blooming and maturation in the days. It should be noted that the duration of sequences is not significantly varied in the case of buds and young bolls falling off.

Phenologic observation for hybrid analyses on the phases of development and the duration of vegetation period is required to be conducted within hybrid progenies (F_2 - F_3) and hybrid families. Every hybrid plant in the selected rows was provided with a tag. All plants are regularly recorded on their tags with the date of their first bud, first flower, and first boll. Finally, the dates of the tags enable scientists to calculate the duration of development phases and vegetation periods of all hybrid plants in the row. This is a time-consuming and labor-intensive process, so many assistants are required. These assistants had to pay for some other newly emerging traits in the hybrid populations. For example, the shape of bolls, leaves, and length between nodes of the main stem are immediately recorded in the respective column of the field notebook. Their maternal plants are tagged with

marked numbers. The genetic and practical connections of the above-mentioned traits with purposeful traits of the population are studied by the breeders.

The data collected in these observations is enough to subject them not only to small sample and large sample but also to hybrid specific analyzing statistic treatments.

Historically, some of the serial forms (with blank tables) to collect the data from phonological observations were published in the publishing departments of the SRIs, but they weren't always suitable for use in all observations of the breeding process, and scientists of the breeding departments had to invent by hand with alterations, which fully fitted to their own observations and accountings.

Account of bacterial blight and wilt. Accounting of infection by bacterial blight is done two times—in the month of May, when the seedlings emerge, and at the end of August. Infected plants are diagnosed by the existence of oil spots on the cotyledon leaves (cotyledon form of infection), stems, and bolls. The accounting takes into account the total number of infected plants independently of the extent of infection. Observation of this disease is important in the nursery where initial cotton accessions are grown and their resistance to it is studied.

In general, accounting of wilt is carried out in the fields artificially infected by the disease-causing pathogens—in the middle of July, August, and at the end of September. Records are kept in order as: -total number of plants infected by wilt in general extent (weak infection) and in a strong extent. When weakly infected plants are infected, the whole leaves or leaf edges wither and begin to fall off; the edge places of leaves wither and bolls fall off, and the plants produce a small crop. Strong extent, the plants lose all leaves and the whole crop. This disease is one of the most disastrous diseases of cotton in our republic and its pathogenic effect is studied in natural and specially infected soil conditions. That is why all experimental plants in the breeding plot are under observation by the breeders with regard to naturally existing pathogens causing this disease. Any individual plant in any breeding nursery with a morphologic outlook that resembles the symptoms of this disease is immediately noted in the respective field notebook, and elite plants in this row are not allowed to be selected.

Hybridization. Deliberated pollinations in the nursery of hybridization, in general, are carried out annually by the help of instructed assistants. They fulfilled on the base of prior mapped out and approved paternal and maternal plant combinations (look at appendix 8). Annual list on the coming hybridization is composed with the selected parental forms by using commonly accepted symbols (maternal plant **symbol** ♀, paternal plant **symbol** ♂) in the list and on isolating butterfly paper packages. These packages with the size of 15 x 20 cm bears order numbers up to 150 and united into one bundle for every combination. Except the order number, combination of crossing with names of two parental varieties together their respective symbols (♀ Karshinskiy-6 X ♂ ML-108) should be written on the every package. The numbers of defected packages at the time of pollination will be fixed in the blank cells of crossing list every day. Except

bundles of isolating packages there should be surgical blades, gentle brush, Petri dish, sharpened lead pencils, paper caps, ring (plastic tube), paper tags, one or two bundles of color threads (about 15 cm long) containing 1000 pieces each one for binding the packages putting on pollinated flowers. This set of equipment is used as the necessary supplies for cotton plant pollination and kept by placing them into one special lab bag with the size of 50 x 60 cm (in cotton breeding practice this bag named as row crop harvest bag) and is carried by the assistants of the department with themselves at the time of plant pollination.

Naturally, cotton is considered a frequently cross-pollinated crop. Usually it consists of 75% self-pollination and 25% outcrossing, but due to insect activity it gets up to 50%. The first flower to open occurs on the lower side and near the main axis (appendix 7). And instructed staff for pollination have to keep in mind that the cotton plant itself is self-pollinating and does not need artificial pollination to set a crop. The flowers open as white blooms in the morning with self-pollination occurring within about 4-5 hours. Fertilization of flowers occurs 12 to 24 hours later and is completed in 36–40 hours after pollination. The first pollinated flower requires 6 to 8 weeks to ripen. A young fruit or fruit bud is called a square. The most generalized explanation of this process can be found by listing the following in order: pollination by pollen grains; germination of pollen grains; penetration of the ovule; and fertilization. This knowledge helps them to implement the handmade pollination in time and to a high quality.

Handmade pollination is a common technique that consists of three main steps: 1) pollination bud selection; 2) emasculation; and 3) pollination (a bunch of photo ..38).

Selection of flower buds for crossing is initiated in the second week after the start of the first flower blooming. Then, according to the list of crossings, the rows of necessary rows where were grown maternal plants were examined for the adequate state of plants and their flowers. The flowers at the proper stage of development (buds which are likely to open the next day) are selected for emasculation. In general, such buds have a creamy-yellow color and are well formed. Emasculation is done in the evening by the selected buds of maternal or female plants. At this point, the petals and stamen tube surrounding the style are gently pulled off after a shallow cut given by the thumb nail in the base of the petals. If the nail is not pointed enough, it can be made by cutting the petals through giving an incision with a surgical blade near the basal line (or at the bottom near the calyx). Then, the staminal column along with anthers and attached corollas are removed gently with both hand thumbs. And now, to check if there is not even a single pollen falling on the surface of the opened female parts of the flower and an absence of ovary injury on its thin protecting cover. After that, emasculated flower covers (bagging or selfing), in which depending on the convenience can be used one of three selfing techniques: paper cap, ring or mud swear, and tagging all emasculated flowers by writing on tags the male plants' names. The next morning (9 to 10 a.m.), the opened flowers of male plants are collected from the rows by looking at the numbers of list crossings and pegs'

numbers on the rows. Anthers of flowers are rubbed against the stigma of an emasculated flower and then bagged with the needed remarks with the date of pollination, symbols, and names of parental plants as mentioned above. In some cases, petri dishes and gentle brushes, or even plastic tubes with a 3 cm length, are used to collect pollen and dust it on the stigma of emasculated flowers. Prevents self or random cross pollination of flowers because matured pollen is shed directly on the stigma. In other cases, straw tubes may be used for collecting and pollination. They were filled with pollen from male flowers and put on the emasculated stigmas.

Under an uncontrolled situation, cross-pollination would reach up to 25%; sometimes it exceeds 50%. However, by combining pollen from own and off-plant plants, this method can also be used successfully in purposeful crossings. If the crossings, for some reason, are conducted without emasculation, the tag is hanged on the scape with an indication of the combination and date of crossing (photo 38).

At least 150-200 flowers (with an account of 30% shedding) have to be pollinated in every combination in order to ensure the adequate dimension of the hybrid population in the progenies of F_2 . Because the maximum potential for the conjugation and recombination of available parental gametes to target traits takes place in this progeny of hybrids.

Harvest of raw cotton out of crossed plant combinations but plants infected by wilt and off type is required to be done in the autumn separately. Taking into account the number of crossing combinations, the same number of row crop harvesting bags are prepared to harvest matured hybrid bolls. Bags are marked with numbers and tags with cross-names. The numbers of the bags refer to certain crossing combinations and are either written in the corresponding blank cells of each female parent in the list of crossing combinations or at the time of harvesting, the bags are laid out on the rows of nurseries where the female parent plants are. Responsible lab assistants to harvest check the similarity of the crossing combination written on the bag tag and the paper bag of matured boll. This order secures the proper harvest of hybrid bolls from all crossing combinations. All bags with harvested hybrid bolls are put on the shelves of the depository and stored until the necessary seed separation and study. Usually, bolls are inspected in the fall-winter period for the color of fiber, seed fuzz, length of fiber, and other traits. Then hybrid seeds are united over the combinations. In other cases, when genetic observation is intended, the seeds of the hybrid bolls on the combinations are not united, stored and seeded separately in the parted experimental plot.

Despite the long history of various methods of hand pollination being described, it has remained an undeveloped handwork. It is commonly recognized as a tedious, time-consuming, and inefficient process. Many scientists all over the world worked on new methods of crossing based on male sterility. They suggest that incorporation of a new innovative method for pollination would avoid the need for hand emasculation in the cotton plant, thus encouraging target crossing and producing only hybrid seeds under natural conditions.



Bunch of photo 38. Images of pollinating steps.

Study of productivity. Breeders pay great attention to the productivity of experimental plants because of its decisive role in the breeding process. Accounting of fruit setting and raw cotton yield precedes the identification of the productivity of studied cotton populations.

Accounting of fruit setting is conducted selectively in the different nurseries depending on the intentions of the breeder. 10 plants are picked out at random from every registered row. It is usually carried out in September, until early frosts. It accounts for the total number of all bolls, cracked and non-cracked, and also the number of fallen fruit components. Counting of bolls is done by following this order: first counts and records the number of fruit components on the monopodies, then on all sympodial woods from the first until the last square. By holding in hand the main stem, one counts the number of bolls on the first wood, then, without letting go of the hand, moves it up until the second fruiting wood and counts the number of bolls on it. Similarly, the counting of fruit components continues in sequences from wood to wood up along the stem. The left hand does not hold the stem off all the time in order to don't miss sympodia or don't count the number of bolls on that twice. The same approach is repeated for counting the places of fallen fruit components. The determination of the place of fallen components is easy because the nodes with fallen components are disposed against every leaf on the sympodia. This accounting is one of the complicated tasks, and it is to be done by a pair of assistants.

According to common breeding practices, a separate account of opened, immature enlarged, and immature small bolls may be conducted instead of a general account of all maintained fruit components.

Accounting of the raw cotton crop in the breeding plot is carried out by the following sequence:

- harvest of raw cotton probe from opened bolls;
- harvest of raw cotton from individual selected plants;
- general harvest of raw cotton in the discarded rows;

general harvests of raw cotton in the registered rows (families)-prior to frost and after the first frost.

All these harvests are conducted after prior preparation measurements related to the preparation of separated lists for each harvest on the basis of field notebooks under the personal control of the senior scientist or even by himself. Then assistants get to start preparing different bags for harvest. The bags (for probe, individual selections, general harvest of registered rows and supplementary bags for prior and after frost crops) are numbered similar to the numbers registered in the respective harvest lists. They are packaged into bundles of numbered bags with 100 units in each one. Raw cotton from the discarded rows is harvested beyond the harvest lists in the working bags without numbers. The weight of raw cotton in these bags is measured on the working scale and they are handed over to the ginnery house of the SRI with the needed reference on behalf of the senior scientist. All junior scientists in the department actively take part in these projects.

Harvest of raw cotton probes. Probe bolls (raw cotton of bolls) are picked up from the first place on the second to fourth fruiting woods as possible, as well as from all plants in the rows remarked by the breeder. There is no need to take more than two bolls from one plant. 25 boll probe samples are taken from the collection nursery. F_1 –10 and F_2 –25 boll probes from hybrid nurseries; 25, 50 boll probes from breeding nurseries depending on row length; and 100 bolls from station variety trials. Mature bolls from competitive trials are taken for all plants, independently of their disposition on the plants. About 200 bolls are harvested in sequences on every replication. Inspected bolls are brought together in a special wooden box with cells (photo87). In every cell is placed one boll. From the filled boxes, the raw cotton is replaced in the numbered bags prior to being laid out on the registered rows. Every bag has a tag that records the year, nursery name, row number, and bag number. At the same time, the numbers of the row, bag, and line are written in the form or notebook for probe samples. The bags with probe samples are tied to each other to make garlands and then placed in large sacks with respective numbers. These sacks are transported to the storehouse. At the time of lab analysis, 22 locks are taken from the middle of the breeding probe sample and then one seed fiber (papus) within every lock is separated. 44 locks are singled out from probes taken from station and competitive variety trials. The seed fibers from every probe sample are put on individual folded pages (photo 39), on which are written the probe, row, and bag numbers. The same data is recorded in the list, which together with seed fibers is handed to the technological laboratory or the

fiber lengths are measured by the lab assistants after a little instruction. Remained probe samples of raw cotton are weighed and taken weights are written in the same form after separation of fiber seeds to measure the length of fiber. Weighing is conducted on the scales with an accuracy of up to 0.1 g. **The size of one boll** (weight of raw cotton per one boll) is defined by dividing the weight of raw cotton in a probe sample by the number of bolls. Then the material is handed to ginning. The fibers of probe samples are compulsorily kept. Seeds and fibers from every probe sample are weighed individually after separation of fibers from seeds. **Fiber output** is calculated via the expression of the percentage of fiber weight separated from seeds to the total weight of raw cotton in the probe sample. This data is included in that form which rewrites the data about the fiber length of probe samples received from the laboratory of technology.

The fiber probes from some families are distinguished as the best once the complex of traits are sent to a technological laboratory for defining as well as their fiber strength, rupture length, metric number, and maturity of fiber.

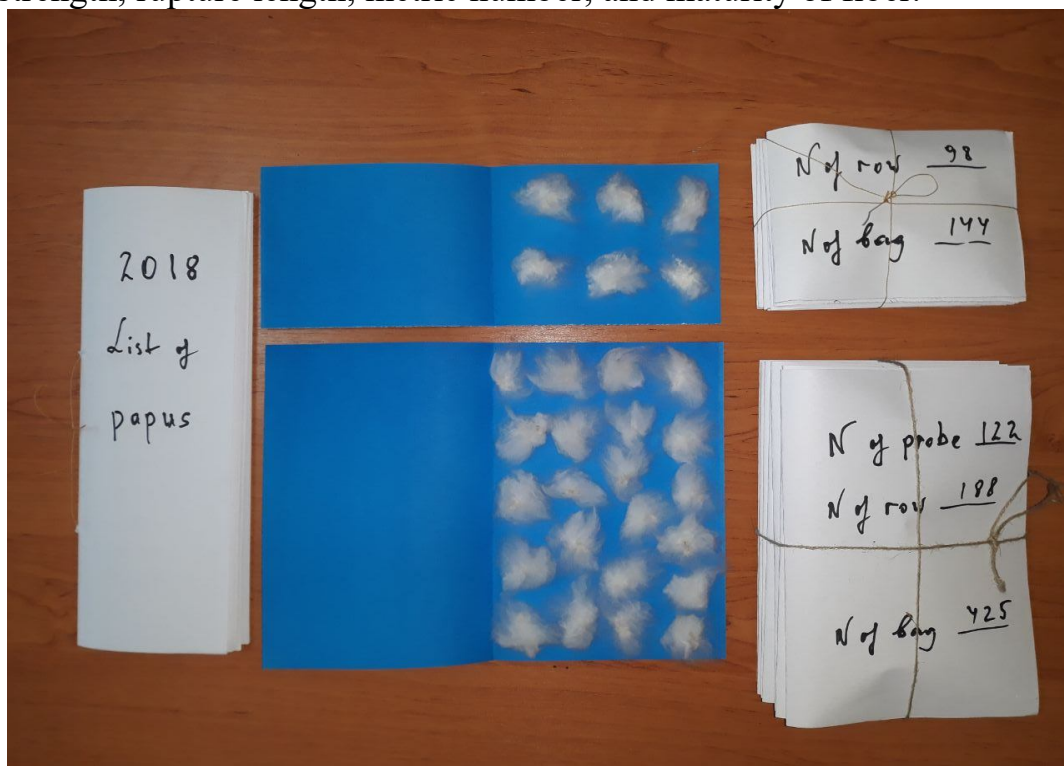


Photo 39. The SRI's technological laboratory will receive the list and papus.

Harvest of individual selections. Individual selections are remarked from the best uniform plants with complexes of economically valuable traits in the generation of F_3 after taking out the probe samples. The seeds of individual selections taken from the most uniformed families of F_3 are planned for seeding in the family (breeding nursery of the first year); all others retained, except discarded at the time of lab analysis, are kept for seeding in the hybrid nurseries of the next generation. These materials are polished up in the hybrid or family nurseries until there is continued segregating in the families and are not handed over to the parts of breeding nurseries.

In general, individual selections are marked by the senior scientist (or breeders) at the phase of maturation, when the plants have 6-8 open bolls. If the selections are made too late, when the majority of the bolls on all the plants have opened, the breeder will be unable to reveal early ripening plants. In contrast, when selections were fixed too early, at two-three opened bolls, the breeder had no way of accounting for plant maturation rate. The tops of plants fixed to selection are broken or raw cotton is wound around the plant tops. The breeder remarks the number of selections on every row in his field list. Assistants before the beginning of the harvest under the control of the breeder hang the bags on the remarked plants. The bags are prenumbered consequently. At the transfer from nursery to nursery, their numbers are continued and do not begin with the first number again. So, all the bags of individual selections for one year have different numbers. At the same time, the numbers of the rows and the numbers of the bags laid out in the rows are registered in the new special list (appendix 4). The harvest of raw cotton from plants is then completed; raw cotton is only picked from fully mature bolls. In some cases, individual harvests are accompanied by the counting of the bolls on the plants. Bags of individual harvests bind to each other and make a garland with 100 individual bags per harvest bag. They are put in large tagged sacks and transported into dry storehouses. In the laboratory in winter, five seed fibers (papus) are taken from each individual selection before weighing their raw cotton to define the length of fiber. For this, six locks are singled out from different places of raw cotton of one selection, and from the middle of each is taken one papus. These papuses out of one selection are put into one folded page on which is written the number of rows and individual bags. At the same time, their information (with the name of the variety or others) is recorded in a specially prepared list. They are bundled into packages with ten pages in each, and with the list are sent to be analyzed in the technological laboratory (photo 39).

Raw cotton is weighed on a technical scale with an accuracy of up to 0.1 g, and the weight is recorded on a special form. They were given to ginning after being weighed as raw cotton. The seeds are separated using 10-saw fiber cleaners. After that, the seeds taken from every individual selection are weighed and the fibers as well. If only the seeds are weighed, the fibers of all individual selections unite at the ginning. The percentage of fiber output on every selection is defined on the basis of data on the weight of raw cotton and the weight of seeds. The percentage of fiber output can be defined not only by the weight of seeds but also by the weight of fiber. To define fiber output, the weight of raw cotton of individual selection is accepted as 100% and the weight of fiber is expressed per cent in regard to raw cotton weight. The data on the fiber output is also recorded in that form for individual selections. The data received from the technological laboratory on the definition of fiber length was also recopied in that form.

Row harvests are carried out to specially prepared and laid out bags on the rows of the registered families into the harvest list. Raw cotton harvests out of families until frost (I and II harvests) and after frost is conducted as the following: probes and individual selections from all registered rows. The crop of

the first harvests out of the best families of breeding (family) nurseries appointed to hand trial and seed multiplication is kept; the raw cotton of other harvests is weighed in the field and written off as the technical. The crop of registered rows from row bags is brought together into sacks with tags laid out early on the rows; on the tags are written the numbers of nursery, rows, and sack. At the time of the weighing of raw cotton, which is implemented in the field, all information from tags and weight indexes of all family harvests is rewritten in the special form of the list. The sacks (see appendix 5) of family harvests are tied to each other into groups of 10–50 units each (depending on the size of the sacks). Then they were transported to the store in the dry storehouse until ginning.

The most prolonged splitting into different genotypes is seen in the progenies of interspecific hybrids. All data on the field accountings, phenological observations, results of analysis of probe samples, and accountings of family crops are entered into the "Basic Report of Breeding Nursery" in order to detect the best family in the comparison to the standards which are planned to be handed over to the breeding nursery. All data standards are also added to that report. The crop of raw cotton is added up from the probe sample, individual selection, and crop of the family. The index of family on all traits compared with an average index of neighboring standards.

So, the breeding process involves reasonable monitoring with making timely remarks on the distinguished plants and multiyear selections by successively checking the progenies and reproductions in the optimal background; "from diversity to uniformity and stability" results in obtaining comparably unified, productive plant families meeting the expectations of the ultimate output of the breeding process. These families are studied in the completion stages of breeding processes in which the qualitative traits of fibers as well as stabilization of biological properties take place.

While fiber assessment*, families*, disease and pest assessment* are carried out correspondingly in a specialized laboratory equipped with fiber test instrument (in particular HVI) and in the condition of areal isolated field where soil and plants artificially infected or populated by the harmful diseases and pests. For these purposes, in the first case, the sample of fiber in the amount of 4 grams picked out (in 3 replications) from the fibers harvested from the best families is fluffed and cleaned by hand and placed gently inside of two-page envelopes with the size of 10 to 15 cm, with the numbers of the order recorded in the list. Then, in packages of 10 samples each, they are sent to the fiber testing laboratory. In the second case, a specially infected field is disposed far enough from the main breeding plots of all breeding departments and its soil and experimental plants are annually infected with pathogens of disastrous diseases or pests to test the resistance of selected families to those specific diseases and pests. This part of the breeding process has to be implemented in cooperation with scientists of the SRI of Plant Protection. They are specialists in the artificial infection of soil and plants with diseases and pests. By their methods, they conducted seeding, phonological observations,

measurements, and accountings of the experimental plants in the infected background.

So, the newly created, new cotton families are the output of the above-listed proceedings of the breeding process conducted in the breeding plots. Furthermore, in some textbooks like published in 1987 by N.G. Semongulyan and others, the uniting of seeds from all family harvests, which had original relationship and transfer to extended variety testing, was noted. The author of this book, on the basis of his activities in the breeding process from 1985-1994 at the breeding department of the SRI on the breeding and seed production of cotton, has described that 3 or 5 families annually were isolated from the 2nd year of breeding nursery. And experienced breeders advised them to test primarily for one year in the nursery of station testing (figure 1) designed in the breeding plot. Only after that, not more than 2 out of them could be represented in competitive variety testing and prior to extended variety testing and extended seed reproduction.

Station testing Some of the developed new cotton lines have to be present in the near future as the cotton varieties extend across the regions of the agricultural industry. That is why they are required to be at the top in any way in their productivity and fiber quality competitiveness not only nationwide but also internationally as distinctness, uniformity, and stability (DUS). So, the station testing organized in the sphere of breeding plots has extraordinary importance in the creation of new, elite cotton varieties.

The methodic condition of station testing coincided with the testing condition of a special plot under the governance of the SRI in which two-year competitive variety testing is conducted.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “History of *G.hirsutum*”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

Table of Insertion of the Pedagogical Technology

The rule of filling in the table of insertion. They themselves systematized the information acquired during the study – “they insert” in the columns of the table according to the marks noted in the text:

“V” – relevant to the information that I knew;

“-” - contrary to the information I know;

“+” - new information for me;

“?” - it is not clear to me or information needs to be clarified.

V	+	-	?

Chapter 2. **Conception about cotton variety.**

The term "cotton plant variety" means an aggregate of cultivated cotton plants, similar in phenotypic and economic valuable traits, adapted to joint cultivation in certain agro-technical and soil-climatic conditions. But we can see insignificantly different definitions of this term of plant breeding and its seed production in the related educational literature of other crops.

According to the international sources of information plant variety may refer to

- Variety (botany), a taxonomic nomenclature rank in botany, below subspecies, but above sub-variety and form
- Plant variety (law), a non-taxonomic, exclusively legal term
- An informal and ambiguous substitute for form (botany) (a taxonomic nomenclature rank in botany, below variety (botany))
- An older substitute for cultivar or hybrid (biology), now discouraged by the International Code of Nomenclature for Cultivated Plants. It is still used especially with regard to grapes and rice.

Cotton variety performance was evaluated at experiment stations and in farm fields, but performance may vary on individual farms due to soil type, environment, and other factors. Producers should select recommended cotton varieties tested at the locations most representative of their farms. Currently, by the world's cotton growing experiments, it has been proved that if the new cotton variety has an advantage in its economic traits and biologic properties than widely commercialized varieties and has taken progressive technologies for cultivation, such a variety can give 20–30% more crop, which is seen in the examples of foremost cotton farmers. While these varieties are separated based on yield, producers also should consider other important factors such as resistance to pests and diseases, drought tolerance, fiber quality, earliness, etc., when making their last selection.

New varieties are intellectual property of breeders and are created through the breeding process as a result of multiple selection unless to get uniform material with a genetically stabilized complex of traits. If selection was not conducted sufficiently during the creation of the new variety, such a variety appeared genetically non-uniform, and it inevitably lost its valuable property as a result of segregation. Selection is continued as far as achieving genetic uniformity by the hybrid population and forming variety. But the character of the selection and the intention to pursue them changes. If the selection has a directed creative character in the process of variety breeding and later, in the population of formed variety, it has a stabilizing character; the aim of saving the initial concentration of new variety genes is pursued. This is attained by maintaining only those individuals who correspond to the norm of variety reaction; saving only the modal part of the population, all those who are beyond the norm of variety reaction are rejected.

The International Union for the Protection of New Varieties of Plants (UPOV), an intergovernmental organization with headquarters in Geneva, operates all over the world (photo 40). It was established by the International Convention

for the Protection of New Varieties of Plants. The Convention was adopted in Paris in 1961 and it was revised in 1972, 1978, and 1991. The major mission of this international organization is to provide and promote an effective system of plant variety protection, with the aim of encouraging the development of new varieties of plants for the benefit of society.

On the basis of the respective information of the UPOV, dated February 22, 2021, it has a total of 77 world countries in its membership with Uzbekistan.

One of the major tasks in the resolution of the President of the Republic of Uzbekistan dated April 27, 2018 on the measurements in the radically improvement of the seed production system in the republic was "to conduct full inventorization of all existing varieties of agricultural crops in the country and their molecular-genetic (DNA code) passportization as well as to implement the registration of new plant varieties in the UPOV to protect the selection achievements of the country."



Photo 40. Headquarters of the World Intellectual Property Organization and of UPOV, Geneva, Switzerland.

It is noteworthy that the "General introduction method to be conducted on the testing of distinctness, uniformity, and stability (**DUS**) of plant breeding achievements" has been worked out by the technical commission of the UPOV and approved at the 36-session of the convention held in Geneva in 2000. With accordance of the chapter 11 of this document the specialists of a national center of Uzbekistan for testing of agricultural crop varieties and the breeders of related SRIs have together worked out the new methods to test the priorities of the plant varieties to protect.

A comprehensive explanation of the conception of cotton variety is given in the international context of plant variety rights (PVR) and plant variety protection (PVP): "Plant Variety Rights are an internationally recognized form of intellectual

property used to protect unique plant varieties." The PVR system allows plant breeders to collect royalties on the production and sale of seed of their protected varieties.

The determination of the scope of protection of a plant variety right lies in the area of conflict of several objectives:

What is to be protected by an industrial or intellectual property right largely depends on the intention of granting an exclusive right to a certain object. As regards inventions, including improvements in plant breeding, the purpose is to foster progress by granting, for a limited period of time, the right to the creator to exclude others from using his achievements in order to allow the exploitation of the invention to the best possible extent, and thus not only to leverage the investments made in the invention but to induce further research by the inventor/breeder.

The reward concept needs to be considered from three aspects:

- There is an existent claim to the protection of breeding activities that result in a variety which differs significantly, in at least one decisive characteristic, from every other variety of the particular type generally known on the date of application;
- On the other hand, an adequate scope of protection must be ensured which, in view of the breeder's exemption, does not allow third parties to simply create something new by using a protected variety, thereby putting into question the amortization of the efforts of the breeder;
- Finally, the basis of the rights granted must be defined or described as precisely as possible so as to allow the right holder to assess the scope of protection of his right. This mirrors third parties' interests in being able to ascertain whether their activities may possibly infringe granted rights.

The last aspect has a close tie with the objective that the grant of a right should induce third parties to continue their efforts to find or to invent something new in light of the information achieved from the latest technical advancements due to the publication of the invention.

1. **The Object of Protection**

1. Article 3 (1) (ii) of the International Convention on the Protection of New Varieties of Plants 1991 (UPOV 1991) obliges the contracting parties to the Convention to grant protection to varieties-not defined in this Article-of all plant genera and species.

Object of Community plant variety rights

Varieties of all botanical genera and species, including, inter alia, hybrids between genera or species, may form the subject of community plant variety rights (CPVR).

Similarly, Article 5 CPVR defines the object of community plant variety rights as **varieties** of all botanical genera and species, including, inter alia, hybrids between genera or species.

2. Article 1 (vi) UPOV 1991, which is reflected identically by Section 2 of Article 5 CPVR, defines the term "variety". According to this provision, "variety" means

"a plant grouping within a single botanical taxon of the lowest known rank"
as far as it is possible

"-defined by the expression of the characteristics that result from a given genotype or combination of genotypes,

-distinguished from any other plant grouping by the expression of at least one of the said characteristics, and

considered as a unit with regard to its suitability for being propagated unchanged. "

In indents one and two, reference is made to the **expression** of characteristics. The requirement "*distinguished from any other plant grouping by the expression of at least one of the said characteristics*" in indent 2 refers to the distinctness requirement as defined in Article 7 of UPOV 1991 and Article 7 CPVR.

If the above-summarized conditions are fulfilled, a plant variety in the sense of the Council Regulation is given, regardless of whether it meets the protection requirements.

Moreover, Section 4 of Article 5 CPVR has to be taken into account for the determination of the object of a plant variety right as well as for its scope of protection. Section 4 emphasizes that all plant material belongs to a variety as defined in Section 2, regardless of whether the expression of the characteristics is invariable or variable between variety constituents of the same kind, as long as the differences result from the genotype or a combination of genotypes.

It takes into account that the expression of characteristics is dependent on the specie and more or less variable, not only due to environmental conditions but also due to the fact that living organisms are subject to constant variability.

Thus, there is rarely factual identity in the phenotypic characteristics, even among plants of the same variety. As long as variability is caused by the genotype or a combination of genotypes, the same does not determine a different variety.

In order to find out whether variations in the characteristics of a variety are due either to the cultivation conditions and/or to the natural variability of plants of the relevant species, in most cases, a technical examination in the form of a comparison trial is performed, including comparison varieties which the Examination Office deems necessary to include in such trials. In the frame of the technical examination of a candidate variety, plant material of the variety will be grown by the Examination Office and, in compliance with Article 57 paragraph 2, examined with regard to the DUS-requirements in accordance with the Test Guidelines issued. If distinctness cannot be assessed in a reliable way by comparing documented descriptions—which is usually not the case—the candidate variety must be cultivated by the Examination Office side by side with varieties which it deems to be included in the technical examination.

3. The objective protection criteria are summarized in Article 6 CPVR, which, in essence, is identical with Article 5 UPOV 1991.

Article 6-CPVR

Protectable varieties

Community plant variety rights shall be granted for varieties that are:

- (a) distinct;
- (b) uniform;
- (c) stable; and
- (d) new.

Moreover, the variety must be designated by a denomination in accordance with the provisions of Article 63 CPVR.

In the context of this article, the distinctness requirements need to be scrutinized more closely.

4. Article 7 of UPOV 1991 defines a variety as being distinct.

".. if it is clearly distinguishable from any other variety whose existence is a matter of common knowledge at the time of the filing of the application."

In contrast to Article 6 (1) (a) of the 1978 Act, no further explanation is given with regard to "*clearly distinguishable*". The 1978 Act included the requirement that the characteristics which define a distinguishable variety "*must be capable of precise recognition and description*".

Article 7 of the CPVR is more precise. It requires, with regard to distinctness, that the variety must be clearly distinguishable, **by reference to the expression of the characteristics that result from a particular genotype or combination of genotypes**, from any other variety whose existence is a matter of common knowledge on the date of application. From this definition, the conclusion must be drawn that the object of protection is plant material defined by its specific characteristics, which

- Its genotype or a combination of genotypes must be determined by its genotype, thus excluding characteristics caused by external factors and
- Such characteristics must allow a clear objective distinction between the varieties that are capable of being described.

5. A PVR protects the variety in its genetic singularity, which finds its expression in a characteristic outer appearance. This appearance must be sufficiently different (distinct) from the appearance of varieties of the same species and the relevant application date. Distinctness, however, is not sufficient. It must be determined by the genetic structure of the variety and not by any external factors that influence it from the outside, such as cultivation and environmental conditions. Moreover, the differences must be obvious.

In comparison to patent rights, not an abstract idea-the exercise of which leads to a technical solution-is protected but the object of the breeder's activities, namely the plant material achieved as a result of his breeding activities. In this context, "result of breeding activities" refers to not only the systematic effort to obtain plants with desired characteristics through the use of classical (technical) breeding techniques, but also the discovery of plant material that exhibits

characteristics that distinguish it from plants of the same species. While wholly naturally occurring plant groupings, such as sports or mutations, regularly do not fulfill the protection requirements of uniformity and stability, the finder of such material is awarded by the grant of a plant variety right if he achieves the removal of lack of uniformity and/or stability through his skills.

II. Scope of Protection

1. According to Article 62 CPVR, a decision to grant the applied for community plant variety right shall include an official description of the variety.

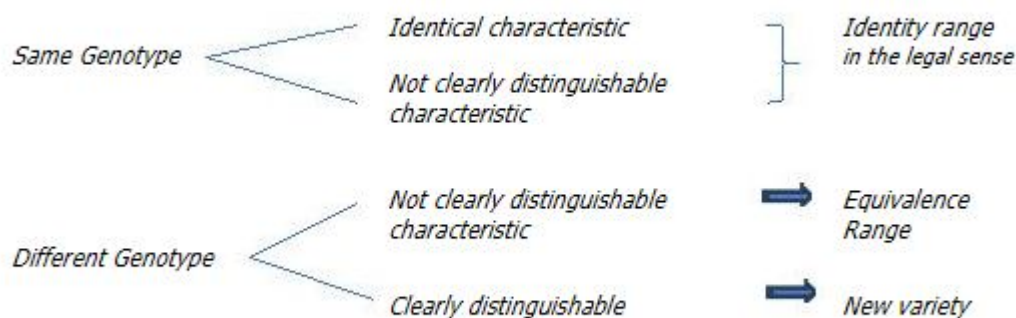
According to Article 57 CPVR, the Examination Office shall, at the request of the Office or if it deems the result of the technical examination to be adequate to evaluate the variety, send the Office an examination report and, where it considers that the DUS-conditions are met, a description of the variety that is part of the Community Plant Variety Office (CPVO) decision.

The scope of protection of a protected variety is determined by the combination of the characteristics specified in the granting decision of the Community Plant Variety Office, as set forth in the official description of the variety in accordance with Article 62, sentence 2, of the Community Plant Variety Regulation, insofar as the same can be attributed to the genotype or a certain combination of genotypes. Most of the characteristics specified in the variety description are subject to environmental impacts and hence fluctuate more or less according to these influences; the scope of protection of a protected variety also incorporates the variations/alterations expected for the plant species in question. The German Federal Supreme Court names this the so-called "tolerance range". 1. This ascertainment of the German Federal Supreme Court creates the impression that the official variety description, which was generated within the framework of granting protection, determines the range of identity. Equally, Article 62 creates the impression that the characteristics, established by the granting authorities as a result of the technical examination and on which the grant of plant variety protection was based, allow an unambiguous determination of what is precisely protected. This, however, is not the case as the variety description does not mention the fluctuation range.

2. Unlike the subject matter of patents, an abstract solution to a technical problem, plants, as living organisms, are essentially subject to the conditions under which they are propagated or grafted and cultivated. The environment and cultivation conditions, such as soil properties, water supply, fertilization, quantity of light, and similar factors, are crucial to the expression of the characteristics of plants. The consequence of this interaction between plants and the environment is that, depending on the environmental and cultivation conditions, the same genotype could produce different manifestations, that is to say, different phenotypes. Changes in the phenotype caused by external factors are reversible, as opposed to evolutionary (genotype) adaptation, which relates solely to hereditary properties. The variations in the expression of characteristics caused by the environment and other cultivation conditions change the outer appearance. These

changes are not due to a genotype or a combination of genotypes determining the plant and, thus, do not characterize another variety than the protected one.

3. Only the genotype is decisive. All variations in the phenotype that can be traced back to the same genotype thus fall into the range of identity of the protected variety. Because, despite advances in genetic structure analysis, it is still not widely possible to determine which sequences of a DNA are "responsible" for reducing specific physical and phenotypical properties that determine variety, it must be decided on the basis of the outer characteristics whether any differences that can be ascertained in different years of observation are caused by one and the same genotype, a different genotype, or by exclusion. In order to make such an assessment, the fluctuations of the phenotypical characteristics, i.e., modification in the sense described above under II.1, must be known within the plant species to which the variety in question belongs. If all fluctuations of a variety typical for a certain species are traced over a number of years, the species' variation range is determined. If the range of modifications of characteristics of the respective variety lies within this variation spectrum, it can be concluded that these fluctuations are exclusively determined by outer factors and not due to a different genotype. These different characteristic features determine the identity range of the protected variety in a legal sense. The equivalence range in the sense of plant variety protection law is then determined by alterations going beyond the variation or modification range that are not clearly distinctive in the sense of Article 7 of the CPVR and Article 7 UPOV 1991. The above may be illustrated by the following drawings:



As living material is continuously subject to changes, the variety description has to be seen as a summary of the observations made by the Examination Office during the year or years of examination. It only describes the expression of the relevant characteristics in relation to the expression of the characteristics of the varieties included in the technical examination in the relevant year or years, as the expression of the characteristics in the plant variety description is dependent, on the one hand, on the external conditions in the relevant examination year and, on the other hand, on the expression of the characteristics of varieties included in the comparison tests.

For this reason, the examination of whether a new variety fulfills the DUS requirements is not based on a comparison of the variety description—being part of the decision to grant the right—with descriptions of the comparison varieties but is made by means of a biological comparison as described earlier.

In light of the above, the Board of Appeal of the CPVO most recently outlined the following in its decision of September 2, 2016 in appeal case A007/2007-RENV under paragraph 36:

The unique nature of the plant variety is reflected by the fact that the emphasis is on the physical material, the plants themselves, and not on the description of the variety. In other words, both the evaluation is to grant and the decisions relating to infringement of registered plant variety rights are also made by reference to the actual plants concerned. In particular, the plant material of the candidate plant is normally compared with control varieties from within the same species in a comparative cultivation for assessing the distinctness, uniformity, and stability (DUS) criteria. Variety descriptions of plant varieties do not have the same legal value as patent claims. Whereas the scope of protection of patents is assessed on the basis of the plant claim, the assessment of a plant variety is generally conducted in a trial (technical examination and technical verification) and not on the basis of the variety description. The variety description is nothing more than a "snapshot" of the plant variety as it was tested.

III. Outlook

In principle, since it is impossible to examine distinctiveness by a comparison of variety descriptions and bearing the deficiencies in a description of the features of a protected variety in mind, the question should be given thought to whether, in light of the progress achieved in recent decades by analyzing the genetic structure of plants, modern DNA technology should be used to determine whether a variety is distinct or not. This question has been a matter of debate among breeder organizations for quite some time.

In light of the difficulties already mentioned with regard to proving the main protection criteria "distinctness" by a clear visible distance between the relevant phenotype characterization of the candidate variety and its closest neighboring varieties within the same species, it seems that using the genotype or a combination of genotypes represented by the plant's DNA as the basis for examination might not only increase the difficulties in determining a right which gives sufficient scope of protection but, presumably, will create more legal uncertainty for the rights holder as well as for third parties. The reasons are the following:

Even now, minimal distances are the subject of great debate. The value of a right depends on the scope of protection it grants. The less innovative a new development achievement is in comparison with what is common knowledge, the less value a granted right will have. Exclusive property rights have, as already mentioned, inter alia, the purpose of allowing the holder to leverage his investments. This cannot be achieved by rights which only grant a minimum of protection. Aside from the fact that there is insufficient information about genetic

linkage, making DNA marker profiles unpredictable for most phenotypic characteristics, the use of such markers could result in a decrease in distance between varieties, as stated in the ESA Position Paper published in 2003, and thus "jeopardize the value" of the rights. The ESA Paper mentions, moreover, that markers would have to be used to test uniformity and stability as well as distinctness, and there could be consequences to using the markers for that purpose. While this argument, however, is not further specified by ESA, It supposes that assessing uniformity and stability by comparison of DNA profiles will be even more complex or possibly impossible in comparison with the present practice.

The ESA position is shared by the ISF. The ISF is opposed to the use of DNA markers for DUS testing because

- Due to a lack of genetic linkage information and the complex way in which genetics controls the phenotypic traits, these are not yet predictive of many of the phenotypic characteristics.
- If these markers were used to determine distinctness, they could also be used to determine uniformity and stability, which could give rise to both financial and technical problems;
- Their use would not recognize the extent of existing variability within a variety, which avoids narrow genetic diversity and could serve to emphasize cosmetic or non-valuable characteristics and, finally,
- could serve to decrease the minimum distance between varieties and jeopardize the value of the right granted.

The debate with regard to DNA analysis to establish whether a new variety is essentially derived from a protected variety proves that, for the time being, determination of the degree of similarity in the genetic structure through genetic analysis is only a rather simplified method. Such a method to examine whether a new variety is sufficiently distinct to varieties of common knowledge is not (yet) apt to, first of all, justify the grant of an exclusive right. Moreover, such an approach does not guarantee that something really new has been created which deserves to be protected. Finally, with all probabilities it will not allow to determine the scope of protection for others not to run into infringement problems with the required certainty. The most reliable technique to determine the scope of protection of a variety is a comparison test as provided in Article 56 CPVR."

Chapter 3. **Cotton varieties must meet certain requirements.**

Cotton plant variety, like all other agricultural crop varieties, is an extremely important means of high efficiency in agriculture, providing the opportunity to get higher crops from the same area at the same cost. Up to date, bred cotton plant varieties present themselves as a community in the origin and uniformity of the population, which distinguishes them in a certain condition of cultivation by definite economic and biological traits. Usually, the varieties are adopted in definite agro-ecological conditions and give the highest productivity. And, because changing cultivating conditions, the development of virgin areas in new ecological zones, and the perfection of agro-practice works to cultivate cotton plants necessitate the continuous renewal of cotton varieties,

Extension of innovative technologies in the cultivation of agricultural crops is considered one of the key directions in agriculture based on market principles. An integral part of innovative technologies is the cultivation of typical intensive varieties to secure higher, earlier and more stable crops. Cotton varieties of intensive type are required to have higher productivity and earliness, resistance to diseases and pests, fitness to mechanical care after and harvest of the crop, high fiber output, length and textile properties of fiber, and a good oil content of seeds. Cotton varieties have to possess the highest adaptive possibility to changing environmental conditions, including deficits of moisture, and efficient response to improving agro-backgrounds. The characteristic particularity of intensive type varieties is the combination of high economic productivity and earliness at the limited development of the vegetative weight of plants.

Accumulation of high economic yield is secured by superior photosynthetic activity of leaves and changed accumulators in favor of fruit organs. That is why the varieties of intensive type react to improving agro-background by increasing economic yield in contrast to the varieties of extensive type. All these requirements must be kept in mind during the creation of the new varieties. By the way, breeders have to take into account not only the requirements of to-date but also those changes which may occur in the agricultural industry in the next ten or more years. Only with this approach, the varieties of cotton plants that have been around for about ten years will be cultivated for a long period of production.

Productivity is the most economically valuable property of the cotton varieties. The number of normally developed bolls per plant and their size—the weight of one boll refers to the structural components of cotton productivity. In general, about half of the fruit components formed on the cotton plant are shed as buds (squares), flowers, and young fruit in spite of possessing a great potential for boll setting, even in the most optimal conditions of cultivation. When watering is insufficient, soil fertility is low, and other unfavorable conditions exist, the

percentage of fruit components shed increases. Variation in the accumulation of fruit components and their shedding is the result of their hereditarily conditioned cotton varieties. The number of stored bolls on the plants defines, at the highest rate, the productivity of cotton rather than their size. It is widely known that the varieties of extremely enlarged bolls have fewer bolls on the canopy (bush) and that is why the creation of the varieties with one boll weight of 8–8.5 g is not purposeful. Taking of enlarged boll varieties has a sense when there is the highest share of hand picking. Because of the decline in hand picking due to the introduction of mechanical picking in farms, a weight of 7-7.5 g per boll is optimal.

The cotton plant is cultivated for the sake of its fiber. Fiber yield is defined by the total productivity of a variety and its fiber output, that is, the ratio of fiber to the weight of raw cotton. The variety with the higher fiber output at an equal crop of raw cotton gives a great crop of fiber. Fiber output depends on the seed weight and index of fiber. Preferably, the fiber output has been defined not by lowered seed weight but by the higher index, that is, the thickness of the fibers on the seeds. It was calculated (data of Symongulyan N.G. and others., 1987) that increasing fiber output by 1% across the country gives the government an additional 570 million meters of fabric. That is why the state plan to provide since 1984 has been based not on raw cotton but on fiber. This has stimulated a radically growing necessity in the varieties of high fiber output and so was born one of the most actual goals because of the cotton industry, which does not have cotton varieties with a fiber output of more than 36-37%.

In the international arena of cotton exports and imports, based on mainly the trade of cotton fiber, 1 kilogram of which belongs to the middle staple cotton varieties, is equivalent to 1.41 USD. Cotton belongs to fine-staple cotton varieties, which are expensive over 1.7-2.2 times (data of 2020).

One of the leading economic traits of cotton plants is its earliness. The cotton belt of Uzbekistan is located in the most northern zone of the world's cotton cultivation, between 37 and 41° northern latitude. The restricted period of vegetation in Middle Asia has made the real productivity of cotton varieties dependent on their earliness. The term "earliness" refers to not only the size of crops grown from cotton varieties, but also the quality of raw cotton and fiber, the possibility of mechanical harvesting, and the raw cotton production cost. Commonly, the term earliness means the rate of accumulation, the output of a crop, and the length of the vegetation period. Crop accumulation rate is determined by the length of short and long sequences, which demonstrates variety specificity (see appendix7). Crop dimensions are determined not only by the date of the first square or flower on the cotton plant, but also by the intensity with which they

accumulate. The scheme of flowering in varieties with branchy spreading (non-limited) type of fruiting branches, first described by G.S. Zhaitsev, and the scheme of flowering in varieties with limited branching (figure 10) are well known. It can be seen that the horizontal lines that correspond to major simpodial branches are applied on both sides of the vertical axis, which corresponds to the main stem. All simpodial branches, with the exception of monopodials of the bush, are divided into tiers on the three branches in each at the time of consideration of the scheme of flowering. If we accept that a short sequence of flowering is equal to 2 days, and a long sequence to 6 days, the ratio of long to short is equal to three ($6:2=3$). Correspondingly, the sequence of the blooming of flowers within the bush will be as shown in this scheme. So, blooming goes up from branch to branch on the first nodes, accompanied by the opening of flowers at the same time on more and more peripheral nodes of distinct branch numbers of previous tiers. Blooming extends rapidly upward, faster from branch to branch than the sides along the branches. Consequently, the space which was occupied by the blooming within the bush at every moment has a cone shape.

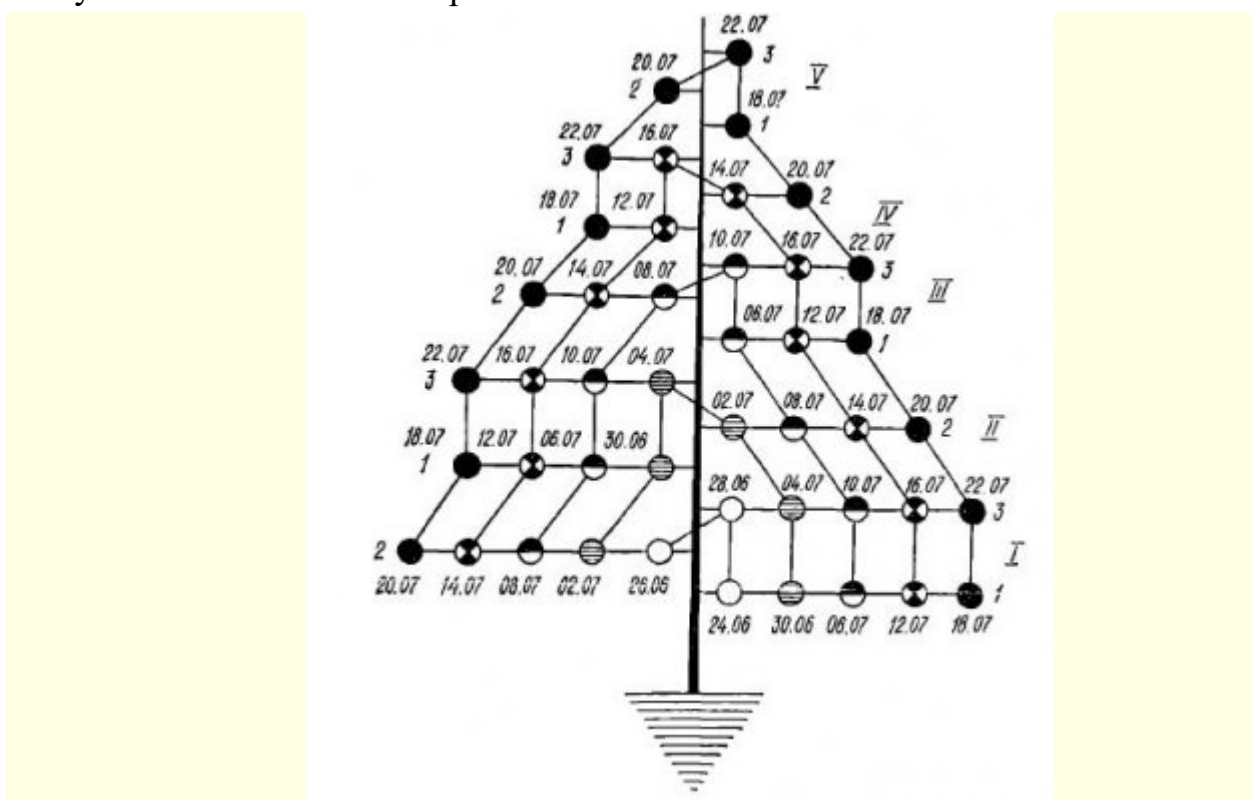


Figure 10.. The flowering scheme of cotton plants at the long sequence to short 6:2 ratio (the number of tiers of simpodial branches has been denoted by Roman numbers, the order numbers of branches in the tiers of two sides have been denoted by Arabic numerals).

By observing the flowering within the bush, the successive formation of individual cones of bloom can be distinguished, which occupy definite nodes of simpodial branches on their concrete tiers. So, the first cone of blooming forms out

of first node flowers on the branches of first tiers; the second cone – out of first nodes of second tier and flowers of second nodes on the branches of first tier; the third cone – out of first node flowers of third tier, flowers of second nodes of second tier, and the flowers of third nodes of first tier branches; and so on.

A long period sequence is absent in the limited type of simpodial branch, and the first square on the left simpodial branch has flowered at the same time as the second square on the previous simpodial branch. It was calculated that 15 flowers were produced at a certain time in the varieties with limited types of simpodials, 11 flowers in the varieties with non-limited types of simpodials, and a completely similar sequence of flower production occurred in the varieties of zero-type branching of *G. barbadense* L. species.

The varieties of simpodial type have similar sequences of the opening of next bolls but different durations (in days) of short and long sequences that determine the rate of bolls' maturation. The varieties with an early starting ripening date but a slow rate of boll opening cannot be considered early maturing. The rate of ripening is judged by the indexes of a decade's raw cotton harvests. This index should be taken into account when the varieties are estimated. The length of the vegetation period (appendix 14) is a complicated trait that depends on the duration of growth cycles (germination of seeds - square forming) and time required to turn a bud into a flower and one day square into an opened boll (squaring - blooming, blooming - maturation) of marked intra cycle periods ranges depending on the varieties, soil-climatic and agro-practice conditions. The number of days from sowing to the opening of the first boll, crops of first and until frost harvests, and raw cotton harvests are used to determine earliness in breeding work.

The resistance of cotton to diseases is connected with physiologic, anatomic, and phenotypic peculiarities, and they are the most important economic valuable traits of a cotton plant. Special consideration is given to the resistance of cotton varieties belonging to *G. hirsutum* L. species to verticillium wilting damage, as this disease is a persistent threat. The history of cotton growing showed that the crop lost in the years of massive infection attained almost several dozens and radically worsened the technological quality of fiber.

Breeding of wilt-resistant cotton varieties is one of the ways of controlling this disease. All other agro-practice measurements do not provide long-term and sustainable results. That is why the state variety trial and the preliminary seed reproducing organizations accept varieties only with superior wilt resistance. The cotton varieties created on the basis of the historically existing races of wilt (1 and 2) are perfectly non-resistant to the last, more aggressive strains. As a result, a complex resistance to the new varieties is required, which is known as horizontal resistance. this purpose, the search for immune donors to the new races of

pathogen and the attempt to combine genes of resistance to different races through hybridization of varieties resistant to race 1 and tolerant to successive races Early ripening varieties, spreading more in the northern regions, should be resistant not only to wilt but also to bacterial blight of cotton, which damages cotton at lower temperatures and high humidity. The varieties of fine staple cotton have to be resistant to fusarium wilt, macrosporous and black root rot. The disease of black root rot on *G. barbadense* varieties, which is widely spread throughout Central Asian cotton-growing republics, was first identified in 1926. So far, improper attention is paid to the development of forms with hereditary resistance against the damage caused by mites, aphids, winter moths, and others. To combat the pests, they use chemical preparations of high toxic index that require technical insecurity and precaution measurements on the part of rural populations. This question has acquired a special significance in the last dozen years because it is one of the most current problems of modern life – the problem of the environment from poisoning, especially by the substances of cancer genes, mutants, and others threatening the health and heredity of men, animals, and plants. As a result, developing pest-resistant forms based on their anatomical, phenotypic, and physiological characteristics, as well as developing biological measurements of pest battles, merits special attention.

With the transfer to complex mechanization of cotton cultivation, the suitability of varieties to mechanical cultivation and harvesting acquires paramount significance. Such varieties should have earliness, weak leaf density, and a strong, non-lodging stem. Cotton varieties with a spreading canopy, fruiting woods of the third and fourth types, and plants with large twisted bolls are less suited to spindle machines. This is observed in some varieties with simpodials of limited and short fruit scapes. To modern type machines, the fruiting wood should be no lower than 10 cm above the ridges of the row; otherwise, the machines will not capture the bolls located lower.

It is the heavy leaf density of plants that makes the effect of defoliant difficult on all leaf surfaces. In the varieties suitable for the machine harvest, the strength of fiber coupling with pods has to be in the range of 200–250 g. and the strength of coupling in the locul is 100–150 g. At the strongest coupling on loculs with pods, the fiber residues are left on the plant, and at the weakest coupling, the fibers fall on the ground as a consequence of the shaking at the time of machine passing. The fitness of varieties to machine harvesting ensures the higher efficiency of machine work. The varieties of cotton have to meet not only the requirements of the agricultural industry but also those of the textile industry—they should have a high quality of fiber. The fiber of cotton fiber is characterized

by the indexes of mature, fiber length, rupture strength, fineness, metric number, rupture length and others.

The maturity of fiber depends on the degree of the fullness of the cavity of fiber with cellulose. All the properties of cotton fiber are defined by the quantity and structural peculiarities of the cellulose accumulated in the fiber. They depend on the varieties, species, and condition of cotton cultivation.

The length of fiber varies, mostly depending on the species diversity. *G. hirsutum*, or Upland cotton fibers, range from 28 to 36 mm or more in length and are characterized as medium coarse. While *G. barbadense*, or Sea Island and American Egyptian cottons, have extra long, fine fibers, 37-41 mm long or longer in some cases. And the other cottons, like Asiatic, are classified as *G. arboretum* and *G. herbaceum*. Their fibers are very coarse and short, their length being generally 25 to 28 mm.

Lined density characterizes the **fineness** of fiber and exhibits how many millimeters of fiber are contained in 1 g.

The metric length is the total length in meters of one gram of fiber. The metric number of middle-stretched cotton varieties grown in our country is equal to 5000–5500, and fine-stretched cotton varieties range from 6500–7000. The thinner the fiber, the stronger it is, and it can be used to produce fine and strong yarn and fabric. Varieties of *G. barbadense* have the thinnest fiber.

The rupture strength is the possibility of a fiber to resist the breaking effort at its elongation, directed along the axis of the fiber. Rupture strength or strength of fiber is denoted in grams and it ranges from 4 to 7 g in the different varieties and forms. Immature fibers and fibers from did not split open bolls until frost had reduced rupture strengths.

The rupture length is determined as the product of the firmness and the metric number and is expressed in kilometers. The rupture length of a fiber is its theoretical length, in which it is suspended by one end, breaks under the action of its own gravity. Longer, thinner and firmer fibers are those that present the most value to the textile industry.

Historically, the Central Scientific Research Institute of Cotton Products' (in Russian) long-term laboratory research has made it possible to divide the first grade of fiber on the quality of all varieties of cotton plants into industrial types by which fibers are sorted in the textile industry (table 9).

The fibers of the I, II, and III types are formed from varieties of fine staple cotton, while the fibers of IV–VI are taken from middle staple cotton varieties. The more splendid and durable fabrics are woven from the fibers of the first three types, and the demand for them is not considerable. The fiber of the V type is required most of all (about 2/3 of the total quantity). This is the main type of fiber.

Fabrics for mass consumption are made from this. Cotton varieties derived from *G. herbaceum* L. and *G. arboreum* L. have short and coarse fiber (metric number - 4000), corresponding to VI and VII types.

Table 9. Technological properties of fiber for industrial types I-VI.

Indexes	Types of fiber					
	I. Varieties should have been	II. Varieties should have been	III. Varieties should have been	IV. Varieties should have been	V. Varieties should have been	VI. Varieties should have been
1. Staple length of fiber, mm.	39-40	37-38	36-37	34-35	32-33	30-32
2. Line density, m\text or metric number	134 (7500)	142 (7000)	153 (6500)	172 (5800)	185 (5400)	200 (5000)
3. Relative rupture strength, g\text.	34.5	32.5	30.5	27.0	25.0	24.0

After the independence of our republic, the evaluation of cotton fiber quality has been reformed into the defining of fourteen marketing indexes on the basis of a semi-automatic classing system determined by the USA department of agriculture. According to this, the testing systems of HVI 900 SA or HVI 1000 (photo 41) have made it possible to automatically fulfill the determination of the fiber qualitative indexes with high precision and reliability. These fiber quality indexes are listed in the table 10.



Photo 41. System of HVI 1000.

At this evaluation, the micronaire (Mic) characterized the fiber maturity and its fineness. The characteristics of fiber depending on the micronaire index are as follows: A micronaire ranges from 3.0 to 3.9 - very fine; 3.0 to 3.9 - fine; 4.0 to 4.9 - middle; 5.0 to 5.9 - coarse; and 6.0 to up - very coarse. is a measurement of the lint surface area. Measurements above 4.9 or below 3.5 will result in a discount.

Fiber strength is expressed as grams per tex. Strength values between 23.5 and 25.4 will not receive a premium or discount. Values below 23.5 will be discounted, and values above 25.4 will carry a premium on the loan chart.

Table 10. Quality indexes of cotton fiber measured by the system of HVI.

Mic	Micronaire
Str	Relative rupture strength of HVI, gs\tex.
Len	Higher mean length, inch.
Unf	Uniformity on the length, %.
SFI	Index of short fiber
Elg	elongation at the rupture, %.
T	code of impurity, trash.
Cnt	Trash mixes quantity on the area of measuring window.
Area	Ratio of trash mixed area in regard of area of measuring window, %.
CG	Grade on the color
RD	Light reflection coefficient, in % (it used for defining of grade on the color).
+b	The yellowish degree of fiber (it used for defining grade on the color),
SCI	The spinning properties of fiber, a calculated value based on the regression formula containing all indexes measured by the HVI
CSP	Calculated strength of immature thread.
All indexes presented above corresponding to American standards	

The length (UHM) represents the average length of the longest one-half of the fibers measured. The uniformity index is determined by dividing the average staple length of all the fibers by the UHM.

Producers should consider these fiber properties along with yield when selecting varieties.

According to our new state standard on cotton fiber (Uz.DST 604:2001), cotton fiber is divided into nine (9) types: 1a, 1b, 1, 2, 3, 4, 5, 6, and 7 by length indices in accordance with the norms, which are given in the table 11.

This standard contains determinations for understanding some terms on the fiber quality indexes. They are:

UHML-upper half mean length, the average length of the longest fibers, which constitute a half of the tested sample by weight and expressed in mm or inches. This term is also known as "upper half mean length" in correct translation.

Staple-staple length 32-nds. is a fiber length, which a classer defines visually by a staple of parallel fibers laid out by him or her manually (photo 33). It is expressed in 1/32 inch (for example, 1 1/32) or by a code equal to the number of intervals in 1/32, in the example given, code 33.

Inch***-is the unit of measure which is equal to 2.5 cm.

If there is divergence while type specifying by different quality characteristics, the priority is given to Upper Half Mean Length (UHML), expressed in mm.

Table 11. Types of cotton fiber.

Type	UHML*		Staple**		(Str) for sorts 1 and 2 cN/tex (df/tex)
	mm	inch	Inch***	code	
1a	33.7-34.3	1.33-1.35	1.11/32	43	29.4-34.3 (30.0-35.0)
1b	32.9-33.6	1.30-1.32	1.5/16	42	
1	32.2-32.8	1.27-1.29	1.9/32	41	
2	31.4-32.1	1.24-1.26	1.1/4	40	
3	30.7-31.3	1.21-1.23	1.7/32	39	
	29.9-30.6	1.18-1.20	1.3/16	38	23.0-27.8 (24.5-28.4)
4	28.9-29.8	1.14-1.17	1.5/32	37	
	28.1-28.8	1.11-1.13	1.1/8	36	
5	27.4-28.0	1.08-1.10	1.3/32	35	
	26.6-27.3	1.05-1.07	1.1/16	34	
6	25.8-26.5	1.02-1.04	1.1/32	33	
7	25.1-25.7	0.90-1.01	1	32	

Types 1a, 1b, 1, 2, and 3 are referred to by *G. barbadense* (Long Staple Fiber), while types 4, 5, 6, and 7 are referred to by *G. hirsutum* (Middle Staple Fiber).

Depending on appearance, color and presence of spots, cotton fiber of each type is sub-divided into five grades: the first (1), the second (2), the third (3), the forth (4), and the fifth (5) in compliance with the requirements of table 12. and standards of cotton appearance (boxes), approved by the established procedure.

The creation of varieties with superior fiber quality (1 type for *G. barbadense* L. and the 4th for *G. hirsutum* L.) has great economic significance. It has been calculated that 1500 m of fabric can be manufactured out of 1 ton of fiber belonging to the I industrial type and 8620 m of fabric out of V industrial fiber. But the profit to the producers from the marketing of 1500 m of fabric excesses is almost 300% greater than the fabric of 8620 m because of the nominated prices for the fabric of high quality.

Table 12. Fiber grades on appearance

Industrial Grade	Fiber color and appearance by fiber types	
	1a, 1b, 1, 2, 3	4-7
I	white, or white with a natural creamy shade or creamy according to the breeding variety or region of cotton cultivation. Lustrous, silky, and dense in appearance.	White, or white with natural creamy shade
II	From mat-white to creamy or yellow, of uneven coloration with yellow spots. Lustre, silkiness, and	From mat-white to creamy with light yellow spots

	density are lower than in the case of the sort I	
III	From mat-white to creamy or yellow, of uneven coloration with yellow spots. Greyish shade, almost lusterless.	From dull-white to creamy with yellowish spots with mat-greyish shade
IV	Yellow, or light yellow, of uneven coloration, with a grey shade and brown spots. Lustre less.	From dull white and cream-colored to yellow-creamy with grey shade and brown spots.
V	From brown to yellow with spots. Grey.	Dull-white or dull-creamy to bright yellow with brown spots. Grey.

Note. Cotton fiber with color shades different from the requirements of the table and standards of appearance (boxes) is supplied on co-ordination with the consumer.

Taking into account *G.hirsutum*'s high productivity, breeders worked for many decades to create varieties of this species with fiber of III, even II industrial type. They achieved a radical change in cotton cultivation during their independence years by making a decision on which the breeders of the world's leading cotton-growing countries had fought for decades. The world's first "gene knockout technology," worked out in the laboratory of the Center of Genomics and Bio-information at the Academy of Science, Ministry of agriculture, and association of "Uxpakhtasanoat," has made it possible to develop unique, native gene-modified cotton varieties like "Parloq". These cotton varieties promote the production of the fibers of 1-2 types, which allows the production of a higher textile product – "shirting fabric" – without the addition of artificial fibers. It is very difficult to evolve such kinds of varieties in conventional breeding because of negative conjugating in the inheritance of fiber quality (length and thinness) with such kinds of economically valuable traits as productivity of raw cotton and fiber. Moreover, cotton varieties pertain to a certain type, and they have to produce fiber correspondingly to the standards of that type. In this point of view, the agro-practice condition of the cultivation of cotton has great importance.

Fiber output is another important index in the assessment of various cotton varieties. It is determined as the ratio of net fiber weight to the weight of raw cotton, and it is expressed in the percentage. Conditionally, the fiber output is divided into lower – 30% and lower, mean – from 30 up to 33%, and higher – over 33%. The fiber output is determined by the weight of 1000 seeds and the fiber index. index is the weight (in grams) of separated fiber out of 100 seeds.

The oil content of seeds attracts little attention in the assessment of varieties owing to the increase in demand for vegetative oil. Cotton seed oil is used for national consumption and technical purposes. Cotton seed fat content ranges from 24 to 28% depending on variety and cultivation practices.

The absence of pubescence on the seeds or naked seeds is a positive trait. It is well known that planting with a precise number of seeding drills will gain a considerable economy of elite seed material and decrease the expenditure for the hand thinning of cotton seedlings. But the precise seeding requires the mechanical cleaning of the seeds out of their pubescence or seed delighting to get their free-flowing capacity. The process of seed delighting requires supplementary

expenditures, but it is not perfected and increases seed crushing. Therefore, the varieties with natural naked seeds have an advantage over the varieties with fuzzy seeds, and the breeding of such kinds of varieties has presented practical interest.

The development of intensive type varieties in many crops, particularly cereal crops, is gaining popularity. Intensive types of varieties mean a close ratio between vegetative and generative organs. Such kinds of varieties efficiently respond to the increasing mineral dose of fertilizers in the increase of economical yield. The development of the varieties of intensive type has become the strategic direction of cotton breeding throughout the world. The varieties of intensive type ensure maximal economic productivity with the possibly restricted development of vegetative mass – leaves, stems, and so on. This is achieved on the account of the highest productivity of photosynthesis and transport of assimilation products for the benefit of generative organs. The profitable ratio of vegetative and generative organs defines less expenditure of nutritious substances in the creation of unit economic products and the higher economic efficiency of such varieties. The varieties without fruiting branches (zero type) may be a good example of the altered ratio of farm and biologic crop of cotton plant, but this is possible in the simpodial forms with limited growth and a weakening of leaf forming on the plant bush. This is a problem for the cotton plant because its vegetative organs don't have a special farm value. The ratio of biologic and farm crops is called the index of productivity. It is one of the indexes in the assessment of the new cotton varieties. In the history of our cotton breeding, we have created intensive types of cotton varieties (Tashkent-6 and Korotkostebelnyy and others) which have a 55-60% index of productivity (that is, 55% of all biologic mass is raw cotton). At that time, the well-known historic varieties such as 108-F and 175-F had an index of productivity of not more than 40–45%.

Definite significance is paid to the creation of cotton varieties with radically restricted growth, such as the types of dwarfs. Breeding such forms of cotton usually relates to the idea of thickened cotton crops of up to 200-300 or more thousand plants per hectare. At the highest density, retaining no more than two or three bolls on the plants and ripening early or almost simultaneously, raw cotton can be harvested only once. Not all modern cotton varieties fully meet the requirements presented to intensive type varieties. The difficulties here are in the negative correlation that connects many valuable traits; to overcome them takes effort.

The creation of the genetic grounded model of intensive type varieties attracts researchers' interest at the present time. Elaboration of the model is based on the isolation of correlation-regression relationships of traits, securing the highest and earliest crops as between itself and the limiting factors of the environment in a concrete ecological zone. Inadequate study of intensive type variety requirements and factors of the environment and aspects of cultivation technologies for new varieties creates obstacles to displaying the potential possibilities of genotypes of new varieties and getting the highest crops.

The Zonal principle in cotton breeding Agricultural crop varieties are typically adapted to the soil-climatic and agro-technical conditions of cultivation in the zone where they were developed. kind of adoptability or heritable adaptation of the varieties is the result of the action of natural and artificial selection in the concrete conditions of the environment.

The background of selection plays a decisive significance. Historically, it is known that the more early ripening forms of cotton of *G.hirsutum* L. are those which are released in Bulgaria, Ukraine, Russia, the northern Caucasus, and Karakalpak. These regions are the most northern zones of cotton cultivation. The Bulgarian cotton varieties were extraordinarily short-season varieties. Varieties of Garant, Beli Izvor, Balkan, and Ogosta presented a productivity potential of 5.5 tons of raw cotton and 1.7 tons of fiber per hectare for 120 days of cultivation. Dneprovskiy-5 and Prizorniy-4 are the varieties in Ukraine. Their productivity consisted of 2.0–2.2 tons per hectare for 110–120 days of cultivation. Other cotton varieties, such as Ugtex-2, POSS-3, Pioner, AC-4, and so on, were evolved by the cotton breeders working in the southern regions of the Russian Federation. Very early ripening cotton varieties from the fine staple species *G. barbadense* have been developed in the northern regions of Uzbekistan. S-6030, S-6029, S-6037, and other cotton plant varieties have been developed at the SRI of Cotton Plant Breeding and Seed Production in the Tashkent region. Varieties out of Fergana experimental station, located in a zone with soil strongly infected by the pathogens of wilt, are always distinguished for their superior resistance to wilt. It is known that creating one cotton variety in one agro-ecological zone and cultivating them in the other is one of the reasons for their failure in their extension into production. It is difficult to develop the elite variety suitable simultaneously for all soil-climatic conditions – in the plains and foothills, in the soils of shallow and deep groundwater levels, and so on. At the same time, the best varieties are usually grown in the enlarged areas owing to their plasticity, which has good adaptive potential. For example, the 108-F variety, which had evolved in Uzbekistan's Fergana valley over the last 50 years, occupied the majority of the former Soviet Union's cotton-growing republics. Plastic varieties have widened reaction norms, the ability to adapt, and suitability in a variety of agro-ecological conditions. Usually, such varieties have a higher photosynthesis potential, a well-developed root system, a more damaged vegetative system, and are less generative in unfavorable conditions. Plasticity is an important indicator of the value of varieties. This property of varieties can be distinguished during testing at zonal breeding stations and variety trial plots located in the republic's various soil-climatic zones.

Modern plastic cotton varieties like An-Bayaut-2, Bukhara-102, Namangan-77, and S-6524 are splendid examples of modern plastic cotton varieties. They have a great adoptive potential and, according to the State register of agricultural crops recommended for planting on the territory of the republic of Uzbekistan in 2021, they could occupy more than four regions each. Because they were the best varieties among locally grown varieties and were recognized by farmers from various regions as a variety with great potential for their regional conditions, their

genotype is able to express a widened norm of reaction in regard to different soil-climatic harsh conditions of the republic.

An-Bayaut-2 was driven from the population of well-known and historically wilt-resistant Tashkent-2. The breeding process of this variety was passed by the breeders of the Institute of Genetics and Experimental Biology (IGEB) in the condition of salted soil in the Sirdarya region and it has been registered into production since 1983. It also has earlier ripening by 10 days than the variety 108-F.

The variety of Bukhara-102 originated from hybridization of [(-4380-7097)] yopo-6 and successive multiyear directed selections at the Bukhara branch of the Uzbek Scientific Research Institute of Cotton Growing (Uz.SRICG). included in the state register in 2006.

Namangan-77 It was developed at the Kizilrabot experiment farm of the Uzbek Scientific-Research Institute of Cotton Breeding, Seed Production and Agro-technologies (Uz.SRICBSPA), located in the Namangan region of the Fargana valley. The natural hybrid of the variety S-6526 was the initial material for the selection, which later resulted in the forming of a new variety and has been included in the state register since 1994.

S-6524. This variety is the result of the hybridization between the home variety of 159-F and a semi-wild sample of *G.hirsutum* ssp. *punctatum* at the (Uz.SRICBSPA). Since 1988, it has been listed in the state register for planting in the different regions of the republic.

The new cotton varieties have to have a wider norm of reaction. The ability to create these varieties remains today due to the use of the zonal principle in breeding work. According to that, the variety should be created in the place of cultivation. Depending on the soil-climatic conditions in the territory of our republic, the whole net of the republican zonal breeding experimental stations We can know these zonal stations by looking through the last cotton catalogue (third issue) on Uzbek cotton varieties created for the period of 1913–2012 (published by M.Iksanov and others., 2012). All organizations of the republic were engaged in the creation of cotton varieties listed in it. They are: the Uz.SRICBSPA; the Andijan branch of the Uz.SRICG; Bukhara branch of the Uz.SRICG; Djizzakh branch of the Uz.SRICG; Samarkand branch of the Uz.SRICG; Surkhandariya branch of the Uz.SRICG; Kashkadariya branch of the Uz.SRICG; Namangan branch of the Uz.SRICG; Fergana branch of the Uz.SRICG; Khorezm branch of the Uz.SRICG; Department of plant breeding and seed production of the Uz.SRICG; Andijan institute of cotton growing; Bukhara State University; Karakalpak scientific research institute of agriculture; Republican station of preliminary seed production and seed science; Tashkent state agrarian university; SRI of plant growing; Uzbek national university; Center for genomics and bio-information, etc. They occupy all regions of our republic. Regions like Karakalpak, Khorezm, Bukhara, Surkhandaiya, Kashkadariya, Samarkand, Djizzakh, Tashkent, and Andijan considerably differ from each other in regard to soil-clamatic conditions. Some of these scientific research stations have historical practice in

creating the highly adopted local cotton varieties and are successfully working today and have solid potential to continue in releasing the new modern cotton varieties able to meet international standard requirements.

Usually, the varieties indicated via numbers and index (letter) just before this numbers that shows the place of the release. One letter, as the example of above-mentioned variety S-6524 can be taken from the first letter of the place or the name of the known breeding organization like Seleksiya. The Uz.SRICBSPA was known historically and locally as the Seleksiya. 108-F and 175-F means that they were developed in the Fergana valley. In some cases, the varieties can be named by the name of the region where they were bred. For example, Andijan 37, Besh Kakhramon, Gulistan, Bukhara 8. According to the old generation of the breeders the numbers before or after letters or names could indicate that number of the selection bag and the last noted number in the selection list of the breeder from which the seeds of the last selection distinguished for the preliminary seed reproduction to present the future variety. This number could help the breeder easily to trace way back to the initial material or to its parents even it was a true point of start in the case of judicial investigations. For the last decades of the cotton breeding often appeared new names given to the new developed cotton varieties. For example, Kelajak, Istiqlol, Porloq, Sultan and these names in general mean the enthusiastic content. And later the certain numbers were adopted by the breeding departments of the organizations to streamline the naming of new cotton varieties.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton biology”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Germination			
2	Seedling formation			
3	Budding			
4	Flowering			
5	Maturation			

Chapter 4. **The initial materials.**

The following forms of cotton plants are referred to as the initial material and are used as the quality of initial parental plants in the process of cotton breeding:

1. Variety population, created by multi-year national plant breeding
2. The best local varieties
3. Foreign-bred varieties from ecologically remote regions of the world.
4. Hybrid populations are created by: a) intra-species hybridization; b) interspecies hybridization with domesticated, wild, and semi-wild species and subspecies. population exposed to ionizing radiation, chemical mutagenesis, and other natural factors.
6. Population of genome-altered varieties

1. Our republic's territory is located on the northern edge of the world's cotton planting belt. That is why, in the history of national cotton growing, local cotton peasants and seed producers jointly developed a number of unique regionally different variety populations, like local varieties "Kok chigit", "Chimbayskaya zavodskaya smes", "Samarkand zavodskaya smes" and others. They were splendid variety populations, created by multiyear national plant breeding and having exquisitely notable economic traits and biological properties meeting the requirements of peasants and reprocessing enterprises posed to them in their period of history. Of course, they were the most preferable initial material for the first national cotton breeding stations to evolve new cotton varieties to meet the rapidly developing textile industries at the turn of the xx century. Namely, one of the first Uzbek cotton varieties, 182 (Djura), had been separated from the variety population of the local variety of "Kok chigit" by the breeder G.S. Zhaytsev. Later, this breeder exposed it to hybridization with cotton sample 607 and was able to develop another variety, 2017 (Bolshevic). The second variety population, "Chimbayskaya zavodskaya smes", had given the splitting out of its genotype the following bred cotton varieties: Ch-925 (registered in 1935), Ch-2186 (registered in 1936), Ch-237 (registered in 1944), Ch-423 (registered in 1949), which were selected and stabilized by the breeder of G.I. Gavrilov in Karakalpakistan. The breeder A.T.Svetashev could isolate one unique plant shape from this variety population and evolve it into a new cotton variety as 1375. Moreover, it had been selected as a valuable initial material by many cotton breeders from other regions and subjected to hybridization in their breeding processes to get even better cotton varieties. The third variety population deserved as an initial material in getting the best cotton variety KK-1543 by the breeder G.I. Gavrilov, registered in the years of 1952 and 1957.

As well as nationally bred variety populations of other nations had meant a great role in the history of Uzbekistan's cotton growing. According to N.I. Vavilov, for example, most of the good varieties of American breeding were developed on the basis of populations found outside of Indian villages in the mountains of Mexico and on Caribbean Sea islands. Truly, prior to the discovery of America, cotton growing had been widely spread in Mexico, the Ukatan semi-

island, Columbia, and Peru. Their national varieties were used as the initial material for developing some of the first American cotton varieties. Later, some of these cotton varieties: Acala, Russels, King, and Triumph (*G. hirsutum*) from America, and Ashmuny, Yanovich, Faudy, and Maarad (*G. barbadense*) from Egypt and other countries, were introduced in Central Asia in the second half of the XIX century. At that time, only those cotton varieties with fine fiber quality have met modern, developing textile demands. However, in the climatic conditions of Central Asia, they required approximately 200 sunny days to fully mature, and for their fine fiber, they became a valuable starting material for the development of the first locally bred cotton varieties in Uzbekistan. For example, the cotton varieties 8427 (Turkman), 8196 (Uzun), 8517 (Kolkhoznik) and 8582 (Kazakh) were separated from the foreign variety population of Acala by the breeder of S.S. Kanash. P.V. Mogilnikov's breeder isolated another historical variety of 36-M2 from an Acala sample. Another new variety, 110-F (registered in 1943), which was 1 day earlier than 36-M2, was either separated from this variety population by N.A.Topusheva. G.S. Zhaytzev's breeder separated the varieties 508 (Batir) and 1306 (Shreder) from the Russel and King variety populations, respectively. On the basis of Triumph population divergences, the breeder E.A.Navrozkiy could create new varieties Navrozkiy (0100) or Triumph Navrozkiy. There were other varieties such as Stounwell, Express, and Cook imported into our country for planting and were used as initial materials for developing middle staple cotton varieties successfully.

Fine staple cotton variety breeding on the basis of scientific methods began almost simultaneously with middle staple cotton varieties in our republic at the beginning of the xx century. The seeds of imported Egyptian variety populations were seeded in the production fields and in the breeding stations to learn their adaptation to local climatic soil conditions and genome potential. They were very late ripening as foreign middle-stapled cotton varieties and often subjected to segregation into new cotton plant forms. Breeders take their opportunities to use this habit in their breeding processes. For example, A.I. Autonomov selected one of the desirable segregating forms of Ashmuny to develop the local variety of 35-1, which was registered in 1936 and 1938. Another form splitting out of this population has served to create the variety 35-2, also by A.I.Autonomov, which was registered in 1937 and 1939. The breeder F.I.Uchevatkin, who engaged with cotton breeding in the Fergana valley at that time, also isolated some segregated forms and could bring them ultimately to varieties: 46-F, 47-F, and 48-F in the results of breeding works. Successively, these new varieties have genetically turned into superior initial materials to develop native local fine-staple cotton varieties. Yanovich mainly deserved it for the purpose of hybridization to transfer some of their desirable genes controlling the fiber qualities into the genomes of locally developed varieties. 2525, created by breeder A.I.Autonomov out of Yanovich and registered in 1950; T-3, created by breeders G.A.Goldberg and others and registered in 1963. The variety 123-F was isolated from the Faudy population by L.A. Turks and registered in 1944 and 1954. The population of

Maarad took part in the breeding process to create one of the well-known cotton varieties, S-6022, by the breeders Yu.P.Khutornoy and A.I.Autonomov (registered in 1958 and 1962).

2. The duration of the vegetation period, as well as the state of soil conditions in the cultivation of cotton varieties, play a significant role in determining the efficiency of cotton growing. Adequate water and optimal mineralization are the following necessary factors in the cultivation of cotton. The consequences of extensive and multiyear irrigation of mono-cultural cotton areas have led to rising land water tables and salinization. And now 49% of total cotton planting areas have become exposed to salinization. In 2011, the following regions of Uzbekistan had the highest salinization rates: Khorezm - 100%; Sirdaria - 98%; Bukhara and Navoiy - 87%; Jizzakh - 79%; and Karakalpak autonomy republic - 77%. So, cotton varieties commonly cultivated in these regions are required to be genetically the most salt-resistant varieties. Cotton varieties such as Bukhara-6, Bukhara-102 (photo 42), S-6524, and AN-Bayaut-2 can be found frequently in the state register of cultivating varieties in these regions from the previous year. These varieties have not only resistance but early ripening, high productive and fine fiber qualities and will therefore make good initial material for the breeding process to develop new elite varieties in the near future. The history of the well-known cotton variety Tashkent-1 has substantiated that the population of this variety was enriched with a lot of desirable traits and properties. The genes responsible for the expression of these traits and properties have been successfully transferred by the well-known breeder S.M. Mirakhmedov into the genome of a hybrid plant population. Multiple individual and bulk selections were used prior to the forming of a local variety population later named Tashkent-1. This variety's parents were locally productive, early ripening, but susceptible to wilt disease, and wild *G.hisutum* L., ssp. *mexicanum* var. *nervosum* (wat). Otherwise, this method of combination is called "remote interspecies hybridization." The genes of the wild parent have high resistance to that disease but very late ripening. Obviously, their hybrid population mostly showed the dominance on the resistance to the disease and late entering into the setting of fruit components, and all genes from domesticated varieties were left in the recessive state. Then they used backcross of F₃ progeny plants of the population again with maternal plants of domesticated cotton variety S-4727 to consolidate the expression of genes responsible for early ripening and to inhibit the expression of genes from wild cotton which expressed late ripening. The elite hybrid plants were selected in wilt-infected soil conditions. All plants with the habit of late developing plant architecture were removed from the field before flowering. The accumulated potential of genes for early ripening, productivity, and resistance to wilt was so great that the newly developed variety Tashkent-1 in 1971 could replace all known but prone to wilt cotton varieties not only in our republic but all varieties grown in the Commonwealth of Independent States (CIS). And later, it has deserved, in its turn, to be the remarkable initial material to release new cotton varieties.

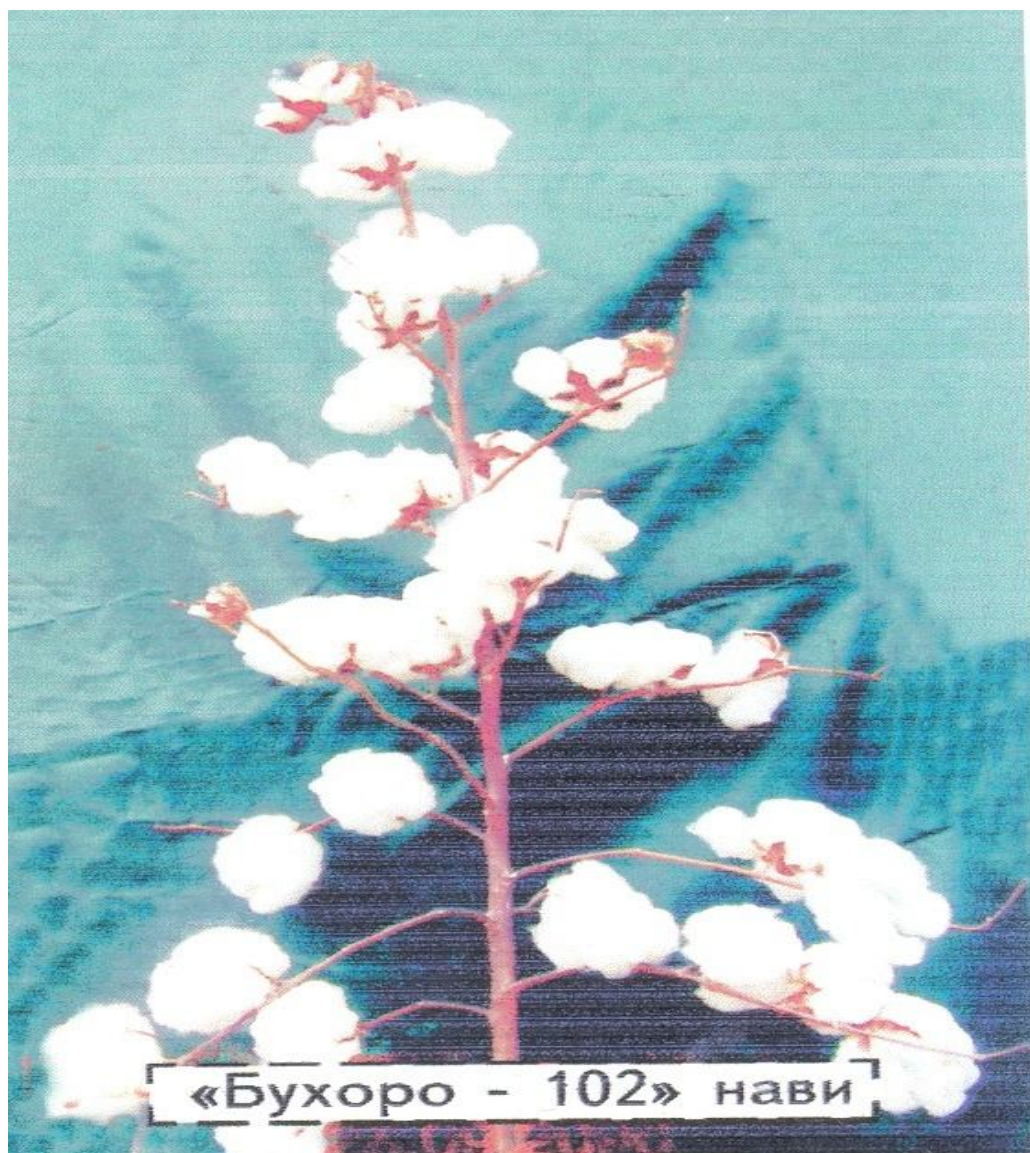


Photo 42. Exhibition model of a bush variety, Bukhara-102.

Due to its genome of many useful traits and properties, which had been combined in the result of previous multiyear national cotton breeding, was taken in the breeding process of cotton varieties like Kizil Rabot, Uychi-2, AN-Bayaut-2, INEBR-1, AN-Sertola, Tashkent-6, SB-6, and others. One of them, AN-Bayaut-2 is still being cultivated in the regions of our republic. According to the state register in 2021, this variety was recommended for planting in the regions of Jizzakh, Navoiy, Sirdariya, and Tashkent. Another variety of Bukhara-6, which was introduced into production in 1990, could gain farmers' attention. Since that time, it has been cultivated in the regions of Bukhara, Kashkadariya, and Navoiy. It also bears the genes of the variety Tashkent-1. Because the selected plants from the Tashkent-1 population had been used by the breeders A.M.Batalov and M.Barakaeva as the maternal donor parents for crossing with the variety of I-9647 (fine staple cotton) in order to create a new cotton variety to plant in the conditions of the Bukhara, Kashkadariya, and Navoiy regions of the republic. These regions are characterized by their comparable harsh temperature alterations and soil mineralization conditions to other cotton-growing conditions. Because of proper

organization of continuous seed production and elite seed reproducing (renewing) works, the genome of this variety in particular has stabilized with desirable gene combinations to strengthen plant population resistance against all environmental stresses, making the variety superior in terms of productivity and fiber quality. Ultimately, this variety population has turned into a local and highly valued source for cotton breeding processes. The consequences of its use by the breeders have been the varieties Bukhara-8 (registered in 2002-2007) and Bukhara-102 (registered in 2000-2006). Nowadays, the first variety is grown by the farmers of Bukhara, Kashkadariya and the second, Bukhara-102, has become an option for farmers from Karakalpkistan A.R., Khorezm, Surkhandariya, Samarkand, Jizzakh, Sirdariya, Namangan, and other regions of our republic, but Bukhara, Navoiy, and Kashkadariya. Such types of dignity are related to the population's extensive genetic potential. It has the following descent data, phenotypic indexes, economic traits, and properties, according to recently published reports on the study of variety characteristics grown in production: the variety was created by the breeders S.I. Maqsudov, B.O. Muslim, and E. Mavlonov in the Bukhara field station of the Uz.CGSRI through the crossing of [(L-4380 x L-7097)] x Bukhara-6. of multiyear, directed selection on the traits of the hybrid population was used in the breeding process. The plant canopy has a pyramid shape, with wood similar to 1-2 types, and the height reaches 100-120 cm. The stem is strong and does not lodge, which means downy. The leaves are medium sized, mean-haired. The first fruiting wood emerges on the 5–6 nodes.

115–124 days are needed for plants of a variety to mature. The weight of raw cotton from one cotton boll is 7.4 g., and the weight of 1000 seeds is equal to 123–130 g. Fiber output is 36.8%, fiber quality is IV: mic-43.3-4.4, fiber length (UHML) - 1.08-1.12 inch, and relative rupture strength is cod - 34.1.

The Fergana valley encompasses cotton plantations from three regions: Namangan, Fergana, and Andijan in the republic of Uzbekistan's northern east, each with its own unique climatic and soil characteristics that have an impact on the formation of local cotton populations. Some of them have historically become well-known varieties and have served as an irreplaceable source of cotton population to create new ones for a long time. Cotton variety Namangan-77, for example, was registered in 1990 and 1994 and is now grown in Namangan, Tashkent, Kashkadariya, Surkhandariya, and Khorezm. If to dissect its genetic potential on the basis of gene function principles, we can easily sum up that this variety has the genes adaptable to all of the listed region's climatic-soil conditions and is possible to exhibit annually high productivity and the best quality of fiber. And this potential was accumulated in its descent from many parental varieties with genes well adapted to local conditions and tolerant to environmental stresses. Parental variety populations can be traced back in any direction to their origin. So, the variety Namangan-77 was created from selected plants out of the variety population of S-6526, which in its turn had been taken from the crossing of 159-F x 05152. 159-F has been one of the historically well-known varieties (registered in the years of 1960 and 1970) in the valley regions. Surprisingly, the maternal source

for this variety was another widely cultivated variety for these regions, 137-F (registered in 1948 and 1952). We now know the genetic potential of variety Namangan-77, which was created through multiyear national plant breeding. potential of any cotton variety is determined not only by evaluating its biologic and economic indexes in comparison to other varieties but also by its genetic value in the choice of initial material for the evolution of modern cotton lines and varieties. Plants of variety population of Namangan-77 were often chosen by the breeders and, as a result, such cotton varieties as Andijan-37 (registered in 2002 and 2012), Surkhan-2 (registered in 2000), Denov-5 (registered in 2003), Polvon (registered in 2003), Dekhkanbob (registered in 2002), Dekhkanmanzur (registered in 2004), S-6771 (registered in 2007), S-6775 (registered in 2006) and others.

In the history of cotton growing, our breeders created some magnificent fine staple variety populations, which became valuable initial materials for the release of many new fine staple cotton varieties meeting modern requirements. Among them, variety S-6041 is well-known among farmers. It was created and registered in 1979 by breeders Yu.P.Khutornoy and M.I.Iksanov. The more notable point here is that former varieties S-6022 (adopted to our republic's southern region) and 504-V (from Tajikistan) have been drawn to crossings. positive genes out of these two space remote variety populations had enough gene recombination to result in getting this best variety. Its advantage was earliness for 3 days in comparison with one of check variety S-6037 to fine-spun cotton. And other economic and fiber indexes of this were: weight of one ball of raw cotton-4.0 g., fiber output – 30.0 %, fiber length – 40.7 mm, rupture strength – 4.8 g., metric number – 7750 and relative rupture strength – 37 gtex. This variety was one of the populations of fine staple cottons introduced to our republic's southern regions, and its fiber was completely compatible with the templet of the first textile fiber type. That is why many cotton breeders paid great interest in getting from this variety to their future cotton varieties, especially cotton breeders who were engaged in the development of fine staple cotton varieties. Consequently, we can see this variety as the initial material in the development of fine staple cotton varieties Surkhan-6 (registered in 1991), Surkhan-8 (registered in 1993), AN-5428 (middle staple cotton, registered in 1993), Surkhan-10 (registered in 1996), and Nafis (middle staple cotton, registered in 2007). The genetic value of variety populations created by multiyear national breeding in the release of new cotton varieties that would meet not only the national requirement but also be internationally compatible with best foreign cotton varieties in the export of their fibers or fabric goods is discussed in this context.

3. Seeds of many foreign cotton varieties are annually introduced in the collections of SRIs related to the cotton growing and cotton breeding in Uzbekistan. We can list some of selected foreign cotton varieties, successfully used in the nearest history of breeding process and could played notable significances for forming new best local cotton varieties. Foreign varieties as Bulgarian early ripening (from Bulgaria), Pay Master, American dwarfish, Delta Pain, Express (USA) and diversities of Acala (from Mexico), Kirgizskiy-3 (from Kirgizia), and

fine staple cotton Ashkhabad-25 (from Turkmenistan) were often remembered as one of the parental forms in the list of natively developed cotton varieties of Uzbekistan since 1913 to 2012 (table 13).

The first rank on the number of released varieties by the participation of the variety belong to the diversities of Mexican variety Acala. According to the report of O.F.Kuk (1932) he had selected one cotton plant bush in the district of the city Acala in the residential area of Chiapus (Northern Mexico) which subsequently has become an origin to all cotton variety diversities of American Acala. In the history of our cotton breeding the diversities of this variety were an unique treasures on the desirable cotton traits to develop more than 50 local middle staple cotton varieties: 36-M₂ and 8517 (in 1923-1924), 8427 (Turkmen), 8517 (Kolkhoznik), 8582 (Kazakh), 102-F (registered in 1941), 106-F, 110-F, 127-F, 162-F, 163-F, 164-F, 165-FS, 166-FS, 168-FS, 171-F, 172-F (registered in 1972), S-2501 (registered in 1968), S-2601, S-2602, S-2605, S-2607, S-2608, S-4811, S-4851, S-4860, S-4861, S-4880, S-4910, S-4914, S-6523, S-9060, S-9062 (registered in 1973), Chimbay-3039 (registered in 1977), Ml-11, Namahgan (registered in 1992), Ak-Kurgan-3, Ak-Kurgan-4, Gulistan (registered in 2011), 3P-23, Andijan-2, Andijan-302 (registered in 2003), Chimbay-3047, VIR-23, VIR-315, Istiqlol, S-01, Istiqlol-13, Sultan, S-02 and Navbakhor-2 (registered 2013) were developed and registered by the participation of one of the collection diversity of this foreign variety. In general, this foreign cotton variety truly had been one of the splendid choices for breeders in the history and now, who's breeding processes since 1924 to 2013 have been completed with creating of best cotton varieties.

Table 13. The characteristics of the cotton varieties where were used Acala, Ashkhabad-25 and Kirgizskiy-3*.

Variety	Origin	Authors	Years of registration	Earliness	Boll weight, g.	Fiber output, %.	Fiber length, mm.	Rupture strength, g.	Metric number	Relative rupture strength, g./tex.
Acala (collection diversities)										
36-M ₂	036 (Acala, USA.)	P.V.Mogilnikov	1924	-	6.0-6.5	34	32.2	4.7	5320	24.9
102-F	(8247x13656)8247=Acala(0464)13656=Bolgarskaya skorospelka	L.V.Rumshevich	1941	-2 (1306)	5.1	33.5	34.4	-	-	-
Vir-315	(1306xRed leaf Acala)xgibuscus	K.A.Visotskiy	1961	+4,+5 (108-F)	6.5	32-33	35.5	4.3	5980	25.7
Chimbay-3939	[Acala-4-42x06422]	A.B.Bereznuyakovskaya	1977	+4 (C-4727)	6.6	35.6	34.0	4.5	5810	26.1
Namangan	[(S-1622x159-F)x(Acala 4-42x06422)]	B.P.Straumal, A.I.Tishin K.A.Teshabaev V.M.Efimenko	1992	+1 (Tashkent-1)	6.0-6.5	36-37	32-33	4.5-4.6	5700-5800	25.5-26.5
Navbakhar-2	(Л-348 x Acala 08086)	Н.Г.Губанова and others	2013	121-123	6,5-7,0	40,0-42,0	**4.2	***1,1 2-1,15	****3 0,2	
Ashkhabad-25										
Karshinskiy-6	(ML-101xAsh-25)xL-39]L—39=(ML-100x7318-V)	A.R.Tiyaminov T.Kalandarov	1983	-15 (5904-I)	3.6	37.0	38.2	4.7	7290	34.3
Surkhan-6	(S-6041xAsh-25)xS-6038	M.I.Iksanov Yu.P.Khutornoy V.S.Vasilev	1991	128	2.8-3.0	33.8	40-41	4.7-4.8	7400-7500	35.0
Surkhan-8	(S-6041xAsh-25)	M.I.Iksanov	1993	133	3.2	31.2	38.9	5.1	7630	38.9

		M.Ashurov Kh.Khusanov								
Surkhan-10	(S-6041xAsh-25)	M.I.Iksanov M.Ashurov Kh.Khusanov	1996	127	3.7	33.5	38-40	4.5	7700-8700	35-36.0
Termez-40	(9883-IxAsh-25)	E.Gavrilov Kh.Avliyakov V.Istomin	2000	112	3.2	32.8	39.5	4.1	7110	29.4
Termez-208	(Ashkhabad-25xTermez-14)	Kh.Chorieva J.Akhmedov R.Kambarov	2011	118	3.6	34.0	39.8	4.8	-	-
Kirgizskiy-3										
Chimbay-3158	(Kirgizskiy-3xS-9063)	A.Saytmusaev A.Tishin D.Shashmetov	1998	116	6.1	38.0	32.6	4.4	5546	24.6
An-515	(AN-510xKirgizskiy-3)	D.A.Akkujin O.I.Kuznetsova	2003	114	5.4	38.4	35.8	4.5	5630	25.1
AN-517	(AN-510xKirgizskiy-3)	D.A.Akkujin A.A.Abdullaev A.Akhmetjanov	2008	114	5.5	38.8	35.0	4.4	-	-
AN-419	(AN-415xKirgizskiy-3)	K.Dadajanov I.Kakhkharov A.A.Abdullaev	2008	110	5.4	38.7	34.1	4.4	-	-
UzFA-707	(AN-415xKirgizskiy-3)	I.Kakhkharov K.Dadajanov	2010	112	5.6	38.1	35.7	4.2	-	-

Notes: *-catalogue of Uzbek cotton varieties; **-micronair (mic); ***-upper mean fiber length (UHML), in inch; ****-relative rupture strength, gs/tex.

The second valuable initial material for breeding cotton varieties was Ashkhabad-25. This variety was registered in 1977. It was a variety of Turkmen SRI on fine cotton breeding and seed production. The breeders D.Babaev and V.S.Bulax have used one of the extraordinarily complicated methods: [(10964 x 01277) x (01277 x 2525) x 8173-I] x 9123-I in order to get this fine stable cotton with fiber at the level of the first textile fiber. On the performance of cotton indexes, it has an earliness of-2 days less than the standard variety 8763-I. One boll weighs 2.9-3.0 gs; fiber output is 34.4%; fiber length is 40.5 mm; rupture length is 4.7-4.9 g; metric number is 7900-8120; relative rupture strength is 37-39 g./tex.

The participation of this cotton variety in the breeding process has enabled us to get exclusively combinations of hybrid genotypes, resulting in the evolution of eight best local fine staple cotton varieties: Karshinskiy-6 (registered in 1983), Surkhan-6, Surkhan-8, Surkhan-10, Karshinskiy-9, Termez-32, Termez-40, and Termez-208 (registered in 2011), which successfully demonstrated their high variety dignities at the regional state variety trials.

Kirgizskiy-3 is a cotton variety from Kirgizstan. It was developed at the cotton growing experimental station in Kirgizstan and registered in 1984. Complicated hybridization: (159-F x 1998) x S-1622 x (159-F x 06422) was used by the breeders by B.A. Golosov and others to get it. This variety has cotton bolls of 5.6–5.9 g., fiber output – 34.8–34.9%, fiber length – 33.8–34.7, rupture strength – 4.5–4.8, metric number – 5900–5920, and relative rupture strength – 26.6-28.4. It occupies the third rank in this kind of analysis because the five best local middle-stapled cotton varieties of Uzbekistan were developed by its participation as the initial material. They are: Chimbay-3158 (registered in 1998), AN-515, AN-517, AN-419, and UzFA-707 (registered in 2010).

4. Intra-species diversities of domesticated tetraploids, in particular rare gene fund samples of *G. barbadense*: *ssp.vitifolium*, *ssp.vitifolium f.brasiliense*, *ssp.vitifolium f.bogota*. Those which possess a number of valuable biologic and economic traits like resistance to aphids, wilt, and bacterial blight as well as being productive (there are forms which have one boll weight of 7 g.) and eventually super fine, long fiber (subtropical forms of "Sea Island" have 50 mm or more) may frequently be involved in hybridization as the initial. Unfortunately, their genetic potential is not effectively utilized in the generation of hybrid populations through breeding processes. One of the examples of utilizing their effects can be seen in the research of B.Kh. Amanov and Jh.Q. Otamurodov (2013). Crossings were carried out between the ultra-early ripening variety Karshi-8 (with 112 days of vegetation) and *ssp. vitifolium* (a tropical domesticated sub-species). In general, they have abrupt distinguishing characteristics in the studied economic traits (table 14). According to the data presented in this table, it is obviously shown that the economic characteristics of initial materials abruptly distinguish. The variety Karshi-8 has a fiber length of 37.0 mm and a fiber output of 34.0%, while *ssp.vitifolium*, on the contrary, has lowered indexes on these traits: 28.7 mm and 28.4%, respectively. But on the basis of general genetic principles of inheritance and heterosis, some family plants with superior economic characteristics are

expected. For example, plants of families 4 and 6 were superior in the data of fiber length and fiber output in comparison with both parents.

Table 14. **Important economic trait indices of family (F4) populations based on intra-species hybridization.**

Initial materials and families of hybrid plants	Fiber length, mm.			Fiber output, %.		
	$\bar{x}$	S $\bar{x}$	limit V %	$\bar{x}$	S $\bar{x}$	limit V %
Initial materials						
Variety Karshi-8 (Uzbekistan)	37,0 ± 0,60		30,0-39,0 5,6	34,0 ± 0,63		30,0-36,0 5,8
<i>ssp. vitifolium</i> (Brazilia)	28,7 ± 0,63		26,0-32,0 6,9	28,4 ± 0,64		26,0-32,0 7,0
F ₄ -families						
Family -1	35,2	0,47	32,0-37,0 4,19	36,7	0,30	35,0-38,0 2,57
Family -2	38,8	0,71	36,0-42,0 5,74	33,1	0,35	31,3-34,6 3,39
Family -3	39,7	0,40	38,0-41,0 3,17	33,9	0,48	32,0-35,3 4,52
Family -4	38,0	0,63	36,0-40,0 5,26	36,7	0,26	36,2-37,7 2,23
Family -6	38,3	0,48	37,0-40,0 3,99	39,5	0,16	39,0-40,0 1,28
Family -7	35,6	0,18	35,0-36,0 1,64	38,3	0,36	37,0-39,2 3,01
Family -8	36,0	0,53	34,0-38,0 4,65	37,6	0,60	35,0-40,1 5,03
Family -9	38,5	0,80	36,0-42,0 6,54	37,2	0,26	36,1-38,0 2,20

These families, chosen from among all families descended from intra-specific hybridization, hold great promise for the evolution of new variety genotypes with complexes of biologic properties and economic traits.

At the same time, there are unique artificial forms created on the basis of intra-species and interspecies hybridization within cotton gene funds. According to the results of our researchers, trigenic hybrids of *G. hirsutum* x (*G. harknessi* x *G. trilobum*) have inherited fruitfulness and earliness from *G. hirsutum*, drought and wilt resistance from *G. harknessi*, and early leaf shedding from *G. trilobum*. These hybrids can be widely used by breeders in the breeding process as initial materials. Other interspecific hybridization between *G. barbadense* and the Australian species *G. bickii* has resulted in the ultra early-ripening lines L-171 and L-172.

A striking example of the use of interspecies hybridization by the attracting of semi-wild samples of *G. hirsutum* ssp. *punctatum* to the breeding process with domesticated cotton (variety of 159-F) can be seen in the development of the famous local cotton variety S-6524. It was released at the SRI of Uz.CBSP by the breeders B.A. Autonomov and others. Since 1988, when it was registered, it has been widely planted in the regions of Uzbekistan. It ripens for 125 days. Plant architecture - 1-2 types of branching, 100-110 cm plant height the stem is strong and not prone to lodging. The first fruiting branch has formed on the fifth or sixth stem node. Leaves have middle sizes (photo 43).



Photo 43. *Cotton variety S-6524.*

Boll weight 5.5-6.6 g, 1000 seed weight 125-135 g, fiber output 33.5-34.5% Fiber quality suits the IV type of textile fiber template, mic – 4.3-4.6; fiber length (UHML) – 1.12-1.15 inch; cod – 33-35; relative rupture strength – 27.7 g/tex.

This variety is one of the farmers' preferable varieties in regard to sustainable productivity, resistance to soil salinity and shallow soil water table, and tolerance to biotic and abiotic stresses often occurring in the conditions of Jizzakh, Sirdariya, Tashkent, Namangan, and Fargana regions of our republic.

Another cotton variety, Dustlik-2, was taken as the result of similar hybridization (-1973 02800 (*G.purpurascens*) to get remote intra-species hybrids for the breeding process. Eventually, this combination was also successful enough that breeders U.Aytjanov and others at the Karakalpak farming SRI could register it in 2011 for planting in the soil-climatic conditions of Karakalpak AR.

Cotton variety Jarkurgan, registered in 2013, can be shown as one of the latest interspecies hybridizations in order to get more complicated hybrid genotypes with the greatest gene diversities, which could enable us to select individual plants with necessary but deficit traits from remote species. This variety combines the unique traits and properties of the species *G. thurberi* Tod. and *G. raimondii* Ulbr. Successive multiyear selections to decrease the long vegetation period of wild species after crossings with line LZG-187 have ensured hybrids maturing for 120-125 days. The complex biological properties of the parents transferred to this variety have facilitated this variety's high resistance to the harsh environmental stresses of growing and maintaining a maximum amount of crop elements.

By the scientists of the Institute Genetics and Experimental Biology of Plants of the Republic of Uzbekistan (2007) have been suggested new cotton lines: L-2777 and L-6161, which evolved as a result of crossings between cultivated varieties of 108-F, 159-F, S-4727, Tashkent-1, Dilocot-277, Toncot sp-37, Paymaster-266, Acala-1512, Delto-naime-682, with wild and ruderal Mexican cotton forms which are especially distinguished for their high wilt resistance, earliness, fine fiber quality and higher fiber output.

The possibility of using the largest group of wild and ruderal cotton forms combined by N.K.Lemeshev in 1971-1981 from different states of Mexico as the initial material in the creation of complex resistant varieties to water deficit and salinity has been studied by S.S.Alikhodjaeva and others (2017). The first were yucatananense samples from the state of Ukatán. Some of them showed that from flowering to getting ripe they needed 40-45 days. This is one of their unequal values. Other economically important traits in the point of view of breeding also were analyzed in the samples that belong to *mexicanum*, *palmerii*, *punctatum*, *morillii*, *richmondii*, and *mari-galante*. They have many economic and farm traits that have already been used in the breeding process of complex-resistant new cotton varieties: Gulistan, S-5706, S-5707, S-5709, S-5710.

The use of interspecies hybridization is underlined by most breeders for its hardness in regard to getting fertile seeds, time-consuming for the breeding process, and extra expenditure. But traits and properties to secure high product quality and resistance to environmental stresses of cotton plants can be found only in the representatives of such wild species. Much research has been conducted by scientists in related fields in the hopes of methodically discovering low-cost and simple techniques to overcome interspecies incompatibility in the hybridization of distant cotton species.

For example, incompatibility has already been displayed at the "stigma-pollen" level of the interspecies hybridization *G.hirsutum* L. x *G.anomalum* Wawra (Djuraeva B.S., Daminova D.M., 2007) and was accompanied by successive disorders which eventually resulted in an inconsiderable number of pollen tubes grown up to ovule. In this case, incompatibility has been described by the internal physiologic constraint against the development of pollen tubes, which has been overcome by scientists D.M. Daminova and M.S. Rahmankulov (2007).

They worked out two possible approaches to getting interspecies hybrids. The first one is the application of exogen phytohormones and the other way is the cultivation of fertilized ovules and embryos. These approaches involve, in biotechnological ways, the dependence of concrete hybridizations:

- cultivation of ovules at 2-3 days of age and successive isolation and cultivation of immature embryos in vitro till plant forming. Positive results have been obtained in the hybridization of *G.arboreum* x *G.hirsutum*, *G.herbaceum* x *G.hirsutum*, *G.arboreum* x *G.barbadense*, *G.herbaceum* x *G.barbadense*.

- treatment of ovules with phytohormones in 2-3 days after pollination in vitro, singling out and cultivating in vitro immature triploid embryos. It was shown in the combinations: *G.hirsutum* x *G.bickii*, *G.hirsutum* x *G.klotzschianum*, and *G.hirsutum* x *G.anamalum*.

- treatment of ovules by the phyto-hormons in vitro and getting of fully fertile triploid seeds from the hybridizations of *G.hirsutum* x *G.raimondii*, *G.hirsutum* x *G.thurberi*, *G.hirsutum* x *G.sturtii*, and *G.hirsutum* x *G.davidsonii*.

However, similar techniques continue to have some difficulties, high expenditure requirements, and are not always available to all breeders. Unfortunately, most breeders must work around their ability to determine the problems that lie ahead and release new cotton varieties using common methods of selection and collection of formed interspecies lines. One of the opportunities for them is the genetic and cyto-genetic collection built up since 1974 at the National University of Uzbekistan by the guidance of the famous academician D.A. Musaev. Since 1991, some of the introgression cotton lines originated from the crossings between *G. thurberi* Tod and *G. peruvianum* have been included in new crossing programs with allotetraploid lines and local cotton varieties to develop new introgression cotton lines resistant to "A", "B", and "A+B" races of verticillium wilt, aphids, and spider mites. As a result of genetic-breeding research, nine new introgression cotton lines (L-244, L-396, L-398, L-399, L-862, L-865, L-900, L—242 and L—39) were developed and recommended to cotton breeders in the republic as donors to improve the resistance of cultivating cotton varieties to the aforementioned biotic stresses.

One of the priority directions in the breeding program at the Institute of Genetics and Plant Experimental Biology, Academy of Science of Uzbekistan (Uz.IGPEBAS) was the development of early leaf defoliating cotton varieties. They hoped for the presence of source *G. trilobum*, which has early defoliation and is used for hybridization among three cotton species (*G. hirsutum* x (*G. harknessi* x *G. trilobum*)). This three-genetically hybridized population enabled the breeders to select cotton forms having fruitfulness and earliness from *G.hirsutum*, drought and wilt resistance from *G.harknessi*, and early defoliation from *G.trilobum*. Taken cotton forms were widely used as the initial material to introgress some of their desirable traits into their own newly developed cotton varieties.

Thanks to the government of the republic, our scientists and breeders of the SRIs have quite enough initial cotton sample diversity at their disposal whenever.

Uzbek Scientific Research Institutes such as the Uzbek Scientific Research Institute of Cotton Breeding, Seed Production and Agro-technologies (the Uz.SRICBSPA), Uz.IGPEBAS and the Uzbek Scientific Research Institute of Plant Growing (the Uz.SRIPG) have world cotton collections with a total of more than 14 thousand samples. Only the Uz.IGPEBSA cotton systematics and introduction laboratory has more than 45 varieties of world wild diploid and tetraploid species and more than 7500 domesticated samples. In which 4903 *G.hirsutum* L. samples, 970 *G.barbadense* L. samples, and 857 *G.herbaceum* L. samples are reported. These kinds of collection samples have been brought from all continents of the world. In particular, they have been introduced from more than a hundred countries. It is the availability of such kinds and quantities of initial materials combined with advanced scientific techniques and growing technology that enables us to make great promises for cotton breeders and seed producers in the evolving of any possible hybrid combinations to rapidly release elite cotton varieties compatible with any world's superior cotton varieties.

5.Many factors of the environment have physical and chemical origins that affect the plants and result in mutation – emerging plants with changed traits or properties. These plants are called mutants. Depending on the intensity of the affecting factor, the emerging changes may be hereditary (gene level) or phenotypic. Changes in traits related to the alteration of their gene structure are transferred to the plant progenies and stabilized in the plant population. This natural phenomenon has been studied by scientists for a long time and has similarly developed different artificially (experimental) induced mutation methods. In general, scientists intend to use mutation to identify hereditary changes in plant traits of a population and use them as donor plants (initial materials) in hybridization to improve similar traits of cultivating varieties.

Physical mutagenesis of radio-active Co 60 has become very familiar to our cotton breeders within physical mutagenesis. Because in 1966 and 1969, two cotton varieties, Mutant-1 and Mutant-5, were registered. Their initial materials were plants subjected to radiation by CO 60 at the developing stage of budding. Purposeful selection of M₁ plants has secured them to become varieties which have +2 to 3 days earlier than their parental plants with more other positive economic indexes. In 1969, AN-Chimbayabad, developed by N.N.Nazirov and others through radiation effect on 30 day old cotton bolls of the variety S-4727, was registered.

The seeds of the variety S-5570 treated by Cobalt-60 were unequal initial material for the breeders of P.T. Sadikov, E. Akhmedov, and T.Makhmudkhodjaev to develop the cotton variety S-3585 and to register it in 1979. It is one day earlier than the control variety 108-F. Boll weight-5.5 g., fiber output-35.9, length of fiber-33.5 mm., rupture strength of fiber-4.9 g., metric number-5850, and relative rupture strength of fiber-28.4 g./tex. A.R.Tiyaminov, Sh.I.Ibragimov, and A.M.Batalov were encouraged by hybridization (S-6030 x S-6029) and radio-mutagenesis to develop the fine-stripped cotton varieties Karshinskiy2 and Bukhara-2, which were registered in 1980. -active Co-60 was also used by the

breeders K.D. Sultanov and K.K. Gulamov to develop the cotton variety. They took plants from the famous Tashkent-1 and exposed them to radiation. And successive selections of mutant plants desirable to decide their problem could give them the opportunity to form a variety population named VNISSKh-101. It was registered in 1986. Plants of the cotton variety 108-F exposed to the radioactive rays of Co 60 gave the breeders Sh.I. Ibragimov and R.I. Kovalchuk the opportunity to create the cotton variety S-7503, distinguished for its earliness (-3 days) rather than standard and best fiber qualities. It was registered in 1991 and widely planted in production. Then the variety of Gulsara was developed by the same method and authors and registered in 1997. These breeders with A.Kushaliev subjected vegetative plants of hybrids (108-F x Mutant-1) to radio-active rays of Co 60 and got a cotton variety of S-7510. And then, the seeds of the variety S-6524 are also exposed to the ray affected by the Co 60. This attempt gave these three breeders the variety of S-7512, which was registered successfully in 2000.

Biologists of the National University of Uzbekistan named after Mirza Ulugbek (Bekmukhammedov A.A. and others., 2007) have applied the method of complex treatment – gamma ray radiation of Co⁶⁰ + hormone to broaden the frequency and specter of mutation in the cotton plant. The seeds of cotton lines L-20, L-543, and their hybrids were exposed to radiation at the Institute of Nuclear Physics of the AS of the Republic of Uzbekistan. The analysis of lines M₁ and their hybrids M₁F₁ showed that the highest frequency of variation of M₁ plants in the line of L-20 took place on the traits of seed germination, plant architecture, shape of leaf, color of fiber, size and shape of cotton boll and others. On the basis of variation, M₁F₁ plants outperformed both parental plants, M₁ L-20 and M₁ L-543, in terms of studied traits. In particular, M₁ L-20 has increased seed germination by 13% and would be recommended as the initial material for enhancing the field germination of cotton varieties.

Chemical factors (mutagenesis) are more advantageous than physical radioactive mutagenesis in the rupture of correlative relations within those of co-adaptive traits of plants in the process of traits' evolution, which has become a serious obstacle to the success of the breeding process.

Furthermore, it was noted that every chemical mutagenesis has its own specific optional peculiarity in the genetic variations of traits. For example, DMS (dimetilsulphat) often causes mutations in the fiber output, fiber length, and wilt resistance; EI (ethilenimina) promotes the emerging of mutants with enlarged cotton bolls and long fiber; treatment with NMM (nitro zomethyl carbamide) causes an increase in productivity and wilt resistance of cotton plants. The most useful mutations occurred in concentrations of 0.1–0.05% of mutagenesis.

Under the guidance of N.N. Nazirov, the treatment of plant parts of *G.hirsutum* L. ssp. *mexicanum*, var. *nerosum* L. with radio-active phosphorus to get varied plants with useful traits was implemented. Scientists were able to create cotton varieties by studying the plants M₁ and purposefully selecting mutants, as well as involving them in hybridizations. AN-Kattakurgan was created by soaking 1306 DV seeds in a radioactive phosphorus solution. It was registered in 1969.

AN-401 (registered in 1971), AN-403 and AN-405 (registered in 1975), AN-407 and AN-408 (registered in 1976), AN-402 (registered in 1979), and AN-411, 412, and 414 (registered correspondingly in 1984, 1984, and 1988).

In 1980, A.Egamberdiev and M.Daminov registered their cotton variety Listopadnyi-1. The initial material for getting this variety was cotton plants taken from the treated seeds of variety Tashkent-1 with ethilenimin. In 1996 was registered the cotton variety Diyor, which is the result of hybridization of cotton plants after treatment with chemical mutagenesis. Soaking of seeds of wild cotton also gave the cotton variety Kopaysin, which was registered in 2003.

Many natural factors, other than physical radiation or chemical substances, have been observed in the foreign and native history of cotton breeding, which could be referred to as genetic divergence in plants of variety population. Plant trait variation provides an excellent opportunity for breeders to select and isolate useful plants with desirable traits as the starting point for developing new cotton lines or even varieties.

For example, the variety AN-209, the author of which is S.S. Sadikov, has been created through the selection of the useful plants within segregated plants from the variety population of S-1225 prior to being exposed to the lowered temperature. It was registered in 1961 because of its earliness by 3-5 days more than Tashkent-1 and the fiber output reached almost 40–41%. Another, more similar in origin, cotton variety, AN-Chillaki, was registered in 1979. The authors of this variety, M.M.Kiktev and others, subjected the plants of Tashkent-1 to continuous lighting. This factor is either called artificial divergence within the variety population or segregating different plants, attracting the breeders' attention. Selection and reproduction done by breeders have resulted in them forming this variety. M.Ashurov, who was initiated by the effects of natural factors, in particular, the lowered temperature and its effect causing the split of the cotton genotype into different biotypes, has begun to use this kind of factor in his scientific work since 1985. From 1985-1993, he subjected the germinating seeds of varieties Ashkhabad-25 (spreading plant bush), S-6037, and Karshinskiy-6 (zero type of plant bush) to lowered temperatures of +9, +12C°. These lowered temperatures have inhibited and spread the germination days of seeds and promoted the breeder to divide sprouting seedlings into different fractions depending on their days of germination. Differentiation on the day of germination has been distinguished in the varieties. The late and middle-ripening varieties of Ashkhabad-25 and S-6037 gave 3 and 2 seedling fractions, respectively. Karshinskiy-6, an early ripening variety, does not differentiate on germination and was therefore excluded from further research. Plants developed from different fractions exhibited considerable alterations in their economic traits and properties. They were isolated from each other and even subjected again to the lowered temperature to increase the variation within plants of every fraction. The double effect of lowered temperature and selection could enable the breeder to distinguish biotype plants 10-12 days earlier than their maternal plants, and they were united into new cotton family populations. Early maturity of the families promotes them

to accumulate considerably more yield than maternal plants. Later, two years were devoted to the field tests, where the seeds of families of selected biotype plants under the condition of lowered temperature were compared with the maternal varieties Ashkhabad-25 and S-6037. The obtained results confirmed yet again that progenies of biotypes selected from maternal varieties for their earliest arrival fully return their acquired traits. But the field inspections often reminded the breeder that within the populations of these early ripening families often appeared new plant forms with an expression of lowered earliness. That is why the breeder especially emphasized the importance of taking preliminary seed production measurements in the seed reproduction process. A special seed production under the control of the breeder was needed to maintain the uniformity of the populations' traits and properties. These cotton families were highly appreciated for their value in the quality of initial material for breeding processes of fine-staple cotton varieties.

Relatively lower conditions of watering were also studied in 2000–2010 at the experimental stations of the SRICBSP and TSAU by M.Ashurov as the splitting factor in the aim of splitting the variety genotypes into valuable biotypes, in particular those tolerant to water stress conditions. Development of varieties resistant to water stress had become one of the priority prospects of the plant breeders' researches just after our republic has adopted its independence. To organize this experiment or background with water stress conditions during cotton vegetation was comparably easy due to the possibility of a decreasing number of watering in one of the replications where were planted varieties Bukhara-6, S-7510, Armugan, Akkurgan-2, Omad, S-6524, Namangan-77, and Okdariya-6. The number of field irrigations ranged from 5 to 8, which corresponded to soil moistures of 65-65-60, 65-70-60, and 70-75-70 at the cotton development stages of flowering, flowering, and maturation. Plants of varieties in the condition of watering 65-65-60 exhibited different, mostly depressed directions in the growth and accumulation of fruit components in comparison to variety populations in the optimal watering condition (70-75-70) and each other. Some varieties were relatively resistant to this condition of growth and could set and retain fruit components, whilst others, like Armugan, S-6524, and S-7510, could retain a small number of cotton bolls (table 15). On the return of formed cotton, variety populations greatly differentiated.

All efforts of the breeder were focused on the selection of plants which had the highest number of cotton bolls in this stress condition. So, individual plants from populations of varieties like Akdariya-6 and Omad with many bolls on them have been selected during the vegetation periods of 2000-2002. Then the seeds of selected biotypes with many formed and returned bolls in the lowered condition of irrigation were seeded to reproduce in the places of varieties which were not tolerant to the exposed condition and were excluded from further study. Progenies of selected plants were studied in comparison to maternal varieties, combined into special families based on acquired trait inheritance, and hybridized with similar

families selected from other varieties to consolidate their water stress resistance on heterosis bases.

Table 15. Variation in boll number on plants grown under water stress conditions (an average from 2000 to 2002).

№	Varieties	Groups of boll number per 100 cotton plants								X+-Sx	S
		0-1	1.1-2.0	2.1-3.0	3.1-4.5	4.6-5.0	5.1-6.1	6.2-7.4	7.5-8.5		
1.	Bukhara-6	9	11	13	18	24	17	6	2	4.9+-1.5	2.54
2.	S-7510	14	16	19	15	13	10	10	3	4.2+-0.9	1.4
3.	Armugan	10	12	18	18	17	13	9	3	1.8+-1.0	1.9
4.	Akkurgan-2	8	12	18	21	17	13	13	1	4.4+-1.6	2.89
5.	Omad	2	5	8	10	16	17	31	11	6.1+-0.7	1.34
6.	S-6524	3	11	18	18	20	18	10	2	4.1+-0.2	0.35
7.	Namangan-77	4	11	17	31	17	10	7	3	4.3+-0.7	1.20
8.	Akdariya-6	1	8	10	15	18	20	23	5	7.4+-0.9	1.69

The following research years saw the continuation of selection and seed production efforts aimed at strengthening acquired resistance to water stress and productivity. Some hybrid-based lines were submitted to the competitive variety testing plot for study, comparably with commonly accepted check varieties of S-6524 and Namangan-77. According to the data of scientists who conducted the field test at the Uz.SRI of CBSP, L-06 was later ripened than S-6524 and Namangan-77 by 4 and 7 days correspondingly (table 16). Here, the more joyful breeding fact is that, in spite of these late ripening data, this line was able to accelerate the accumulation of fruit elements and retain almost all the fruits set on the progeny plants out of selected plants in the condition of lowered water conditions. The line-06 was reliably superior in the calculated yields by +6.2 and +3.7 in comparison with the two check varieties. Fiber yield has increased by +3.0 t/ha over the control variety Namangan-77.

Table 16. Cotton line performance in the CBSP Uz.SRI competence variety testing plot (2005 data).

№	Varieties and lines	Earliness		Productivity		Fiber output		Productivity of fiber		Maturity of fiber	
		Number of days	Than check variety	Cha	Than check variety, +- ton/ha.	In %.	Than check variety, +-.	Cha	Than check variety, +- ton/ha.	Coefficient	Than check variety, +-.
1	S-6524 (st.).	125	-	41.0	-	34.9	-	14.3	-	4.5	-
2	L-B6	-	-	29.3	-11.7	37.2	+2.3	10.9	-3.4	4.9	+0.4
3	L-02	-	-	33.0	-8.0	35.6	+0.7	14.2	-0.1	4.7	+0.2
4	L-06	129	+4	47.2	+6.2*	37.6	+2.7	19.3	+5.0	4.6	+0.1
1	Namangan-77(st).	122	-	43.5	-	37.5	-	16.3	-	4.7	-
2	L-B6	-	-	29.3	-14.2	37.2	-0.3	10.9	-5.4	4.9	+0.2
3	L-02	-	-	33.0	-10.5	35.6	-1.9	14.2	-2.1	4.7	-
4	L-06	129	+7	47.2	+3.7*	37.6	+1.1	19.3	+3.0*	4.6	-0.1

*-indexes of difference are methodically reliable.

Accordingly, with other breeding advantages occurring in these cotton lines, in terms of their fiber output, they were used later as the initial materials in

different cotton plant breeding processes by breeders. Some of these cotton lines' seeds were seeded earlier than usual to increase their resistance to the early lowered temperature with excess moisture in the soil. Because the planted cotton seeds remain under unexpected cold rains and fall soil moisture temperatures in the cotton plantations of Uzbekistan, which causes rotting of wakened seeds and roots of young seedlings, which results in a sparse plant stand. For this aim, selections of biotypes within performed family-lines resistant to water stresses were continued to improve their resistance to the early spring adverse soil conditions. The method of selection was the same as the selection of biotypes from plant populations for water stress resistance.

The results of this selection have been demonstrated since 2010 (figure 11), when published and prepared cotton lines were widely involved in purposeful breeding processes. Actually, these cotton lines have presented themselves as the potential initial material originated and reproduced from multiyear selected biotypes out of a variety of genotypes and thereby resistant to water stress and adverse soil conditions. Cotton lines L-B-2, L-02, and L-06, which were brought up within, were particularly notable for their complex of economic traits and properties. Field germination indexes of these lines in the spring conditions of the 2009-2010 crop year in comparison with check variety S-6524 again confirmed their superiority (figure 11). In that particular year, planting of seeds in the experimental plot happened on May 25th. The variation curve of observed entries along their germination progress clearly shows that their differences from each other and divergence from the check variety (S-6524) along the recording days were remarkable.

All of the plants with the greatest germination progress are from the lines L-06, L-B-2, and L-02.

The above-mentioned examples of natural factors that promote the segregating of a variety of genotypes into some of the constituent biotypes are distinguished by various traits and properties that present the background of diverse gene plants to the selection efficiency of breeders. They were motivation in particular for M.Ashurov in making the following inferences: 1.As a result of continued breeding and reproduction processes, any cotton variety has combined genes of biotypes with comparably narrowed variation on phenotype expressions; 2.Pollination within the population (and recombination of intra-genotype genes) in a specific soil-climatic condition and recommended production practices, as well as by properly taken seed production measurements, maintains a stability in the uniformity of variety traits and properties as in previous v 4. In particular, disturbance of genetic-physiologic courses accompanied by plant phenotype expressions like splitting of new plant forms, segregation of biotypes with different maturation and divergence in hereditary traits or properties; 5.Some of the segregated plant biotypes have inheritable traits and properties and are valuable initial sources for the cotton breeding process; 6.The methods involved in the use of light, temperature, drought, and other naturally unusual factors devoted to the

creation of initial material for the breeding process are comparably easy and available for our breeders due to their existence in our natural conditions.

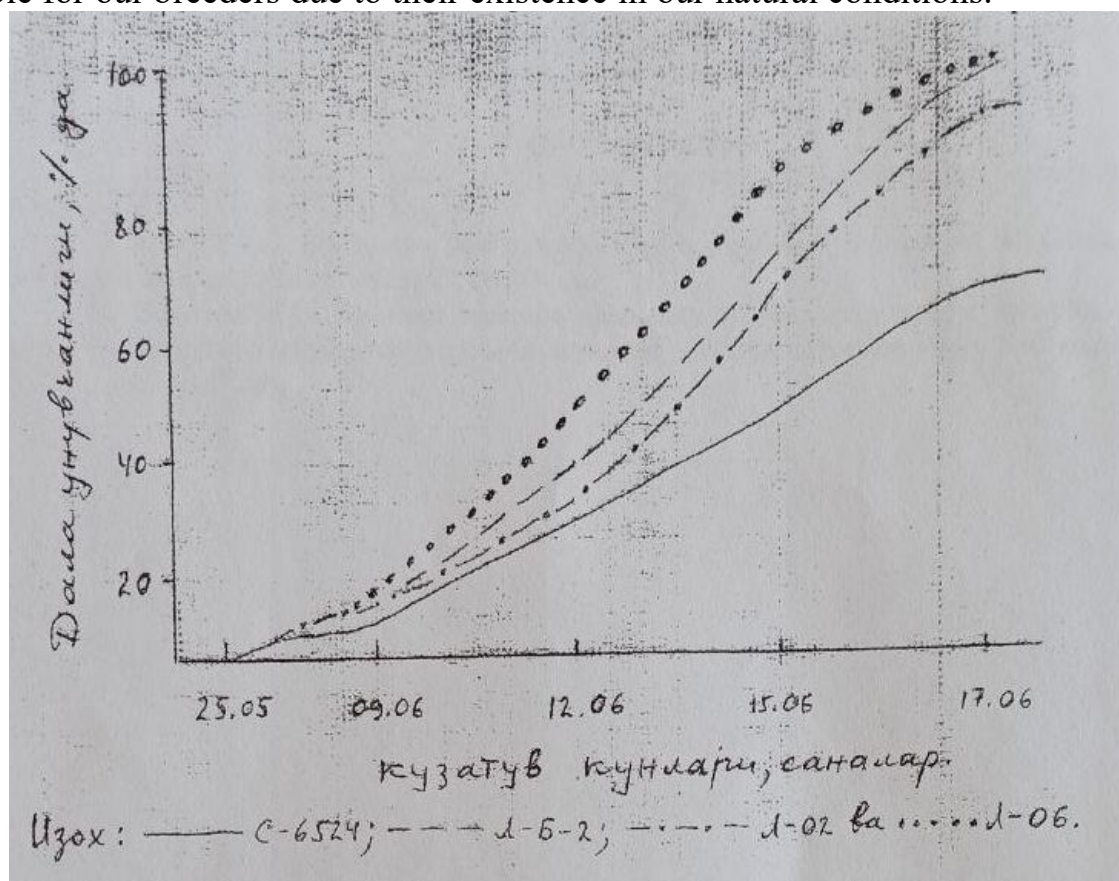


Figure 11. Curve of variation on the field germination of cotton lines and the variety S-6524.

6. Phenotypic traits and biological properties of plants are expressed by the control of genes constituting their genomes. Every trait and property of cotton plants is the result of individual genes or associated gene actions. Their transfer from generation to generation is managed by the genetic theories identified by G.Mendel and his followers. Under the guidance of G.Mendel's principles, the breeders can trace the inheritance of valuable traits of selected initial materials in the progenies. Aside from these genetic theories and principles, today's bio-scientists have worked out more advanced methods and techniques to analyze the responsibility of the genes in a certain cotton species. The creation of mono-some cotton plant collections is one of the world's recognized genetic technologies in the isolating of necessary genes responsible for desirable traits in the improvement of cotton varieties. Today, there are only two cotton mono-some cotton collections in the world. One is in the USA and the second has been built in the botanic garden of the Faculty of Biology at the National University of Uzbekistan (photo 44). Generally, cotton plants have 52 chromosomes, or 26 pairs.



Photo 44. External and internal views of the all-year-round functioning cotton collection complex.

Sh.Bobokhojaev, a bio-genetic scientist, explains that the cotton plant collection contains 52 mono-bodies. The basic mono-some idea is the isolation of mono-some bodies from all 26 chromosome pairs. Despite the fact that there are only 18 people, the full implementation is 8. of this idea into life is remaining as the world's most topical problem before the scientists of cotton-growing countries.

What causes mono-some in the initial material? Scientists can map cotton genes across cotton genus thanks to mono-some cotton plants. Through mono-some cotton lines, scientists would be able to get genes replaced in new cotton lines and use them in the decision of concrete cotton problems through localizing the genes in the cotton genotypes. That means knowing where a gene on which chromosome is located. And as well, it will help to simplify the analysis of polygene controlling traits as well, such as fiber length and output, no matter whether they refer to quantitative or qualitative traits. Successively, American scientists have released chromosomes that replace cotton lines. They show that if one replaces the small shoulder of the 5th chromosome of the cotton line of Hirsutum with that of Pima, the blooming of Hirsutum frequency is sharply accelerated. Why? It was identified that the same chromosome is present in the genome structure of Pima but is not strong enough to express its function because of epistasis effects. So, the mono-some technique is one of the innovative ways to overcome commonly occurring epistasis effects in the correlation of plant traits and properties in the process of traditional cotton breeding. But to great regret, world cotton plant bio-genetic scientists are still not fully able to map all cotton plant genotypes until they get all mono-some bodies from all 26 pairs of cotton chromosomes. In spite of this, the bio-genetic scientists of the department of Biology of National Uzbek University, alongside world scientists, created inbred cotton lines, which are irreplaceable initial materials for improving economic traits and biologic properties of cultivating cotton varieties. For example, inbred lines 16 and 44 are distinguished for fiber output and one boll weight correspondingly: 37.5-38.5% and 7.0-9.5g. The development of science and innovative technologies in Uzbekistan in the last decades of the 20th century promoted cotton breeders, in

particular, to possess the genetic technique of marker assisted selection (MAS). It has made great promises to Uzbek cotton breeders by significantly shortening the cotton breeding process. MAS method, it is possible to quickly and reliably identify necessary genes controlling desirable traits and properties in selected cotton diversities. It ensures the selection of superior genotypes in early generations of hybrid populations, which is extraordinarily necessary in the creation of initial materials from remote species hybridization. This type of hybridization is highly valued for obtaining unequally rare cotton traits, but it takes a very long time (up to 20 years) to split and recombine required traits. On the basis of the MAS programs, Uzbekistan has developed several protein markers associated with biotic and abiotic stress resistance and fiber quality that are successfully used to evaluate cotton diversities for getting initial materials in particular. Moreover, advanced breeding technologies are continued by the scientists of the recently established Center of Genomics and Bio-information. These scientists have made achievements in the molecular mapping of economically valuable cotton traits by using DNA markers such as RFLP, AFLP, SSR, and CAP, which greatly accelerate the cotton breeding process. Using molecular marker technology, they were able to molecularly characterize Uzbek cotton germplasm resources in collaboration with experienced foreign bio-genetic scientists, as well as identify initial materials (candidate cotton accessions for fiber quality and yield potential) to create cotton varieties profitable for farmers while also meeting foreign standards. result, our bio-genetic scientists have released cotton varieties "Parloq-1" and "Parloq-2" in a short period of the breeding process. The variety "AN-Bayout-1" was deserved as the initial material, and its A1 phyto-chrome gene function was slowed down through the method of "knock down". It is characterized as early ripening (with vegetation of 110-115 days). Fiber quality meets the requirements of the I and II fiber types and was registered in 2014. The second, "Parloq-2," was created using the same method, but the initial material was cotton variety S-6524. It is slightly later ripening than "Parloq-1" (+5 days), but the fiber quality is corresponding to the fiber type. It was also registered in 2014 for planting commercially. As a result of multiyear experience in breeding work, identifying genetic laws on trait inheritance and the process of transformation in hybrid populations, the main principles of parental pair selection at hybridization have been worked out. They are: 1. Pairs are chosen based on their trait components and structure. 2. Pairs are chosen based on their ecological and geographical proximity. Selection of a pair with a lower number of negative traits in the parents 4. Maternal parent selection 5. Selection of pairs on the effects of varieties on the combination ability.

Chapter 5. Hybridization.

The term "hybridization" in plant breeding means the process of crossbreeding between genetically dissimilar parents to produce hybrid plants. There are two types of hybridization: natural and artificial hybridization. Hybridization in cotton breeding is one of the breeding methods. The process of implementing this method commonly requires crossings (pollinations) between two genetically different individuals to result in a third individual with qualitatively different sets of traits. Plants of the same species populations cross easily and produce more fertile progenies than remote or interspecies hybridization.

Natural hybridization of cotton happens within plants of various populations because of the cotton plant's out-crossing nature. Historically, all cotton varieties of locally grown, such as Bukharskaya, Kokandskaya, Khevinskaya, Tashkentskaya, Malla, and some cotton plant mixes, were formed not only as a result of seed mixing at the old ginning houses, but also through continuous natural hybridization (cross pollinations) followed by natural and peasant selections. Local cotton producers were elsewhere interested in increasing profit on the account of excess yield and, consequently, they made all efforts to leave the best cotton seeds to plant annually. Moreover, the first cotton breeders highly appreciated the biological dignities of those local cotton forms that performed naturally. No doubt, they were more suitable to the local soil-climatic conditions, tolerable to local environmental stresses, and had comparably earlier ripening properties than many of the introduced cotton varieties from some of the developed overseas cotton countries. Consequently, they were involved in cotton breeding processes by the first cotton breeders. Otherwise, this process is called the "analytical method of plant breeding." For example, our first cotton variety, 182 (Djura), was selected by G.S. Zhaytsev from a diversity of local guza (cotton plant), "Kok-chigit". Another cotton variety, 126-F, created by the breeder L.M. Rumshevich and registered in 1946, also originated from a hybrid population where local Khorezm cotton diversity took part in the hybridization. G.I. Gavrillov, who worked in the west regions (Chimbay and Kungrad) of Uzbekistan from 1930-1950, highly emphasized the genetic potential of local cotton diversity populations and, on the basis of them, created over ten cotton varieties which contributed greatly to the development of our cotton farming. The longevity of the famous cotton variety 108-F, developed by L.M. Rumshevich (registered in 1942), also took its start from the natural hybrid 17687, which was subjected to pollination with cotton variety 36M₂.

Cotton varieties required for the development of cotton growing and, in particular, the textile industry in the republic can be evolved through artificial hybridization involving the second method of plant breeding - the artificial method of plant breeding. new textile industry has required specific fiber quality parameters. According to these parameters, the fiber quality of a certain cotton variety is to be referred to as one of the textile fibers types. And cotton breeders had to often conduct crossing combinations between local cotton varieties and

introduced ones. Introduced foreign cotton varieties (Russel, King, Express Vebber, Acala, Ashmuny, Yanovich, Faudy) of high fiber quality were mainly late ripening in the conditions of Central Asia. It was obvious that the earliness and productivity of local variety diversities and the fiber quality of foreign accessions had to be incorporated into new cotton developing varieties. Resolving this problem was seen only through artificially elaborated hybridizations.

The process of artificial hybridization (or hand pollination) is divided into simple (between two) or pair crossings (between double crossings) and complicated crossings (for example, stepped, backcross, remote intra-species, interspecies, vegetative and others). In the simple crossing, breeders needed to develop a new cotton variety based on two different varieties of the same species and take from them the best traits. Let's analyze some of the historically developed cotton varieties on the basis of simple crossing and compare what was achieved as a result of breeders' hybridization. For example, the famous cotton variety S-460 was developed by the breeder S.S. Kanash (registered in 1931) with the hybridization that took place between the varieties 8517 and 36M₂. 8517 is a cotton variety of this breeder earlier selected in the conditions of Tashkent from the plant population of 0278 Acala, and 36M₂ is a variety of P.V. Mogilnikov selected from other samples of the same introduced cotton variety (036 Acala) in the conditions of Fergana (table 17). The data in the table shows that the breeder could release his new variety (S-460) with a fiber output of 39–40 inherited from the variety 8517.

Table 17. Performance of cotton varieties developed by Uzbek cotton breeders.

Varieties (and their parents)	Earliness	Boll weight, g.	Fiber output, %.	Fiber length, mm.	Rupture strength, g.s.	Metric number	Relative rupture strength, g.s./tex.
1.S-460	+2 (108-F)	6.5	39-40	32.6	4.9	5220	25.6
(8517)	+4,+5 (108-F)	6.5-6.7	37-39	31.6	4.7	5210	24.5
(36M ₂)	-	6.0-6.5	34	32.2	4.7	5320	24.9
2.S-4727	-8,-10 (108-F)	6.3-6.8	37-38	33.5	4.6	5660	26.0
(137-F)	+1,+3 (108-F)	6.7-7.2	37-38	32.8	4.6	5320	24.5
(S-1470)	-5,-7(108-F)	6.8-7.2	38-39	33.7	4.4	5840	25.7
3.Ulduz	-	-	39-40	33-34	4.6-4.8	5660-740	26.4-26.9
(AN-Samarkand-2)	-	6.0-6.9	36-37	35-36	4.9	5700	28.0
(AN-Samarkand-3)	-	5.5	36-37	34-35	4.7	5830	27.4
4.Surkhan-8	133	3.2	31.2	38.9	5.1	7630	38.9
5.Surkhan-10	127	3.7	33.5	38-40	4.5	7700-700	35-36.0
6.Surkhan-12	135	3.2	35.7	39.3	4.9	7600	37.2
7.S-6039	-3 (5904)	3.8	30.6	40.4	4.8	7370	35.3

Fiber length was inherited from the variety of 36M₂. Rupture strength and relative rupture strength of fiber in the new variety are slightly enhanced due to hybridization. Another comparably known cotton variety, S-4727, was also developed on the basis of a simple inter-variety crossing (137-F x S-1470). It was released in 1955 by the breeder B.P. Straumal. Here, the new variety has inherited earliness (-5, -10 days) and fiber length (33.7 mm) from the variety S-1470. Eventually, this variety was also better than its two parents and was grown for a long time as the early ripening and productive cotton variety. Fiber output is one of

the economic traits of the cotton variety. The breeder O. Jalilov (1983) used simple hybridization of two cotton varieties to create the cotton variety Yulduz. The varieties of AN-Samarkand-2 and AN-samarkand-3 were crossed at the beginning of the breeding process. This inter-variety hybridization and the successive selections gave the new cotton variety an increase of up to 40% in its fiber output.

Simple, inter-variety crossings have been used since the beginning of scientific breeding in the releasing of fine staple cotton varieties in Uzbekistan, and now it remains an effective method within applied breeding methods. Supkhan-8 (registered in 1993), Surkhan-10 (registered in 1996), and Surkhan-12 (registered in 1999) cotton varieties were superb fine-stripped cotton varieties that fully met 1st fiber type qualities (table ..). They were chosen in collaboration with seed producer Kh.Khusanov by breeders M.I.Iksanov and M.Ashurov. The parental varieties for these three cotton varieties were, respectively, (S-6041 x Ash-25), (S-6041 x Ash-25) and (S-6037 x Ash-68). In general, cotton breeding based on this method is commonly considered an easy one, which seemingly requires a comparatively shorter time than other, more complicated crossings. But it also requires some definite actions by the side of breeders, which are essential to complete this process with expected outcomes. One of these acts is the finding of potential parents with targeted traits by the exclusion of diseases, pest resistance, drought, hot tolerances, or contrary. Parents are usually selected out of close genetically related varieties in order to get more hybrid seed material. Selected parents are sown in the nursery of initial materials and must be cleaned of off plants before being studied for the upcoming hybridization the following year. So, this period takes two years. The third year is spent on crossing to take no less than 100-150 fertile hybrid cotton bolls. The next two years are spent analyzing hybrid plants (F_1 and F_2). In the successful course of the breeding process, the sixth and seventh years will be spent learning about some of the selected families. As usual, on the experience of the author of this textbook, who was a former cotton plant breeder, the eighth year of the breeding process in the simple hybridization between two varieties is devoted to the testing of developed families in the station testing nursery (figure..). This nursery is laid similarly with the method of the SRIs' competitive variety testing nurseries where all realized families (sooner cotton lines) from departments of this SRI are tested prior to state variety testing plots. A real situation involving research years to be spent, collection of initial materials and results to be achieved, forces the breeder not to divide the cotton breeding methods into easy or difficult ones.

Pair crossing is technically characterized by its slightly greater complexity than crossing between two varieties. Its difficulty over simple crossing can be explained by the number of varieties pretending to participate in the hybridization and their set of traits and properties on which the breeder hoped to end his research and produce a new variety. Most certainly, the result of the breeding process depends on the breeder's erudition formed on the basis of experience, his understanding of principles about inheritance and control of proper seed reproduction in order to retain the uniformity of evolved family, line, and variety

populations. The complexity of the number and set of traits can cause confusion for inexperienced breeders during hybridization periods. Because two hybrids taken from four cotton varieties should be crossed again. This work increases the period of the breeding process by one more year than crossing between two varieties. The period of recombination of parental traits is really the same as in the first method, in spite of the consequences of gene interactions of four parental varieties. As usual, the breeder hopes here to catch more rich recombinants within segregating progenies of F_1 and F_2 . Another difficulty is connected with the number of hybrid populations. There is a real chance of catching more desirable individuals by increasing the numbers of hybrid plants in the population. To overcome the above-mentioned difficulties, the breeder pays great attention to getting the maximum number of pollinations, not less than 100-150, in order to get an extended population of F_1 plants. This method of hybridization can ensure the breeder incorporates not only economic traits but biological properties as well. Because four cotton varieties rather than two as above can embrace more contrasted genotypes and increased potential.

Examples of pair hybridization in the history of cotton breeding, according to the catalogue of cotton varieties of Uzbekistan developed for the period of 1913–2012, can be considered since the variety registered in 1980 by the breeders A.N. Tribunskiy and others. Their variety 175-F is an example of a first pair hybrid, with hybridization consisting of [(156-F x 2795) x (L-204 x 06422)]. The main aim of this work was to transfer wilt resistance from semi-wild nervosum - 06422 into the genotype of a cultivating cotton variety. Plants were pyramidal in architecture, with a height of 100–120 cm and weak leaf cover. Simpodial woods are the second type of branching. The stem is strong and resistant to lodging. The first simpodia is formed on the 5–6th node. The leaves are medium sized. The weight of 1000 seeds make up 118-120 g. The variety refers to the group of middle ripening. The average productivity was 4.0–4.5 tons per hour. Fiber yield: 33-34%.

The weight of one cotton boll is 5.2–5.6 g. The remarkable dignity of the result of this combination of hybridization was the creation of a cotton variety which was recognized for its highest resistance to wilt within cultivating middle staple varieties. C-6039, the first among the fine staple cotton varieties, was developed by the breeders Yu.P.Khutornoy, M.M.Iksanov and merited seed producer V.S.Vasilev as a result of a similar pair hybridization method. It was registered in 1982. The quality of fiber has corresponded to the first fiber type (table ..).

Crossing (pollination) can be reciprocal and has two directions ($A \times B$ and $B \times A$), because the results may be different because of the trait controlling not only nucleus but cytoplasmic genes as well.

Complicated crossings can be organized by taking parts of several cotton varieties in different directions. Breeders are free to select hybridization combinations based on their opportunities. The second fact is satisfaction of the hybrid genotype with the target trait of the chosen variety, which was not fully

transferred in the first pollination into the new forming variety line. Sometimes this is presented as the hybridization among hybrids ($F_3 \times F_3$ or $F_3 \times F_5$).

Stepped crossing in cotton hybridization refers to complicated crossings that are carried out step by step, using a target variety of cotton plant for some of its valuable traits or properties that should be transferred in sequence into the genotype of a new cotton variety to be formed as a result of the breeding program that has been initiated. The development of the famous early ripening cotton variety S-4727 and the wilt-resistant cotton variety Tashkent-1 remained one of the most notable examples of this crossing method's achievements. So, on the first step, crossing was done between varieties of 8517 and 36M2 by academician S.S.Kanash. These varieties were taken from different samples of Acala through analytical selection. From the materials resulting from the crossing of these two varieties, then reselected the high-productive but late-ripening variety S-460. In the second step, it was crossed with the long-fiber variety 18819 and taken to the early ripening and productive variety S-1470. This variety was weakly resistant to verticillium wilt. In the third step, cotton variety S-1470 was crossed with variety 137-F, yielding S-4727, which outperformed both parental forms in terms of early ripening and productivity. This cotton variety occupied all cotton plantations in Karakalpakstan at the time, but it inherited a weak resistance to wilt from its parent S-1470. On the fourth step, this variety S-4727 was crossed with the wild subspecies *G.hirsutum* ssp. *mexicanum* by S.M. Mirakhmedov. The hybrid F_3 was backcrossed with variety S-4727. Tashkent-1, a productive, wilt-resistant cultivar, was developed from this backcrossed material. This cotton variety was known to have occupied nearly 1 million hectares of cotton plantations in the former Soviet Union in 1977. The scheme of this stepped hybridization is presented below (figure 12). Cotton varieties developed by stepped hybridization combine in their genotype, due to continuous selection, the best qualities of all varieties involved in their genotype. N.G. Semonguyan, a well-known geneticist and cotton breeder, reminded us that stepped selection for productivity increases the combination ability of varieties due to the concentration of valuable genes.

The abovementioned principle of inheritance of desirable traits can be traced to another example connected with this complicated method of hybridization to get a new variety with high fiber output. We can present the example of the variety S-1759, where the fiber output was raised by up to 41-43% as a result of this kind of hybridization. This is the utmost high index of fiber output that has occurred in bred cotton varieties of *G. hirsutum* L. This accomplishment was most likely achieved by incorporating high fiber output expressing genes into newly established genotypes via step-by-step crossings: $(S-1225 \times S-1336) S-1336 = (S-460 \times S-1098) S-1098 = (8517 \times 36M2)$. The first step, made of a variety of S-1336, originated from the crossing of S-460 x S-1098. The second step was the crossing of 8517 x 36M2, which resulted in the selection of S-1098. The last step is explained with the crossing of S-1225 x S-1336 and the development of the variety S-1759 by the breeder S. S. Kanash. This method of hybridization is comparatively

difficult and requires exclusive attention to the increase of one of the desirable traits because of numerous genetic and environmental obstacles.

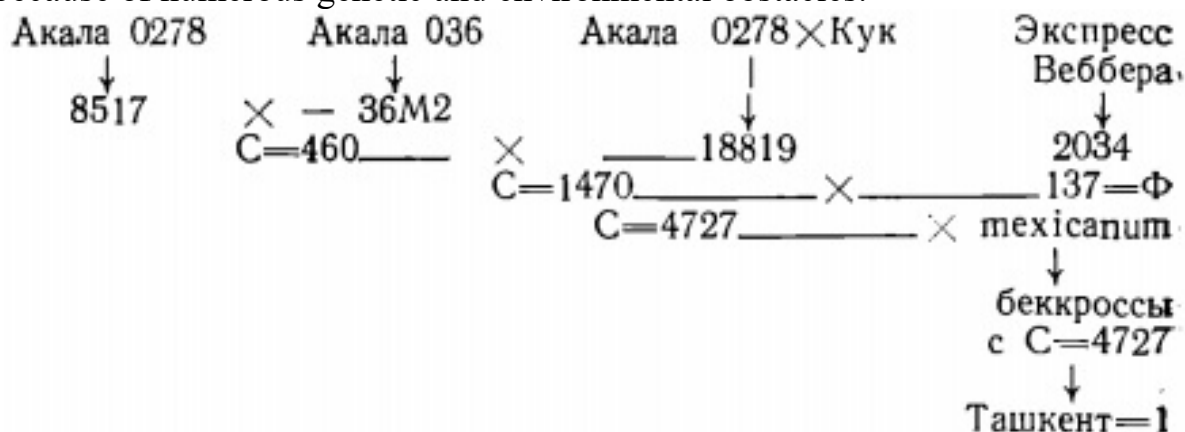


Figure 12. The scheme of the stepped hybridization.

The method of **backcross hybridization** is the world's most deserved method due to its efficiency in general plant breeding practices. It is typically used to obtain a sufficient amount of a specific trait or property when developing a new cotton variety. Many genes function under complicated correlations in theory, which is why it takes several attempts of repeated crosses to rupture them, allowing for new gene conjugations. All these are accompanied by backcrosses with donor variety again. The cotton varieties S-9041 and S-9074 are the best examples of the first complicated hybridization by the application of backcross in the history of cotton breeding. They were registered in the years 1969 and 1993, respectively. These varieties were developed under the guidance of D.G. Minko and P.V. Papov. The written origin of the first variety consisted of L-76319 x (76319 x 2282) 76319 = (7631-I x 1119) 2282 = G. barbadense L. Here, the cotton l-76319 was taken again to cross with the hybrids where it was one of the parental cotton plants. It means that the hybrid plants are strengthened with genes of one parental form through backcrossing. The same order of choosing of parental forms we can see in the second variety, where cotton line L-5989 is repeated two times in the crossing works. Its backcross was needed to satisfy the expression of one of cotton's traits or properties: (L-5189-10 x L-65-687) L-5189 = (S-9070 x 08089) L-65-687 = (S-9063 x S-9065). Later, an attempt was made again to use this method by our cotton breeders led by R.G. Kim in the development of their cotton variety S-8284, registered in 2014 (photo 45).

We can see here using of backcross in the several times: [(L-158 x S-6530) x L-158) x L-158]. No doubt, most part of economical traits was achieved due to backcrossing of the cotton line L-158. They are: branching of 1-2 type; height of main stem – 70-90 cm.; the first fruiting branch sets on the 5-6th node of the stem; weight of one cotton boll – 6.5 g.; weight of 1000 seeds – 120-130 g.; fiber output – 37% and its quality met the requirement of 5th type; mic -4.5; fiber length (UHML) – 1.14-1.16; cod – 34-36; relative rupture strength – 30-32.0 g\text. Early ripeness of this variety makes of 118 and 121 days. Independently, all directions

and combinations of hybridization of varieties and lines within one cotton species means **intra-species (or intraspecific) hybridization**. As remarked by the famous cotton breeder B.P. Straumal (1974), the next crossings are used at the intra-species hybridization:



Photo 45. Outlook of the cotton variety S-8284.

- A. Close variety hybridization for origin and environmental conditions;
- B. Hybridization of various varieties for agro-economic traits, environmental medium, and origin;
- C. Backcross hybridization;
- D. Hybridization of home varieties with wild and semi-wild forms within species of *G. hirsutum* L. and *G. barbadense* L.;
- E. Pollination using pollen mixtures;
- F. pollination with off-pollen;
- G. Hybrids, taken as the result of natural crossings.

According to his concept, the breeder selects the method of hybridization depending on the taken object and initial material.

Remote intra-species hybridization is defined as those pollinations of cotton plants in which one of the cultivating cotton varieties or lines is crossed with one of the geographically remote cotton varieties from the same cotton species. Wilting disease, caused by the soil fungi *Verticillium dahlia*, has become one of the distracting abiotic factors in the decrease of cotton yield and fiber

quality in Uzbekistan cotton plantations since the half of the last century. Famous scientists have predicted that the resistance of cotton to wilt can be solved via the application of remote intra-species hybridization. Comparatively resistant varieties 108-F, 150-F, 153-F, S-2501, and S-3506 couldn't meet the existing requirements in regard to vegetation period, productivity, and fiber quality. As a result, for the first time in our cotton growing history, breeder S.M. Mirachmedov crossed susceptible variety S-4727 with form 06422 *G.hirsutum* ssp. *mexicanum* v. *nervosum* Mauer in 1959. Then, the hybrid F₃ was crossed with the parental form of S-4727. Tashkent-1, 2 and 3 cotton varieties were released as a result of this remote intra-species hybridization. The first of them has implied a great international significance not only in our republic but internationally in the suppressing of wilt in the fields of neighboring republics and the Caucasus of the former Soviet Union. This method was used successively by many breeders, such as A.N. Tribunskiy, D.M. Minko, B.P. Sterne and others. Because this method became more effective during that period of cotton breeding, and as a result of other remote hybridizations with the form of *mexicanum*, such historical cotton varieties as S-2601, S-2602, Andijan-1, S-9060, S-9061, and 164-F were successfully released. In 1988 was registered the next commonly familiar cotton variety, S-6524 (photo 46). This variety, like the above-mentioned ones, has been developed by the same method—remote intra-species hybridization. Here, cotton variety 159-F was crossed with another semi-wild cotton, *G.hirsutum* ssp. *punctatum* form. Seemingly, the authors of this variety, V.A. Avtonomov and his colleagues, noted many valuable traits and properties of the remote, semi-wild cotton and made all selection efforts in the segregation of hybrids in order to maintain them in a new cotton genome. Because, even today, we can see this variety planted continuously in the salty, drought-prone soils of regions (Khorezm, Jizzakh, Sirdariya, Tashkent, and Namangan) of the republic of Uzbekistan. Apart from its long period of cultivation (since 1988), under cruel growing conditions, it could retain its essential bred traits and properties. Their current indices are as follows: early ripeness - 125 days; bush architecture has cone shape, 1-2 types of branching; height - 100-120 cm; main stem - strong, not prone to lodging; leaves are medium in size; and the first fruiting wood sets on the 5-6th stem node. Cotton bolls have 4-5 lobes and one boll of raw cotton weighs from 5.5 to 6.5 g. 1000 seeds weigh 125-135 g, with a fiber content of 33.5-34%. Fiber quality corresponds to IV fiber type: mic 4.3-4.5; UHML 1.12-1.15-inch, cod 33-35, relative rupture strength 27.7 g./tex. Andijan-35, which was registered in 2005 and is now cultivated in the Andijan, Namangan, and Fergana regions, was developed through complex hybridization with the attraction of distant intra-species cotton form *G.mustelinum* Miers from South America: [(AN-402 x Line-90) x (*G.mustelinum* x Andijan-13)]. These three regions have old cultivated land and enough specifically adopted and modified races of disease pathogens and pests that need the most potential cotton varieties. So, this cotton variety has become the farmers' favorite because of its rapidly recopying feature in account of expenditures and justifying ability in regard to its reputation.



Photo 46. Outlook of the cotton variety S-6524.

Interspecies (or interspecific) hybridization refers to the breeding process where the breeders pollinate cotton plants with each other selected from various cotton species of the same genus. This method of hybridization has earned the common acknowledgement of scientists involved in worldwide cotton breeding processes for its malty promising transformations. The reason is, different cotton species grow separately in different continents, their climates, soil conditions, and light length vary. Cotton breeders now have year-round access to modern cotton greenhouses where almost all semi-wild, wild, shrub, and even tree type cotton forms have been brought from all geographic latitudes around the world. Therefore, our breeders had bravery in the sphere of their possibility to do some cross-pollination between cotton species. For example, cotton variety S-8252 in the list of cotton varieties historically developed in our republic was created by A.D. Dadabaev and N.G. Simongulyan through interspecies hybridization and registered in 1968. This is the first cotton variety in which it can be noted that cotton variety S-1587 (*G. hirsutum* L.) was pollinated by the pollen mixes of *G. herbaceum* L. and *G. arboreum* L. This variety inherited resistance to pests (due to dense hairiness on the surfaces of plant parts), to drought (decreased number of transpiration holes on the leaves) and to cold (physiological features) from those

two species by maintaining the highest fiber output (39%) from cultivated variety S-1581. Later, the number of interspecies cotton varieties has increased. Some of them are Bukhara-4 (1978), Bukhara-6, and Andijan-60 (1984). By the way, remote interspecies hybridization has been enriched by the introduction into hybridization of semi-wild and ruderal subspecies too. So, as the initial material has become used by *G.tricuspidatum* ssp., *purpuranscens*, and *G.hirsutum* ssp. *punctatum*, which are tolerable to race 2 of *Verticilium* fungus, Donors of resistance to wilt and other variable traits are being investigated in the world's cotton collections. Remote interspecies hybridization methods are being refined and modified. In particular, Orzu (1991), Turon (1998), and others were the results of these methodic improvements. Another cotton variety, S-9082, was also the result of triple interspecies hybridization: (L-2736 x K-71) K-71 = [(*G.turberrii* x *G.raimondii* x S-4727)]. The authors of this cotton variety are M.P. Sukurov and P.Sh. Ibragimov. It was registered in 2002 due to its earliness (-2 days earlier than S-6524) and high fiber output (39%) inherited from the early ripening variety S-4727 and superior resistance to many of the biotic and abiotic stresses of the environment from the species of *G. turberrii* and *G. raimondii*. The varieties of Jarkurgan (2007), S-7277 (2009), S-9085 (2010), Sultan (2011) and others were also the results of the triple interspecific hybridization method. The abovementioned trend of research has been continued by many other scientists. For example, under the supervision of doctor Kh.Saidaliev in 2009–2013, he studied hybrid lines taken from the crossings of *G.tomentosum* x *G.hirsutum* x *G.barbadense* and identified inheritance and variation of such traits as plant productivity, fiber output and quality.

Vegetative hybridization (graft junction). In regard to the formation of new cotton plant forms, this method is closed to interspecific hybridization (photo 47, 48, 49). In the history of cotton breeding (Straumal B.P., 1974), T. Kaziev is considered one of the first who engaged in vegetative hybridization in 1931. Subsequent cotton breeding research works in which vegetative hybridization was used can be found in the works of E.Kh. Uzenbaev and others, with the result of cotton varieties AN-2 (registered in 1954), AN-17 (registered in 1959), AN-105 (registered in 1966), and AN-203 (registered in 1957) developed by S.S. Sadikov and S. Mirakhmedov. It was identified that cultivating hybrids in the embryo and post-embryo periods on the different seedling stocks provides a widened form formation process. Special effects can be taken in this process if late ripening intraspecific hybrids of F_1 are cultivated on the seedling stocks taken from crossings of early ripening varieties.

In general, it is a great regret that some of the latest cotton varieties have been developed in the period of transition from an economy into market orientation, which caused a worsening of plant breeding processes. Consequently, these cotton varieties were not able to enhance the world rank of Uzbekistan in seed cotton yield (12th, data of the FAO 2017) and cotton yield (29th, data of the USDA 2018). This is the first problem of cotton growing which has emerged since the development of scientific plant breeding in our republic.



a

b

c

*Photo 47, 48, 49. Representation of various development stages and graft junctions of mature grafts (Mehhmet Karaca and others., 2020). (a) [TM-1(*G.hirsutum*)—Pima 3-79 (*G.barbadense*)], (b) lateral shoot formation on TM-1 rootstock of graft [Pima 3-79—TM-1] and (c) [Pima 3-79—Pima 3-79].*

According to the history of cotton breeding and the accomplishments of our breeders, the problems they face today have a terminal character and, hopefully, will be resolved in the near future. Government is a powerful initiator and investor in the creation of innovative breeding research to involve new highly potential and world-competitive cotton varieties.

Chapter 6. Selection and its kinds.

In general, **selection** means selecting plant varieties and animals bred by man in accordance with his consumption.

It was pointed out by Ch. Darwin that heredity, variation, and selection are the basic elements in the evolution process of organic matter.

All the varieties of cultivating plants have been created through **artificially** mutating species and forms of plants in nature—through **natural selection**. Natural selection is the major factor in species evolution. The primary differentiation of species and cotton genomes occurred as a result of natural selection during the Cretaceous period's primary disconnection of the united mainland and the development of various branches of the genus *Gossypium* in sharply differentiated ecological-geographical conditions.

Later, after the introduction of cotton into cultivation, the effects of natural and artificial selection will be amplified. Primarily, artificial selection has carried an unconscious character. Primitive people could use the fiber of wild cotton for different needs, using the best seed samples for replanting. Ruderal forms of cotton with improved economic traits—productive, enlarged cotton bolls, length and quality of fiber—have been formed by this process in the last few thousand years. With the development of agriculture, artificial selection accepted more conscious character - preference was given to forms with less longevity of above soil organs, simplified types of branching, and weak photoperiodic reaction. Cultures of weak photoperiod reaction, adopted to annual cultivation, have been established in the place of perennial monopodial cotton trees and shrubs with severe photoperiodic behavior. Overall, these annual cotton forms have allowed for a significant increase in productivity and the intensification of cotton farming. Cotton cultivation has greatly expanded in various soil-climatic and agro-technical conditions, contributing to the establishment of an enormous variety of ecological forms and hastened the evolution of domesticated species.

The most valuable parts of plants for people are developed through artificial selection. Currently, the role of artificial selection being conducted by the man himself is unmeasurably growing. As suggested by academic N.I.Vavilov, "selection is an evolution directed by the wishes of a man." And artificial selection has turned into the main chain of plant breeding, which is applied to any genetically non-uniform material, as a result of hybridization, induced mutation, polyploidy, and other factors. Genotypes are kept in the process of artificial selection, which is the best way to correspond to those purposes which were pursued by plant breeding. One of the major differences between artificial selection and natural selection is that only those traits presenting an interest to a man are exposed to selection. In the cotton plant, they are: economic productivity, fiber length, fiber quality, the output and others. Economically valuable traits do not always coincide with biologically useful ones necessary to survive the species in its natural conditions. For example, such important economic-valuable traits as fiber output, its length and quality, and boll size are contentedly indifferent to the biological view of point. The large difference in the listed traits that watch between

wild and domesticated forms of one species is only the result of artificial selection and is clear evidence of the selection's creative role. It turned out well by a man that the size of boll has been increased by 7–10 times, the length of fiber to 20–25 mm, the fiber output to 30% and others through artificial selection.

Biological and economically useful traits of cotton plants may coincide. Such traits, at least at the level of plant breeding, are formed under the joint effect of artificial and natural selection. Resistance to diseases and pests, for example, is beneficial from both an economic and biological standpoint because it ensures yield as well as the survival of the species during epidemic years. Earliness is the important economic and valuable trait of the cotton plant. It defines the dimensions of crops, quality of raw cotton and fiber, possibility of mechanical harvest and others. Together with them, undoubtedly, biologic profitable traits that determine a major aspect of domesticated species evolution, occupying vast growing areas by these species, their polymorphism.

Cotton plants are cultivated by man, mainly for their fiber. Namely, the greatest differences within varieties are observed in the color, length, strength, and fineness of fiber. Leaves, seeds, and others have significantly fewer differences.

The emergence of hidden, recessive traits in populations and varieties as a result of cultivation in unusual climatic and agro-soil conditions; hybrids resulting from intra-species, inter-species, and mutation deserve to be the starting material for selection.

Two kinds of artificial selection in cotton plant breeding are differentiated into mass and individual, which can be used one time, multiple times, and continuously.

At the **mass selection**, a one-time repeated or multiple selection of the outstanding plants is carried out within local or introduced materials from other regions and seeds of which are planted jointly. Such a kind of selection is efficient in the case of, when necessary, an exclusion of mechanical impurity in the essential variety or isolating the earliest ripening, productive plants. As was mentioned in the former textbooks, this method in Uzbekistan restored cotton varieties Navrotsky and 168. Plant mixtures of *G. herbaceum* L. and *G. hirsutum* L. The local varieties of the Asian cotton species *G. herbaceum* L. formed in the definite natural historic regions of Middle Asia as a result of mass selection under the influence of external conditions. At that time, cleaning of raw cotton was conducted by hand in the winter. Those peasants needed to have such cotton varieties which would not be subjected to contamination when they piled raw cotton up in the heaps, would not fall out of boll lobes under wind effects, and would not spoil under rains, snows, and other unfavorable meteorological conditions. Because Asian cotton varieties are frequently grown as a second crop following the harvest of grain crops such as barley and wheat, it was necessary to adopt the ability to grow and develop at the highest (20–25 °C) spring temperatures.

Cotton fiber is used for the manufacturing of robes and blankets, consequently it was very important that they be elastic and wool like.

Mass selection was being fulfilled by the people during long periods of years, in the direction of plants with closed or half-closed bolls, which were able to grow and develop well in the later terms of sowing (May), with elastic wool like fiber. These local varieties (guza) are differentiated into the following main types:

*Bukharskaya guza, which has more enlarged bolls in comparison with other guzas with wool like fiber of a length of 22-24 mm.

*Kokandskaya guza has wool-like fiber but is shorter in fiber than Bukharskaya guza.

*Khivinskaya guza has a characteristic trait which is longer and finer fiber (24-25 mm).

*Tashkentskaya and Khorasinskaya – on their traits were more similar to Bukharskaya.

*Malla – guza with the fiber of brownish color.

Closed and half-closed cotton bolls with a weight of 3-4 g., not over (25-28%) fiber output and short (22-26 mm) fiber were characteristic of all the above listed guzas.

All guzas were notable for their ability to withstand the highest temperatures in the period of sowing and their ability to withstand moisture scarcity in the spells of vegetation.

Guzas gave a yield of 10-15 c\ha in the conditions of a second crop. During the former Soviet period of cotton growing, guzas were sown from 1921 to 1931. The most extended area of cotton plantations was 12.6 thousand hectares in 1929.

Apart from the above mentioned outcomes, at the end of the 1800s and since the beginning of the 1900s, they continuously introduced the cotton seeds of early ripening varieties of *G.hirsutum* L. in Uzbekistan from the USA. Local, early-ripening varieties (populations) of the species *G.hirsutum* L., colloquially known as "plant mixes," have been established as a result of accumulation, best agro-practices than their native land, natural outcross pollination between various varieties, and mass selection carried out by peasants in Turkistan's various natural geographic districts. As a rule, the peasants left the seeds of the first harvest to plant, where the crop was taken out from the earliest plants. Eventually, the majority of "plant mixes" after continuous mass selections acquired the highest early maturity. In 1910-1917, in Central Asia, they differentiated the following "plant mixes".

Chimbayskaya, the earliest ripening (113–125 days), with the highest fiber output (31-32%) and fiber length (27–29 mm). This "plant mix" has remained in production longer than others and was removed from it in 1935. In 1930, its largest plantations totaled 21.6 thousand hectares.

Chimkentskaya is similar to Chimbayskaya in its traits and properties.

Tashkentskaya matures significantly later than 1306 (+5-7 days), with a fiber length of 26-28 mm, fiber output of 30-32%, and a weight of one boll of 4.3-4.5 g.

Assakinskaya ripens later (+6 - 8 days) than variety 1306, with fiber length of 27-29 mm, fiber output of 32-34%, and a boll weight of 4.6-5.0 g.

Kuvin and Mervskaya are similar to Assakinskaya in their traits.

For 5-7 days, Khorezmskaya, late ripening varieties than variety 1306. Fiber output is 29-30%. length of 29–30 mm at a boll weight of 4.0–4.5 g.

They differentiated some of the local varieties by the colors of seed hairiness:

Kok chigit - a variety with green seed hairiness, a fiber length of 25-27 mm., a fiber output of 29-30%, and a weight of 4.5-5.0 g per boll. It matured later (+6-7 days) than the 1306 variety. It was planted by the peasants of the former Namangan uezd.

Ak-chigit - a variety with white seed hairiness, a fiber length of 25-27 mm, a fiber output of 30-31%, and a weight of 4.5-5.0 g per boll. It was planted in the former uezd of Andijan. It has later ripening (+7-8 days) than variety 1306.

This variety was characterized by its naked, black seeds. at a fiber length of 24–26 mm. at a fiber output of 30–32%. The weight of one boll is 5.6–5.0 g. It was planted in the former uezds of Margilan, Khodjent, and Tashkent. It ripened 7-8 days later than variety 1306.

Plant mixes were earlier ripening than local ones, and had superior yields by 50–100%. Plant mixtures were planted in the years following the first strain change. The last plantations of the plant mixes of Chimbayskiy belong to 1935.

The breeders have used the plant mixes in the quality as initial material in the selection of early-ripening cotton varieties. So, G.S. Zhyitsev had selected variety 182 out of the Tashkentskiy plant mixes, and out of Kok-chigit the variety of 169. G.I. Gavrilov released early ripening varieties KK-351, Ch-924, Ch-925, Ch-936, and others out of the Chimbayskiy plant mixes. However, the result of massive selection can be seen in the late history of cotton breeding. For example, cotton variety Ok-Oltin-10 (registered in 2002) was developed through massive selection from the cotton sample of No-1410.

Individual selection. Selection of plants is conducted by the breeders on the basis of complexes of economically valuable traits: earliness, productivity, size of cotton boll, resistance to diseases, fitness to mechanical harvesting, technological properties of fiber and so on.

Prior to selection, the breeder studied plants under experiment during the vegetation period in view of their biological properties, responsibility to conditions of agro-technicians, resistance to diseases and damage caused by agricultural pests.

At the time of selection, the breeder should remember the related conditionality of the majority of economic-valuable traits. For example, earliness correlates with a lower (on the 2-5th node) setting of the first fruiting branch, a lower weight of raw cotton per boll, the smallest seeds, and the smallest leaves of length 29-32 mm., late ripening is frequently connected with the high setting (on the 7-8-9th node) of the first sympody, with enlarged fleshy leaves, bolls, and seeds. Length of fiber is not rare, connected with the egg-shaped or cone form of cotton bolls and the absence or availability of weak hairiness on the seeds. It is very rare that the length of fiber has reached up to 34-36 mm in the circled and globe-shaped bolls. Fiber output is usually correlated with the smallest seeds, low or middle fiber length, and danced hairiness.

Fitness to mechanical harvest is related to the comparably higher setting of the first fruiting branch—on the node of 12-15 cm above the soil surface—either with comparably loosened locations of cotton bolls on the bush, with the strength of the cohesion of the flies and lobules among themselves, and with boll flaps and so on.

It is commonly recognized that in our conditions, varieties with naked stems and no haired leaves are less affected by spider mites.

Correlative traits are, of course, valid barriers. Skillful selection of pairs for hybridization, exposing them to radio-active substances, chemical reagents, and others, may shift these connections in one direction or another.

Climate and soil conditions are important factors in how selections are made. So, more early-ripening types of productive varieties like S-4727 (registered in 1961), Tashkent-6 (registered in 1981), KK-3565 (registered in 2010) are selected in the northern regions of the republic, and, contrarily, more productive and more late-ripening forms are selected in the regions of Kashkadariya, Bukhara, and Surkhandariya.

There should be conditions in the place where the selection is conducted, which make possible the selection of one or another trait. For example, wilt-resistant cotton varieties can only be released in plots infected with wilt pathogens. Cotton variety 175-F (registered in 1980) was the result of individual plant selection out of segregating hybrids resistant to wilt in the artificially infected plot in the Andijan branch of Uz.SRICG; the varieties tolerant to hot wind can be released in the other parts of our republic like Bukhara, Surkhandariya, and Kashkadariya. Because these regions are distinguished by their vegetation periods, in part by frequent hot winds which rapidly dry the fruit components and cause them to fall. Bukhara-6 (registered in 1990), Surkhan-2 (registered in 2000) and UzPITI-2601 (registered in 2011) are the best examples of the individual selections that ultimately have resulted in the release of these varieties tolerant to the hot winds of the above listed regions of our republic. On the suggestion of well-known cotton breeder B.P.Straumal (1974), selecting varieties with long, strong fiber is better in the environment of higher air temperatures in June (+25, +26°C) and at a sufficient, but not exceeded water supply.

The breeder implemented several field inspections on the wilt during the vegetation period with compulsory records on August 1st and 15th and on September 1st and 15th and noted the best families at the time of harvest of individual selections. Then probe samples will be taken out of the best families, which gave many individual selections, and after that, the first general harvest will be done.

At the end of September when 12-15 cotton bolls split open on the cotton bushes, the breeder begins his selection on the best plants with complex traits. At this, taking into account the early ripening, in general on the family and on the individual plants (to this intention it is better to remark the starting dates of flowering and opening of bolls on labels attached on the fixes plants), productivity, general outlook of plant architecture, boll types, shape and size of leaves, infection

of plants by the wilt through cuts of plant stems and other diseases, visually to define technological quality of fiber (length, output, fineness, strength), the degree of attachment of the fiber to the seed, the ability to not give a blemish when the fiber is detached from the seed – “skin with fiber”, size and the hairiness of seeds.

It is impossible to determine the technological properties of raw cotton in the field when it is humid, because in this case, strength and fiber length are overestimated.

Selected plant bushes are marked by breaking the tops or by wrapping cotton or labels. The harvest of individual selections is started immediately after the finishing of the marking of individual selections. Probe samples out of a recorded family with 50 cotton bolls per row are collected to determine the weight of one boll, fiber output and technological properties of the fiber. Prior to individual selections, samples are collected to ensure that only one plant bush is selected, not two.

The number of selections along the lines depends on the value and promise of the breeding material.

Economically valuable traits can be genetically and phenotypically non-transferable to offspring. The breeder must be able to tell the difference. It is true that, in some cases, it is actually difficult to decide which one of them will inherit. In this case, checking of selection along the progeny is carried out with a comparison of the last one to the parental form. For example, we can recall the early breeding efforts of our cotton breeders. the beginning of cotton breeding in Turkistan, King from the USA was introduced—a variety of early ripening, productive but with short fiber. Much work with individual selections via checking progenies above this variety was done by M.M. Bushiev (1912) at the Golodnostep station and R.R. Shreder (1911) at the Turkestan agricultural station. In 1908, R.R. Shreder (1911) began selection on the variety King, and in 1909-1910, he obtained several families with high productivity and earliness. He handed these materials to G.S. Zhaytsev, who in 1920-1921 released the variety of 1306, This variety was earlier than the original King by 6-8 days and the fiber by 1.5–2 mm. I.K. Tardjimanov, in 1934, in the elite farm "Pakhtaaral", selected plants within a plantation of 1306, similar to 1306 but with more enlarged bolls (+0.5 +1.0 g) and better fiber length (+1 +2 mm). These materials have earned the release of the 1306-DB variety. The variety 18819 was another cotton variety released by the individual selection. It was developed by the breeder S.S. Kanash from the population of Kuk and registered in 1942. Its extension got up 149.3 thousand hectares and removed from the planting in 1952. Cotton variety S-2028 was also developed through the method of individual selection and was grown in the years of 1966-1972.

In later stages of cotton breeding, **multiple individual selection** has gradually become one of the most frequently used methods. At this individual selection, plants are chosen based on their phenotype, but the progeny of each selection are planted separately the following year and studied for the most economically valuable traits in comparison to the standard variety. **Check by**

offspring is the major principle of this method and allows isolation of those plants whose variability has been hereditarily conditioned. In this way, checking over offspring is like checking over a genotype. All materials, the variability of which is caused by the conditions of the environment and which are not approved at the check along with the offspring, are discarded. In the next year, individual selection is repeated only within non-discarded families. Selected plants on the phenotype again are checked along with the offspring and so on. Individual selection in the cotton plant and other facultative crossing plants facilitates rapidly separating the population into separated genotypes, testing them, and isolating the best one out of them. On the more complicated polygene traits, where there is a strong variation depending on the condition of cultivation, checking of the offspring should be carried out on the leveled agro-backgrounds. Replicated and randomized sowings can be introduced in the process of breeding in order to weaken the effects of soil differences on trait variation.(appendix10)

"AN-Bayaut-2" (registered in 1983), "Namangan-77" (registered in 1994), "Omad" (registered in 1997), "Khorezm-127" (registered in 2002), "Mekhnat" (registered in 2006), "Chimbay-5018" (registered in 2007), "Gulbakhor" (registered in 2012), "Kupaysin" (registered in 2012). The most known varieties of them are:

"AN-Bayaut-2". This cotton variety was developed by the breeders S.S. Sodikov and others at the SRI of Plant Experimental Biology of the UZ.RSA. It was selected from the varied forms of "Tahkent-1." It has become one of the early ripening varieties because its vegetation period can be extended for 114 days. The plant bush has a pyramid shape, 1-2 types of branching, and a height of 90-100 cm. is strong; it is not subject to lodging. The leaves are medium sized with medium hairiness. The first fruiting branch sets on the 5-6th node.

Cotton bolls have 4-5 lobules. The weight of one boll is equal to 4.5-6.4 g., the weight of 1000 seeds is 120 g., and the fiber output is 34.7-35.5 %. The fiber belongs to the V type: 4.5-4.9, 1.07-1.11-inch fiber length (UHML), cod 34-36, relative rupture strength 27.6-30.4 g./tex.

One of its valuable characteristics is related to its resistance to the soil salinity and drought specific to the region of Sirdarya.

Namangan-77. Vad. A. Avtonomov and others are the authors of this cotton variety (photo 50).

It was selected from natural hybrids of the cotton variety S-6524 in the conditions of the Kizilrabot experimental farm of the Uzbek SRI of Cotton Breeding and Seed Production. It needs to mature for 120-124 days. The plant bush has a cone shape, branching makes of 1-2 type, height -100-110 cm., stem is strong has middle hairiness.

The stem is strong, has medium hairiness, and does not lodge; the leaves are medium in size and hairiness; and the first fruiting branch emerges from the 5-6 nodes. Bolls have 4-5 lobules. The weight of one boll is 4.5-4.7 g., the weight of 1000 seeds is 100-110 g., the fiber output is 37.2-38%, and the fiber quality

coincides with V type: 4.3-4.7, 11.08-1.12-inch fiber length (UHML), cod 35-36, relative rupture strength 26.5-30.7 g./tex.



Photo 50. Cotton variety "Namangan-77".

This variety possesses the best adaptation to the soil-climatic conditions of the valley regions (Andijan, Namangan, and Fergana) of Uzbekistan and the genetic potential to provide a stable crop and good fiber quality annually.

"Chimbay-5018". It was developed by the authors of U.Aytjanov and others at the SRI of Farming in Karakalpakistan (photo 51). Method of multiple individual selection out of hybrid offspring of crossing: S-9070 x 175-F was used to develop this variety.

Its early ripening makes it 115-120 days. The plant bush has a pyramid shape, 1-2 branching, and a height of 110-120 cm. is strong, middle-hairy and does not lay. The leaves are medium sized. The first fruiting branch forms on the 5th or 6th node.

Bolls have 4-5 lobules. The weight of one boll is 6.7-7.0 g., the weight of 1000 seeds is 128.5-131 g., fiber output is 37.8 %, the quality of fiber corresponding to the IV type: 4.5-4.6 micronaire, fiber length (UHML)-1.09-1.11-inch, cod-33-34, relative rupture strength-28.4 g./tex.

It has most of the genetically necessary traits and properties to withstand the environmentally adverse factors existing in the cotton growing plantations of Karakalpakistan.



Photo 51. Cotton variety "Chimbay-5018".

"Jarkurgan" (photo 52). This cotton variety was released through the method of multiple individual selection out of interspecies complicated hybrids F10 [(F₁G.thurberi Tod x G.raimondii Ulbr.) x LZG-187].



Photo 52.. Cotton variety "Jarkurgan"

Vegetation period is equal to 120 and 125 days. A plant bush has a cone shape. Branching belongs to 1-2 types, height-140-150 cm., The stem is strong with medium hairiness; it is not prone to lodging. Leaves have 3-5 lobes of medium size. The first fruiting branch sets on the 6-7th node.

One boll weighs 6.0-6.5 g, 1000 seeds weigh 135-140 g, fiber output is 36.0-38.0%, and fiber quality corresponds to IV type: 4.5-4.7, 1.20-1.25-inch fiber length (UHML), 33.0-34.0 g./tex. relative rupture strength

Selection of initial plants of the variety "Jarkurgan" was carried out in the soil-climatic conditions of the experimental station of Surkhan. This experimental station of Uz.SRI of Cotton Breeding, Seed Production, and Agrotechnology is located in the southern region of Uzbekistan. Consequently, it has bred to the high levels of resistance to the specific biotic and abiotic stresses of this region, which could ensure the variety is able to show itself as the most profitable for farmers.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton breeding process”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Conception about variety			
2	Requirements to variety			
3	Initial material			
4	Hybridization			
5	Selection and evaluation			

Chapter 7. Evaluation of breeding material.

Cotton breeders, like other plant breeders, must constantly assess the resistance of their chosen (initial plant forms) and bred material (plant families, lines, and varieties) to environmental biotic and abiotic stresses, as well as their economic potential. N.G. Semongulyan (1987), a well-known scientist among cotton geneticists and breeders, has elaborated splendidly on the basic principles of assessment of cotton breeding materials.

In order to properly organize breeding works, the genotypes and combination abilities of new native and introduced varieties must be systematically evaluated in the department of genetics at the plant breeding establishment, in addition to the phenotype study of initial material in the nursery of collection. According to the explanations of a number of geneticists and breeders, this work must be done in the order of "genetic service" with the recommendations to the breeders of concrete varieties for selection of parental pairs and planting them in the nurseries of parental forms. It is intended that the **combination ability** of varieties for certain economically valuable characteristics is the most precise criteria of evaluation of initial material under any principle of selection of parental forms. If the combination ability of varieties has been studied, the crossing in the nursery of parental forms must be conducted in a limited number of combinations with enlarged scales in order to provide enough dimensions of the F_1 hybrid population. It means that prophase in the meiosis of hybrid F_1 is the sole period when the pairwise convergence of all chromosomes of one parent with the chromosomes of the other parent is observed. It creates the maximum opportunity for recombination of genetic material of parents, establishment of new groups of conjugations and new correlative connections. As the number of F_1 individuals grows, it becomes easier to implement rare recombinations. Exists a straight dependence between the number of F_1 and the chances of getting a zygote, in which would be united all desirable genes incorporated by both parents (F.E. Eliot, 1961).

The possibility of almost full study of the combination ability of varieties via precise assessment of F_1 hybrids on the economically valuable traits is presented in the nursery of F_1 . F_1 hybrids of various crossing combinations must be sown on the method observed during the variety trail (control nursery) for this purpose. Accurate and reasonable evaluation of F_1 hybrids enables breeders to not only determine a variety's ability to combine but also to reliably identify successful and unsuccessful combinations so that other breeders do not waste time and resources repeating their tests.

If the initial material has been sufficiently uniform, the F_1 will be genetically uniform, which agrees on the principle of Mendel, and that is why selection and rejections are not carried out in the F_1 . Unsuccessful combinations in whole can be rejected in F_1 . For example, low wilt resistance, extremely low productivity, and low indices of important economically valuable traits.

However, if the development of quantitative traits is correlated on the positive side by non-dominant and not recessive genes, the lower F_1 indexes cannot be used to evaluate hybrid combinations. This, one more time, shows the necessity of genetic analysis of economically valuable traits. Massive self-pollination is recommended in the F_1 and successive hybrid generations. Despite the fact that cotton is primarily self-pollinating, the degree of outcrossing achieved is 1-10% or higher, depending on bee flight. **Cross-pollination occurs as a result of the availability of extended and diverse breeding materials in nurseries, as well as the planting of standard varieties, which contaminates the materials and delays the variety releasing process.**

The maximum number of plants should be grown in the nursery of F_2 per every combination in order to have a great variation, identification of transgressions for quantitative traits, as well as to isolate rare recombinations for traits which are negatively co-related. Famous Swedish plant breeders Occerman, Mack-Key (1955), P.P.Lukyanenko (1961), A.N.Tribunskiy (1989), Vad.Avtonomov (2003), O.Jalilov (2007), and others emphasized the importance of providing a large number of F_2 populations.

The success of plant breeding depends on the scientifically substantiated principles of selection. **The intensity of selection and rejection** in the nursery of F_2 must be determined by the genetic conditioning of the trait. For the phenotypic traits controlled by one or several genes, the strictest rejections and selections may be carried out (type of branching, fiber color, downy of seeds and others). The same concerns wilt resistance.

The intensity of selection and rejection for quantitative traits depends on three factors: a) trait inheritance, b) genetic hetero-genesis of populations, and c) genetic control of traits by dominant or recessive genes. In one and the same hybrid population on such traits as size of boll, length, output of fiber, and index, having relatively high inheritance, rejection can start in the F_2 , but it should not be carried out strictly. Most economically valuable traits are correlated negatively. That is why, if the hybrid plants of F_2 contain mostly positive traits but for individual traits that do not satisfy the breeder, in this case, these plants are kept, because the favorable recombination might split in the subsequent generations. In this case, when the change of trait to a positive trend is managed by the recessive genes or even the genes expressing not full dominancy, intensive selection and rejection are strongly unacceptable in the early hybrid generations, as plants with extremely positive traits appear in the later generations of F_4 – F_6 , when recessive "positive" genes transfer into a homozygote state and express their effects. According to the experiments carried out under the guidance of N.G. Simongulyan (1987), strength, fineness, and particularly length of fiber belongs to such traits in many cotton varieties. Analysis of the cotton breeders' points of view confirms the truthfulness of the point of view expressed. The increase of length and fineness in the individual selections from generation to generation in the creation of fine staple cotton varieties was remarked by the breeders of Yu.P. Khutornoy, E.G. Gavrilov, and A.R. Tyaminov.

It should be kept in mind that genetic control of one trait in different groups of varieties may be controlled in different ways depending on their origin. Assessment and rejection of F_2 materials for productivity are not only ineffective but do direct damage to the breeding process by leading to the loss of valuable genotypes. It shouldn't be forgotten, however, that the efficiency of assessment and selection depends not only on genetically conditioned traits but also on the genetic heterogeneity of the population. That is why the indexes of heredity of the same name in the heterogeneous populations taken from remote hybridization are sharply increased, and consequently the effect of selection increases. As a result, such combinations enabled more intensive evaluation and selection for F_2 plant indexes.

Assessment of plant indexes and family indexes is carried out in F_3 nurseries as well as breeding nurseries using the generally accepted method of plant selection and rejection. The last one increases the precision of assessment of materials on the phenotype. It is necessary to suppose that the preciseness of assessment and rejection justification will increase considerably if the conditions (including in nursery: replication, agro background) which decrease environmental variation in these nurseries are created.

The creation of the conditions promoting the enhancement of the precision of assessment of breeding material and increasing the efficiency of selection must be at the center of the breeder's attention at all stages of the breeding process. If the initial material was developed via the method of remote hybridization, the period of study in the hybrid nurseries is prolonged and the material is transferred into breeding nurseries as it aligns.

Provocation backgrounds play an important role in evaluating plant forms in plant breeding and, in the first turn, background – artificially infected by the agents of wilt. On one occasion, the work is constructed by the method of "half", that is, beginning with F_2 , the half of seeds out of individual selections is planted in the "wilt background", and the second part in the healthy background. The families damaged by the disease in the artificial background are rejected together with the healthy. In recent years, with the massive extension of wilt, great attention has been paid to the development of wilt-resistant varieties. Depending on the possibility, all breeding operations, from parental nursery to variety testing, are carried out in parallel in an artificially infected background with a sufficiently high infection burden.

The key differences between *Verticillium* and *Fusarium* fungus are the following: *Verticillium* wilting is a plant disease caused by the fungus of *Verticillium*, which has a wider circle of hosts, and by the fungus of *Fusarium*, which is specific to the host.

Their internationally recognized symptoms are:

The symptoms of verticillium are seen when the crop is in squares and bolls. Plants infected at early stages are severely stunted. The first symptoms can be seen as bronzing of the veins. It is followed by interveinal chlorosis and yellowing of leaves. Finally, the leaves begin to dry, giving a scorched appearance (photo 53).

At this stage, the characteristic diagnostic feature is the drying of the leaf margins and areas between veins, which gives a **"Tiger stripe"** or **"Tiger claw"** appearance.

The affected leaves fall off, leaving the branches barren. Infected stems and roots, when split open, show a pinkish-brown discoloration of the woody tissue (photo 54), which may taper off into longitudinal streaks in the upper parts and branches. The infected leaf also shows brown spots at the ends of the petioles. The affected plants may bear a few smaller bolls with immature lint (photo 55).



Photo 53, 54, 55. *External and internal symptoms of cotton wilt diseases.*

The disease fusarium wilt affects the crop at all stages. The earliest symptoms appear on the seedlings in the cotyledons, which turn yellow and then brown (photo 56, 57, 58). The base of the petiole shows a brown ring, followed by wilting and drying of the seedlings. In young and grown-up plants, the first symptom is yellowing of the edges of leaves and the area around the veins, i.e., discoloration starts from the margin and spreads towards the midrib. The leaves lose their turgidity, gradually turn brown (photo..), droop and finally drop off.



Photo 56, 57, 58. *Fusarium wilt and its effects.*

Crossings in the artificially infected background will be required because the varieties used as parental forms are often unaligned for wilt resistance, and seeding in the infected background prevents the accidental inclusion of genetically resistant forms in the crossings.

At present, the resistance of newly developed varieties to the wilt has become the first requirement for their introduction into production. Cotton breeders are already accustomed to keeping this requirement in mind. The SRIs related to cotton breeding have **specially protected plots** (under open areas or in greenhouses) with soil continuously infected by the pathogens of *Verticillium dahlia* and *Fusarium oxporium* f.sp. *vasinfectum*. Moreover, cotton breeders can

evaluate their breeding materials in terms of the condition of **vegetative vessels**. These vessels with sterilized soil are convenient to use for preparing mobile infected soil or inoculating plant materials with certain isolates of any fungus. The resistance of breeding materials (collection samples, families, lines, and varieties) to the wilt is evaluated in the comparison with a standard (the most susceptible) variety sown side by side in the neighboring rows. Cotton varieties of S-4727 and S-6524 are being used for the last time as the standard varieties.

The more simple methods for evaluating the resistance of breeding materials were described in the research of G.Ya. Gubanov (1972). According to it, the infection of the plot is done through the scattering of infected and dried seeds of oat on the surface of the soil, which is then ploughed to a depth of 25 cm at the time of spring soil tilling. The norm of application of infected oats has equalled 400 kg per hectare. The technique of getting and reproducing virulent fungi from nature was described in the textbook of N.G. Simongulyan (1987). Correspondingly, infected plants are collected according to the method of the Institute of Plant Protection from main furnaces of disease spreading to enrich them with various geographic fungus populations. Disease agents are isolated from infected plants by putting the darkened part of wood in the agar. Further, the fungi are reproduced by planting them into oats or barley in the bottles. They mature for two weeks at a temperature of 20-25 °C. Then, the fungus is taken out of bottles, dried and applied in the autumn or spring under a plough at a depth of 5-7 cm. At a weight of 250-300 kg, infected oat is applied to create the background infected by the agents of *Verticillium* at an infection rate of 70%.

The observation dates can be distributed as suggested by G.Ya. Gubanov for general degree of infection (on the 30.06; 15.07; 30.07; 15.08; 30.08; 15.09; 30.09); and the strongest degree of infection (for the plants have been fully dried) at the end of vegetation. Calculations of gathered data to define the general and strongest degrees of infection are often implemented by the following mathematical equations (Voytenok, F.V., 1992):

$$1. B_{\text{general}} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} = 100\%$$

$$2. B_{\text{s.d.}} = \frac{\text{Number of plants infected at the strongest degree}}{\text{Total number of plants}} \times 100\%$$

Uzbek National University scientists typically use four categories in assessing cotton plant resistance to wilt diseases: healthy-0; weak infected-1, mean infected-2, and strongly infected-3, once at the end of vegetation (in the first decade of October) via making a cut on the stem slightly up the cotyledon level to see the presence of internal symptoms (see photos).

The condition of vessels in the creation of artificially infected soil helps breeders to get more precise doses of infection per amount of soil than open plot. Because every soil vessel is filled with 30 kg of sterilized soil and can be

infected by any level of infecting dose (from 15 g of infected oat seeds per vessel, the least dose, and up to 120 g, the highest dose of infection). Every vessel has the possibility to include even 50 cotton plants to assess the wilt resistance. These plants in the vessels can be subjected to another kind of assessment method – **inoculation** of plants with isolates of wilt races. This method is remarked for its easiness and has a high level of precision in the identification of resistance of new breeding materials to existing races of wilt.

According to the latest data, the harmfulness of wilt to cotton production has been increasing and is resulting in a great loss of cotton growing in Uzbekistan. Considerable sparse within cotton seedlings in the consequences of wilt infection at their early development stages is observed in the cotton plantations and also causes inhibition in their further growth, accumulation of yield components and eventually a decrease in total productivity. By the way, the vulnerable varieties of cotton grown on the fields of strongly infected soil are fully destroyed. That is why the creation of complex resistant cotton varieties to verticillium and fuzarium wilts and their introduction into production has become one of the radical measures to control these diseases, which may increase the cotton yield. The exemplary assessing procedure wherein was used the method of inoculation for studying the resistance of new cotton lines can be carried out by the breeders under the supervision of R.G. Kim (2013). At that, 10 plants per registered row were artificially inoculated by the different isolates of wilt at the beginning of July, which coincides with the start of plant budding (table 18). Inoculation is made on the cotyledon part of the stem and every plant was labelled.

Table 18. Assessment of wilt resistance of new cotton lines to virulent isolates of fungus: *V. dahliae*, *F. oxysporum*, *F. verticillioides* (on September 4, 2012).

№	Cotton lines	<i>V.dahliae</i>				<i>F.oxysporum</i>				<i>F. verticillioides</i>			
		Phenotype view, %		View of cut, %		Phenotype view, %		View of cut, %		Phenotype view, %		View of cut, %	
		Total	Includin g strong degree	Total	Includin g strong degree	Total	Includin g strong degree	Total	Includin g strong degree	Total	Includin g strong degree	Total	Includin g strong degree
1	Л-374	49,9	-	66,6	16,6	49,9	-	49,9	16,6	33,3	-	33,2	16,6
2	Л-1309	49,9	-	49,9	-	33,3	-	33,3	-	16,6	-	49,9	-
3	Л-1335	16,6	-	16,6	16,6	16,6	-	33,3	-	0	0	49,9	-
4	Л-1394	0	0	0	0	16,6	-	16,6	-	33,3	-	66,6	-
5	Л-45	33,3	-	49,9	-	0	0	33,3	-	16,6	-	33,3	-
6	Л-1203	66,5	-	66,6	-	33,3	-	49,9	33,3	16,6	-	16,6	-
7	Л-1222	49,9	-	66,6	16,6	33,3	-	33,3	-	0	0	16,6	-
8	Л-1435	46,6	-	66,6	-	49,9	-	49,9	33,3	33,3	-	33,3	-
9	Л-1642	46,6	-	66,6	-	0	0	0	0	0	0	0	0
10	Л-1743	46,6	-	46,6	-	16,6	-	33,3	-	0	0	50,0	-
11	Л-2324	33,3	-	33,3	-	16,6	-	33,2	-	16,6	-	16,6	

12	Л-2366	50,0	-	66,6	-	0	-	16,6	-	0	0	16,6	-
13	Л-2473	50,0	-	49,9	-	0	0	16,6	-	0	0	0	0
14	Л-2587	50,0	-	83,3	-	0	0	16,6	-	33,3	-	33,3	16,6
15	Л-2627	49,9	-	49,9	-	0	0	16,6	-	16,6	-	16,6	-
16	Л-45/64 0	83,3	-	83,2	-	16,6	-	33,2	16,6	33,2	-	33,3	-

On the labels were noted the date of inoculation, starting and extent of disease appearance. The virulent indexes of isolates were evaluated on the number of infected plants and on the intensity of infection as well as recorded the length of the incubation period. The degree of wilt emerging in the vegetation period is determined visually by the 4 score indexes: resistant, weak, mean, and strongly infected; and at the end of the vegetation, on the cutting of stems: healthy plants (absent of brown spots), weak (inconsiderable spread of spots), mean (spot spread across all cutting area) and strong (full infected or destroyed plants). The data in the table allow readers to reach the authors' conclusions, which stated that new cotton lines (L-45, L-1642, L-2366, L-2473, L-2587, and L-2627) with the highest complexes of immunity to the new virulent isolates of fungus: *V. dahliae*, *F.oxysporum*, and *F.verticillioides* were developed. It should be noted that these lines are extremely valuable for future breeding efforts aimed at developing early-ripening, high-yielding cotton varieties with complex resistance to three virulent pathogens of the wilt population (*V. dahliae*., *F.oxysporum*, and *F.verticillioides*).

Along with wilt in the cotton fields, other diseases like bacterial blight, seeding blight of cotton, root-rot of cotton, microsporiosis and alternariosis of cotton and diseases specific to boll and fiber cause economically harmful consequences to the cotton producers and agriculture as a whole. Development of new genetically resistant varieties remains the best way to overcome problems caused by their disease-causing agents. And breeders have worked out different methods of assessment of initial materials' resistance to these diseases and are successfully using them in the breeding processes to create new cotton varieties.

There are some environmental factors like drought and salinity of soil and heat wind which have often restricted regional progress in cotton growing and the local farmers expect cotton varieties to be able to withstand these adverse factors. For example, drought tolerance of cotton varieties in Uzbekistan has become another, not less important, than the above-listed challenges in the last decades of cotton growing history. Many cotton breeders have worked to evaluate the tolerance of cotton samples from various origins in artificially reduced watering conditions (including the author of this book) and select the best plants. Most of them demonstrated that using reduced irrigation norms (reducing watering amount from 8-10 to 5-6 times) during cotton vegetation allows them to divide the cotton population into different individual biotypes or genotypes based on their drought tolerance potential and thus improve the drought tolerance of cotton varieties

through the selection of more tolerable plants. positive result of this idea is confirmed, particularly by the availability of phenotypic and physiologic differentiated plants within a population. Moreover, the genetic nature of biotypes within a population with stems and leaves that make it possible to reduce water evaporation during vegetation encourages breeders to improve drought tolerance of bred materials. Gradually, different conditions of watering have become the specific background for assessing the drought tolerance of breeding materials. And some breeders have created cotton lines with drought tolerance through selections and reproductions of their seeds in successive generations.

To accelerate the breeding process, physiological methods for assessing drought tolerance have been developed. Mainly, these methods are based on the physiological characteristics of the cotton leaves (Loka D.A. and others, 2011; Lukyanova S.V. and others, 2013). Here, we can get acquainted with the physiological characteristics of the leaves of eight cotton varieties: Bukhara-6, Bukhara-102, Gulbakhor-2, Ibrat, Ishonch, Navbakhor-2, Kelajak, and Sultan. Two watering regimes, optimal water supply – 1:2:1 and inadequate watering supply – 1:1:0, were used as backgrounds to study these cotton varieties comparatively. Soil moisture in the period of the first and second regimes has been retained correspondingly at the levels of 70%–72% of full field water capacity (FFWC) and 48%–50% of FFWC. The second regime was called "dried background". The study of stomas showed that the number of stomas on the upper side of leaves of various varieties was greater (from 160 to 210 per mm²) than on the lower side (from 20 to 50 per mm²). Consequently, the study of the percentage of opened stomas on the lower side of leaves in those cotton varieties at these two soil moisture backgrounds was better to evaluate their drought tolerance (table 19). According to the data in the table, the extent of open stomas has fluctuated within 50% to 85% in the various cotton varieties.

Table 19. State of stomas in the various cotton varieties at the different soil moisture.

Cotton varieties	% of opened stomas (optimal background, 30.07.12)	% of opened stomas (dried background, 30.07.12)	% of opened stomas (optimal background, 10.08.12)	% of opened stomas (dried background, 10.08.12)
Bukhara-6	80,0±2,97	67,8±2,04	79,1±2,92	66,0±2,81
Bukhara-102	74,1±3,10	69,4±2,81	72,5± 2,56	67,8±2,04
Gulbakhor-2	79,8± 2,55	70,0±3,95	75,8± 2,38	69,4±2,84
Ibrat	68,5± 3,48	59,5±3,45	63,7± 2,15	52,7±2,03
Ishonch	70,0± 3,62	63,1±3,27	69,3± 3,11	56,1±2,17
Novbakhor -2	85,4± 3,25	72,4±2,28	80,3± 3,30	71,4±2,86
Kelajak	54,2± 3,15	50,7±2,91	48,4± 3,15	42,7±1,98
Sultan	65,3± 2,35	57,9±3,34	59,7± 2,87	53,2±1,79

The varieties of Navbakhor-2 and Bukhara-6 have the most opened stomas (85.4% and 80.0%) in the optimal watering background, and in the variety of Kelajak was observed the least number of opened stomas (54.2%). The varieties Novbakhor-2, Gulbakhor-2, Bukhara-102, and Bukhara-6 have the most opened stomas in the dried background (72.4%), 70.0%, 69.4%, and 67.8%, respectively.

From the point of view of drought tolerance, the variety that has the least opened stomas is valued as the better cotton variety because it has lower water evaporation and is thereby more tolerable in drought conditions. According to the table, varieties of Kelajak and Sultan have the fewest open stomas (50.7% and 57.9%, respectively) on July 30 and varieties of Kelajak and Ibrat (42.2%) on August 10. These data, on the other hand, aid in evaluating the drought tolerances of tested cotton varieties. Their indexes are the average data for their populations. Cotton varieties with fewer stomas are promising plant populations, from where the breeders could implement selections to isolate individual biotypes which have at least a number of open stomas. It is widely known that cotton varieties evaporating less water during vegetation have a greater chance to expand the stored water into the setting of fruit components. Eventually, the result of this method is valuable not only for evaluating drought tolerance of varieties but for selecting sole biotypes out of them, which can be used as initial materials for improving water stress resistance of new cotton varieties. S.M. Nabiev and others (2013) especially noted the necessity to conduct hybridization of initial materials in the conditions of limited water supply to get a lot of resistant genotypes (recombinants) in adaptive genetics and cotton breeding for drought tolerance.

Soil salinity has a dual effect on cotton plants: on the one hand, increasing osmotic pressure of soil solution makes water intake difficult for plants; on the other hand, an excess of salt is harmful to the plant. Water regime processes of plants are disordered in the consequences of soil salinity, change processes of growth and development, which decrease productivity and worsen the quality of the crop. So, the **assessment of the peculiarities of water exchange and salt resistance of breeding materials** is carried out through the creation of laboratory, vegetation (using vessels) and field backgrounds. The concentration of CL in the lab and vegetation experiments results in the following calculations per 100 g. of dried soil: 0.012-0.014% (weak salinization); 0.019-0.029% (mean salinization); and 0.019-0.20% (strong salinization). background at three levels of salinization is created. Different soil moisture (70%, 50%, 30%) is obtained by the help of full soil moisture capacity. The resistance of breeding materials to salinity is evaluated on the basis of the difference in intensity of evaporation depending on salt concentration in the soil and moisture, crop, and quality of crop.

Scientists of two SRIs (Uz.SRICBSP and IGEBP.AS.U.s.) R.G. Kim and A.P.Shadmanova and others (2013) have jointly used molecular markers in the cotton breeding process. The portion of their research devoted to assessing cotton genotypes is using molecular markers. This technology was worked out at the laboratory of applied bio-chemistry of plants at the IGEBP and it facilitates selection and assessment of genotypes at the level of seed materials on the previously marked traits. Here, the selection of seeds is connected with the fact that the seed is the fixed stage of plant development and has all the traits of a future organism. Except that the qualitative characteristics of proteins and enzymes in the seeds do not depend on environmental factors. Individual proteins and enzymes directly or indirectly related to the expression of traits are consolidated in the

process of adaptation to salinity, disease, and deficiency of water supply. Microgram amounts of seed germ (genotypes) out of the micropillar region of seeds were used for analysis, which were subjected to biochemical analysis to isolate marker enzymes in them. The devices for tube electrophoresis in the PAAG may be used for individual assessment of every genotype for several traits or even a group of genotypes. Taken data has identified indexes of precision and can be evaluated visually. The practical value of assessing breeding materials for phenotypic, biologic, and physiologic traits using molecule markers is that the breeder still allows some errors in his field phenotypic assessments of family and line uniformities, which leads to the prolongation of breeding work and the reproduction of non-uniform lines. The method of assessment is also able to differentiate not yet lined hybrid materials, which have no own markers and are heterozygote for all complex traits. Isolating of markers and assessment of early ripening, wilt resistance, as well as phenotype economic traits in the early stages of the breeding process will promote the more effective selection of genetic uniformed cotton families and lines. The availability of markers for all complex traits in the hybrid families and lines is indicative of the genetic homogeneity of these traits, which is important for breeders.

The regions of Kashkadarya and Surkhandarya annually have the most enlarged areas of cotton plantations: 135.9 and 74.0 thousand hectares, correspondingly (in 2020). The productivity of cotton plants is an average of 2.5 tons per hectare in the Kashkadarya region and 2.8 tons in the Surkhandarya region. They are southern regions of Uzbekistan and have all the necessary conditions for growing cotton but one—**heat wind "garmsel"** blowing from Afghanistan and named by local people "Afghan shamoli". This factor, because of its negative effect on agricultural crops, is being ranked as one of the most serious abiotic factors. According to the statistical data, heat wind at the end of July and the first half of August results in a loss of wheat yield of 0.7–0.8 tons per hectare, 0.3–0.5 tons per hectare in rice, and 0.9–0.11 tons per hectare in cotton. Its intensity varies with global temperature and is currently visible in the regions of Bukhara, Jizzakh, and Sirdarya. It is characterized by continuous heat and wind blowing for 4-5 days. Its speed gets up to 6.8–7.8 m\sec. As a result, the relative moisture of soil decreases by 2-3% and a lot of cotton fruit components (buds and flowers) are being lost. The breeders strive to control this factor as well, taking it into account at the time of mapping breeding projects for improving cotton varieties' resistance to heat effects. For example, cotton breeders at the SRICBSPA have constructed hand-made installations in the section of the "Fitotron complex." Its parts (photo 59) are mobile and able to create an artificial heat wind background in the condition of the vegetative section of the greenhouse to evaluate the resistance of growing cotton plant samples or plants growing in the vegetative vessels at any time of the year.



Photo 59. Parts of the handmade installation for supply of heat wind.

It is powered by home-consuming electro-energy and has a high level of security for conducting personality research. Today, breeders of RSIs related to cotton breeding can study heat resistance of all their breeding materials, paving the way for the development of cotton varieties for the southern regions of Uzbekistan.

The environment surrounding cotton fields and within cotton fields provides an ideal environment for the habitat and reproduction of many insects classified as cotton pests. divided into sectorial (Mite, Thrips, Aphis) and rodent (Winter moth, Boll worm, Cutworm moth) pests. They have a brilliant adaptation to the place of habitation and cause great harm to cotton and eternal problem for farmers in getting the desired harvest and profit. They form another direction of cotton breeding before the breeders. This is the resistance of cotton varieties to these pests. Breeders have to study the unique features of pests and cotton plant samples in order to select resistant plant forms. Often, the breeders need to build **artificial habitation chambers** for pests in the greenhouses to evaluate the resistance of breeding materials to them. Such experimental chambers encourage breeders to have complete control over the target pests' reproduction and activity, as well as to draw reliable conclusions about the resistance of their breeding materials. **Indexes of forks** on the top of cotton plants in the recorded cotton population (photo 60) caused by the activity of the pests have been proposed by doctor Kh. Saidaliev (2013) for use in the breeding process as a method of assessment for the damaging extent of thrips.



Photo 60.

Cotton plant bush with a fork on its top part caused by the pests.

These kinds of cotton plants have an accepted late developing manner because of the formation of many monopodial-like branches above the half of the main stem. They led to the development of the vegetative organs as intra-species hybrids. The increase in the number of such fork-top plants considerably decreases the yield to be taken from a definite area. Their effect is more important in the breeding nurseries because of their phenotypic change. The breeder cannot select all truly desirable plants.

Review questions:

1. What is the cotton breeding process?
2. Can you explain the conception of plant varieties?
3. How do the requirements affect the performance of the cotton variety?
4. Do you know the diversities of the initial cotton forms to use in the cotton breeding process?
5. What does hybridization mean in the development of cotton varieties?
6. Is selection used in all cotton-bred processes? If not, where?
7. How can be evaluated the economical values of cotton varieties?

Part IV. Methods of cotton breeding.

Chapter 1. Scheme of the cotton breeding process in Uzbekistan and abroad.

The leading method of cotton breeding in the history of cotton growing of Uzbekistan was inter-varietal (intraspecific) hybridization with successive multiple individual selection and verifying on the progenies (figure 13). All work on the released cotton varieties according to this method is carried out in the different nurseries of field plots, where the breeding materials are studied, evaluated, and selected for the best plants, families, and lines that more respond to those breeders' goals.

The scheme of breeding work is laid out for 8–10 years, and if the wild forms of cotton are attracted, the duration of the breeding scheme can be prolonged up to twice as much.

According to N.G. Simongulyan and others (1987), the following types of nurseries are laid out in this scheme of cotton breeding:

- *Nursery of collection;**
- *Nursery of parental forms;**
- *Hybrid nursery of the first progeny;**
- *Hybrid nursery of the second progeny;**
- *Hybrid nursery of the third and next progeny;**

The nurseries of the hybrids of the first and third generations are called biologic nurseries.

- *Breeding nursery of the first year;**
- *Breeding nursery of the second year;**
- *Nursery of artificially infected by the agents of diseases;**
- *Nursery of station variety testing (control nursery).**

Nursery collection. This nursery involves new and periodically renewing accessions from foreign, local and variety diversities available at the plant breeding Scientific Research Institutes (SRI). The collection was systematically enriched with new accessions, entered from other plant breeding establishments and from other foreign cotton growing countries due to scientific research relations. By the way, all newly introduced accessions are preliminarily inspected in quarantine nurseries for the absence of diseases and pests. The third part of every introduced accession is kept as the original material.

In the plant breeding establishment, all accessions are planted in two backgrounds – common and artificially infected by the pathogens of diseases. Because, the collections attain the great dimensions to restore planting qualities of collection accessions annually replanted only 1/4 part of collection. In the collection nursery are carried out: botanic descriptions of newly introduced accessions; studies of their biologic and farm properties, resistance to diseases; and entire characteristics of accessions.

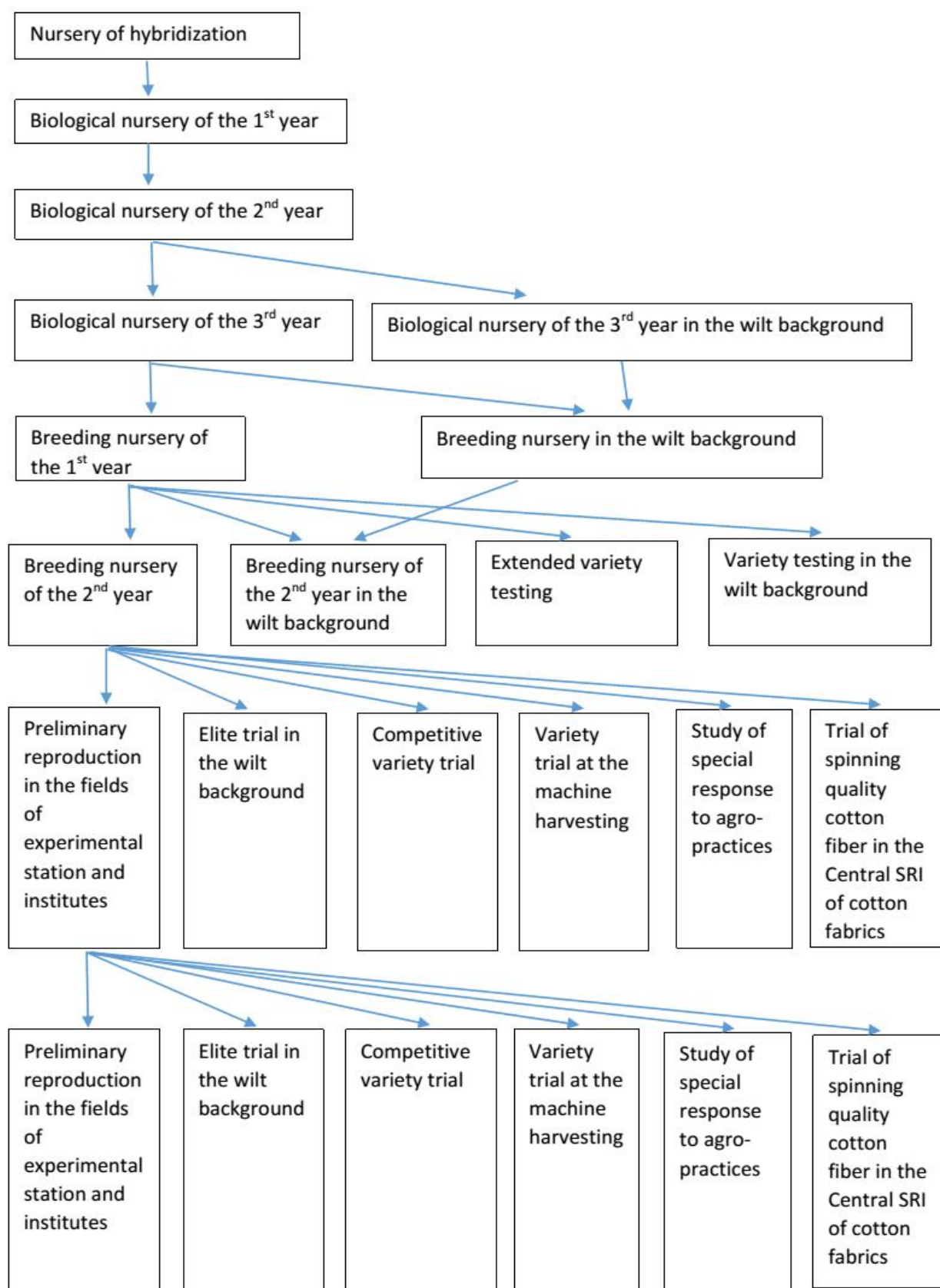


Figure 13. **Scheme of breeding works with cotton plant.**

Collection accessions seeds are planted in a single replication with 10-12 nests per patch, depending on the number of seeds at the single plant stand. The accessions are united into individual groups according to their biological features,

and optimal agro-practice conditions are created for them in order to display the traits.

Short-day conditions with the help of white and black plastic films (Yu.I.Ikramov) or by the mobile carriages are created for the forms with short-day photoperiodic reactions, which do not reproduce in the relatively long days of Central Asia. The plants needed to cover the plants from 18-17 hours in the evening and open at 8-9 hours in the morning to create a 9-hour day. But, as stated by N.G. Simongulyan and Yu. Uzakov, the above-mentioned effect can be achieved by covering the top part (4-5 young leaves at the top) with a bag made of black light-proof fabric. Such a local effect of a short day on the growing point entirely provides the effect of a short day and even facilitates the better accumulation of fruit components than under carriages. The white-black films to cover the accessions are more useful because of their specific effects. At this point, white films help to raise the temperature, whereas black films create a short day. effect has the most favorable result in regard to photoperiodic accessions. Compulsory pollination is conducted for all planted accessions.

Nursery of parental forms. The varieties are planted in this nursery according to the previously mentioned plan of hybridization. Commonly, elite seeds of genetically typical materials taken after multiple self-pollination (not less than 4-5 years) are used as the varieties planned for crossings. We must be reminded that the material self-pollinated for 1-2 years is not genetic uniform because the self-pollination at the beginning leads to heterogeneity of the material, destroying it to individual genotypes. Every variety occupies one plot in several rows, with such an account that the available plants are enough to conduct crossings corresponding to the planned crossing (pollination). A high level of agro-practices is kept in the nursery in order to decrease the shedding of buds (or squares). The plants are topped (the growth points are cut). It is purposeful to remove the exceeded buds on the plants, especially on that wood where hybridization was conducted. All off-plants are removed from the field until flowering. The list of crossings (appendix 8) is prepared prior to the beginning of planned pollinating combinations. The first, second, and seventh sympodial branches are pollinated. The flower buds are emasculated and all anther sheaths are removed in the evening before the day of blooming. Then, the paper packages or hand-made isolators (photo 62) are put on the emasculated flowers in order to prevent pollen from landing on the stigma. These packages effectively prevent random cross-pollination. They have numbers of crossing combinations and dates of pollination (picture 62). The pollens combine in the glass cup (picture 61) with the help of a soft brush or shaking (holding flowers above the glass) the flowers of paternal plants in the morning of the next day. The pollen grains combined from different plants and taken pollen mixes (photo.61.) rub on the stigma of the emasculated flower with the help of that brush. Pollinated flowers are once again surrounded by their own packages, which remain until the boll matures. If the crossing is done without emasculation, the tag is set on the pedicel (photo 62) with records about the combination of pollination and date of pollination. In order to

ensure enough dimensions of the F₂ hybrid population, it must be crossed 150–200 flowers (with an account of 30% shedding) on every combination.



Photo 61. Collecting of the cotton flower pollens for handmade hybridization.

Mature hybrid bolls are harvested in the autumn on the combinations – bolls from disease infected and off type plants do not harvested.



Photo 62. View of cotton plant with tagged young hybrid boll.

The hybrid bolls are examined in the lab for the fiber color, pubescence, length of fiber and other traits. The seeds are compared with those of parental plants. Then hybrid seeds are united in the combinations. In other cases, when the goal of study is targeted to genetic observation, the seeds in the combinations are not united. They are kept separately and planted in the field individually.

Hybrid nursery of the first progeny. The nurseries to plant hybrids of the early generations are called hybrid or biological nurseries. The seeds of crossed bolls, united on the combinations or separately, are seeded in the nursery of the first progeny. In the first case, the number of rows and their length depend on the number of hybrid seeds. Usually, one row has 20-40 seed nests. If the progeny of

every crossing is planted separately, the rows may be covered with 5–10 seed nests. The standard variety is planted every tenth row (1, 11, 21, 31, and so on). At this order of disposition, the crossing of hybrids with standards is obvious, which causes biological contamination of the materials. That is why, the self-pollination of the first-year hybrids is necessary. If, it needs to determine the combination ability of varieties on the economic traits and heterosis of F_1 , their seeds are planted in 3–4 replications with the introduction of both parents and standard. In other cases, when initial material is genetically uniform (elite of variety, self-pollinated lines), selection of plants within hybrid combinations is not conducted and the crop from all plants is united. All differences between plants in the hybrid combinations of F_1 are phenotypic and will not be inherited. If the initial material is not uniform, the common rejection is carried out in the backcross progenies within hybrid combinations (photo 63).

Cultivation of a first-year hybrid generation in the high agro-background is compulsory in order to obtain a higher quality of seeds and correctly characterize the population.

Field observations are conducted in the F_1 nursery, where the character of traits' dominancy is defined. On the results of phenologic observations, the yield of raw cotton and the analysis of probes give characteristics of hybrid combinations on the economic traits entirely.

Hybrid nursery of the second progeny. This nursery consists of seed plantings of total harvests harvested individually on the hybrid combinations of F_1 . The standard in the nursery of F_1 and in all other nurseries is disposed in nine rows in the tenth. Providing possibly as much as twice the number of plants in every combination is one of the most important tasks in the nursery of F_2 . The quantity of plants in every combination must be at least 1000. The single out of successful recombination of genetic material and a favorable combination of traits of parental varieties from a great mass of hybrid plants is the object of breeders. For this, the hybrids of the second year are thoroughly studied. 2-4 field inspections are conducted for the vegetation period.



Photo 63. Cotton bolls within every plant bush vary greatly.

Individual selections are harvested, and the following traits are considered: plant productivity; number of bolls; size of bolls; number of bolls per locus; precocity; determined length of fiber; rupture strength; maturity and fiber output; plant bush outlook; fitness to machine harvest; grade of leaf formation; level of the first fruiting branch; grade of fiber attachment to pods and pappus each other. Plants marked for selection must be perfectly healthy; plants at the end of rows or standing in the large stand are not chosen. A tough rejection was conducted in the F_2 on the phenotypic traits. This means that plants of zero type branching are only selected if the taking of zero type of branching with other combinations of traits out of crossings between sympodial and zero forms was the aim of the breeder. Another example is that all hybrids with fuzzy seeds will be discarded if the breeder's goal was to produce a naked seed form from a hybrid combination (involving parents with naked and fuzzy seeds). Plants of F_2 with white fiber are kept only as a result of crossings involving cotton forms with brownish and white fibers. For example, cultivating varieties with a wild wilt resistant form of *mexicanum*, which has brownish fiber.

The wild short-day subspecies *mexicanum* has a high setting level of a first fruiting branch on the main stem of the plant; during the short day condition, the first fruiting branch forms out of the 13th or 14th axil of the true leaf (appendix 11), whereas with the arrival of autumn short days, its appearance is expected from the 25th or 30th axil of the leaf.

Lowered setting is often dominated in the F_1 , and segregation begins in the F_2 at the crossings with cultivating varieties of lower setting of the first fruiting branch (in the 3–7 nodes). Moreover, most plants have a lower or intermediate height of first fruiting branch setting. All plants with the first fruiting branches above the 9–10th nodes are rejected in the F_2 .

The notes which were remarked above on such kinds of traits as fiber length, fiber output, productivity, and others, expressed under the control of many genes and considerably changing under the influence of cultivating conditions, are carried out with care, taking into account genetic control of the trait, its inheritability, and correlative relations. Because the lowered productivity may be conditioned by the inadequate nutrition of hybrid plants and not genotypic, the insufficient fineness and length of fiber in some combinations can be consequences of the traits controlled by the recessive genes, the lowered fiber output by the result of correlation with fiber length and so on. That is why good knowledge of genetic principles of traits' inheritance, as well as experience, attention, and erudition of the breeder, play decisive importance.

Individual selections taken from nurseries of the F_2 were additionally studied and discarded as a result of laboratory analysis on the weight of seed, fiber output, and length. Fiber output is determined through the weighing of raw cotton of individual selections until separation of seed and successive weighing of the fiber and seed. Fiber weight is converted into a percentage of the weight of raw cotton. The fiber length is defined in the technological laboratories by how 6 puppus (photo 64) are picked out of every individual selection (from the middle part of

normally developed loculs). The collected data is recorded in a special form (appendix 4). If the numbers of bolls on the plants were fixed at the combining of individual selections, the average weight of one boll (which means the weight of raw cotton per boll) is determined by dividing the weight of raw cotton of one individual selection by the number of bolls of one plant. Following additional rejections of laboratory analysis data, the remaining material is prepared for plantings in nurseries of hybrids of F_3 generations according to the seed planting list (appendix 4).



Photo 64. Pappus of cotton loculs for determining fiber length of individual selection.

Hybrid nursery for the third and next progeny. If the breeding work is conducted in a healthy background, the seeds of individual selections taken in the hybrid nursery of the F_2 are divided into two halves. One part of the seeds targeted and planted in the hybrid nursery of F_3 in the main plot and the second half to be planted in the nursery of testing of families on the resistance to verticilium and fusarium wilts. These nurseries are laid out on remote plots where the soil is artificially infected by the pathogens of diseases.

Hybrids of the third generation on the healthy background are planted in the view of individual families with 30–40 seed nests in the rows depending on the amount of seeds. As usual, standard is found every 9 rows. Families of F_3 , derived from homozygous hybrids of F_2 on particular phenotypic traits, are genetically and phenotypically uniform. It is known that 50% of plants are homozygous on the mono-gene traits in their second progenies, 12.5% of plants are homozygous on the traits controlled by three pairs of genes and so on. Homozygous plants in F_3 are considered genetically uniform on a specific trait. In all likelihood of discovering the genetic uniform on more complex economic traits in F_3 is lower than on phenotypic traits.

Field observations were carried out in the nursery of F_3 , which fixed the best families and discarded inferiors. Phenology observations on flowering and maturation are carried out in the best phenotypic uniform families. In 50% of the plants, the date of flowering and maturation, as well as the appearance of flowers and boll splitting open, are determined.

Testing of half of the individual selections in the artificially infected background gives the possibility to judge the resistance of every family to diseases. Its half in the usual background, independently of its other characteristics, is rejected if the half was infected in the background, artificially infected by the pathogens of wilt. 25 boll probes out of the best families are taken in the autumn until the combining of individual selections. Raw cotton is harvested from the bolls located on the first, second, and third sympodial branches of bolls, fiber output, and length of the probes are determined by the laboratory analysis. 22 pappus

taken from the middle part of various loculs of every probe sample is handed to the laboratory of technology for determining the fiber length (appendix 6). **Boll size** (or weight of raw cotton per boll) is defined by the ratio of the raw cotton weight of a probe sample to the number of bolls. **The fiber output** is calculated by the percentage of fiber weight, separated from seeds, to the total weight of raw cotton of the probe sample. Fibers out of some best families, pretended to be the best in their complexity of traits, are handed to be analyzed in the technological laboratory, where the fiber strength, metric number (length uniformity), maturity of fiber (micronaire), and staple are determined.

The best plants in the nursery of F_3 are fixed to individual selections after the taking of probe samples. Individual selections taken from the most uniform families of F_3 with a higher complexity of economic-valuable characteristics are fixed for planting in the breeding nursery of the first year; all remaining selections combined from segregating families are fixed for planting in the hybrid nursery. The families during their segregation remained in the hybrid or biologic nurseries to improve and were not transferred to breeding nurseries. The progenies of intraspecific hybrids have the longest segregations.

All data of field mappings, phenologic observations, results of analysis of probe samples, and records of family yields together with standard data are registered in the "main bulletin of breeding (biologic) nursery" to elicit the best families in comparison with standard, fixed to hand in the breeding nursery. The yield of the families consists of weights of probe samples, individual selections and family harvests. It must be noted that the indexes of families on all characteristics are compared with the half sum of neighboring standards.

Breeding nurseries of the 1st and 2nd years. The best materials elucidated in the hybrid nurseries are improved, evaluated and reproduced in these nurseries. Breeding nurseries, where hybrids are laid out in both healthy and wilt-infected backgrounds. Appropriate agro-practices are applied at the highest level. Every family occupies one patch with 30-50 seed nests of one plant standing (photo 65).



Photo 65. Young cotton plants with individual stands in the registered patch (row) in the breeding nurseries.

The standard's disposition is similar to that of hybrid nurseries. More thoroughly investigated the materials on their phenotypic and economic traits, as

well as the family uniformity in the breeding nursery. Field inspections are carried out three times for each vegetation spell. The second inspection is conducted until flowering and off-type plants are removed from families. If there are more than three off-type plants, the family is rejected entirely. Phenological observations of starting and 50% emerging of seedlings, flowering and maturation are compulsorily carried out in the breeding nursery. Prior to harvesting, rejection of families containing off-type or disease-effected plants is conducted again. If the half of the family planted in the infected background shows weak resistance to wilt, together with the family planted in the healthy background, they are rejected. 25 or 50 probe samples are taken from all non-rejected families for the analysis of fiber length, output, and boll size. The technological qualities of fiber are determined selectively. Individual selections are fixed in the non-rejected families, taking into account the complexity of traits. The total productivity of the families is determined by the summing of the weight of probe samples, individual selections, and family harvests. The yield is calculated per plant. The yield out of the breeding nursery is combined in the following order: the rejected families are harvested first and removed out of the field; then probe samples, individual selections, and lastly, family harvests.

All data on the families planted in the breeding nursery and the standard are included in the breeding nursery's main bulletin (form №7). If any family in the data of the main bulletin becomes inferior to half the sum of neighboring standards on the important economically valuable traits, it will be rejected with its individual selections.

The breeding nursery of the second year is made up of seeds of better selections and family harvests out of non-rejected families. Progenies of selections occupy one row patch. Seeds of family harvest are planted in several rows depending on the number of seeds.

Similar recordings (mapping) and observations as in the nursery of the first year are conducted in the breeding nursery of the second year. Seeds of general harvests of relative families (originating from one family in the previous years) are united and handed to an enlarged variety trial. The best lines out of the breeding nursery of the second year, exhibited an advantage on the data of two-three year enlarged variety trials, which were fixed to competitive variety trials and preliminary reproduction, which were implemented at the same plant breeding establishment. An artificially infected background is set up for a competitive variety trial.

Material, transferred to competitive variety trial and preliminary reproduction, presents itself as a variety and assumes a definite number, which is entered in the general catalogue of plant breeding establishment.

Plant nursery testing for resistance to verticillium and fusarium wilts in an artificially infected background of new varieties to wilt is one of the important economic-valuable traits, the significance of which especially has grown in the last decades in connection with the accumulation of loads of infection in the soil. The systematic selection of resistant plants in an artificially infected background

induces disease development in genetically susceptible forms, which is required for the development of wilt resistant varieties. Backgrounds for testing the plants' resistance to wilt are laid out separately and for taking measurements in order that the infection does not spread to neighboring fields.

Wilt of cotton is a fungal disease. Fungus *Verticillium dahlia* is a pathogen in the cotton species of *G. hirsutum* L. and the fungus of *Fusarium vasinfectum* in the cotton species of *G. barbadense* L. According to the method of plant protection, infected plants are combined from all furnaces of disease distribution to enrich them with various geographic populations of fungus. Isolated darkened particules of wood of infected plants are placed into agar to isolate pathogens from infected plants. Furthermore, the fungus is reproduced by planting it in oats in the bottles. For two weeks at a temperature of 20–25 °C, it matures. Then the oats are taken out of the bottles, dried and applied in the autumn or spring under a plough at a depth of 5–7 cm. The pathogen of verticillium uses 250–300 kg of infected oat per 1 hectare of soil to create 70% of the infection. In the artificially infected background, optimal agro-practice must be maintained. It was noted above that seeds of individual selections with a weight of 50–60 g taken out of F₂, F₃ and next generations as well as first and second breeding nurseries are divided into two parts, one of which is planted in the healthy background of a hybrid or breeding nursery and the second – in the infected.

Sometimes, breeders seeded in the infected not half of individual selections but whole seeds of certain selections, accepting them as the criteria to evaluate other selections of the same family planted in the healthy background. This method is not considered correct because the materials in hybrid nurseries are not genetically uniform in terms of various traits, including wilt resistance. That is why some selections may be more resistant than others within a family. At the conducting of the breeding works in the two backgrounds it would be purposeful to test F₁ parallel in two backgrounds. Non-resistant combinations are rejected entirely.

The second generation can be cultivated fully in an artificially infected background, conducting tough discarding on this trait. Many breeders cultivate F₂ in a healthy background. Assessment, selection on productivity and other economically valuable traits are conducted in the healthy background only in cases when they show higher resistance in the infected background. Frequently, all breeding efforts are organized solely in an artificially infected background. Such kind of method will promote the conduct of systematic tough rejections of non-resistant copies and simplify breeding work.

High soil fertility and optimal agro-practice are compulsory conditions in an artificially infected background. Cotton variety S-6524 is often being used as the standard in the artificially infected by *Verticilium* wilt backgrounds as well as Namangan-77 which is more susceptible. Infestation of plants is judged not only by the phenotypic symptoms but on the infection of main stem, to which do cutting of main stem under the first fruiting branch (photo 66, 67, 68).



Photo 66, 67, 68. *External and internal symptoms of Verticillium Wilt.*

Competitive variety testing is also conducted in the artificially infected background, the same as in the healthy background. Besides foreseen records and observations, triplicate records of varieties' infestations are conducted on the 15th of July, 15th of August, and 15th of September. Infected plants by wilt with strong and general grades are recorded in the percentage. Infected plants in strong grade refer to the plants which have fully lost yield and leaves with darkened stems (photo 66). In the records of general infestation of varieties, plants with any grade — from very strong to weak with drying of individual leaf edges (photo 68) — are involved in the records.

The resistance of varieties is judged on the percentage of infected plants in the general and strong grades as well as on the productivity in comparison with the wilt resistant standard S-6524 for varieties with the IV-type of fiber and Namangan-77 for varieties with the V-type of fiber. For the last decades, the diversity of the second race of *Verticillium* has grown rapidly. To create varieties resistant to all wilt races, the hybrid population of F₂ and selections is divided into two parts: one half is planted in the artificially infected background with both races, and the second half is planted in the naturally infected background.

According to the proposal of plant breeders, it would be better to conduct all breeding operations to create new fine staple cotton varieties resistant to fusarium wilt in an artificially infected background, starting with the nursery of parental forms. Fusarium wilting explains plant life in its early stages. Hybridization in an infested background allows for the avoidance of non-resistant plant crossing. Cotton varieties are expected to be genetically diverse and will not be uniform in their resistance to wilt.

Data on cotton production and yield by country are published annually in US Department of Agriculture reports. According to this report, from 2020–2021, 72 countries over the world have been engaged in producing cotton. In the analysis of top cotton producing countries, Uzbekistan ranked 6th (762 thousand tons of fiber) after China (6.423 thousand tons), India (6.162 thousand tons), the USA (3.181 thousand tons), Brazil (2.341 thousand tons) and Pakistan (980 thousand tons).

In terms of cotton (fiber) yield, our country ranks 20th (711 kg/ha), trailing Australia (1.923 kg/ha), China (1.879 kg/ha), Brazil (1.796 kg/ha), Turkey (1.742 kg/ha), Israel (1.611 kg/ha), and others.

Not only our country, but all countries in the world grow cotton for its fiber. So, the most valuable characteristic among the economic traits of growing cotton

varieties is their yield of fiber. And all cotton breeding efforts previously focused on the increase of fiber output and yield per hectare will be focused on. Herein, analyzing the data on the countries, we can easily judge the efficiency of our cotton breeding methods are being used to create highly productive cotton varieties, in particular. It is very unfortunate that our country, despite having all-natural advantages in growing agricultural crops, lags behind nineteen other countries in fiber productivity. That is why we must study the cotton breeding methods of the countries that have bred highly productive cotton varieties and get experience from advanced breeding techniques to improve the efficiency of our breeding methods.

Australia. In accordance with the internet sources, cotton growing in Australia has begun since the 1800s. In the beginning, the introduced cotton varieties from America dominated. In 1971, CSIRO (Commonwealth Scientific Industrial Research Organization founded in 1949) and CSD (Cotton Seed Distributors founded in 1967) joined together and started cotton breeding and seed production for the Australian market. In 2007, this partnership was formalized into Cotton Breeding Australia (CBA), which is a joint venture targeted research fund set up to facilitate cotton breeding which in the near future could release over 116 cotton varieties.

The first Australian cotton variety was developed in the 1980s by the breeder Norm Thomson, which was resistant to blight. The next variety introduced by the breeder, Peter Reid, was resistant to fungal diseases, and so CSIRO native cotton varieties started to dominate over American-imported varieties. Since 1984, new CSIRO cotton varieties have increased yield by 2% per year, and growing regions throughout Australia have been expanded. A great success from Norm's breeding work was the release in 1985 of the variety Siokra-1-1. This variety has okra leaves (narrow leaflets in contrast to the broad normal leaf) and excellent fiber quality and is also resistant to the serious bacterial diseases. The more open canopy results in a less favorable environment for pests and enables a considerable reduction in pesticide use. The narrow leaflet (photo 69) also gives a small improvement in water use efficiency.



Photo 69. Shapes of broad normal leaf and okra - narrow leaflet.

The range of environments in Australia meant that the cotton breeders aimed to create varieties with specific adaptations to the different growing regions. Norm Thomson concentrated his breeding work on fuller season areas, and the breeding programs of Fred Gillham and Peter Reid have been focused on shorter season and late season plantings. And sooner, varieties of Sicala V-1 (1991) and Sicala V-2 (1994) were released by Peter Reid, which revealed strong resistance to Verticillium Wilt. Since 1996, many transgenic traits to increase insect resistance

and improve weed control have been introduced in the combination of Bollgard II traits in CSIRO's better varieties. Now, the best conventional varieties are: Siokra 1-4, Siokra L23, Siokra V-16, Sicala V-2, CS50, Sicut 189, and Sicut 71.

Commonly, the cotton breeding cycle from initial crossing to the introduction of a new variety into production can take up to ten years, similar to our breeding scheme (figure 14).

Obviously, cotton projects are the main basic of breeding process and mainly focused on the developing of locally adapted varieties. That is why, line varieties were selected for a range of particular circumstances:

- Short season production systems (Siokra S-324, Siokra S-101, CS7S);
- Dryland production systems (Siokra L23, Siokra V-16);
- Premium fibre (Sicala 3-2, Sicala 34); and
- Wilt resistance (Sicot F-1).

Advances in cotton breeding were provided in part by the availability of glasshouse working and the possibility to construct any needed new glasshouses, laboratories, trial sites to plant, study, pick, seed testing, storage, and cotton trials.

The more modern varieties developed (such as Sicut 71 and Sicut 75) have been the result of multiple selections in the stress tests, which helped to develop more widely adapted as well as combine desired fiber quality, disease resistance, and yield. Likewise, in the transgenic era (since the late 1980s based on biotechnological methods), there have also been released commercial varieties such as Sicala V-3i, Sicut 289RRi, and now Sicut 71BRF. The average fiber output on the production scale is 35%.

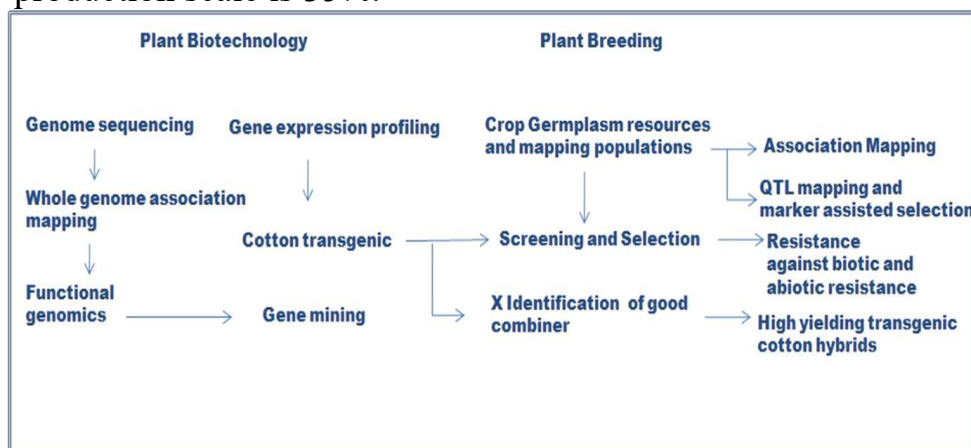


Figure 14. Currently integrated cotton breeding scheme in Australia.

Cultivation of cotton in Australia takes place on flatter land with laser levelling and farrow irrigation. Seeds are planted on a ridge between the furrows at a rate of 60 000 to 100 000 plants per hectare. Cottonseed is sown in the spring months of September and October, leading to the setting of cotton fruit elements in January and February. During the months of March and April, the bolls mature. Cotton picking lasts up to July. Enhancement of mechanical harvest operations is achieved by spraying to kill the crop.

At this date, over 99% of commercialized cotton varieties in Australia are GMO, with the majority containing the B3F traits under license from Bayer.

Cotton biotechnology has offered a more precise way to select desirable traits for the breeders to select and insert the gene for a specific trait.

China. The creation of cotton hybrids in China had begun since 1956, and attention was concentrated afterwards on the development of intra-species hybrids. The first marketing of the hybrid cottonseeds started in the early 1990s. These cotton hybrids were created according to the indexes of productivity, fiber quality, and resistance to diseases.

The commercialization of Genetically Modified Cotton (GMC) started in 1997, with varieties integrating a Bt gene (Bt-cotton) to control the attack of some cotton pests, notably *H. armigera*. It is estimated that Bt-cotton covers about 60% of the total Chinese cotton area, but one can consider that coverage is close to 100% wherever the target pests of Bt-cotton are a real threat. GMC and hybrids have been extensively diffused for the next ten years. Cotton diversities are commonly encountered as follows: hybrid and Bt-cotton; hybrid and non-Bt-cotton; non-hybrid and Bt-cotton; non-hybrid and non-Bt-cotton; non-hybrid and non-Bt-cotton; non-hybrid and non-Bt-cotton; non-hybrid and non-Bt-cotton; non-hybrid and non-Bt-cotton has confirmed that these four types of cotton diversities can actually be found at farmers' level, but their distribution was very different with the predominance of hybrid and Bt-cotton cultivars. Because the F₁ hybrid developed by crossing the Bt line with a non-Bt line achieves a 20% yield increase over the Bt cotton variety.

Currently, the brand of cotton grown in China corresponds to the number 32 woven thread, and the thread made from the transgenic variety of cotton corresponds to the number 60 thread.

Scientists of China through expeditions to cotton origin sites as Mexico, Brazil and Australia could combine until, 2014 - 2.236 cotton accessions including 2.024 of *G. Hirsutum*, 198 of *G. barbadense* and 14 of *G. arboreum*. These accessions were gathered from 53 foreign countries for the period of the last 100 years. The accessions were introduced mainly from the United States, Russia, Australia, Pakistan and Egypt.

Currently, the genetic diversity of the majority of cotton sources and germplasm is being studied using chromosomal markers such as simple sequence repeat (SSR) markers. These cottons' germplasm included the cultivars bred in different periods and grown in different ecological areas in the country and abroad, the lines transferred with genes and exotic DNA, and the introgression lines from interspecific hybridization. Furthermore, SSR analysis was successfully set up to identify the elite germplasm with superior productivity and high fiber quality as well as QTL mapping was implemented to screen the markers associated or linked with the beneficial genes. The results of these studies present an overview of the genetic diversity of cotton germplasm in China, and provide a guide for breeders to create new cotton cultivars efficiently.

Different agro-practices of cotton cultivation were experienced by the farmers of China to increase cotton productivity and profitability. For example,

seedling transplanting since the 1950s and widely adopted in the 1980s, which accounted for 18% of the nation's total cotton growing areas.

The potential of home cotton cultivars is efficiently used by the introduction of other optimal growing practices such as mulching, adopted for cotton production since the 1980s. According to the data of 2016, about 70% of total cotton plantations, equivalent to 2.7 million hectares in the arid and semi-arid regions of Northern China, are annually covered with plastic film.

In the 1990s, in order to avoid the limitations of Northwest regions in the consequences of short seasons and low temperatures in spring, a cultivation pattern was developed called "short-dense-early". In part, this method of cultivating cotton cultivars has increased the number of plants per hectare from 200 000 to 300 000. The height of plants is controlled to a range of 60-75 cm through chemical substances. This method also allows planting the seeds of early maturity varieties and the use of drip irrigation under plastic film mulching (figure 15). As a result, the average lint yield in this region has reached 1927 kg/ha. And some farmers in Xinjiang province using the "short-dense-early" pattern easily produce 2250 kg/ha of lint yield annually. Even so, the highest yield of 4900 kg/ha was obtained in 2009.

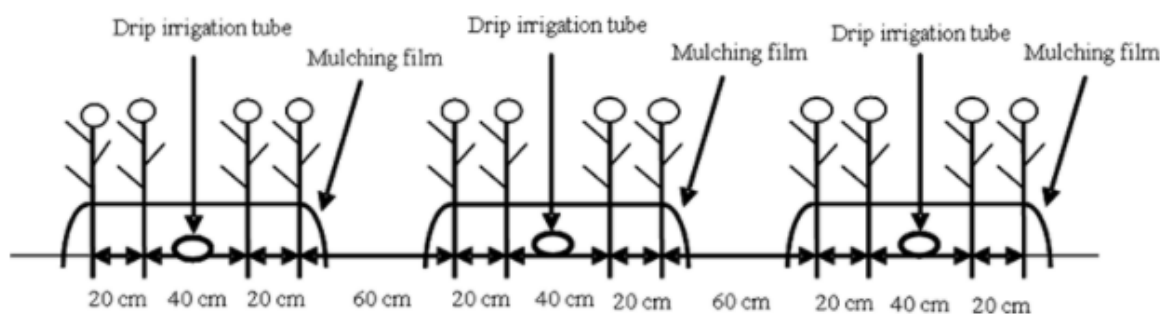


Figure 15. *Drip irrigation system with four rows per drip irrigation tube.*

China uses its own area measuring unit, the "Mu". According to it, one hectare is equivalent to almost 15 mu. We can convert the yield taken by Xinjiang farmers, which ranged from 115 to 180 kilograms per mu, into hectares by multiplying to 15. So, the result will be equal to 1725 and 2700 kilograms, or in our measuring units, from 17.3 to 27.0 centners per hectare (National Information Agency of Uzbekistan, 2018).

Brazil. As in Australia, cotton vegetation in Brazil (figure 16) begins in the late autumn (November and even December). Rapid development in cotton production has been achieved due to the establishment of ABRAPA (Brazilian Association of Cotton Producers), which currently covers 99% of Brazilian cotton states and 100% of Brazilian cotton exports. To minimize pest damage, the association invested in the development of early maturing varieties with compact fruiting, aiming to avoid the peaks of insect infestation. For this purpose, in 1985, researchers developed the early maturing "CNPq precoce I" variety as a result of selection from the line of GH 11-9-75, derived from cv. TANCOT SP-37, and introduced in Brazil. Further, other similar early-maturing varieties were

developed, including some involving subspecies of *Gossypium*. But the efforts did not decrease the insect damage because the insects have spread widely in all cotton states in Brazil. Cultivating varieties present 179 nominations which are available in the National Register of Cultivars (RNC), developed by public and private companies, among which 79 are Genome Modified Cotton (GMC) and colored cotton varieties.

Production of cotton in Brazil has rapidly increased from 1.3 million tons in the 2015–2016 crop year to approximately 3 million tons in the 2019–2020 crop year. The more unique Brazilian feature is that the country is distinguished by its 1st rank in productivity on dry land, which consists of almost 1800 kg per hectare. It gets more surprising when we know that 92% of the cotton area in this country is not irrigated.

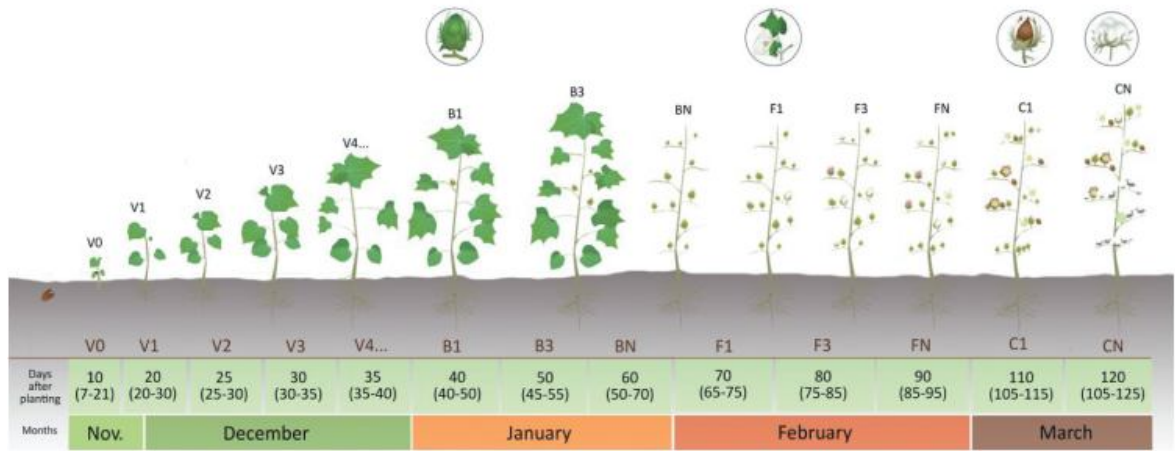


Figure 16. Phenology average for the cotton crop. Legend: *V*₀–beginning of the plant emergency; *V*₁=*V*₀ to the main rib of the second leaf; *V*₂=*V*₁ to the main rib of the third leaf; *V*₃=*V*₂ to the main rib of the fourth leaf; *V*₄=*V*₃ to the main rib of the fifth leaf; *B*₁ =first visible floral bud; *B*₃ =first floral bud visible on the third branch; *F*₁ =opening of the first flower in the first fruit branch; *F*₃ =opening of the first flower in the third fruit branch and *C*₁ =first apple of the first open branch (boll cotton).

Production of naturally colored cotton in Brazil has begun since the 1980s, and the fiber colors of current varieties range from green to dark brown. Generally, they are derived from *G. hirsutum* and *G. barbadense* subspecies. The selection process lasts longer because it requires several backcrosses to simultaneously fix the cotton color and improve fiber quality. The first registered (in 2001) variety was BRS 200 Marrom (photo 70, a) with colored fiber obtained through crosses of accessions *G. hirsutum* and *G. barbadense*. Other colored cotton varieties include BRS Verde (photo 70, b), BRS Rubi (photo 70, c), BRS Safira (photo 70, d), BRS Topazio (photo, e), and BRS Jada (photo 70, f), all of which were registered in 2004.



Photo 70: a, b, c, d, e and f. *Colored fibers of Brazilian cotton varieties.*

In Turkey. The main directions of the cotton breeding programs in Turkey are yield and quality of fiber; earliness; adaptation to specific regional conditions; and resistance to wilt disease (*Verticilium Wilt*) and insects. The first of them has always been of the primary importance to the Turkish cotton breeders. Because Turkish farmers derive the majority of their income from fiber (cotton) yield. Hand picking of raw cotton (cotton with seed) is preferred. Cotton plants are grown under conditions of irrigation (98%). The earliness of cotton varieties in Turkey is also an extremely important goal remaining before cotton breeders in the consequences of rains that started in October.

The cotton research institute in Nazilli and three universities in Adana, Antalya, and Izmir have been charged with developing cotton varieties in Turkey. Today, Turkish breeders are proud of their 22 registered cotton varieties and are working to solve a variety of issues, including increased pest and environmental resistance, improved yield quality, seed ingredients, organic and colored cotton farming. Consider five cotton varieties that produce the most cotton (fiber or lint) and their textile indexes (table 20).

Table 20. **Cotton varieties of Turkey and their characteristics.**

Varieties	Origin	Breeding method	Yield (kg/ha)	Fiber length, mm.	Fineness, mic.	Strength (k lb\inch ²)	Lint, (%)
Nazilli 84 S	Nazilli C.R.I.	Hybridization	2.148	29.4	4.2	82.9	44.3
Nazilli M-342	Nazilli C.R.I.	Hybridization	2.052	30.6	3.9	77.8	41.3
Nazilli 84	Nazilli C.R.I.	Hybridization	1.843	29.0	4.0	80.2	43.5
Nazilli M-39	Nazilli C.R.I.	Hybridization	1.834	28.8	4.4	79.3	40.7
Nazilli M-503	Nazilli C.R.I.	Hybridization	1.815	30.0	3.7	76.1	41/0

According to the data in this table, it turns out that the varieties released from the Cotton Research Institute of Nazilli were the most productive varieties out of those 22 varieties, and more notable, that these varieties have been

developed through one breeding method—hybridization. They have productivity potential in the range of 18 to 21 centners per hectare and it also seems that such a higher fiber yield is more probably substantiated due to their higher fiber output, which makes up 40 to 44%. So, we can unite both the abovementioned facts and draw the conclusion that the hybrid origin and the higher output of fiber in these varieties are the key elements that made it possible for the Turkish cotton farmers to achieve one of the top ranks in the world in obtaining a higher cotton yield per hectare.

Other varieties are distinguished by their breeding methods of hybridization (6 varieties), selection (8 varieties), and introduction (3 varieties), which are kept in the lower positions of the above-mentioned table based on their cotton yield indexes. The varieties evolved on the basis of hybridization have interspecific (*Gossypium hirsutum* L. x *G. barbadense* L.) crossing processes. Because this combination of crossings was designed to improve cotton yield and quality potential often, varieties of Israel (like: 48-08, Sevilla, Europe, Ica, Etna, 14-08, and Acalpi) and commonly grown varieties (like: GW Teks and DP-Opal) in the regions of Turkey were parental varieties.

Israel. Cotton varieties grown in Israel are mainly characterized as inter-specific (IS) hybrids and called "Acalpi" (table 21), which expresses its origin, derived from a hybridization between Acala (*G. hirsutum*) and Pima (*G. barbadense*). Hazera is the only seed company that offers commercial cotton IS hybrid seeds in Israel and in the international market. As the cotton breeder Yechiel Tal informed us, the first selections of inter-specific hybrid lines had been launched in the mid 1990s and all of them were characterized by a high fiber (lint) yield with improved quality, closely similar to Pima's.

Table 21. **Cotton diversities in Israel and their fiber quality.**

Variety	Strength (HVI)	Mic. (HVI)	Length, mm (HVI)
Pima	GPT 40-43	3.7-4.5	37-38
Acalpi	GPT 34-37	3.4-4.2	34-36

Over years of comprehensive and intensive breeding processes of IS hybrids were continued in many important aspects that could affect the result of the breeding outcome, up to the stage of variety introduction. In general, the scheme of the breeding process has to deal with the issues of:

1. Experimentation large number of test hybridizations and to evaluate the combining ability of different bred lines from those two cotton species. Hybrid lines obtained from those species and breeding studies helped breeders to learn the heredity and expression of important traits when combining those two species.

2. On the base of above gained results, the breeders developed criteria for selecting new lines to be parent lines for the new improved inter-specific hybrids. Breeders continuously eliminated of genotypes that may cause undesirable heterozygous effects in the performance of the IS hybrid such as poor fertility of

flowers, excessive growth of vegetative organs and negative heterosis in fiber characteristics.

3.Preparing of the parent lines necessary for efficient hybrid seed production. In this procedure, a genetic technology was developed to enable the breeders and seed producers to produce IS hybrid seeds in an effective and economic system.

4.Stabilizing of female parent lines in keeping the full male-sterility that could save on hand emasculation. Furthermore, to develop some of the female parents, it is possible to pollinate by the help of insects or to have full fertility restoration that ensures normal fertility of the hybrids and thus to exclude any hand pollination in different growing conditions.

Hazera successfully markets inter-specific cotton hybrid (ISH) seeds worldwide, characterized by their vigorous plant development, high water use efficiency, and tolerances to soil-borne diseases such as Ha-175, HA-195, and others (table 22).

Table 22. Marketed F₁ cotton hybrids generated from Inter-Specific Crosses.

Trade names	Farm characteristic	Lint quality values			
		Strength (gr\text.)	Elongation, %.	Fineness (micr.).	Length (inch).
HA-211\Intercott 211	Early hybrid with determinant plant	36-39	7.5-8.0	3.6-3.8	1.36-1/37
HA-1432\Intercott 1432	Very high yield potential	36-39	6.5-7.5	3.7-3.9	1.33-1.35
HA-701\Intercott 701	Early hybrid with determinant plant (white corolla)	36-39	6.5-7.5	3.6-3.8	1.33-1.34
HA-690\Intercott 690	Medium season (white corolla)	36-39	6.5-7.5	3.7-3.9	1.33-1.35

Chapter 2. Plant breeding scheme based on intraspecific hybridization.

B.P. Straumal (the author of 20 registered cotton varieties) defines the plant breeding terms hybrid and crossing in his book "Cotton varieties on the basis of plant breeding" (1974). As he stated, a **hybrid** is the organism that originated as the result of the crossing of two or several varieties with various heredity and increased heterozygotes in comparison with both or one of the parental forms.

Crossing is a significant source of variation in farm valuable traits. He analyzed the results of historical cotton breeding research devoted to the studies of biology of cotton flowering, flower structure, fertilization, the role of insects and wind in the pollination of cotton flowers, cytological basis of fertilization in the sphere of self and outcrosses and came to the conclusion that the flowers of cotton plants are mostly adapted to outcross pollination by the help of insects and not to self-pollination.

In general, the scheme of cotton breeding described by N.G. Simongulyan and others (1987) has been accepted by our breeders as commonly acknowledged in the implementation of all traditional methods of cotton breeding to create new varieties in our country. Differences involved in the duration of breeding work from initial material to formation of variety lines last 8–10 years in the inter-variety (intraspecific) crossings and may last twice or more in the crossings of remote intra-species and inter-species crossings and differences in the schemes of hybridization.

Herein, it is purposeful to analyze schemes of hybridization and to substantiate the importance of chosen ones in the development of the best cotton variety:

- a) hybridization of varieties with similar origins and cultivation conditions;
- b) hybridization of varieties that differ on the farm in terms of valuable traits, cultivation conditions, and origin;
- c) backcross hybridization;
- d) pollination by pollen mixtures;
- e) pollination using off-type pollen;
- f) use of hybrids obtained as a result of natural outcrossing.

The breeder's decision to use one of them is primarily determined by the breeding task at hand.

Productivity, precocity, boll weight, length, and fiber output were slightly increased in the scheme of hybridization of close varieties based on origin, cultivation condition, and quality traits. It seems that the new varieties that result from this scheme of hybridization have rapidly leveled the main phenotypic and economic traits with inconsiderable segregation. So, this method is good when one trait of any variety should be improved without changing, notably the type of variety. The cotton varieties of C-460 (registered in 1931), C-1225 (registered in 1947), 152-F (registered in 1957), Khor-15 (registered in 1966), Ok-oltin (registered in 1979), Yuldiz (registered in 1990), and S-8292 (registered in 2010) were developed by using the scheme of hybridization where parental forms were

close to each other. For example, Ok-oltin, Yuldiz, and S-8292 have the schemes of hybridization correspondingly: (AN-Chimbayabad x AN-401); (AN-Samarkand-2 x AN Samarkand-3); and (L-59 x L-9).

The scheme of **hybridization where the varieties differ** on the traits of cultivation medium and origin has promoted a considerable upheaval towards precocity, productivity. The improvement of other qualitative traits was obtained in cases when the geographically remote varieties were involved in hybridization. Of course, these varieties differ significantly in terms of vegetation period and the combination of the most valuable farm valuable traits: early ripening, yield, type of plant architecture, fiber quality, seed oil content, disease resistance, mechanical care fitness, and so on.

The Great Practice on the Hybridization of Cotton Varieties has fully approved the method of crossing of geographic remote plant forms worked out by I.V. Michurin. "The farther standing each other pairs of crossing parent plants on the place of origin and condition of their medium, the more adaptability of hybrid seedlings to the condition of medium in the new place," wrote I.V. Michurin.

In the example of cotton breeding, we can present many varieties, historically were created on the basis of hybridization of varieties far from the origin and agro-economic traits (table 22).

Table 22. Characteristics of varieties taken from hybridization of different varieties with different agro-economic traits.

Varieties	Scheme of hybridization	Registration	Vegetation period, in days.	Boll size, g.	Fiber output, %.	Length of fiber, mm.	Remarkable properties.
S-4727	(137-F x S-1470)	1961	136-138	6.3-6.8	37-38	33.5	Early ripening.
Ok-Darya-6	(Tashkent-6 x 175-F)	2000	127	6.7	34.5	35.1	Early ripening.
Surkhan-12	(S-6037 x Ash-68)	1999	135	3.2	35.7	39.3	Resistant to Fuzarium wilt.
KK-3565	(S-9070 x Chimbay-3104)	2010	111	6.6	38.1	33.4	High fiber output.
S-9086	(S-9070 x ssp.punctatum)	2012	123	5.5	36-37.0	1.15	Resistant to Verticillium wilt

The information in this table represents some of the most important traits and properties of varieties developed as a result of a hybridization scheme in which the varieties differ in terms of cultivation medium and origin. For example, the first variety, S-4727, has early ripening properties and was cultivated preferably in the northern regions of the republic. Not only is it early repining, but it also has the highest fiber output, which is made up of 37–38%. Of course, its important traits and properties were the result of parental plants' differing on the origin of cultivation (137-F x S-1470). The second variety, Okdariya-6, was also famous for its early ripening adaptability to the soil climatic conditions of the Samarkand region. These characteristics were unquestionably inherited from parental plants found in the Tashkent and Fergana regions (Tashkent-6 x 175-F).

Resistance to Fuzarium and Erticillium wilts in the new cotton varieties has been improved in the results for Surkhan-12 and S-9086. Resistance to the first variety was most likely acquired through parental varieties from Uzbekistan (S-6037) and Turkmenistan (Ash-68). The second variety, S-9086, also has parents developed from different agro-ecological locations (table ..). Besides these, the parents of the discussed varieties differ from each other in the other complexes of economic traits and bio-properties depending on their conditions of cultivation.

Backcross hybridization was highly emphasized by V.I. Michurin that this method of hybridization promotes the development of useful and weakens or fully repays the development of harmful traits under the guidance of external display of the traits. This method is widely used by all cotton breeders and was justifiably stated by some of them (A.E. Egamberdiev and others., 1993) that the best backcross is to be started since the F₃ progenies. Because in F₃-breeders can find the best family to involve in crosses, not as in F₂-hybrid plants.

The scheme of intraspecific backcross hybridization is characterized correspondingly with one of the parental varieties which chooses to do crosses again with that hybrid population whenever it takes part in the crosses. In the table .. will be shown some of the historical examples of cotton variety breeding where backcrossing was used to develop or to transfer fully one or some of the traits from parental plants to the genomes of the newly formed cotton varieties.

In the first example, the hybrid plant progenies taken from the crossing of 159-F and 1363 were not satisfactory for the traits of the parental variety of 159-F. So, the breeder made an additional attempt to cross again with 108-F with the intention of fully transferring the necessary traits or properties from the variety of 108-F. Finally, the results show that the formed cotton variety AN-302 is distinguished for its enlarged boll size and wilt resistance. In the scheme of the second variety, we can see the variety 153-F, which was crossed again with hybrids whenever hybrids had been developed by its participation. In the result of this backcross, more probably, the achievement is made of high fiber output (37.1%) and resistance to wilt. The third and fourth varieties have a similar hybridization scheme, but the breeding process took place in different breeding stations and targets. The variety 159-F was crossed again with hybrid plants whenever itself had taken place in their crossings. The fourth variety differs in its precocity, boll size, and wilt resistance. The third variety also acquired resistance to wilt due to the scheme of its backcross.

The varieties named after Termez are developed within our fine staple cotton varieties and are well known for their short period of vegetation. More likely, the precocity and fiber length of the variety Termez-17 were aimed at enriching the future genotype as Kashkadariya-5. This aim was actually achieved fully after the backcross of Termez-17 with hybrids of Kashkadarliya-6 x Termez-17 (table 23).

Table 23. Cotton varieties created in the result of backcrosses hybridization.

Varieties	Scheme of hybridization	Registration	Vegetation period, in	Boll size, g.	Fiber output,	Length of fiber,	Remarkable properties.

			days.		%.	mm.	
AN-302	[(108-F x 1363) x 108-F]	1963	144	6.5-7.0	36-37	32-33	Enlarged boll size and wilt resistant
ZP-29	(153-F x 06422) x 153-F	1978	144	6.5	37.1	33	Resistant to wilt
S-9064	(159-F x 06422) x 159-F	1978	145	6.9	35.8	33	Resistant to wilt
Akdariya-2	(159-F x 06422) x 159- F	1981	141	7.1	36.5	35.0	Enlarged boll size and wilt resistant
Kashkadariya- 5	[(Kashkadariya- 6 x Termez-17) x Termez-17]	2003	120	4.1	34	39	Early ripening and long fiber.

The method of pollination by mixing of pollen. Really, the process of natural hybridization is beyond the breeders' adjusting. And the breeder has to select what has been created by nature. Often, the formed traits are not always needed by a man. The method of applying mixed pollens of many pollinator varieties to the stigma of the flower of the maternal plant, worked out by I.V. Michurin, was an attempt to adjust the important process in the life of plants. This method was widely used in the breeding of cotton varieties. During pollination with pollen mixtures, many pollen grains land on the stigma. According to the reports of L.G. Arutyunova (1965) and others, up to 3000 pollen grains grow at the time of applying the pollen mixes. Most of them grown in the pollen tubes of stigma favorably effect fertilization and promote reflection of those alterations within species, which is possible in the process of individual development of organisms, enhancing their vitality.

As it was remarked by the cotton breeder B.P. Straumal, taking the pollen mixes is especially effective when one trait of one variety is necessary to change. In this case, the pollen mixes of 3–4 varieties are selected on the basis that the pollinating varieties were superior to maternal varieties on the trait which is going to be improved. On the other hand, economically valuable traits also must be desirably better but not inferior to the maternal form.

Many historical cotton varieties were developed by our breeders as a result of using pollen mixes for hybridization. These schemes of hybridization (table 24) clearly show that there were pollen mixes collected from several varieties. In the last scheme of hybridization, we can see not only varieties' pollen mixes but pollen mixes of hybrids as well. These schemes of hybridization promote the accumulation of desirable traits of paternal varieties through maternal variety into the new variety. So, our breeders have opportunities to achieve some variety improvements in the precocity, resistance to wilt, fiber output, and leaf shedding.

Table 24. Cotton varieties developed by the using of pollen mixes.

Varieties	Scheme of hybridization	Registration	Vegetation period, in days.	Boll size, g.	Fiber output, %.	Length of fiber, mm.	Remarkable properties.
S-1472	(S-5502 x	1950	146	6.3-6.8	35-36	35.0	Relatively

	pollen mixes)						resistant to wilt.
S-6015	(S-6002) x pollen mixes of varieties: 2525 and 5904-4	1960	-20 days than st.	3.5-3.7	28-29	38.9	Wilt resistant and early ripening.
Khor-6	(S-1470 x pollen mixes of varieties: 137-F, S-1426, S-1225, S-5347)	1962	-4 days than st.	6.5-7.0	39-39	33.5	Early ripening and high fiber output
A-150	(KK-1407 x pollen mixes of varieties: 108-F, 137-F, S-450, S-460)	1962	146	6.3	40.1	31.0	Leaf shedding and high fiber output.
S-5465	(S-5424 x pollen mixes) S-5424=(S-5502 x pollen mixes)	1968	140	6.3	33.7	34.8	Early ripening.

Pollination by the help of off-type pollen. This method was elaborated by the cotton breeders D.V. Ter-Avenesyan, K.A. Visotskiy, L.G. Arutyunova, A.I. Tishin, and others. The profound component of this method is the occurrence of hereditary alteration of cotton plants under the effect of pollen collected from other species and even from other genres. Emasculation of flowers of maternal plants in this scheme of hybridization was conducted on the day of flowering and the next day they were pollinated with the pollen mixes, composed of one part of pollen of the maternal variety and 30 parts of pollen of other species or genus. Hibiscus roza sinensis L., Malva neglecta, G. herbaceum L., and G. arboreum L. were taken in the quality of off-type pollen.

L.G.Arutyunova and colleagues (1965) discovered that Hibiscus pollens not only stimulated pollen germination and pollen tube growth in the stigma tissues of maternal plants, but also had a profound effect on the character of substance exchange in the process of pollen germination and germ development, as well as in the subsequent growth and development of all plants. As a result of this method, it was possible to get highly heterogeneous, weak-splitting hybrids of maternal type, combining and expressing the traits of paternal plants. The cotton varieties S-4829 (1967), S-8252 (1968) were released by breeders B.P. Straumal and A.D. Dadabaev as a result of the use of off-type pollen. The addition of pollen from variety S-7059 (G. arboreum L.) increased precocity and fiber output while decreasing fiber length in varieties S-4829 and S-8252. Their hybridization schemes are as follows: (108-F x 153-F) x Guza and (S-1581 x pollens of G. herbaceum L x G. arboreum L.). These kinds of hybridization schemes are implemented by other breeders and their achievements can be seen in the examples of the following cotton varieties: Andijan-13 (1984) with the scheme of hybridization: (153-F x 155-F) x Tashkent-1, where 155-F belongs to the species of G. barbadense L.; S-9082 (2002) with the scheme of hybridization: (L-2736 x K-71) where K-71 is the hybrid of G. turberii x G. raimondii.

Using hybrids obtained as a result of natural outcrossing. I.V. Michurin wrote (1914) that if a maternal plant has the possibility of free selection in regard to more suitable pollens brought by wind or insects to its generative organs, in some cases from rather diversified species of plants, the progenies will get relatively more vital individuals of plants, which one would not always expect from the hybrids taken as a result of artificial or, of course, enforced crossings.

The varieties of 108-F (1942), 137-F (1948), 149-F (1956), AN-211 (1962), A-169 (1968) and Namangan-77 (1994) were evolved in the result of method of natural crossing. Their scheme of hybridization is made of:

108-F – Natural hybrid (17687 x 36 M₂). Where 17687 is Kuk (introduced from America).

137-F – (2034 x unknown).

149-F – (108-F x unknown).

AN-211 – Natural hybrid (108-F x unknown).

Namangan-77 – Natural hybrid (S-6526 x unknown).

The duration of the cotton breeding process was extended to 10, up to 12 years or more if some remote cotton forms or subspecies were attracted in the breeding process in all of the above-mentioned schemes of cotton breeding based on intra-specific or inter-variety crossings, which were clearly described by N.G. Simongulyan and others (1987).

Historical progress in science by introducing some new technologies like complexes of greenhouses in the scientific research institutes functioning in the direction of plant breeding has promoted the development of elaborate new breeding schemes which reduce the duration of the breeding process. In particular, the following methods were worked out on the basis of research under the guidance of doctor Yu. Ikramov (photo ..) by the use of artificial climate chambers and greenhouse complexes in the breeding process:

- the method to get three hybrid generations of cotton a year (1985);
- express-temperature method to early assessment and earlier selection of cotton on the resistance to Verticilium wilt (1981);
- method of intensive propagation of the F₁ hybrid seeds (1985);
- method of defining the genetic dwarf-like plants in cotton plants (1987);
- method of polyethylene paper used in cotton breeding (1980).

And on the basis of these methods, Yu. Ikramov and his scientific colleagues have developed **three schemes of reduction in the breeding process**:

1. The breeding process reduction scheme in inter-variety (intraspecific) cotton hybridization

In this scheme, the seed sowing begins with the hybrids of F_2 . Hybrid combinations of F_1 are selected in the field. Sulphate acid is used to delint the seeds, which are then cut out of the micropile end of the seeds and planted in the thermostat at a temperature of 33-35 °C. The germinated seeds are replanted in the paper pots.

Young plants at the stage of 3-4 true leaves are replanted in the greenhouse (hybrid nursery of the second year, F_2). The temperature sharply increased up to 50 °C at the stage of maturity, which has created favorable conditions for seeds to pass through their after harvest ripening in the cotton bolls on the growing plants. The bolls are harvested in the month of June. Raw cotton is delinted. The seeds are linted in sulphuric acid, cut out of the micropile end and planted in the thermostat. The germinated seeds are sown in the paper pots. Plants at the stage of 3-4 true leaves are replanted in the greenhouse (hybrid nursery of the 3rd year).

After harvest, ripening of seeds is conducted by way of temperature rising at the stage of maturity. The raw cotton is delinted, the seeds are linted by the sulphuric acid, cut out by micropile and planted in the thermostat.

Grown seedlings are planted in the paper pots. Plants at their stage of 3-4 true leaves are replanted in the soil of the greenhouse (hybrid nursery of the 4th year, F_4). After harvest, ripening of seeds is conducted in the phase of maturity. The raw cotton is delinted. A micropile of seeds is cut and planted in the thermostat. Germinated seeds are sown in the pots. Developed plants with 3-4 true leaves are replanted in the field (hybrid nursery of the 5th year, F_5). Every individual selected material is planted as a family.

At the beginning of September, the seeds of the best selections are sown in the thermostat. The grown seeds are planted in the pots. The plants at their 3–4 true leaf phase are replanted in the reproduction greenhouse (hybrid nursery of the 6th year, F_6). The raw cotton is delinted in the month of April. The seeds are planted directly in the field (breeding nursery). Simultaneously, selections of F_5 hybrids taken from the hybrid nursery in the 5th year that were not planted in the greenhouse are sown. According to this scheme (figure 17), 6 vegetations are obtained during the 3 years.

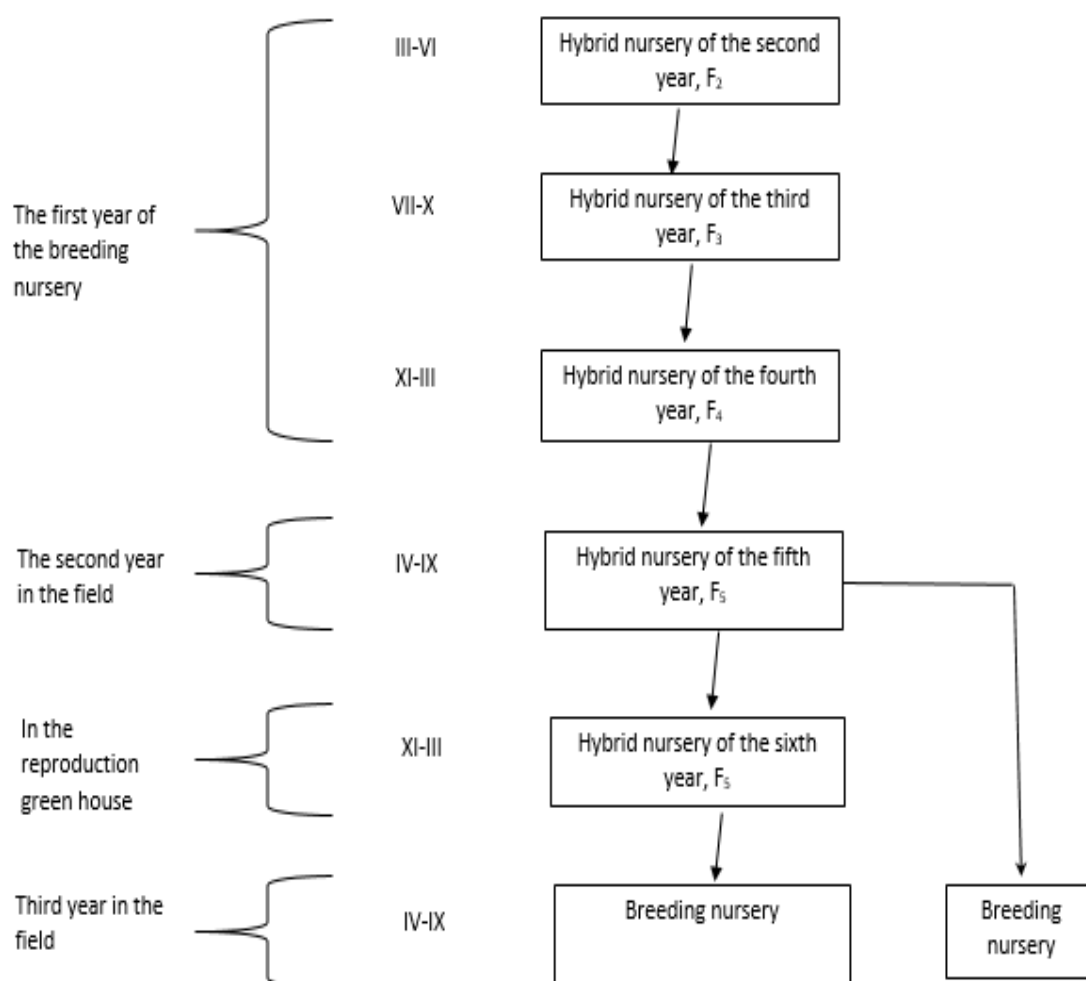


Figure 17. *The scheme of acceleration of plant breeding process at the inter variety hybridization of cotton.*

Yu. Ikramov and his scientific staff used hybrids F_1 combination 16 (18827 x GI-128) topcross 10 and combination 19 (08829 x GI-144) topcross 10 as the initial material taken from the laboratory of Genetic Immunity of the All Union Scientific Research Institute of Cotton Breeding and Seed Production named after G.S. Zhaytsev. The seeds of F_1 hybrids (table 25) were sown in the pots on March 2nd and the first crop of F_2 was harvested on July 13th. The planting of seeds F_2 was carried out on July 15th, and the crop was harvested on September 27th. The seeds of hybrids were planted in the pots on November 30th and replanted in the greenhouse. The crop was harvested on April 1st.

The lamp of the DPL-400 with a power of 740 Wt/m² was used as the supplementary lighting.

The hybrid plants of F_2 in the first vegetation (March-June) were grown at an average air temperature range of 23–38 °C; the maximal temperature ranged from 27 to 50°C; the minimal temperature ranged from 17 to 31°C. The relative moisture of the air ranges from 40 to 64%. The plants of hybrid F_3 in the 2nd vegetation (July-October) were grown at an average day temperature of air in the range of 16–36 °C, the maximal temperature ranged from 21 to 50°C, the minimal from 9 up to 25 °C, and the relative moisture of air from 42 to 71%. The plants of

F₄ in the 3rd vegetation (November-February) were grown at an average day temperature of air in the range of 16–38 °C, a maximal temperature ranged from 20 to 50 °C, and a relative humidity of air from 51 to 77%.

Table 25. **Development of plants F₂, F₃, and F₄ .**

Hybrids	Days from			Length of vegetation period
	From seedlings to budding	From budding to flowering	From flowering to ripening	
1 st vegetation				
F ₂ combination 19.	50.3+-0.40	32.0+-0.22	41.8+-0.93	124.1+-1.00
F ₂ combination 16.	50.2+-0.43	32.1+-0.26	40.8+-0.30	123.1+-0.32
2 nd vegetation				
F ₃ combination 19.	29.0+-1.22	31.1+-0.40	55.5+-0.86	115.5+-1.40
F ₃ combination 16.	28.0+-0.57	30.8+-0.31	54.0+-0.44	112.8+-1.13
3 rd vegetation				
F ₄ combination 19.	60.0+-0.40	32.0+-0.18	49.5+-0.50	141.5+-0.74
F ₄ combination 16.	60.0+-0.29	31.7+-0.25	50.1+-0.31	141.8+-0.30

The data (table 26) describing the development of hybrids F₂, F₃, and F₄ revealed that the length of interphase periods depending on the combination of crossings varied inconsiderably. But the periods from germination to budding (square forming) and from flowering to maturity have significantly varied depending on the conditions of cultivation.

The length of the interphase period in the first vegetation from seedlings to budding in the hybrids F₂ consisted of 50 days, and in the second vegetation it consisted of 28-29 days. The decrease has been substantiated by the optimal conditions of F₃ plant cultivation at this time, when the summer has passed with the highest light and temperature. This was remarked and underlined in the periods of flowering and ripening. The ripening in the first vegetation has passed in the period of June at the highest temperature, whereas in the second vegetation, the ripening has started later, in the autumn.

The length of vegetation period in the first vegetation made of 123.1-124.1, in the second 112.8-115.5 and in the third 141.5-141.8 days.

In 1990, five families were singled out by the breeders from a combination of 19; nine families from a combination of 16. The characteristics of these families were presented in the table 26. These families outperformed S-6524 and some of these families in terms of fiber output and fiber length. Though they had the same fiber output as variety Tashkent-1, they were significantly longer. Moreover, these selected families have been characterized by their high resistance to wilt and more precocity than standard varieties of Tashkent-1 and S-6524.

Table 26. Characteristics of F₇ hybrid families.

Hybrids and varieties.	Weight of one cotton boll, g.	Fiber output, %.	Fiber length, mm.
19 th combination, F ₇ 08822 x GI-144	6.7	36.8	35.2
	6.5	37.4	35.7
	7.0	35.0	37.8
	6.0	37.0	37.5
	6.5	39.0	33.5
16 th combination, F ₇ 08822 x GI-128	5.8	43.7	34.8
	6.5	36.8	35.7
	6.4	38.3	34.5
	6.8	38.8	34.7
	6.8	37.2	35.1
	6.0	37.4	32.2
	6.8	39.5	33.7
	6.4	38.0	34.3
Tashkent-1 S-6524	6.4	38.5	32.0
	5.8	35.3	34.5

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Methods of cotton breeding”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Scheme of cotton breeding			
2	Intraspecific hybridization			
3	Remote geographic hybridization			
4	Interspecific hybridization			
5	Cotton breeding abroad			

Chapter 3. **Scheme of plant breeding by the use of remote geographic and interspecific hybridization.**

The 20th century was a remarkable era in history for its progress in all aspects of life and science. Scientific development in the cotton growing of the republic has also streamlined the use of cotton.

The scheme of cotton breeding described by N.G. Simongulyan and others (1987) is still considered the optimal way for the breeding of cotton varieties in our republic on the basis of traditional breeding methods and is used by all SRIs related to cotton breeding in working out cotton breeding programs. The difference in the plant breeding scheme where remote geographic and inter-species hybridization has been used is the lengthy breeding process to obtain enough homozygote progenies, which can last up to 15 years or more.

The breeding process of these cotton varieties: 102-F (registered in 1941), S-4507 (1956), Tashkent-1 (1968), S-2601 (1971), Bukhara-6 (1984), S-5619 (1985), S-6524 (1988), Turan (1998), Classic (2003), Namangan-34 (2006), Gulistan (2011) were passed in the sphere of this scheme of breeding, which required prolonged periods because of the formation of high heterozygote hybrid genomes as a result of remote geographic and inter-species hybridization, which often required more than 15 years to die down the segregation.

The duration of 10 or more years needed to develop new cotton varieties did not meet the agricultural and industrial requirements of that period in cotton growing. And plant genetics and plant breeders of that period had studied and begun to recommend into practice various breeding schemes to shorten the duration of existing breeding processes.

One of the innovative methods has also been worked out by Yu. Ikramov (photo 71) and his scientific colleagues (1991). This cotton breeding scheme was devised in response to the opportunities provided by greenhouse facilities, which have significantly accelerated the breeding process at the remote geographic and interspecies hybridization levels.

In this scheme of hybridization, the nursery of hybridization is laid in the month of March in the greenhouse. Seeds of parental forms are germinated in thermostats before being replanted in pots. The plants at their stage of 3-4 true leaves are again replanted in the soil of the breeding greenhouse.

Representatives of tropic, wild, semi-wild, and ruderal forms with short day forms used in the breeding process have to be cultivated in the conditions of a 10 hour day under the covering of black polyethylene paper. Hybridization is carried out in the period of mass blooming (in the month of April-May). Favorable temperature, light, and watering regimes are kept during this period for hybridization. The temperature of the air sharply rises to 50 °C in the stage of ripening to pass after the harvest of mature seeds. The seeds are passed after harvest maturation on the plants in the cotton bolls. The bolls are harvested in the month of June and raw cotton is jinned. The seeds are delinted in Sulphur acid and cut into micropyles to speed up the germination and planted in the thermostat at a temperature of 33–35 °C. The germinated seeds are taken in 18-20 hours.



Photo 71. Doctor of biological science and head of the laboratory of artificial climate, Yu. Ikramov, with his colleague observing experimental plants (1992).

These seeds with growth are planted in the pots. The plants of F_1 at the phase of 3-4 true leaves are replanted in the greenhouse (hybrid nursery of the first year F_1). The first backcross of hybrids F_1 is conducted at the period of mass flowering (August-September). The temperature is increased at the phase of maturity, and after harvest, the ripening of seeds is carried out in the bolls of plants. The raw cotton is harvested in October and delinted. The seeds are cleaned by the sulphuric acid and cut from the seed micropile and are grown in the thermostat. The grown seeds are planted in the pots, which are replanted in the green house (the hybrid nursery of the 2nd year and the first backcross progeny). The F_2 and B_1 backcrossing After harvest, ripening of seeds is conducted at the phase of maturity. The raw cotton is harvested in the months of March and April and the seeds are delinted.

The seeds of hybrids F_3 and backcrosses are planted in the pots in April. The plants at the phase of 3-4 true leaves are planted in the natural background of wilt. Every individual selection is rooted in the quality of family. Backcrosses are made in the period of mass flowering of hybrids F_3 . The hybrid bolls are harvested at the beginning of September and the selections of the best plants of F_3 and backcrosses are made. Then the delinting of the raw cotton is done. The seeds are cleaned with sulfuric acid. The micropiles of the seeds are cut and planted in the thermostat. The germinated seeds are planted in the pots. The plants with their 3-4 true leaves are replanted in the greenhouse.

In March–April of the next year, the crop is harvested, the raw cotton is delinted, and planting is conducted directly in the soil of the field (the breeding nurseries of F_5 , B_4 , B_3). The scheme of the breeding process has been presented in the figure 18.

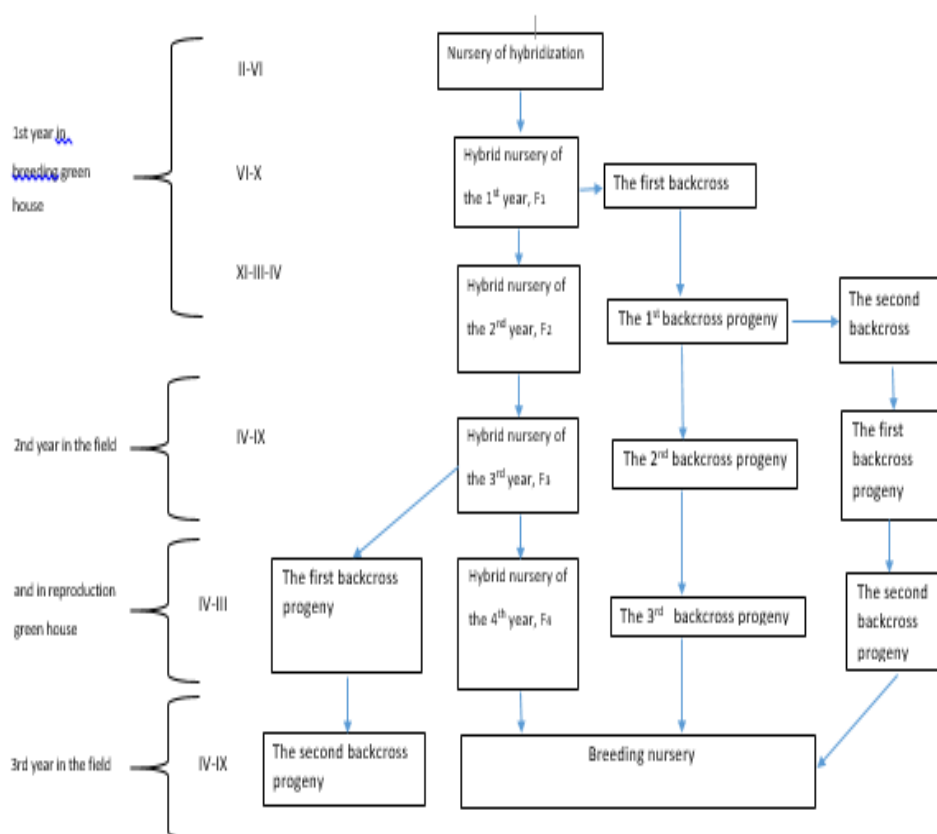


Figure 18. *The scheme of acceleration of breeding process at the remote cotton hybridization.*

Several backcrosses were carried out over three years and obtained six vegetations of the cotton plant. 3 years of the breeding process are shortened on account of this case.

Breeders used varieties 149-F, L-06, and wild form *G. tricuspidatum* ssp. *purpurascens* as initial materials in this cotton breeding scheme. The germinated seeds of SSp.purpurascens at the temperature of 33-35°C in the thermostat were planted in the paper cups on January 6th, and on January 29th they were replanted in the pots.

The germinated seeds of 149-F, L-06 in the thermostat, were planted in the paper cups on February 3. On March 9, ssp. *purpurascens* and 149-F, L-06 were replanted in the greenhouse. It was necessary to plant ssp. *purpurascens* earlier in order to combine its flowering phase with 149-F and L-06 during the crossings. It is known that the wild forms have a more prolonged period of germination – budding (or squaring). Seedlings of ssp. *purpurascens* were grown under black polyethylene paper in a short (10 hour light) day condition until mass flowering. Hybridization has begun since April 27. Direct and back crossings between 149-F, L-06, and SSp.purpurascens have been implemented.

Hybrids of F₁ were planted in the thermostat on July 4th. Germinated seeds were planted in the paper cups on July 5th. Replanting of paper cups in the greenhouse will be done on July 13th. Backcrosses of hybrids F₁ with 149-F, L-06 have been fulfilled since August 31st, in the period of mass flowering. Hybrids of F₂ and B₀ were planted in the thermostat on November 14th and in the paper cups

on November 15th. Replanting in the greenhouse was on November 21st. Backcrosses with 149-F, L-06 have been conducted since February 11th.

The study of hybrids F3 and B1 in natural wilt-infected field conditions has continued.

The plants in the greenhouse, under cloudy days of autumn and winter periods were provided with lighted from 8 to 20 hour, in the sunny days only in the morning from 8 to 10 hour and in the evening from 18 to 20 hour. The lamp of the DPV-750 with a lighting power of 1150 Vtm² was used as the source of additional light. The hearting of greenhouse is done by the help of a conditioner.

Plants in the greenhouse were grown in the breeding greenhouse to alter temperature fluctuations.

Day-altering temperature has substantiated the normal movement of many processes in the plant ontogenesis and promoted the transition from the vegetative to the generative phase, speeding up the growth, development and increase of plant productivity.

Parental forms are grown in the first vegetation (March-June) at the average day temperature of 17–37 °C, where the maximal temperature ranges from 25 to 48 °C, and the minimal from 11 to 27°C. Air has a relative moisture content of 40–52%.

The hybrid plants of F₁ were grown (July-October) at an average day air temperature of 11–36 °C. The maximum temperature ranged from 22 to 50 °C, and the minimum from 15 to 30°C. The relative humidity of air is 42 to 57%. Hybrid plants F₂ and backcrosses (November-February) were grown at an average day air temperature of 18–32 °C. The maximal temperature ranged from 25 to 52 °C, and the minimum from 12 to 31°C. The relative humidity of air is 51 to 77%.

Breeders noted that the higher fluctuating temperature and dispersed light of the greenhouse have promoted the more intensive growth and development of plants.

Breeders believed, based on the findings of O.L. Lange (1959) and R. Geiger (1957), that excess temperature in the field was caused by intense light. The temperature of leaves is often higher (10–15 °C) than the temperature of ambient air in bright light.

Higher temperatures do not oppress the growth and development of cotton in the conditions of light dispersed in the greenhouse.

The results of research. The development of parental forms, hybrids F₁, F₂, B₁ has been presented in the table 27. The data of the table show that vegetation period of varieties and lines from germination to budding is extended and made of 47.3–50.1 days.

Wherein, ssp.purpurascens has 51.3 days. In the ssp. purpurascens, L-06, and 149-F, the time between budding and flowering is 33.1–35.1 days. The boll ripening has passed in the period of the highest temperatures of summer. That has led to a decrease in the period of flowering and maturing. The vegetation period, depending on the materials, has consisted of 127.8–133.8 days. Hybridization was conducted in the mass flowering.

Table 27. Development of parental forms and hybrids: F₁, F₂, B₁.

Parental forms, hybrids, backcrosses.	Days.			Vegetation period, in days.
	From germination to budding.	From budding to flowering.	From flowering to maturation.	
1 st vegetation.				
ssp.purpurascens.	51.3+-1.04	33.1+-0.80	43.9+-0.45	123.3+-0.93
L-06.	50.1+-1.46	34.5+-0.66	49.2+-1.0	133.8+-1.09
149-F.	47.3+-1.97	35.1+-0.34	45.5+-0.54	127.9+-0.78
2 nd vegetation.				
F ₁ ssp.purpurascens x L-06.	25.5+-0.82	29.2+-0.52	55.1+-1.10	110.9+-0.95
F ₁ L-06 x ssp.purpurascens.	32.0+-0.53	30.3+-0.51	54.8+-0.45	117.1+-1.08
F ₁ ssp.purpurascens x 149-F.	29.4+-0.62	29.6+-0.39	54.7+-0.63	113.7+-0.88
F ₁ 149-F x ssp.purpurascens.	31.7+-0.58	29.7+-0.49	57.9+-0.54	119.3+-0.55
3 rd vegetation				
F ₂ ssp.purpurascens x L-06.	53.8+-1.34	35.3+-1.78	55.1+-2.36	144.2+-1.07
F ₂ L-06 x ssp.purpurascens.	55.2+-1.37	34.2+-1.19	54.5+-2.15	143.9+-1.03
F ₂ ssp.purpurascens x 149-F.	62.5+-0.92	36.1+-1.54	45.8+-2.32	144.4+-1.84
F ₂ 149-F x ssp.purpurascens.	56.8+-1.45	36.4+-1.16	50.2+-3.12	143.4+-1.2
B ₁ (F ₁ ssp.purpurascens x L-06) x L-06.	57.7+-1.03	31.6+-0.94	49.7+-1.52	139.0+-1.03
B ₁ (F ₁ L-06 x ssp.purpurascens) x L-06.	54.0+-1.29	35.1+-1.57	55.0+-1.6	144.1+-0.85
B ₁ (F ₁ ssp.purpurascens x 149-F) x 149-F.	52.0+-1.29	32.2+-1.1	56.8+-1.5	141.1+-0.57
B ₁ (F ₁ 149-F x ssp.purpurascens) x 149-F.	51.1+-1.16	36.8+-0.95	56.4+-1.95	144.3+-1.08

The hybrids of F₁ (second vegetation) are cultivated in the summer months with a sufficient temperature of air. So, the period from germination to budding in the studied hybrids of F₁ depends on the combination of crossings made of 25.5–32.0 days. The length of the period between phases of budding and flowering also depends on the crossing hybridization, which consisted of 29.2–30.3 days. Backcrossing was done in the period of mass flowering. The number of days from flowering to maturity depends on the number of crossings made of 54.7–57.9 days. The length of the vegetation period of hybrid F₁ has consisted of 110.9–119.3 days.

The hybrids of F₂ and backcross B₁ are cultivated in the third vegetation. The period from germination to budding is passed in the winter with a deficiency of temperature (take a look at the table 25 in the winter with a deficiency of temperature (take a look at the table 26). That is why this period was slightly prolonged.

The length of phase between studied hybrids and backcrosses from germination to budding was equal to 51.1-62.5 days, and from budding to flowering, 31.6-36.8 days. The maturity of bolls in the hybrids and backcrosses in the 3rd vegetation has passed in the period of higher temperatures, which has led to a decrease in the phase period between flowering and maturity. The vegetation period depends on hybrid combinations made of 139–144.4 days. Backcrossing has been conducted in the period of mass flowering.

The characteristics of remote hybrids F₃, backcrosses B₁, B₂, parental forms and standard variety Tashkent-1 on the natural wilt background of the field were presented in table 28. In the comparable study of hybrids F₃, backcrosses B₁, B₂ in

the field, it was identified that the precocity is increased, the height of the first fruiting wood setting is lowered, the number of bolls, the weight of one boll of raw cotton, the length of fiber, and the output of fiber are increased at the double backcrossing with parental varieties.

Families of hybrids based on their morphological characteristics were uniform. It is necessary to remark that **the absence of bees and other insects in the condition of greenhouse has excluded outcross**, which presents a great interest in the study of trait inheritance of remote hybrids in the condition of greenhouse without artificial self-pollination.

The result of conducted research has identified a visible picture of the positive effect of greenhouse conditions on the acceleration of vegetative period. Cultivation in the condition of a greenhouse also leads to rapid stabilization of the phenotypic traits.

Wilt infection of hybrids and parental forms is presented in the tables of 29 and 30.

According to the data in the table 29, the varieties of Tashkent-1 and 149-F have been infected by the wilt at a general degree of 68–72%, of which the strong degree of infection is made up of 2.6–10.5%. The table shows that lines of L-06 and L-625 were infected to a general degree of 6.0–11.1% and not remarked plants were infected to a strong degree. The same results were noted as well as on the hybrids with the participation of these varieties and lines. Hybrids with the participation of 149-F have a high infection, while less infection has been in the hybrids with the participation of L-06 and L-623. It decreases wilt resistance of hybrids at the double backcrossing with the non-resistant variety of 149-F. Resistance of hybrids is increased at the double backcrossing with resistant lines of L-06 and L-623.

Some of the families were identified as a result of backcross-hybrids B1, indicating a high level of interest in breeding efforts.

Table 28. Characteristics of hybrids F₃, B₁, B₂ and parental forms in the levelling plantings of 1990.

Varieties, hybrids	Vegetation period, in days	Number of bolls, units.	Weight of one boll, g.	Fiber length, mm.	Fiber output, %.
Tashkent-1	118.0+/-1.03	13.5+/-0.77	5.2+/-0.21	31.9	36.0
L-06.	120+/-1.76	9.8+/-0.53	4.8+/-0.81	33.6	35.8
149-F.	117.0+/-0.92	11.6+/-0.54	6.0+/-0.13	33.4	36.6
F ₃ ssp.purpurascens x L-06.	113.9+/-0.78	12.4+/-0.44	5.0+/-0.10	31.8	35.4
F ₃ L-06 x ssp.purpurascens.	118.4+/-0.65	12.6+/-0.43	4.6+/-0.11	34.1	32.2
F ₃ ssp.purpurascens x 149-F.	114.9+/-0.69	13.1+/-0.48	4.2+/-0.10	32.2	32.5
F ₃ 149-F x ssp.purpurascens.	117.4+/-0.69	13.1+/-0.50	4.4+/-0.12	32.6	33.8
B ₂ (F ₁ ssp.purpurascens x L-06) x L-06.	117.7+/-0.50	13.2+/-0.47	5.2+/-0.12	31.6	38.0
B ₂ (F ₁ L-06 x ssp.purpurascens) x L-06.	118.9+/-0.59	13.2+/-0.37	5.0+/-0.13	31.6	35.8
B ₂ (F ₁ ssp.purpurascens x 149-F) x 149-F.	114.1+/-0.37	13.8+/-0.37	5.0+/-0.21	32.7	33.7
B ₂ (F ₁ 149-F x ssp.purpurascens) x 149-F.	115.0+/-0.53	15.0+/-0.53	5.2+/-0.10	32.3	34.3
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-06	108.0+/-1.11	13.5+/-0.70	5.4+/-0.19	35.7	36.3

B ₁ (B ₁ (F ₁ L-06 x ssp.purpurascens) x L-06) x L-06	109+-1.32	13.2+-0.46	5.6+-0.19	36.6	37.7
B ₁ (B ₂ (F ₁ ssp.purpurascens x 149-F) x 149-F) x 149-F	115.0+-2.13	13.5+-1.38	6.0+-0.22	32.8	37.2
B ₁ (B ₁ (F ₁ 149-F x ssp.purpurascens) x 149-F) x 149-F	111.6+-1.50	14.4+-1.75	5.6+-0.50	32.8	35.8

Table 29. Wilt infection of remote hybrids F₃ and their parental forms in the levelling planting (1990).

Hybrids and parental forms	Infection on September 15, in %.	
	In general degree	In strong degree
Tashkent-1	72.0	10.5
149-F	68.0	2.6
L-06	11.1	0.0
L-623*	6.0	0.0
ssp.purpurascens.	0.0	0.0
F ₃ ssp.purpurascens x L-06.	22.0	1.5
F ₃ L-06 x ssp.purpurascens.	28.0	2.7
F ₃ ssp.purpurascens x 149-F.	35.0	8.7
F ₃ 149-F x ssp.purpurascens.	36.0	10.2

*L-623 (paumaster x punctatum).

The characteristics of families are given in the table of 31 Data of this table show that backcrosses on the output, length of fiber and precocity have considerable superiority than standard.

Table 30. Infection of remote hybrids of cotton by Verticilium wilt at the one and double backcrossing.

Hybrids of one time backcrossing	Infection level on September 15, in %.		Hybrids of double backcrossing.	Infection level on September 15, in %.	
	In general degree.	Out of them in strong degree.		In general degree.	Out of them in strong degree.
B ₂ (F ₁ ssp.purpurascens x L-06) x L-06.	18.0	0.0	B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-06)	6.7	0.0
B ₂ (F ₁ L-06 x ssp.purpurascens) x L-06.	14.7	0.0	B ₁ (B ₁ (F ₁ L-06 x ssp.purpurascens) x L-06) x L-06	10.3	0.0
B ₂ (F ₁ ssp.purpurascens x 149-F) x 149-F.	43.7	0.5	B ₁ (B ₂ (F ₁ ssp.purpurascens x 149-F) x 149-F) x 149-F	67.7	17.5
B ₂ (F ₁ 149-F x ssp.purpurascens) x 149-F.	45.7	7.0	B ₁ (B ₁ (F ₁ 149-F x ssp.purpurascens) x 149-F) x 149-F	65.7	33.3
B ₂ (F ₁ ssp.purpurascens x L-06) x L-623	8.7	0.0	B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-623) x L-623	1.7	0.0
B ₂ (F ₁ L-06 x ssp.purpurascens) x L-623.	19.4	0.0	B ₁ (B ₁ (F ₁ L-06 x ssp.purpurascens) x L-623) x L-623	10.3	0.0
B ₂ (F ₁ ssp.purpurascens x 149-F) x L-623.	23.3	0.0	B ₁ (B ₂ (F ₁ ssp.purpurascens x 149-F) x L-623) x L-623	6.7	0.0

B ₂ (F ₁ 149-F x ssp.purpurascens) x L-623.	28.7	0.0	B ₁ (B ₁ (F ₁ 149-F x ssp.purpurascens) x L-623) x L-623	13.3	0.0

A study of selections taken in 1989 has been conducted in 1990. The characteristics of the best families were presented in the table of 32. The taken families were superior to standard varieties in precocity, weight of one boll, output, and length of fiber.

In 1988, a new early ripening variety, S-6524, was registered. You can see it in table 33, used as the second standard variety. Its precocity was 3 days earlier than the old standard Tashkent-1. Families developed from double crossing of B₁ (B₁ (F₁ ssp. purpurascens x L-06) x L-06) x 149-F and B₁ (B₁ (F₁ ssp. purpurascens x L-06) x L-623) were 14 days earlier than this early ripening standard. Moreover, they were able to increase fiber output by 3–7% correspondingly.

The above mentioned schemes for remote geographic crossing and inter-species hybridization with the use of greenhouse opportunities have perfectly improved traditional cotton breeding. At this, the comparable longer period in the breeding process from the choosing of initial materials up to the realization of a new cotton variety decreases closely to the level of widely promising short breeding periods possible on the basis of innovative biotechnological approaches.

Table 32. Characteristics of families taken in the result of double backcrossing.

Hybrids, varieties	Vegetation period, in days.	Weight of one boll, g.	Fiber output, %.	Fiber length, mm.
Tashkent-1	118.0	5.2	36.0	31.9
149-F	117	6.0	36.6	33.4
L-06	120	4.8	35.8	33.6
L-623	114.8	4.5	37.8	32.3
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-06) x 149-F	112	5.6	40.3	37.7
B ₁ (B ₁ (F ₁ L-06 x ssp.purpurascens) x L-06) x 149-F	114	5.7	40.1	36.0
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-06) x L-623	113	5.2	39.1	34.0
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x 149-F) x L-623	122	5.4	38.4	33.8
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-623) x L-623	115	6.2	38.3	33.5
B ₁ (B ₂ (F ₁ ssp.purpurascens x 149-F) x L-06) x 149-F	117	6.2	36.2	33.7
B ₁ (B ₁ (F ₁ 149-F x ssp.purpurascens) x L-06) x L-623	120	5.6	38.0	33.5
B ₁ (B ₁ (F ₁ 149-F x ssp.purpurascens) x 149-F) x L-623	118	5.5	39.0	33.1
B ₁ (B ₂ (F ₁ ssp.purpurascens x L-623) x L-06)	117	6.0	39.0	33.0
B ₁ (B ₂ (F ₁ ssp.purpurascens x 149-F) x L-623) x 149-F	114	5.4	38.3	33.3

Table 33. Characteristics of families taken in the result of double backcrossing.

Hybrids, varieties	Vegetation	Weight of one	Fiber output,	Fiber length,

	period, in days.	boll, g.	%.	mm.
S-6524	130	5.6	34.6	33.3
Tashkent-1	133	6.0	35.9	32.6
B ₁ (B ₁ (F ₁ L-06 x ssp.purpurascens x L-06) x L-06	125	6.0	38.3	33.5
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-06) x 149-F	116	6.0	37.4	34.3
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x L-06) x L-623	116	6.3	41.5	33.2
B ₁ (B ₁ (F ₁ ssp.purpurascens x L-06) x 149-F) x 149-F	125	6.5	37.8	34.0
B ₁ (B ₁ (F ₁ L-06 x ssp.purpurascens) x L-623) x L-06	128	6.5	38.8	33.5
B ₁ (B ₁ (F ₁ L-06 x ssp.purpurascens) x L-623) x L-06	127	7.3	38.0	34.3
B ₁ (B ₁ (F ₁ ssp.purpurascens x 149-F) x L-623) x L-623	125	7.0	40.4	34.4
B ₁ (B ₁ (F ₁ 149-F x ssp.purpurascens) x L-623) x 149-F	128	7.7	41.6	33.5
B ₁ (B ₁ (F ₁ 149-F x ssp.purpurascens) x L-623) x 149-F	128	6.0	40.8	33.7

It rarely reminds us, however, that any new cotton line developed through biotechnological breeding requires a certain period to adopt its genotype and reproduce seeds in sufficient numbers to pass through cultivation tests. And, more likely, no cotton plant geneticists or breeders can deny the natural splitting of a new genome into constructive genome individuals as a result of environment, recombination, and outcrossing. This kind of situation is excluded for the cotton lines developed through traditional breeding because their continuous selections have been made annually in the past breeding process under field conditions.

Remote hybridization has become one of the most fruitful methods in modern cotton breeding in the creation of varieties to meet the most stringent requirements of cotton farmers and industry. Such successful cotton varieties as Namanghan-77 (registered in 1994), Chimbay-5018 (registered in 2007), Namanghan-34 (registered in 2009), Dustlik-2 (registered in 2011), Andijan-37 (registered in 2012), S-8284 (registered in 2014) and others were developed by scientist-breeders as a result of remote hybridization and its scheme of breeding.

Namanghan-77 was a collection sample 05152, which represents the remote form *ssp.punctatum* of species *G.hirsutum* (figure 19) in the classification of Mauer. This remote subspecies was also listed in the list of parents of the varieties of Chimbay-5018, Namanghan-34, and S-8284. The Remote *ssp.purpurascens* of *G.hirsutum* has taken part in the creation of the variety of Dustlik-2. *G.hirsutum.var.nervosum* has taken part as one of the parents in the hybridizations to create the variety of Andijan-37.

According to the given characteristics, these cotton varieties were remarkable in their dignities. For example, the varieties of Namanghan-77, Chimbay-5018, Namanghan-34, and S-8284 were distinguished by their high fiber output, precocity, and resistance to wilt inherited from the diversity of *G. hirsutum*, *ssp. punctatum*.

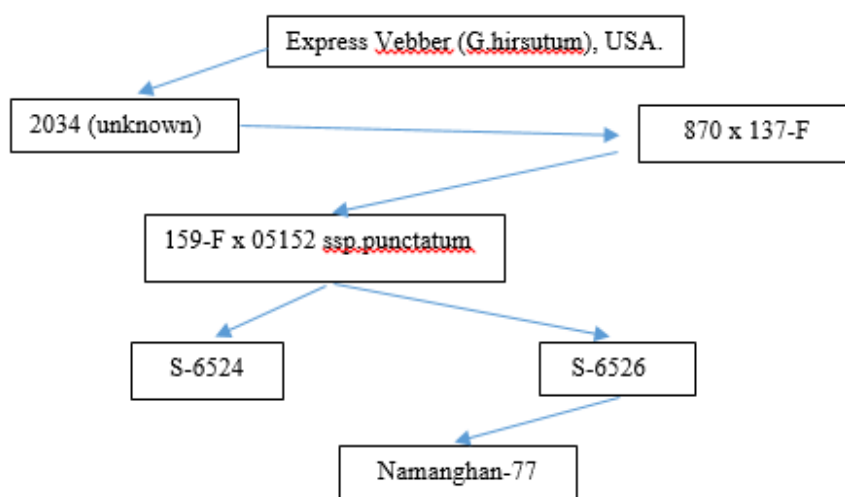


Figure 19. **Historical origin of the variety of Namanghan-77.**

Variety *G. hirsutum* has high output and length of fiber as well as considerable resistance to wilt due to using diversity *ssp. purpurascens* of *G. hirsutum*.

Andijan-37 was also one of the unique cotton varieties comprising in its genotype 32 initial forms, including *ssp. punctatum* and *ssp. mexicanum*, var. *nervosum*, which could be cultivated to form a variety with high resistance to wilt and fiber output. On other farm valuable traits and properties mentioned above make cotton varieties no inferior to standard varieties (table 34).

Table 34. **Cotton varieties and their traits and properties.**

Varieties	Indexes of farm valuable traits and properties.					
	Weight of 1 boll, g.	Fiber output, %.	Length of fiber, mm.	Rupture length, g.c\l.	Metric number.	Relative rupture length, g.c\tex.
Namanghan-77	5.2	38.5	33.7	4.6	5760	26.2
Chimbay-5018	6.5	37.8	32.8	4.5	5540	24.9
Namanghan-34	5.6	38.0	1.15 inch	-	4.3 mic	30.4
Dustlik-2	6.3	37.8	32.5	4.5	5517	24.9
Andijan-37	5.1	38.8	34.0	4.8	5830	27.6
S-8284	6.5	37.0	1.16 inch	-	4.5 mic	32.0

Chapter 4. Scheme of plant breeding by the using of induced mutation.

According to the applied plant breeding, a depression in the development and set fruiting of plants is observed within the remaining plants in the year of cotton seed exposure to radiation. Most plants are characterized by their differentiation in terms of development vigor, plant texture, and fertility degree. There often occur giant and dwarf plant forms, many of which have lowered vitality. The radiomorphosis, which retains the initial state in successive generations, accounts for a large portion of the change in the M_1 . Radiomorphosis in the difference of modification substantiated by the norm of the organism's reaction is not adaptive alterations. That is why they are less vital.

Frequently, the breeders radiate the cotton seeds (figure 20). At the radiation of seeds, different types of mutation take place in the plant cells. In some cells, mutations will not occur. That is why the plants of M_1 have a chimera structure which is characterized by the contents of normal and altered issues.

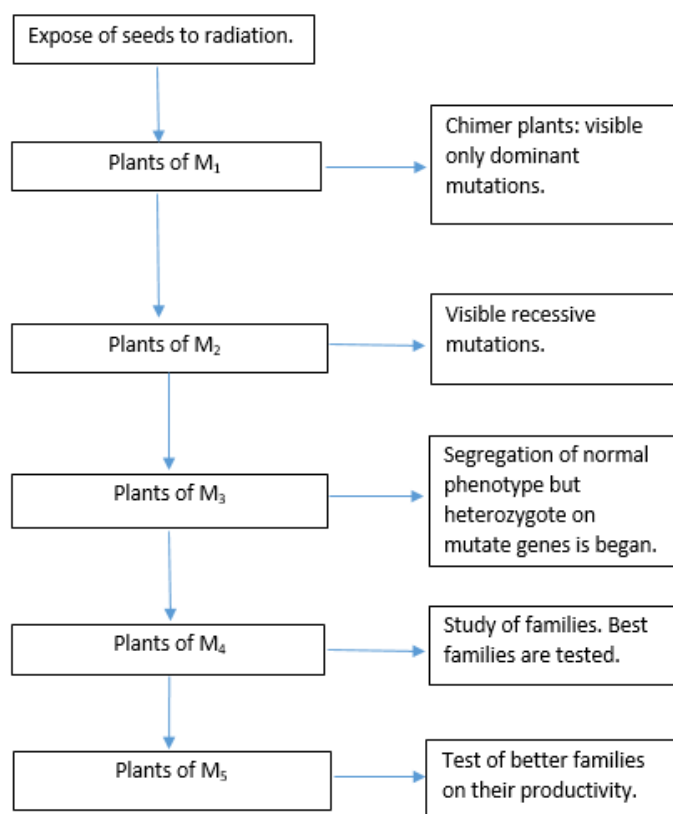


Figure 20. *Schemem of plant breeding in the induced mutation.*

The M_1 more often is in the heterozygote state, so the probability of one type of mutation in the homology chromosomes is not great. Dominant mutations can be found only in the M_1 . Recessive mutations are found in M_2 . Approximately 25% of cotton progenies from self-pollinated bolls set in changing woods will be homozygote on the mutant recessive alleles. Mutants will be segregated into the M_3 and the next generations. They are normal plants on the outside but heterozygote on the mutated gene. That is why, where the useful mutants are detected, without selection, all the plants are taken. Because most of these plants are heterozygote, detection of the best mutations is expected in successive

generations. If the mutation is dominant, the segregation is observed in the coming generations.

In the opinion of the overwhelming majority of researchers, the discovery of mutations and especially useful ones, is one of the most difficult problems.

The M_1 . The important stipulation in the M_1 is the planting of seeds from every boll or even the seeds of every plant. The useful mutations are fixed in the M_2 , but they are relatively few. As a result, the maximum increase in size of the M_2 population exposed to radiation is observed prior to detection. For example, the seeds of every M_1 plant are planted as a sole family to simplify the study of variation lines in M_2 . According to the data of A.E. Egamberdiev (1984), more than 50% of families in the variety Tashkent-1 treated by HMM (N-nitrosomethylurea)-50 g with seed exposition of 9 and 12 days have matured 7-8 days earlier than control. 9 out of 1291 families of M_2 were late ripening in comparison to control. 347 were early ripening at the exposition of this variety by all mutant causing factors. Precocity was discovered in 225 families out of 708. The late ripening families were not in the variety of S-4727. Isolated mutant plants with lowered fruit branch setting (as a rule, the lower the fruit branch setting, the shorter the vegetation period) in M_2 from both varieties. The number of vegetative branches varied significantly across three EI expositions (or treatments) (by ethylamine 0.12, 0.25, and 0.37 days) and one DMS (by dimethyl sulfate 4 days). Absence of vegetative branches was observed as a result of treatment by HMM (3 and 6 days) and HEM (N-nitrosomethylurea) at all expositions.

Isolated mutant plants from these two varieties have an increased number of bolls and sympodies in all variants of the experiment. Mostly, EI caused a positive difference in the weight of bolls in a variety of Tashkent-1. Eight families were isolated at the various treatments where the weight of one boll was surpassed by 9.5 g; 17 families in the experiment with EI, 3 families in the experiment with DMS, 3 families in the experiment with HMM, and 2 families in the experiment with HEM. They have surpassed by 1.0-3.3 g the variation range of control on this trait. In the experiment with DMS and HMM, 1 family in each had cotton boll weight variation of 1.2-2 g greater than the maximal variation of control. Tashkent-1 has produced a few tens of different families with the longest fibers. The greater number of mutants with longer fiber was marked at the 0.12-day exposition of EI (25%). One of them has been characterized by a fiber length of 39.5 mm at a control length of 36.0 mm. At the DSM treatment (4 days), the fiber length mutation in the variety S-4727 was 20%. A mutant with a fiber length of 39.0 mm at 35.5 mm in the control has been isolated from this variant. A mutation with more than 38.5 mm has been induced in the variant with NEM (9 days). Variation in the output of the fiber has also been discovered. The highest fiber output (up to 44.0 %) was registered on the variety of Tashkent-1 at the 8th-day exposition by DMS, which has been confirmed in the M_3 (52.6 %). DMS achieved the highest frequency of plus-mutation (20.0-26.7%) on the fiber output in the variety S-4727 on the 2nd and 6th days of the exposition. The total frequency of positive deviation was 7 times higher than the frequency of negative changes.

All expositions by HMM in the variety Tashkent-1 gave mutations with decreasing wilt infection. In the wilt prone variety of S-4727, the effects of HEM and DMS vapors gave resistant mutants. Mutants on the branching type, plant texture, leaves, size of bracts and mutants with hairy stems were obtained in both varieties of the experiment with mutagenesis.

In the opinion of many researchers, the number of useful mutations in the M_2 has reached 1-3, rarely 10-20% (N.G. Simongulyan, 1987). It was noted that in the families where the useful mutations were discovered, all plants individually are retained for planting in the M_3 : others are rejected. The same selection of valuable mutations and rejections in the M_2 is conducted in the M_3 . Testing of the best lines on their productivity can be conducted in the M_4 , M_5 and the next progenies. It is necessary to note that the majority of plants bearing positive mutations on certain traits have lowered productivity and, in general, vitality. It is clear because the mutation breaks down the genetic balance of the organism and its adaptation to the environmental conditions. Plant **breeding treatment** is required to restore the productivity and vitality of special valuable mutants.

The isolation of plants with tiny mutations on quantitative traits (micro-mutations) has piqued our interest. Such mutations in the cotton plant are frequently observed in phenotypically normal developed plants.

The research of N.G. Simongulyan and her colleagues (1978) revealed that genotypic variation in the phenotypic normal fraction of plants is rapidly increased in the variety population and hybrids subjected to radiation. This takes place on account of the radiation which induces the great number of tiny mutations in the productivity and other farm-valuable traits. She also cited some of the findings of foreign scientists, who concluded that plant breeding based on the selection of tiny mutations is more promising than selection based on plant selection bearing enlarged mutations. Because of her point of view, the advantage of the tiny mutations is their great frequency, which will give a chance to select mutants with desirable traits.

Many of the wild diversities of cotton plants with valuable traits are characterized as the photoperiodic wild cotton races. Here, induced mutation was used to convert the photoperiodic wild cotton races to day-neutral versions. Due to its remarkable results, induced mutation is valued as one of the most effective alternative approaches for directly converting them into day-neutral mutants. The results have contained photoperiod-induced mutant cotton germplasm that has been produced in our country. In particular, more than 200 photoperiodic-converted cotton mutant germplasms have been developed by F.Djanikulov (1992). At this, cotton seeds were treated with ^{60}Co , γ -radiation using ^{32}P , and a low-frequent electromagnetic field. During a plant breeding experiment, they discovered mutant germplasm plants had been self-pollinated and subsequent selections up to M_8 - M_{10} have been conducted for their traits of interest. The combined treatment of radiation and hormone was used by the scientists of Uzbek National University under the guidance of A.A. Bekmukhammedov (2007) to extend the frequency and spectrum of mutation. In particular, the seeds of lines L-20 and L-543, generated

from the genetic collection of *G. hirsutum* L., and their hybrids were exposed to irradiation with γ -rays of C_{60} at the doses of 100 g, 200 g, and 300 g. The irradiation has been conducted by the special equipment of the institute of nucleic physics of AS of the republic of Uzbekistan. Gibberellin A₃ at a concentration of 10⁻⁷ m was used as the quality of phytohormone. The variation of such traits as seed germination, vitality of plants, plant texture, leave shape, color of plant and fiber, size and shape of bolls, flower sterility, and others were fixed by the assessment of the efficiency of radiation and phytohormone A₃ activity.

The analysis of seed germination has figured out that different reactions to the action of various doses of radiation and combined treatment with γ -ray + A₃ is observed in the initial lines L-20 and L-543 and so in the hybrids of F₁. For example, when exposed to radiation doses of 100, 200, and 300 g, the germination of experimental variant seeds increased by 13.25, 16.75, and 5%, respectively, when compared to the check variant. Seed germination was also reduced in the combined treatment of γ -ray + A₃. But, variant M₁ with L-20 at the dose of 100 gr + A₁ surpasses control variant L-20 by 8.75%.

Analysis of the germination of line L-543 has revealed that increasing the doses of radiation effects negatively on the seed germination of the seeds. This kind of negative effect of γ -ray at the doses of 100, 200 and 300 was observed in the germination of hybrid seeds F₁ L-20 x L-543.

The analysis of the height of main plant stems under the effect of different radiation doses on the initial lines L-20 and L-543 revealed that the increase was mostly fixed in the mean values when compared to the control. For example, the main stem height in the control variant of L-20 was 117.0 $\pm$ 0.78 cm and 120 $\pm$ 0.84; 122.63 $\pm$ 0.68 and 112.04 $\pm$ 1.21 cm was fixed correspondingly in the experiment variants of 100, 200 and 300 g in this line. An increase in the height of the main stem was observed in the combined variants of M₁ L-20 with radiation + hormone by 8.00; 5.63 and 4.76 to the control.

Contrast results were observed between the experiments of M₁ L-543 100 g, 100 g A₃, 200 g and M₁ L-543 300 g, 300 g A₃, where the plant heights of l-543 in the first experiment exceeded those of their control plants, while experimental plants in the second experiment were lower than the control.

F.Djanikulov's (1992) induced mutation experiment was replicated by geneticists I.Y. Abdurakhmanov and others (2007) from the Institute of Genetics and Plant Experimental Biology, Academy of Sciences of Uzbekistan, in collaboration with scientists from Texas A&M University's Department of Biology.

The objectives of this experiment were to research the genome-wide effect of induced mutation in photoperiod-converted induced cotton mutants, estimate the genetic change between mutant and wild-type cottons using simple sequence repeats (SSRs), and understand the pattern of SSR mutation in induced mutagenesis. As the scientists note, "three groups of photoperiod-converted radiomutants (32P), including their wild-type parental lines, A-and D-genome diploids, and typically grown cotton cultivars, were screened with 250 cotton SSR

primer pairs." Forty SSRs revealed the same SSR mutation profile in at least two independent mutant lines that were different from the original wild types. Induced mutagenesis both increased and decreased the allele sizes of SSRs in mutants with the higher mutation rate in SSRs containing dinucleotide motifs the genetic distance obtained based on 141 informative SSR alleles ranged from 0.09 to 0.60 in all studied cotton genotypes. The genetic distance within all photoperiod-converted induced mutants was in the 0.09–0.25 range. The genetic distance between photoperiod-converted mutants and their originals ranged from 0.28 to 0.50, revealing significant modification of mutants from their original wild types. *Gossypium hirsutum* cultivar, Namangan-77, revealed a mutational pattern similar to induced radiomutants in 40 mutated SSR loci, implying possible pressure on these SSR loci not only in radiomutagenesis but also during the common breeding process. " The outcomes of the research should be useful in understanding the photoperiod-related mutations, and markers might help in mapping photoperiodic-based desirable genes in cotton. Furthermore, Zihao Zhao and others (2022) underline that although the genome of cotton has been fully sequenced by genetic scientists of developed cotton-growing countries, research, in particular on the function of specific genes, lags behind, due to the lack of sufficient genetic sources. In this point of view, they in their turn exposed the seeds of the variety "TM-1" to a radiation dose of 250 Gy for 1 s in a 10 MeV20 kW reverse wave electron accelerator. This could mutagenize 10-20 tons of cottonseeds in a single radiation. In the field, mutant plants were self-pollinated since M₀ and up to the third generation. The relevant mutants were screened in the M₂ generation. As reported, the mutant plants or mutant library of M₂ has reached 300,000 seeds. The calculation of the number of mutant plants and the mutation frequency of various mutants in the M₂ generation was fulfilled. The results of their calculation are shown in the table 35.

Table 35. Statistical table of mutant phenotype type and mutation frequency in the M₂ generation (Data of Zihao Zhao and other, 2022).

Mutant type.	Mutant number, in units.	Mutation frequency, in %.
Brown colored cotton.	64	0.021
Green colored cotton.	36	0.012
Susceptible cotton mutants.	734	0.245
Dwarf cotton mutants.	1013	0.340
Cotton mutants with chicken-foot leaves.	46	0.015
Leaf yellowing mutants.	212	0.071
Nulliplex fruit branch mutants.	45	0.015

The mutant library was implied by these scientists for its great importance to the study of gene function. For example, acquired traits such as fiber length, stem height, yield quantity, leaf morphology, fiber color, and other mutants have made a

great contribution to the genetic breeding and basic research of cotton. In this study, researchers especially emphasized the efficiency of their new method of radiation mutagenesis using a linear electron accelerator to increase the frequency of diversified mutants. And the mutant library, consisting of all such mutants, provides valuable germplasm resources for cotton genetic improvement and functional genomics. Furthermore, the importance of creating the cotton mutants to be utilized in the applied breeding process of the new, higher-quality cotton varieties and in identifying the genes associated with the control of desirable traits and properties was highly appreciated. They have moved the exclusion forward of the traditional mutagenic strategies, such as physical, chemical, and site-directed mutagenesis, in consequence of their high cost, inefficiency, and difficulties in performance.

The intensiveness of new mutant plant frequencies much more promotes the selection of target plants by geneticists and breeders to use in their plant breeding programs. Analysis of the catalogue of Uzbek cotton varieties developed and submitted to the state variety trials from the 1980s to 2012 figures out that more than ten cotton varieties (Listopadnyi-1, in 1980; Karshinskiy-2, in 1980; Bukhara-2, in 1980; AN-411, in 1984; AH-412, in 1984; AH-414, in 1988; VNSSKh-101, in 1986; S-7510, in 1991; S-7503, in 1991; Gulsara, in 1997; S-7512, in 2000) were developed as a consequence of exposing the cotton varieties or their hybrids to induced mutation. Their methods of origin, authors, and farm valuable traits can be seen in the table given below (table 36). The data in the table might easily be analyzed from the point of view of general targeting traits by the breeders as: precocity (earliness), boll size, length, and output of fiber, and other fiber properties to meet textile requirements.

The formation of ultra-early maturing varieties such as Gulsara and S-7512 with 105 and 113 days of vegetation period, respectively, substantiates the advantages of the breeding scheme in the induced mutation to select the desirable mutant plants and efficiency in using them in the different breeding prospects. Here, it must be specially remarked that the earliness of the variety Gulsara, achieved by the help of induced mutation, is a great achievement in regard to improving the precocity of growing cotton varieties. Because the analysis of the characteristics of 32 new and promising cotton varieties in Uzbekistan and their growing technologies done by cotton variety experts (Nazarov R. and others, 2013) has shown the early ripening cotton varieties in particular. They were S-6541 with 104, Namanhgan-102 with 108, Beshkakhramon with 109, Omad, Parloq-1, and Namanghan-34 with 110 days of vegetation period. These varieties were developed mainly on the basis of traditionally accepted methods of cotton breeding, but one,

Table 36. Cotton varieties developed through the method of induced mutation (1980-2012).

Varieties	Origin	Authors	Early ripening, days or +- than control.	Boll size, g.	Fiber output, %.	Fiber length, mm.	Rupture strength, g\с.	Metric number.	Relative fiber strength, g.s.\tex.
Listopadniy-1	The seeds of Tashkent-1 treated with ethylamine	A.Egamberdiev, M.Daminov	-9	6.8	38.8	35.0	4.8	5660	27.2
Karshinskiy-2	(S-6030 x S-6029) with using of radio mutagenesis.	A.R.Tiyaminov, Sh.I.Ibragimov.	-17 (5904-I)	3.0	34.6	38.0	4.6	7140	33.8
Bukhara-2	By means of experimental mutagenesis from hybrid material	A.M.Batalov.	-	3.5	31.4	39.1	5.0	7470	37.9
AN-411	G.Darwinii + radioactive phosphorus.	N.N.Nazirov, F.Djanikulov, D.Dadajanov, Kh.K.Kambarov.	+0 (Tashkent-1)	5.5	35.0	35.3	4.7	6870	32.0
AH-412	Treated of 20 day bolls of G.Darwinii with P ³² solution.	N.N.Nazirov, F.Djanikulov, D.Dadajanov, Kh.K.Kambarov.	-2 (Tashkent-1)	5.6-6.0	35.3	38.0	4.7	7380	34.6
AH-414	Treated of 20 day bolls of G.Darwinii with P ³² solution.	F.Djanikulov, D.Dadajanov, Kh.K.Kambarov.	-4 (Tashkent-1)	5.4	35.3	35.6	4.7	6300	29.3
VNSSKh-101	(Tashkent-1 x C _o 60 exposing)	K.D.Sultanov, K.K.Gulamov.	-10 (175-F)	6.7-7.0	34.8	34.5	4.6	6000	27.6
S-7510	(108-F x Mutant-1) x plants exposed to C _o 60 radiation.	Sh.I.Ibragimov, R.I.Kovalchuk, A.Kushaliev.	-3	6.0	34.3	39.6	4.8	5640	27.0
S-7503	108-F x plants exposed to C _o 60 radiation.	Sh.I.Ibragimov, R.I.Kovalchuk,	-3	6.0	34.3	39.6	4.8	5640	27.0
Gulsara	Mutant-93=SouzNikhI, radiated by ren-gene rays.	K.B.Bakhramov, Sh.I.Ibragimov, A.M.Bakhramov, A.M.Nuriddinov.	105	5.7	40.1	35.1	4.4	5756	25.5
S-7512	From seeds exposed to C _o 60 radiation.	Sh.I.Ibragimov, R.I.Kovalchuk, A.Kushaliev.	113	5.8	36.1	35.5	4.4	5700	25.0

Parloq-1, was developed through a newly introduced RNA interference (RNAi) method of biotechnology. The precocity of Gulsara (105 days) developed by the help of induced mutation is almost equal to the vegetation period of the most early maturing one of S-6541 (104 days) developed by one of the commonly accepted methods (crossing of S-6530 x S-9070 with multiple individual selections). Besides earliness, the variety of Gulsara has also become recognized for its high fiber output, which has reached 40.1%. So, this variety may be recommended as the best initial donor material for its ultra-earliness and high fiber output to improve new cotton varieties.

Furthermore, Listopadniy-1, VNSSKh-101, and Karshinskiy-2 varieties outperformed their standard counterparts in terms of precocity, with -9, -10, and 17 days, respectively. Between them, Listopadniy-1 can be underlined not only for its earliness but as the best in many traits, such as boll size at 6.8 g., fiber output at 38.8%, and other fiber property indexes not inferior to other standard cotton varieties.

Chapter 5. Scheme of cotton breeding by using of heterosis in the cotton forms.

Heterosis refers to the phenomenon that progeny of diverse varieties of a species or crosses between species exhibit greater biomass, speed of development, and fertility than both parents. This phenomenon in the hybrids of cotton plants and other agricultural crops has significance for plant breeding and directly in the agricultural industry.

The schemes of plant breeding based on the hybrid's heterosis reveal the first and next generations, and the practical use of these heterosis effects is clearly seen in the schemes of plant breeding.

The types of heterosis and the possibility of using heterosis as one of the breeding methods in cotton breeding were clearly explained in N.G. Simongulyan and others' (1987) first textbook on cotton breeding and seed production. Accordingly, three types of heterosis are distinguished: reproductive heterosis, characterized by the accumulating of high farm yield; somatic heterosis, causing powerful development of the vegetative mass of plants; and adaptive heterosis, which is characterized by the better way of adaptation of hybrids to varying environmental conditions. In the opinion of the above-mentioned scientists, reproductive and adaptive forms have the most interest in the cotton plant. Furthermore, this effect captivated early cotton growers such as colonist Pop on the Island of Santa-Cruse in the 1786-1790s, who attempted to create an interspecies hybrid. The effect of heterosis is known to be more pronounced in interspecies hybrids of domesticated tetraploid species than in intraspecies or between variety forms of the definite species.

S.Munir, S.B.Hussain and others (2016) identified the difference between heterosis on the reproductive components of cotton plants occurring between interspecific and intraspecific hybrids. In their summary, yield-component traits have complex genetic relationships with each other. They studied crossings of six cotton lines (Bt. CIM-599, CIM-573, MNH-786, CIM-554, BH-167, and GIZA-7) and three test lines (MNH-886, V4, and CIM-557) in a line x tester crossing design to determine the relationships of yield-component traits and even fiber traits with seed cotton yield. The highest heterosis (114.77) on these traits was observed in the cotton plants of the interspecific hybrid Giza-7 x MNH-886. The highest heterosis (61.29) among intraspecific hybrids was CIM-554 x CIM-557 on the seed cotton yield. The same effect of heterosis (from 19.78 to 78.42%) was remarked in the intraspecific (*G.hirsutum* L.) hybrids implemented by the other scientists, S.R. Patel and others (2018). In the first example, the most valuable results were in defining the number of bolls per plant followed by boll weight, which are the major traits that contribute to seed cotton yield, and for the second example, other attributing traits to be used within breeding programs.

Heterosis is known as it may be stipulated for different reasons. According to the most widely accepted theories—accumulation of the dominant positive genes and the theory of top dominancy—the major reasons for heterosis can be summarized in the following terms:

1. Negative recessive genes in the heterozygote suppress the harmful effects of these genes;
2. Non-allele interaction occurs when dominant alleles of different genes interact with one another.
3. As a result, heterozygotes may express different functions or perform their own functions under different conditions.

The last circumstance stipulates adaptive heterosis, or the high adaptive possibility (homeostasis) of hybrids.

Complementary interaction and top dominance are more important for cotton plant than suppressing recessive gene effects, so that the population of cotton plant, as an example of self-pollinator, is free of obviously detrimental to vitality lethal and semi-lethal genes.

Positive heterosis is seen in not all hybrids. Along with hybrids displaying positive heterosis, many of them occupy intermediate positions in productivity.

In particular, this is often seen in situations when the parental forms are differentiated sharply on productivity. Negative heterosis is observed in certain hybrids when the hybrid cedes the productivity or other studied trait to both parents.

As it was noted by many of the scientists that in the many cases the negative value of trait in cotton plant is controlled by dominant genes; complementary effect of hybrids such dominant alleles may lead to strengthen of trait's negative value, that is on the negative heterosis. Positive heterosis, or increased economic and biological productivity of intra and interspecies hybrids F_1 , has been described repeatedly in cotton plants. The most heterosis is observed in F_1 cotton plants from tetra-ploid interspecies crossings of *G.hirsutum* and *G.barbadense* (figure 21). Desirable positive heterosis on the targeted traits and properties in the F_1 is deemed a good chance for the breeder to isolate initial plants for the successive breeding process. It is self-evident that the potential of such heterosis has always been an irreplaceable source in all kinds of plant breeding activities, and heterosis has resulted in the development of many of the best cotton varieties.

The results of the positive and adaptive heterosis of cotton hybrids used in the practical breeding process may be traced to the book "Genome Performance of Main Cotton Varieties of Uzbekistan", written by cotton breeder M.I. Iksanov (2016). According to one of the informations of this book, heterosis with dominancy in reproductive parts of the hybrids expecting at the interspecies *G.hirsutum* L. (Tashkent-1) and *G.barnadense* L. (9747-I) hybridization was used by the authors (Battalov A.M. and Barakaeva M.) in the forming of variety Bukhara-6. At first, most probably, the hybrid plants with maximal heterosis on the wide environmental adaptive spectrum and the best potential in regard to economic traits in the farmers' interest were selected. Of course, here the previously accumulated heterosis powers on the selected traits and properties of two species varieties as middle staple and fine staple cottons are not exclusion.

The originator of this variety was the Bukhara branch of the Uzbek SRICG and it was included in the State Register in 1990. The planting area of this variety

in the year of 2014 consisted of 107 000 hectares in the regions of Surkhandariya, Kashkadariya, and Navoiy. The variety is distinguished by its enlarged boll size (5.9–7.4 g.) and higher metric number (6020), relative rupture length of fiber (28.3).

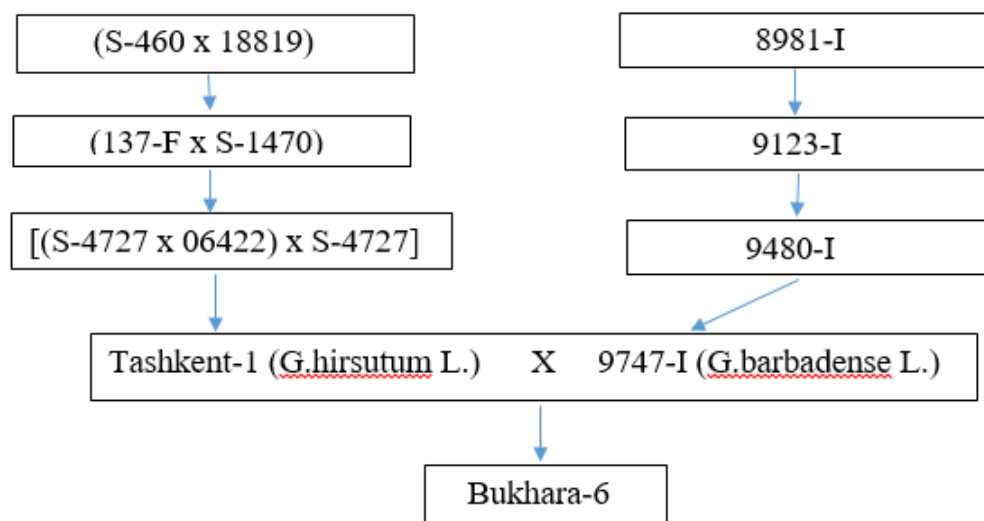


Figure 21. *Origin of Bukhara-6 through intra-species hybridization.*

The best quality of fiber is inherited from the variety of 9647-I (fine staple cotton of *G. barbadense* L.) with the fiber of the first type. The precocity of the variety makes it 119-127 days. The plant canopy has a pyramid shape with branching of 1-2 types. The height of the plant varies between 80 and 110 cm (photo 72). The main stem is strong and not prone to lodging. The leaves are medium sized. The first fruiting branch is setting on the 5th or 6th stem node. The bolls have 4-5 loculs, the weight of 1000 seeds varies 122-123 g., the fiber output is 35.5–36.3%, and the fiber quality meets the requirements for V fiber type.

The highest positive heterosis of the F₁ and the breeder's purposefully directed selections coinciding with dreaming gene re-combinations and suppression of harmful effects of negative recessive genes in the heterozygote, which is taking place in the hybrid plant genomes of the breeding homozygous generations, promote a promising outcome in the evolving of new cotton lines and varieties.

Cotton varieties such as S-6524, Sultan, Dustlik-2, and Jarkurgan were developed through the hybridization of different cotton species or subspecies, which was followed by the emergence of heterosis in the F₁. Here, maintaining the dominance of some genes in the positive heterosis, responsible for the control of targeting plant traits and properties during the breeding processes by the strive activities of the breeder, has secured the formation of the above-mentioned elite cotton varieties. In particular, the variety of S-6524 has been developed by A.A. Autonomov and others. It was included in the state register in 1988. Its fiber quality corresponds to the level of IV textile type. It was resistant to *Verticillium* wilt races I and II for a long time as a result of the remaining heterosis effect from

the *G.hirsutum*, ssp. *punctatum* genes and the remarkable fiber properties inherited from the famous variety 159-F.



Photo 72. Exhibition view of the variety of Bukhara-6.

More complicated hybridization with another interspecies crossing method F_5 (F_1 *G.thurberi* Tod. x *G.raimondii* Ulbr.) x Acala sj-5 in cotton breeding, was employed in the development of Sultan. All the best traits and properties of this variety are also the result of the heterosis effects bringing together the necessary genes into the new variety's genome. It was registered in 2011. The hybrid plants with genes of *G. purpurascens*, S-4727, and S-1973 with positive dominance of traits and properties have been successfully isolated and developed as the cotton variety Dustlic-2, which was registered in 2011. In 2013, the next cotton variety, Jarkurgan, was registered. It was also formed as a result of the emergence of heterosis powers as a result of interspecies crossings F_{10} [F_1 *G.thurberi* Tod. x *G.raimondii* Ulbr.) -187]. But here we should not forget the necessity of multiple selection procedures to release a new variety line in the consequences of complicated and continuous chromosomal conjugation and recombination processes reflecting heterozygote and homozygote plant phenotypes.

The determination of the significant and positive associated correlation of boll per plant, boll weight, lint weight per boll, lint index, seed index, lint per seed and staple length (S.Munir, S.B.Hussain and others, 2016) with seed cotton yield will be helpful for improving cotton seed yield and fiber quality in the newly developed cotton varieties.

Precocity and resistance of cotton plants to wilt remain the more challenging problems today, standing before our cotton breeders. In order to solve this problem, our cotton breeders often use the scheme of breeding on the basis of heterosis and get very promising outcomes in creating wilt-resistant, perspective varieties. Moreover, the heterosis effect with the complex of economic-valuable traits in the intra and interspecies hybridizations promotes isolation of the better cotton families and variety lines.

Another excellent example of native cotton breeding processes involving the use of hybrid vigor in the development of new varieties is the work of our cotton breeders: A. Akhmedjanov and others (2016). The result of this breeding research is expressed by the development of two new cotton varieties that brightly confirm the unvaluable efficiency of the heterosis in the breeding process to develop new varieties.

The cotton varieties of Tashkent-6 (*G.hirsutum* L.) and S-6037 (*G.barbadense* L.) were chosen as the main objects. The direct and the reciprocal hybrid plants were involved in the genetic-breeding process F_1 - F_4 with further study of inheritance and variability of wilt resistance, isolating wilt resistant biotypes on the artificially infected backgrounds with the most spread in the production conditions by aggressive races of *V. dahliae* Kleb fungi. Some of the perspective families and the well-known cotton variety Namangan-77 also took part in the experiment. The study was carried out at the AS Institute of Genetics and Experimental Biology of Plants in the Republic of Uzbekistan.

The resistance of parental forms and their hybrids F_1 - F_2 to the wilt has been determined based on the infection scores of stems by the cuttings at the cotyledon node levels of the plants: 0-healthy plants, 1-weak extent, 2-mean extent of plant infection, and 3-stronger extent of plant infection (photo 73).



Photo 73. An internal view of infected and healthy cotton stems.

Vegetation period and speed of boll opening were studied on the experimental plants to allow the selection of more uniform and early-ripening families. Economically valuable indexes were defined in the laboratory conditions of the center of certification of cotton fiber "Sifat." The experiment is set up in 20-seed nests with four row plots. All plants were numbered by the tagging of every plant. From 75 to 80 plants were initially studied for every hybrid combination.

Field inspections of the breeders have revealed that the heterosis of parental forms but Tashkent-6 in the two infected backgrounds was observed in the form of high resistance to the pathogen of the disease. Heterosis occurring within hybrid plants of F_1 (Tashkent-1 x S-6037) has presented resistance to wilt. In the F_2 , this resistance to wilt has been inherited as a polygene trait at a rate of 55.0–62.0%. In the successive generations, the heterosis of the interspecific hybrids has been stipulated with the dominance (in the plants of F_1 and F_2) of resistance to wilt and further by the lowering from 31.3 to 14.3% of healthy plants (table 37).

Table 37. **Infection characteristics of parental forms and their hybrids (A. Akhmedjanov and others, 2016).**

Parental forms and hybrids	Background of the 1 st race						
	% of healthy plants, 0.	% in weak grade, 1.	% in mean grade, 2.	% in strong grade, 3.	Vegetation per. in days.	Fiber output, %.	Fiber length, mm.
Tashkent-6	63.5	35.7	0.8	-	109	36.5	33.4
S-6030	61.2	35.8	3.0	-	125	30.0	38.5
F ₁ (Tash-6xS-6037)	47.8	47.8	4.4	-	118	34.0	30.0
F ₂ -\\-	62.0	28.0	10.0	-	120	35.0	32.0
F ₃ -\\-	31.3	56.2	10.4	2.1	123	34.0	33.0
F ₄ -\\-	14.3	45.7	40.0	-	117	35.6	32.8
Background of the 2 nd race							
Tashkent-6	21.5	25.4	48.3	6.8	111	36.7	33.7
S-6030	75.5	24.5	-	-	128	28.4	37.9
F ₁ (Tash-6xS-6037)	30.0	45.0	25.0	-	125	30.0	32.0
F ₂ -\\-	55.0	32.5	12.5	-	118	35.0	33.0
F ₃ -\\-	50.0	31.6	15.8	2.6	120	37.0	32.0
F ₄ -\\-	53.6	26.2	13.0	7.2	123	36.5	31.0

More steady progress of the heterosis effect in resistance to wilt of interspecific hybrids was seen in the second background, infected by the 2nd race of *Verticillium* wilt. Here, the percentage of healthy plants has reached 30.0% in the F₁, 55.0% in the F₂, 50% in the F₃ and 53.6 in the F₄. They are considerably improving indexes in comparison to the indexes of parental form (21.5% in the plants of Tashkent-6), which promotes the selecting of promising plant families in the breeding process. But, according to the summary of breeders, other analyzed traits characterized by less fiber output and fiber length, as well as middle ripeness and so on, meant that these hybrids could not have enough practical interest. Consequently, the breeders, taking into account the above mentioned heterosis effect (from 30.0 to 53.6%), have conducted backcrossing (F₃ Tashkent-6 x S-6037) with Tashkent-6 to get a far more genetically enriched population (plant families with early ripening and other economically valuable traits). In this way, hybrid plants of F_{B3} (F₃ Tashkent-6 x S-6037) in the mixed-race background have made breeders able to isolate them as wilt resistant, early ripening, large cotton bolls, and other farm-valuable properties (table 38).

According to the next reports of breeders, the results showed that the resistance to wilt of the hybrid plants of F₁ and F₃ (table 38) has been retained. As a result of these effects, known as interspecific heterosis, hybrid plants with beneficial characteristics such as wilt resistance, early ripening, enlarged cotton bolls, and other economically valuable properties emerged. This situation has

Table 38. Plant infection characteristics in a mixed wilt background (A. Akhmedjanov and others, 2016).

Materials	% of healthy plants, 0.	% of weak grade, 1.	% of mean grade, 2.	% of strong grade, 3.
F _{B1} (Nashkent-6 x S-6037) x Tashkent-6	62.0	30.0	8.0	-
F _{B2} -\\-	50.5	42.5	7.5	-
F _{B3} -\\-	42.0	48.0	10.0	-

promoted breeders to do efficient selection of plants with wilt resistance, early ripening, and high fiber quality within the hybrid plant populations of F_{B2} and F_{B3} and to continue multiple promising plant breeding processes with lab seed analysis and rejections to bring isolated families into genetic homozygosis and phenotypic uniformity. Later, out of the progenies of the best families, they began to form cotton line-118 and continued further breeding and seed production procedures (table 39).

Table 39. Farm valuable traits of the L-118 families (A. Akhmedjanov and others, 2016).

No of families.	Veg. period, days.	Yield per plant, g.	Weight of one boll, g.	Fiber length, mm.	Fiber output, %.	Micro-nair.	Infection, %.
1	115	66.0	6.4+0.4	33.8+0.1	38.2+0.2	4.1-4.3	5.5
2	117	70.0	6.6+0.2	34.0+0.1	37.6+0.1	4.2-4.5	4.3
3	113	63.5	6.3+0.2	34.1+0.1	37.9+0.3	4.0-4.3	7.0
4	118	61.0	6.5+0.2	33.5+0.1	38.0+0.2	4.1-4.4	5.0
5	116	60.0	6.4+0.1	34.2+0.1	37.0+0.1	4.2-4.5	4.8

Breeders report that the data on the farm desirable traits of these families meets all the state standard requirements. Breeding, selection, and seed production work with the best families in the field under infected conditions with mixed wilt pathogen races resulted in the creation of the wilt resistant cotton variety "Ishonch" (photo..) from the elite families of line-118. This cotton variety has recommended itself as one of the perspective wilt resistant cotton varieties and has the following farm valuable traits: Plant height: 90-100 cm; vegetation period: 114-116 days; raw cotton productivity: 3.5-3.8 tons/hectare; fiber output: 38%; fiber length: 34.0-34 mm; weight of one boll: 6.0-6.6 g, mic. 4.3-4.4 The seeds of this variety have been reproduced since 2014 in the southern regions of the republic, where there are observed annual water deficits.

Above analyzed method in relation of using the heterosis potential of the interspecific hybrids was continued simultaneously with the intraspecific hybrids of F₃ (Tashkent-6 x Orzu) x S-6524 to develop early ripening lines with high farm desirable traits (in particular of fiber output and length). Due to multiyear individual and purposeful selections with field progeny inspections was possible to form cotton line-170. This cotton line was shifted to State variety trial in 2014 under the name of "Zafar" (photo 74).



Photo 74. Outlook of the prospective cotton varieties of Ishonch and Zafar

The farm dignity of these new varieties can be estimated by comparing their indexes with the data of some early ripening and productive varieties of that period of farming and cotton breeding research (table 40). These new varieties exhibited equal vegetation periods and a considerably positive difference in the matured raw cotton yield percentage at harvest in the September month. Here, the early ripening properties of new varieties of Ishonch and Zafar are clearly visible and made of 6 and 2 days, correspondingly, in comparison with the ultra-early ripening variety of S-4727. On the productivity, we can see that the first variety, Ishonch, could give the same yield as that variety of S-4727 and the second new variety of Zafar could give even more (4.0 %) yield.

These and many other achievements in the historical cotton breeding process, which were used as the example schemes of heterosis through intraspecific and interspecific hybridizations, are being used by cotton breeders today as the traditional methods to develop new, more efficient cotton lines and varieties.

Table 40. Duration of the vegetation period and harvest yield percentage in September (A. Akhmedjanov and others, 2016).

Varieties.	Vegetation period.	% of harvested yield in September.
S-4727	108	81.0
Tashkent-6	109	85.0
Zangiota-2	112	84.0
Ishonch	114	80.0
Zafar	110	85.0

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Methods of cotton breeding”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Principles o scheme of cotton breeding			
2	Principles of intraspecific hybridization			
3	Principles of remote geographic hybridization			
4	Principles of interspecific hybridization			
5	Advanced cotton breeding abroad			
6	Advanced cotton breeding in India			
7	Advanced cotton breeding in Turkey			
8	Advanced cotton breeding in Egypt			

Chapter 6. Using of untraditional methods in cotton breeding.

Many of the historically native cotton varieties were developed through different means which considerably differed from the above studied, traditionally worked out, and scientifically proven methods to design cotton breeding programs. We can see some of them in the study of the origins of our registered cotton varieties. For example, the well-known variety of 108-F is the result of natural hybridization of different variety diversities, which was registered in 1943; A-40, selected from the variety population of 108-F in the condition of lowered temperature and registered in 1960; AN-209, registered in 1961, which was developed similarly, in the condition of lowered temperature, from another variety of S-1225; Avval-1, registered in 1990. Its origin was also characterized as the result of natural selection.

Untraditional ways of cotton breeding were considered in detail in the book "Cotton varieties on the basis of plant breeding" written by B.P. Straumal (1974). In particular, plant breeding to decrease vegetation period under the effect of cultivating conditions in Uzbekistan, plant breeding to increase fiber output depending on the place of cotton bolls in the maternal plants, plant breeding to increase fiber length under the effect of cultivation practices, plant breeding to create naked seed varieties, plant breeding to develop varieties with limited and zero branching types, plant breeding of cotton varieties with naturally colored fiber, plant breeding of cotton varieties with wool type fiber, and plant breeding of cotton varieties with 6-7 lobule bolls are listed as the untraditional and deeply analyzed some of their achievements. Cotton plant populations with diverse combinative genomes, as well as their specific reactions to medium effects and ultimate phenotypic expressions, were critical in the selection of breeders to bring out desirable biotypes as the new family, line, and variety of cotton.

Of course, in these two situations, the scientists and breeders focused their attention on the phenomenon of population diversity in the initial materials. We know and study the science of genetics as the theoretical basis of plant breeding and seed production. Genetics, on the other hand, studies the variation and heredity of all living organisms, including agricultural crops. On account of the cotton plant, it is prone to outcrossing naturally and leads to natural hybrid variation, which is recombination of genetic material – chromosomes and genes of parental forms as a result of accidental splitting of chromosomes and genes in meiosis of F_1 and their recombination at the genome formation. The mechanism of recombination in different environmental conditions insures the establishment of a new group of coupling and, successively, new types of correlative connections of traits. This is a variation of phenotypic traits and properties of plants, and here its transgression is very valuable. This criterion is commonly used for quantitative traits and is very useful for cotton breeding. It is expressed as the splitting of superior individuals in the F_2 and following generations of hybrids, which overcome certain traits better than their parents.

Precocity (early ripening) is a complicated polygene and defined by the action of a number of genes. Moreover, precocity depends on the environmental

conditions: temperature, duration of day light, feeding (irrigation, fertilizer), and place of selection. It is remarkable to remember that along with the historical movement of cotton plants from warm regions with short days like the subtropics and tropic belts to the more northern cooler regions, the perennial cotton forms with the dominance of monopodial branch types converted into annual early ripening forms with simpodial branches, adapted to the longer day light (14–15 hours).

According to the opinion of some breeders, cultivating of cotton plant in the condition of variable (or changeable) temperature during the day and night has great significance in the appearance of early ripening forms. Temperature indexes of the day and night in the subtropics and tropics are close, and contrary to that, in the northern regions of cotton growing, they vary sharply. For example, Yu.I. Ikramov (1960, 1970) grew varieties and hybrids at the different temperatures of day and night (table 41).

Table 41. The effect of air temperature on cotton maturity (Yu.I. Ikramov data).

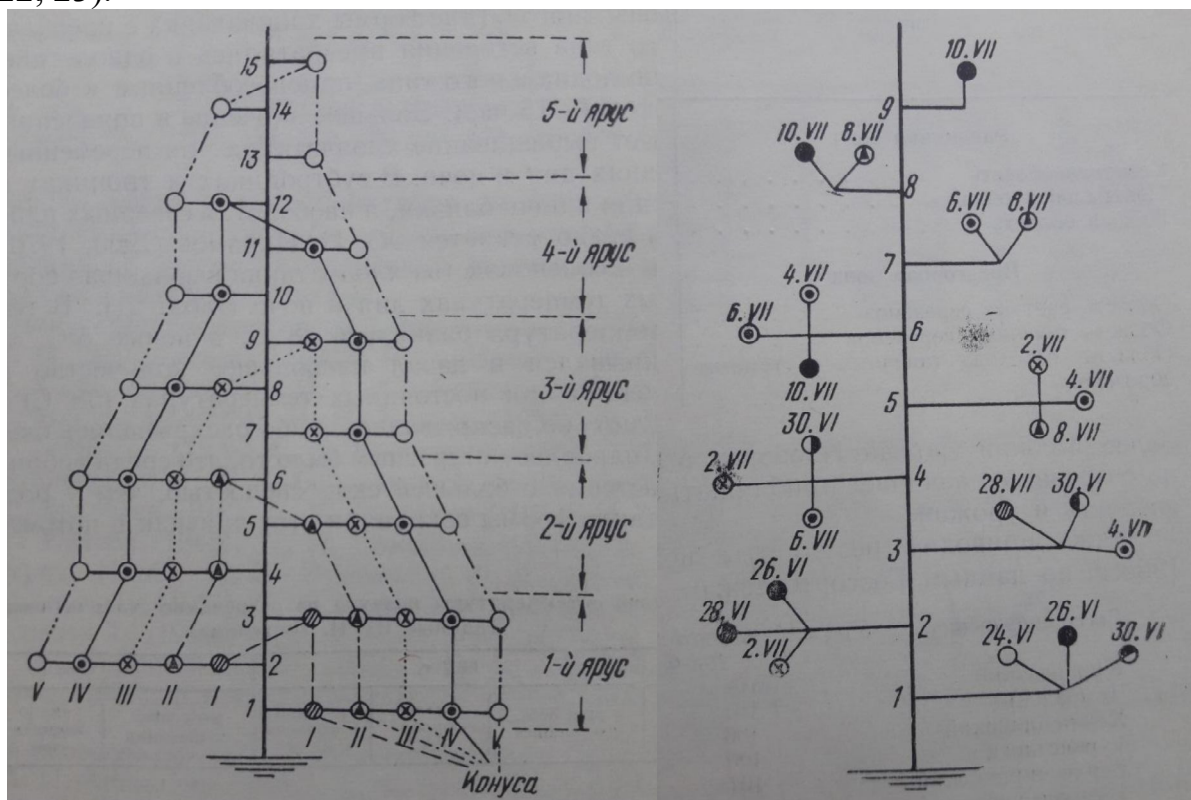
Temperature, C°		1967			1968		
Day	Night	Date of 50% maturity.	Number of bolls.	Weight of one boll, g.	Date of 50% maturity.	Number of bolls.	Weight of one boll, g.
108-F							
+38	+5	24.IX	12	6.5	4.IX	13.0	6.0
+5	+38	21.IX	9	6.0	5.IX	13	5.8
+38	+38	Not matured.	4	7.1	4.X	5	6.7
+24	+24	1.X	6	7.0	27.X	8	6.6
+5	+5	-	-	-	24.IX	6	6.3
Acala-4-42							
+38	+5	30.IX	8.0	6.7	11.X	10	6.1
+5	+38	20.IX	7.0	6.1	11.X	12	5.7
+38	+38	Not matured	3.0	7.0	Not matured	6	6.8
+24	+24	10.X	4.0	7.0	4.X	7	7.0
+5	+5	-	-	-	Not matured	6	6.8

Cotton plants more rapidly matured with a lot of cotton bolls at a day temperature of 38°C and 5°C at night. In the cultivation of cotton plants at constant (38°C), the cotton bolls did not open or opened very late. Here, the more interesting thing was that the more early-ripening plants have appeared within hybrid forms than in parental forms, and based on the practices of breeders, these plants have maintained their precocity in the progenies.

We can also read from many historical reports that more early ripening cotton varieties (King Karevskiy, 915, OD-1, 611-b, C5, 13751, S-3210, KK-1083, KK-1053, 1298, 35₁, S-6030, and others) were released in the experimental stations, located in the northern and hillside districts; on the contrary, the late ripening varieties (36M₂, 137-F, 152-F, 504-V and others) were released in the

stations, located in the more southern districts. Of course, there are exceptions: for example, varieties of 108-F and 5904-I were developed relatively in the former Soviet Union's southern districts. So, the temperature within environmental factors has an important effect during the growth and development of cotton plants and hybrids, which is necessary to promote variation in the population and selection of target biotypes.

The effect of the temperature on the structural components of cotton plants could capture scientists and cotton breeders' attention from the early period of cotton plant breeding history. G.S. Zhaytsev (1929), for example, established that the higher the temperature, the faster cotton plants grow and develop, and brought to light the definite principles in the initiation of blooming and maturity (figures 22, 23).



Figures 22, 23. *The schemes of blooming of cotton plant varieties with an unlimited type of branches (G.S. Zhaytsev) and the blooming of cotton plant varieties with a limited type of branches (N.G. Simongulyan).*

Herein, when buds on the first places of low fruiting branches have not shaded, first of all will open the flower, located on the first place of the first fruiting branch; then in 2-4 days, the first flower on the second branch; and further in the same term, the first flower on the third branch. In the 5-7 days after the beginning of blooming, there will be two flowers per day; one on the second and the fourth branch. In the future, the flowering progresses to the top and the sides, occupying more and more fruiting branches (figure 22). This blooming principle is observed in cotton varieties with an infinite number of branching types at a single plant stand.

In the cotton varieties with limited types of branches, other principles exist. In consequence of the absence of fruiting branches in them, they often bloom 3-5 flowers at once, located on several fruiting branches (figure 23). As a result, precocity is significantly higher in plants with very compressed types of branches than in plants with broad plant structures. At this, the cracking of cotton bolls occurs in a similar way to blooming.

Many scientists and cotton breeders have been inspired by the above mentioned principles to decompose (or split) varieties and hybrid populations into various structural biotypes based on environmental factors. In particular, researchers: S.S. Sadikov, (1956); L.G. Aritunova, (1956); Mustafaev S.A., (1956); Bereznayakovskaya A.B., (1960); Valiev I.M. and Abdullaev G.N., (1961); Kratirov O.V., (1964); and others have used lowered temperature to identify the possibility of the temperature factor of natural background in the differentiation of the variety populations of middle staple cotton to the definite, including early ripening biotypes, fitted to practical plant breeding.

In 1993, M. Ashurov successfully completed his dissertation dedicated to the study of the influence of selection of seedlings in the condition of reduced temperature on the precocity and other breeding traits of varieties and hybrids of fine staple cotton. So, his research has differed from the above research with the use of varieties and hybrids of fine staple cotton and controlled laboratory conditions to justify the effect of temperature on the differentiation of seed germination at the time of seedling formation. In 1986-1989, the experiments were carried out at the Uzbek SRI of Cotton Breeding and Seed Production (Uz.SRICBSP), named after G.S. Zhaytsev. The elite seeds of variety populations of fine staple cotton; Ashkhabad-25 (Ash-25), S-6037, Karshinskiy-6 (Karshi-6) and hybrids F1-F3 resulting from crossing combinations: Ashkhabad-25 x S-6037; Ashkhabad-25 x Karshi-6 were the primary research subjects. Following that, a group of plant biotypes isolated from seed fractions of initial variety and hybrid populations in a lowered temperature medium background are studied.

The research, depending on the task, was conducted in laboratory and field conditions.

Laboratory experiments on the germination of seeds were carried out with the use of china dishes to grow seeds, river sand, thermostats, and refrigerator facilities. The germination of seeds from the initial variety populations was estimated on the four entries (variants) using the following adjusting conditional of medium factors:

1. In the refrigerator chamber with a temperature of $+9 \pm 1.0^{\circ}\text{C}$ and the sand moisture of 40 (a), 60 (b), and 60% (c) out of full water holding capacity.

2. In the refrigerator chamber with a temperature of $+12 \pm 1.0^{\circ}\text{C}$ and in the above-mentioned sand moisture.

3. In the thermostat, the seeds have germinated at the temperature of $+20^{\circ}\text{C}$ (activation of germination) for the periods of 12 (a), 15 (b) and 19 (c) hours at the above mentioned three levels of sand moisture.

4. In the thermostat, at the temperature of +25°C for the periods of 12 (a) and 15 (b) hours at the three levels of sand moisture.

The number of seeds in every entry of the experiment consisted of 200 seeds. The experiment was laid out in three replications. Monitoring of seed germination was carried out every day. Seedlings with a diameter of 2.0-5.0 mm are isolated. Dates of isolation were remarked along with all entries.

Field experiments. The seeds of the initial variety and hybrid populations were germinated on the entry of 3 (a). The seedlings had been isolated and replanted in the paper pots with soil. On the dates of isolation, they were united into different fractions. At the time of mass seedling emergence, the remaining seeds were sown in the thermostat (as a control) and grown at +25 °C, and seedlings were planted in similar paper pots as experimental entries. Then, the pots with the fractions of isolated seedlings of seeds and control seedlings were sown in the soil with 30 plants per row in the 3 replications. recorded the dates of vegetation phases of 50% blooming and ripening; height of first fruiting branch setting; rates of boll opening; number of fruiting branches and cotton bolls correspondingly with accepted methods in the Uz.SRICBSP.

The yield of raw cotton is taken into account on October 1st and November 1st, as well as the total yield with the calculation per plant. Picking out of 5 boll samples out of every registered plant has been conducted prior to harvest of yield. They defined the following: weight of one boll, length and output of fiber, fiber index, and weight of 1000 seeds. Mathematical reprocessing of the experiment data was carried out according to the methods of B.A. Dospekhov (1979).

The physico-mechanical properties of the fiber of studied plants out of different fractions of regionized variety populations Ash-25, S-6037, and Karshi-6 were determined on the instrument of LPS-4 in the technological laboratory of the Uz.SRICBSP.

Results of research. **1. The research on revealing the parameters of medium conditions for optimal differentiation of the seeds of initial variety populations** showed that entries 1 and 2 did not give positive results because of considerable rotting of seeds, the appearance of mold, and damage to the rootlets of seedlings. The normally germinated seedlings were taken in limited numbers. The more sufficient results occurred in the 3 (a) entry of the experiment, where was used the preliminary activation of germination (at the temperature of +20 °C for the period of 12 hours). The percentage of healthy seedlings was 65% on average (table 42).

At the preliminary activation of seed germination for the period of 19 hours, it was observed a very high rate of seed germination of ultra-early ripening variety population Karshi-6, while in the middle ripening variety (S-6037) and the late ripening variety (Ash-25) populations, it was observed a slowing down of seed germination and a reduction of the total number of seedlings.

The entry of 4, for germination of the seeds, was of no use because of the very intensive rate of germination for all seeds of the initial variety populations.

Herein, the period of seed germination was short and the differentiation of seedlings was unsatisfactory.

So, the most optimal medium condition for seed differentiation on the speed of their germination was at the entry of 3 (a) at the moisture level of 50%. Here, the period of seed germination was more prolonged (from 8 to 10 days) and the number of seedlings taken was maximal (170-196).

Table 42. Rate of seed germination in the entry of 3 (a).

№.	Varieties.	Moisture of sand, %.	Days of isolation.																Total number of germinated seeds, units.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1.	Ash-25	60	0	0	0	0	1	2	6	9	18	57	45	15	7	3	2	1	165
		50	0	0	0	0	1	13	30	40	28	19	15	10	9	7	4	-	176
		40	0	0	0	1	8	24	42	47	30	12	5	2	3	2	1	-	178
2.	S-6037	60	0	0	1	2	8	10	15	23	56	24	9	4	2	1	-	-	154
		50	0	0	0	4	19	30	40	35	17	9	8	6	2	-	-	-	170
		40	0	0	0	2	10	25	45	22	20	11	6	2	1	-	-	-	146
3.	Karshi-6	60	0	1	22	44	47	29	23	11	7	4	1	-	-	-	-	-	189
		50	0	10	63	50	33	18	12	8	3	-	-	-	-	-	-	-	196
		40	0	5	101	52	25	9	4	2	1	-	-	-	-	-	-	-	198

The availability of variety specifications in the differentiation of seedlings was shown by the research, depending on the vegetation period of initial variety populations. The more prolonged and exact differentiation in the seed germination was identified in the late and middle ripening variety populations and was weakly expressed in the early ripening variety population.

Furthermore, they figured out the possibility of decomposition and selection of germinating seeds of a variety population to rapidly germinate and later germinate fractions of seed seedlings.

2. Influence of one-time selection of seed seedlings of a variety population in the condition of lowered temperature on early maturity and other breeding traits. A study of plants isolated in lowered temperature conditions revealed that fractions of early and late germinated seedlings showed significant variability in precocity. Precocity increases in the plants of the 1st fraction of Ash-25 and S-6037 in comparison with control made of correspondingly 2, 1 day. This resulted in a slight increase in the level of first and second raw cotton yield harvests, which averaged 3.4 and 3.3 plant, respectively.

3. The effect of two-time selection on the precocity and other breeding traits of seedlings from initial variety populations. Repeated (two-time) selection of early and late germinating seedlings of seeds in the background of lowered temperatures has revealed the same result on the development of plants as one-time selection. The difference is that the plants of the 1st fraction of the early ripening variety population of Karshi-6 also demonstrated a definite shift in the precocity (table 43). So, differentiation of seeds in the condition of lowered temperature, discovered in the first year of selection of seedlings, is retained in the plants of experimental fractions. This is due to the presence of variation in their precocity in comparison to control witnesses.

Table 43. Influence of two-time selection of seedlings on the precocity and other breeding traits (M. Ashurov, 1987).

Variety populations	Precocity, +/- in days.	Raw cotton yield, gram per plant.				Height of fruiting branch setting, hs.	Rate of boll ripening, unit per decade.	Fiber output, %.
		1 st harvest	Difference from control	2 nd harvest	Difference from control			
Ash-25 (c)	-	11.6	-	9.1	-	5.6+0.1	0.8+0.2	33.4+0.5
1 fraction	-3*	12.3	+0.7	10.7	+1.6	5.0+0.2*	0.8+0.2	34.5+0.6
3 fraction	+4*	8.4	-3.2	8.9	-0.2	5.5+0.1	0.7+0.1	34.1+0.8
S-6037 (c)	-	16.6	-	6.7	-	5.5+0.1	1.0+0.2	31.6+0.2
1 fraction	-2	17.6	+0.7	8.5	+1.8*	5.0+0.1*	0.8+0.2	32.0+0.5
3 fraction	+3*	13.2	-6.3*	7.7	+1.0	5.8+0.3	0.4+0.1	30.8+0.3
Karshi-6 (c)	-	21.6	-	11.9	-	4.2+0.5	1.7+0.4	30.6+0.1
1 fraction	-3*	26.8	+5.2*	11.4	-0.5	3.4+0.2	2.4+0.4	30.3+0.4
3 fraction	-1	24.1	+2.7	10.7	-1.2	4.0+0.3	2.3+0.6	31.3+0.5

*-the difference is considerable at the 5% of level value.

4. Study of selected fraction progenies and control in comparing sowings.

The observed decomposition of the variety populations of fine staple cotton to the early and late ripening biotypes in the background of lowered temperatures can be of an interest in practical plant breeding if the observed variation in their vegetation period bears heritable character.

The comparing sowings were laid out with the goal of studying the nature of observed shifts in the vegetation periods of plants of experimental fractions (their progenies after one- and two-times isolation of seedlings). So, the precocity of plants is not only retained in the compared sowings but, to some extent, it has strengthened. At this point, in the variety population of Ash-25, it has been made of 8 days, in the variety population of S-6037, 5 days. It appeared even in the variety population of Karshi-6, which consisted of 3 days. These precocities were accompanied by the lowering of the level of the first fruiting branch setting (hs) and the strengthening of the rate of boll opening. These modifications ensured a more revived maturing and outperformed the yield of raw cotton in the first harvest by 1.1-3.0 g plant compared to the control.

It must be especially noted that the fiber quality in the early ripening plant biotypes taken from variety populations of Ash-25 and S-6037 was not worsened.

The breeders have watched the most reduction of vegetation period in the plant families bred out of individual selections within progenies of the 1st fraction of the variety population of Ashkhabad-25. Here, plant ripening took place 6–12 days earlier than control. The precocity in the families has resulted from the control entry selections of 2-4 days (table 44). A similar phenomenon was observed within selections conducted in the variety population of S-6037. Its selections from the control entry lead to only 1-3 days of earliness, and the selections from the first fraction have promoted the reduction of the precocity up to 4-7 days.

Table 44. Economic-valuable traits of early ripening families in the comparison with initial variety populations (M. Ashurov, 1989).

Varieties and families	Precocity than control, in days.	Productivity per one plant, g.				Weight of boll, g.	Fiber output, %.	Length of fiber, mm.	Weight of 1000 seeds, g.
		Before frost.	Difference from control.	Total	Difference from control.				
Ash-25 (c)	-	33.1	-	40.4	-	2.8+-0.2	33.2+-0.5	39.2+-0.4	107.4+-0.6
Family-21	-6*	43.6	+10.5*	46.3	+5.9*	3.2+-0.4	34+-0.4	39.9+-0.4	106.4+-0.5
Family-22	-12*	41.1	+8.0*	45.3	+4.9	3.0+-0.2	36.5+-0.4	37.6+-0.5	104.3+-0.3*
Family-24	-10*	31.9	-1.2	33.2	-7.1*	2.8+-0.3	32.1+-0.2	37.9+-0.2	107.5+-0.4
S-6037 (c)	-	20.1	-	27.4	-	3.3+-0.3	33.4+-0.2	40.2+-0.3	122.4+-0.5
Family-17	-4*	24.3	+3.5*	26.3	-1.1	3.6+-0.3	33.0+-0.4	40.6+-0.3	120.0+-0.6
Family-18	-7*	27.5	+6.7*	29.4	+2.0	3.2+-0.2	35.0+-0.5	39.8+-0.5	112.4+-0.4*
Family-19	-4*	23.9	+3.1	32.4	+5.0*	3.4+-0.2	32.6+-0.3	40.2+-0.2	124.0+-0.4

*-difference is considerable at the 5% level of value.

Early ripening has increased the 1st harvests of raw cotton in the formed families by 2–5.9 g/plants. As a rule, the worsening of the other traits does not happen, by the exclusion of the family of 24, where fiber output has been decreased by 1.1% in comparison to the initial variety population of Ash-25.

So, additional conducted selections on the precocity in the plants of the 1st fraction strengthen this trait without considerably worsening the rest of the breeding traits.

5. Influence of seed differentiation in the hybrid populations and seedling selection in the background of lowered temperatures on precocity and other plant breeding traits. Beginning with F₂, seed differentiation to early ripening biotypes was observed in hybrid combinations where the components of the crossings were late ripening variety (Ash-25) and middle ripening variety (S-6037). Insignificant seed differentiation was observed only in the hybrid plants of F₃, where late ripening (Ash-25) and ultra-early ripening (Karshi-6) varieties were served as the parental varieties.

In the years, since acquiring independence by our republic (since 1991), the provision of water for irrigation has gradually become one of the most acute challenges in the growing of agricultural crops. This situation was predominating in many cotton regions of our republic because of enlarged areas planted under cotton plants (34% of total irrigation land of 4.3 million hectares in Uzbekistan in 2002 and their remote disposition from major water-forming sources. Unfortunately, our internal water supply rivers take their basic water from neighboring countries, and a part of the water accumulating from internal republican resources (11.53 km³) was able to satisfy only 20% of total annual requirements for irrigation water in agriculture. The rest of the necessary water for irrigation of agricultural crops and cotton must be covered on account of tributaries of the rivers which are forming in the neighboring states. In the light of the government's initiatives and scientists' inferences, many cotton breeding programs have begun to embrace research to improve the resistance or tolerance of new cotton varieties to water scarcity at the time of cotton growing. In particular, under the guidance of cotton breeder M. Ashurov (2013) had also been conducted field experiments (2000-2010) dedicated to the study of multiyear selections of the more resistant plant biotypes out of variety populations in the relatively lower watering backgrounds and its effect on the improving the drought resistance of new cotton varieties.

The field experiments have been conducted at the SRICBSP and The Tashkent State Agrarian University (the TSAU) with the elite seeds of the varieties

Bukhara-6, S-7510, Armugan, Akkurgan-2, Omad, S-6524, Namangan-77 and Okdarya-6. These seeds were divided into 3 parts and sown continuously for three years by planting them solely in different plots to provide definite soil moisture conditions (65-65-60%; 65-70-60% and 70-75-70% of full water holding capacity) at the times of budding, blooming and maturity. The growing condition with a watering rate of 70-75-70% was a control (optimal condition) entry. Sowing and field observations were conducted in the nurseries with three replications. Plant stand in the recording row was ensured by identifying the seed planting scheme of 90x15x2. The number of waterings for the period of vegetation was equal to 5-8 correspondingly to retain the above planned 3 soil moisture conditions.

Field monitoring of plants growing in the three different watering conditions (backgrounds) was focused on the plants which were able to form the highest number of fruiting elements and their maintenance. At the same time, the reaction of the plants to optimal and lowered water insurances in regard to their precocity, maturity, and productivity was studied (table 45) and the best plants on these indexes were remarked to individual selections.

Plants of the varieties on the retaining of the boll number on every plant have established a wide range of variation. Analysis of the relation between the number of plants and the number of bolls revealed considerable variation in the varieties of Omad, Bukhara-6, and Ak-darya-6. On the variety of Omad, 31 plants per 100 could retain an average of 6-7 normally developed bolls at the end of August in the lowered condition of watering. Plants of Bukhara-6 have retained 4-5 bolls in 24 per 100 plants. The third variety Ak-darya-6, as a variety of Omad could retain 6-7 bolls in 24 out of 100 plants.

The data of field observation is annually compared with data taken from control entries. For the next two years, the best plants in the watering backgrounds were selected from their progenies and compared to plants from control backgrounds. Aside from that, hybridization between the best plants of the varieties has been done since the first year of experiments to strengthen and firm the best traits of the plants in their progenies. All plants that did not manifest their parent plants' better indexes on the selected traits were annually rejected and excluded from further study.

Table 45. Variation of boll number in the plants of cotton varieties grown under lowered watering condition (an average for 2000-2002, data of M. Ashurov and others, 2013).

№	Varieties	Groups on the boll number per 100 plants.								X+ ~~Sx~~	S
		0-1	1.1-2.0	2.1-3.0	3.1-4.5	4.6-5.0	5.1-6.1	6.2-7.4	7.5-8.5		
1	Bukhara-6	9	11	13	18	24	17	6	2	4.9+1.5	2.5
2	S-7510	14	16	19	15	13	10	10	3	4.2+0.9	1.4
3	Armugan	10	12	18	18	17	13	9	3	1.8+1.0	1.9
4	Ak-kurgan-2	8	12	18	21	17	13	13	1	4.4+1.6	2.9
5	Omad	2	5	8	10	16	17	31	11	6.1+0.7	1.3
6	S-6524	3	11	18	18	20	18	10	2	4.1+0.2	0.3
7	Namangan-77	4	11	17	31	17	10	7	3	4.3+0.7	1.2
8	Ak-darya-6	1	8	10	15	18	20	23	5	7.4+0.9	1.7

The seeds of progenies of the best plants of every cotton variety S-6524, Namangan-77 and Ak-kurgan-2 were gathered to form families T-02, T-B6 and T-

06 correspondingly. These cotton families formed in the fields of the TSAU were transferred to the Uz.SRICBSP in 2004 for study on the method of cotton competitive variety testing. The main indexes to be studied on the basis of the method of variety testing were precocity, productivity, fiber output, fiber productivity and its maturity in the naturally accepted soil conditions and watering. The results of the study of these families in the plot of competitive variety testing were presented in the table 46.

These families were tested in the competitive variety testing plot of the Uz.SRICBSP as the new cotton lines and conducted in comparison with the widely regionized cotton varieties of S-6524 and Namangan-77. On the basis of precocity, the two lines T-02 and T-B6 were at the levels of standard varieties. Only the third line T-06 has late ripening (+4 and +7) when compared to the standard varieties S-6524 and Namangan-77. However, the raw cotton productivity of these two lines was considerably lower than standards. Here, the third line, which has late ripening, has high raw cotton productivity in comparison to both standards (+6.2 and +3.7) correspondingly. This index was obviously related to its late ripening.

We know that the most important characteristics of cotton plant growth are fiber output and fiber yield. So, the developed cotton lines as a result of selections of resistant plants in the lowered watering (drought) conditions were more productive in their fiber yields. Data from these lines revealed that these three lines (excluding T-02 in comparison to Namangan-77) were superior in fiber output and fiber yield by up to +2.3% and +0.5 and +0.3 tons per hectare, respectively. So, selection of the best and most resistant plants to drought through multiple selection of some resistant plants within a variety population and forming new progenies of selected biotypes as the lines has affected the differentiation of plant generations on precocity and fiber output. The line T-06 drew the most attention for its fiber productivity, with fiber productivity exceeding +0.3 and +0.5 tons per hectare in comparison to both standard varieties when late ripening was ignored. The maturity of fibers of these lines revealed the indexes slightly higher than the first standard variety, S-6524, and around the indexes of the second standard variety, Namangan-77.

Table 46. Economically valuable traits of new family-lines of cotton plant in the variety test plot of the Uz.SRICBSP (2005).

№	Varieties and family-lines	Precocity		Productivity		Fiber output		Fiber productivity		Fiber maturity	
		Number of days	Than standard, +- days	Centner /ha	Than standard, +- cen/ha.	In %.	Than standard, +- days.	Centner /ha	Than standard, +- cen/ha.	Mic	Than standard, +- .
1	S-6524 (st)	125	-	41.0	-	34.9	-	14.3	-	4.5	-
2	T-B6	-	-	29.3	-11.7	37.2	+2.3	10.9	-3.4	4.9	+0.4
3	T-02	-	-	33.0	-8.0	35.6	+0.7	14.2	-0.1	4.7	+0.2
4	T-06	129	+4	47.2	+6.2*	37.6	2.7	19.3	+5.0*	4.6	+0.1
1	Namangan-77 (st)	122	-	43.5	-	37.5	-	16.3	-	4.7	-
2	T-B6	-	-	29.3	-14.2	37.2	-0.3	10.9	-5.4	4.9	+0.2
3	T-02	-	-	33.0	-10.5	35.6	-1.9	14.2	-2.1	4.7	-
4	T-06	129	+7	47.2	+3.7*	37.6	+1.1	19.3	+3.0*	4.6	-0.1

The combined view of table data on early ripening (precocity), productivity, fiber output, and finally, fiber yield of bred lines inspired the breeder to re-combine

genetic abilities of the varieties Bukhara-6 and Omad to produce a greater number of bolls (see table of...) in the condition of reduced watering into the genomes of lines T-B6 and T-02. They may eventually be able to increase their productivity and fiber yield, which were significantly lower in the natural state than both standard varieties. Their precocity had not any problem, but productivity, which had fallen down by -11,7 to -14.7 centner \hectare in the comparable calculations (table ..). Improvement in the productivity leading to higher fiber yield of these two lines on account of the large number of boll maintenances in the selected biotypes from the two above mentioned varieties of Bukhara-6 and Omad could be achieved by the heterosis effect through hybridization and repeated selections. In this point of view, hybridization between the best selected biotypes (family plants) of the varieties Bukhara-6, Omad, and lines T-B6, T-02 was conducted. And, a breeding process with the selection of early ripening, productive hybrid plants and the formation of families and lines has been implemented in the successive years of 2006-2008.

The trend of researches was subjected to gradually correction in the light of current problems emerging in the cotton growing of the republic. In particular, the new cotton families and lines to be not only high productive in the lowered watering (water efficiency) but to produce seeds with high germination of energy which could decide the economy of planting seeds. This has become one of the problems in our cotton growing, in which at minimum 40-60 kgs of super quality seeds had to spend per hectare than 20 kg an average in the developed, other cotton growing countries. So, much attention has also been paid to the field germination capabilities of seeds from experimental plants in the lowered, often unfavorable spring soil conditions and making the relevant selections and rejections to improve their seed germination potential and high productivity in the forming of new cotton lines. Finally, some worthy cotton lines (figure 24) were bred as a result of ongoing selections and rejections within hybrid plant generations.

The field sowing of their seeds in the spring conditions of 2009-2010 and the study of the germination, formation of normal seedlings has shown promising advances in the growing potential of bred lines in comparison to seeds of the standard variety S-6524. It is obvious that for two years of observations, the seed growing index of the standard variety S-6524 was an average of 60% or slightly more. Meanwhile, the best lines outperform it by up to 30-40%. No doubt, the selecting of the best plants within these cotton lines will reduce the excess spending of cotton seeds at the time of sowing. Moreover, positive advances in the new cotton lines with their genetically firmed resistance to drought have provided the breeders to have the new invaluable initial materials to use in the purposeful hybridization or submit some of them to variety testing destinations and their seed reproductions in the preliminary seed producing plots.

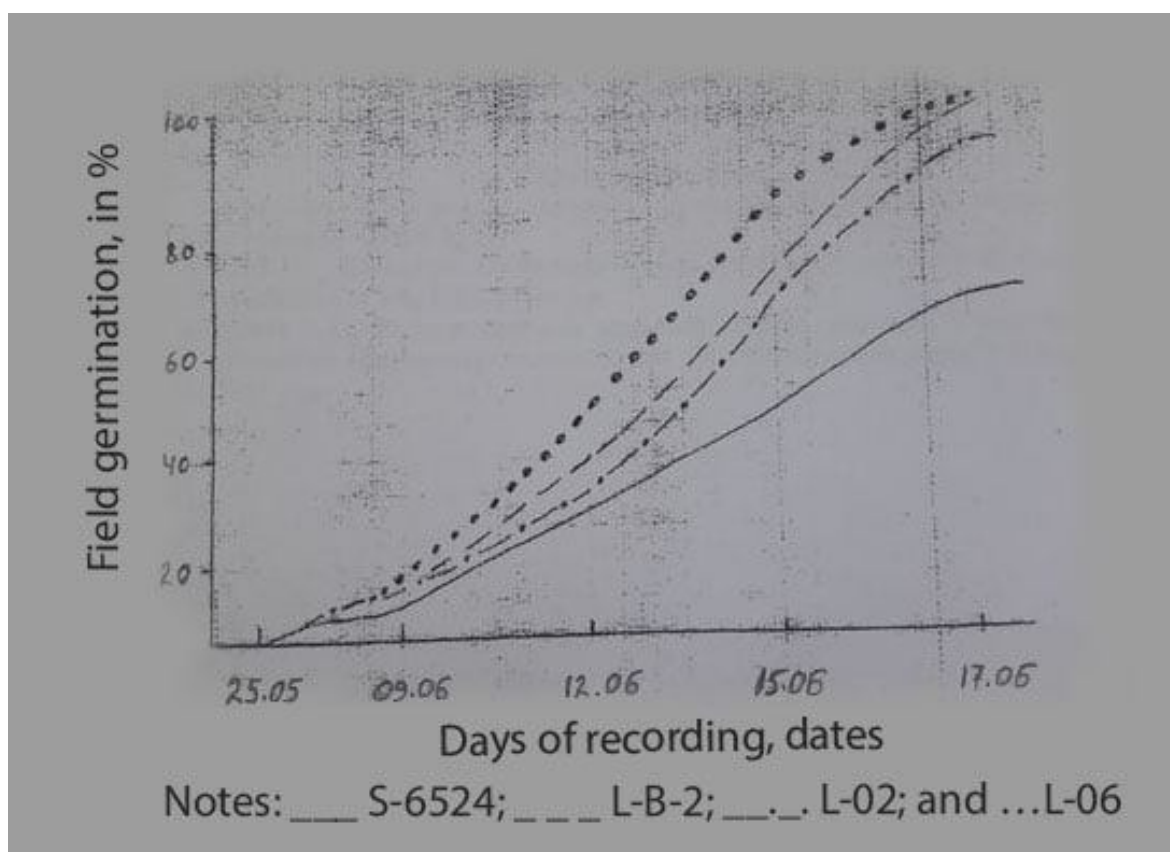


Figure 24. *Variation curved on the seed germination of the best cotton lines.*

Other unconventional breeding methods, such as developing naked seed varieties, plant breeding to develop varieties with wool type fiber, plant breeding of cotton varieties with 6-7 lobule bolls, limited or zero branching type varieties, and varieties with naturally colored fiber, have a illustrious history and results in developing cotton varieties. It must be noted that the analysis of their breeding processes reflects the overwhelming role of hybridization and selection, which can be explained similarly to traditional cotton breeding methods. The development of zero branching types and naturally colored fiber varieties left an indelible mark on the minds of the world's cotton growers, manufacturers, and breeders, and it remains one of the most important aspects of modern cotton breeding methods.

These cotton breeding directions drew the special remarkable attention of many early cotton breeders throughout the history of cotton growing, and some of them remain as multi-promising aspects of modern cotton breeding programs.

Cotton breeding with limited and zero-type branching. The 2 to 4 cotton bolls are formed as a cluster (as a group of bolls) from short (3-5 cm) fruit stems (figure ..) with one node or directly from the nodes of the main stem (zero type). B.P. Straumal (1974) wrote that A. Lyubchenko (1915) had informed the existence of some cotton varieties with cotton bolls set in the group of a "**Cluster**".

G.S. Zhaytsev (1929) has described the collection varieties of the Turkestan Cotton Breeding Station with **limited branching types**. He wrote that these plants are characterized as the less productive plants with undeveloped (limited) fruiting woods (cluster type).

V.I. Kokiev was one of the first cotton breeders who started to select cotton plants with very clenched fruiting organs to develop a cotton variety of limited branches. In 1933, he singled out varieties 150 Baraka and 1602 with limited types from the materials of the central plant breeding station. But his experiments laid out with the crossing of interspecific varieties 1602 (*G.hirsutum* L.-zero type) and 904 (*G.barbadense* L.) had been begun since 1925. His studies produced a few families with considerably improved traits compared to their initial forms.

There was information that the varieties of limited types of branching S-1184 and S-1211 had been developed by breeder S.S. Kanash in 1935-1936 through hybridization of 8517 and S-460 (unlimited branch type varieties). The economically valuable traits of these varieties are given in the table 47.

Table 47. Characteristics of cotton varieties with limited types of branching.

Varieties	Maturity (deviation from 108-F) in days.	Weight of boll, g.	Fiber output, %.	Fiber length, mm.	Planted area, ha.
S-1211	-7, -8	5.7-6.0	38-40	32.9	3400
S-8230	-5, -7	6.0-6.5	37-38	32.7	2000

Beside S.S. Kanash and V.I. Kokuev, other known breeders as A.D. Dadabaev, N.G. Simongulyan (1946), L.V. Rumshevich, B.P. Straumal (1949), A.V. Bereznayakovskaya (1959) and others have engaged with cotton variety breeding of limited branches. From national breeders Nazarali Niyazov, Makhmudov and others either were attracted in this direction of plant breeding.

In 1951, L.V. Rumshevich release his variety 142-F with limited type of branches (photo 75). It has vegetation period shorter (-5 days) than its control (S-460).



Photo 75. Cotton variety 142-F with limited type of branching.

The weight of one boll made of 6.7 g., had a higher fiber output by 42.8%, but the fiber length was 31.2 mm. Here, as in the explanation of N.G. Simongulyan (1987), the precocity of this variety was characterized by the rate of fruit

accumulation, output of yield, and vegetation period. The rate of yield accumulation depends on the elongation of short and long turns, which is stipulated by the variety of features. The size of the yield is determined not only by the appearance of the first bud (square) or flower on the plant, but also by the intensity with which they accumulate. At this time, the schemes of flowering on the plants of the varieties with an unlimited type of fruiting branches described by G.S. Zhaytsev and the schemes of flowering on the plants of cotton varieties with a limited type of fruiting branches (figure 25). Surprisingly, long turn is absent in the limited types of branches and the first flower bud on any branch flowers at the same time as the second flower bud on the previous branch. It was calculated that at a definite time, 15 flowers will form on the varieties with a limited type of branch, while 11 flowers will form on the branches of the varieties with unlimited branch types. Herein, must be kept in memory that the similar character of flower formation sequence exists in the cotton varieties of fine staple cotton (*G.barnadense* L.) with zero type of branching.

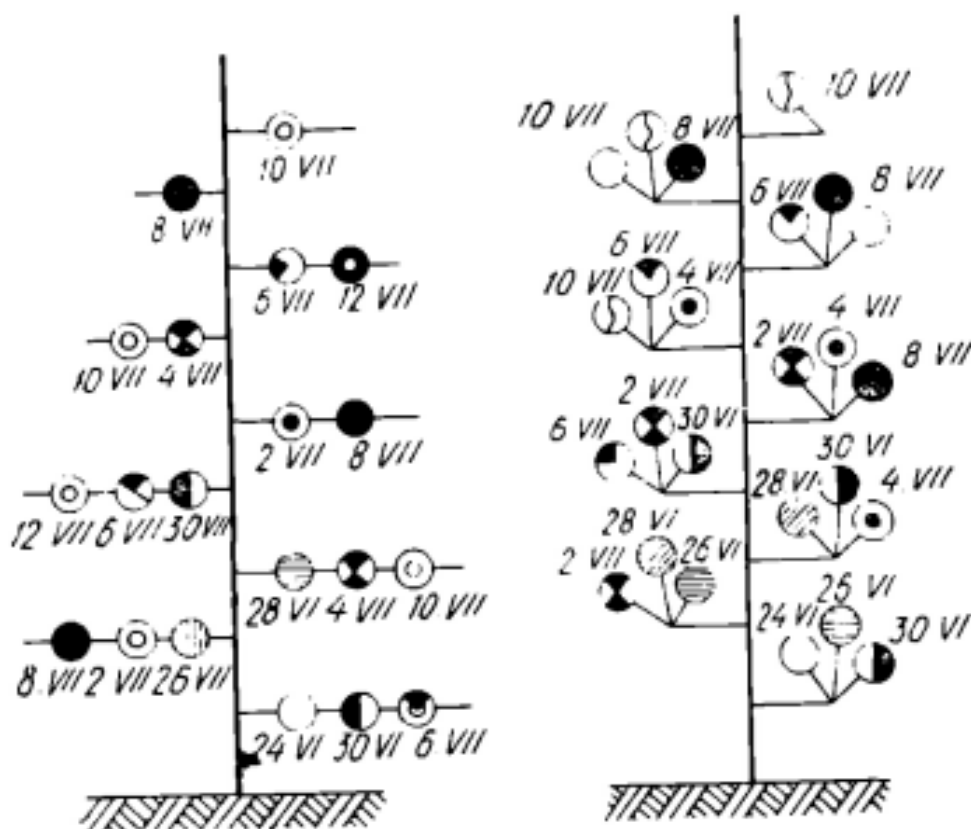


Figure 25. The scheme of cotton flowering with unlimited (left) and limited types of fruiting branches (right).

The history of cotton growing has shown that the varieties of limited branch type could not occupy a considerable area in cotton growing because of their high response to water regime. At the breakage of watering time, they shed a lot of fruiting elements. Furthermore, historically they have had insufficient wilt resistance. Especially in the comparison to the variety of Tashkent-1.

It was supposed that raw-cotton of these kinds of cotton varieties would be harvested by the machine at their best level, but actually this was not proved. So,

the machines harvested 5–10% less of the crop from limited branch type varieties in comparison to their standard varieties such as: 108-F and S-4727. In particular, the reason for this situation was cotton bolls, which are located on the plant with a short pedicel (or fruiting stem) and are not always catchable by the picking mechanisms of harvesters.

We can inspect the later developed cotton varieties to know whether the limited branch type cotton varieties exist between registered cotton varieties or not. The best and the latest information about this can be found in the book about new and prospective cotton varieties and their growing technologies published by R. Nazarov and others (2013). In which full characteristics of 30 registered middle staple cotton varieties and 3 fine staple cotton varieties to be planted in the republic are provided. Their analysis of the difference between branching types has shown that only one (Sultan, registered in 2011) has 1 subtype of unlimited branching type (photo 76) and the rest of the 29 varieties are characterized by 1-2 subtypes of unlimited branching types. All three fine staple cotton varieties: Termez-31 (registered in 1998), Surkhan-9 (in 2004) and Surkhan-14 (2009), without exception, belong to the zero type of branching.

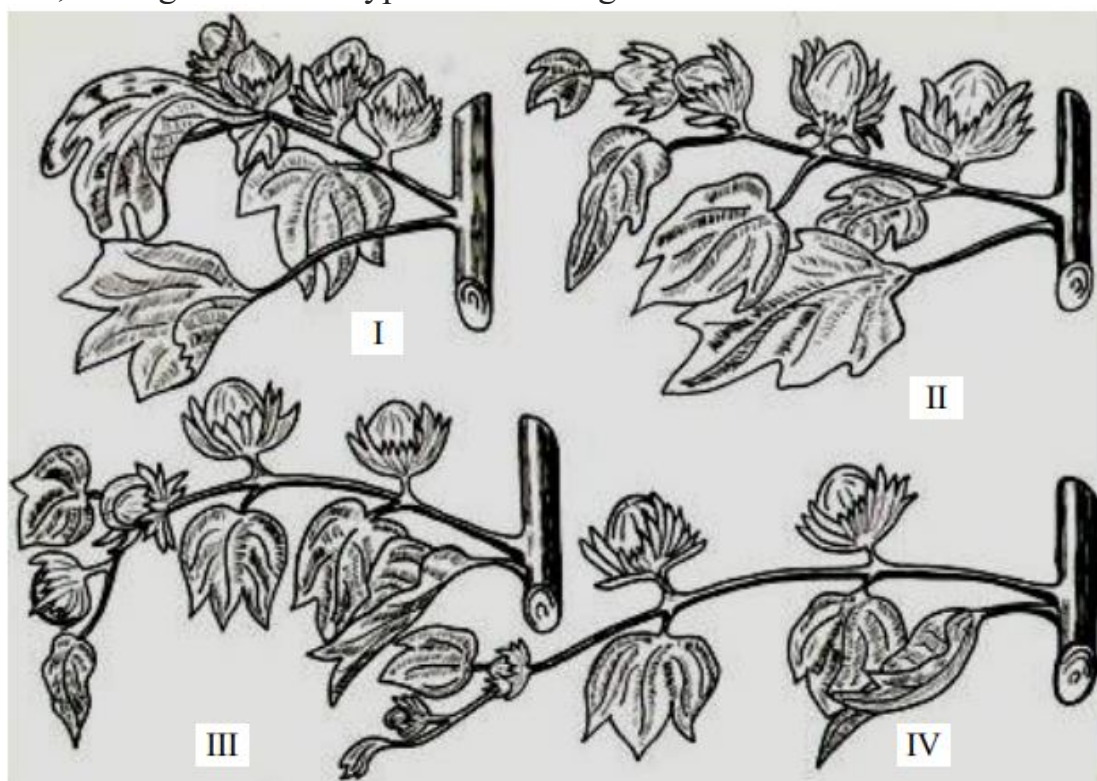


Photo 76. Example views of subtypes of unlimited branch type.

The most beneficial state was for cotton breeders who worked in the field of fine staple cotton breeding, which has enabled them to release highly productive varieties with **zero types of branching**. The first Uzbek zero-type branching variety was 2525. It was bred by the breeder A.I. Avtonomov and registered in 1950. It was described that A.I. Avtonomov had selected plants on the plantation of hybrids crossed between 2I3 and 35₈ subjected to the lowered temperature under

natural snow in 1937-1938, which may have deserved the initiation of this variety 2525 with zero type of branching.

This is the second case of lowered temperature when it has served (in the first it was used for the differentiation of variety populations in various genotypes on the sprouting speed) as a mutant factor. The generation of mutant zero-type branching plants has kept the absence of sympodial (fruiting) branches. This meant that the variation was hereditary. According to N.G. Simongulyan (1987), the zero type correlates with higher plant precocity in terms of lower first fruiting branch setting, earlier flower bud formation, and accelerated rates of flower bud accumulation and boll bursting out. Not a big area of leaf surface and suppressed construction of the bush define the adaptability of such forms to the conditions of dense plantings. Due to positive qualities such as high productivity and precocity, varieties of zero type for a short time have occupied overwhelming areas planted to fine staple cotton in the republic.

The cotton breeders of our republic developed varieties with zero type branching: S-6015 (registered in 1960), S-6029 (registered in 1967), T-7 (registered in 1968), S-6030 (registered in 1971), S-6037 (registered in 1977), Termez-31 (registered in 1993), Surkhan-9 (registered in 2004) and Surkhan-14 (registered in 2009). They were the major fine-stuff cotton (*G. barbadense* L.) varieties in our historical cotton growing, and the last ones are still being grown successfully by our cotton farmers, primarily in the fields of the republic's southern regions (table 48).

Table 48. Characteristics of the last fine staple cotton varieties.

Varieties	Origin	Authors	Precocity, +- than standard.	Weight of one boll, g.	Fiber output, %.	Fiber length, inch.	Cod	Micronair
Termez-31	6608 x Termez-11	A.A.Tvorogova and others.	-3 (T-16)	3.2	32.5- 34.3	1.29-1.31	38-40	4.3-4.5
Surkhan-9	MI-101 x 07630	V.Avtonomov and others.	121-124	3.4-3.6	37.0- 39.1	1.39-1.42	41-44	3.8-4.2
Surkhan-14	Ashkhabad- 53 x Karshi-6	M.I.Iksanov and others.	122-124	3.6-4.0	37.6	1.30	40-42	3.6

Colored cotton. B.P. Straumal (1974), on the basis of some foreign scientists wrote that farmers in some eastern countries like India, Burma and Peru are growing cotton varieties with naturally colored fiber to manufacture craft fabrics that are long-lasting and more resistant to burning than fibers with white color. According to another source (Harland S.C., 1932-1935), fiber of dark-brown known as Enans Brown occurs in Egyptian cotton plants; fiber of light-green in Texas varieties - green lint, belongs to the species *G. hirsutum* L. Also, there is a report that prior to the October Revolution (in 1917), not a big area had been planted under varieties of Asian cotton (*G. herbaceum* L.) with the name "grey-cotton," meaning brown colored fiber. The fiber and pubescence of the wild species mostly reflect red-brown color with a high content of fat substances (photo 77).

Obviously, raw-cotton and seeds with natural colored fiber or pubescence, falling out of boll on land, by the best way masks on the background of red grounded soil in the tropic belt, and the increased content of fat-wax substance has made it better retain the seeds in the unfavorable rainy periods of the year.

There was either a notification that cotton plant with green color is available very rare and only within varieties of the species of *G. hirsutum* L.

On the basis of his multiyear cotton breeding experience, B.P. Straumal (1974) wrote that the colors of the above-explained varieties get light stained in the years of great precipitation and lower temperatures in the autumn, especially in the varieties with green fiber. Apparently, precipitation and lowered temperatures were the major causes of the appearance of the cotton forms with white fiber.



Photo 77.. Cotton boll with brownish color of fiber.

So, in some of the agricultural regions, varieties of cotton with brown color have economic significance, but with the widening of artificial and natural dye-stuffs' production and movement of cotton to more northern regions, man has become selective and grows mainly the forms with white fiber.

For the first time, our cotton breeding with colored fiber was initiated by S.G. Badalov at the Central Plant breeding station in 1937. Since 1939, this direction of cotton plant breeding has been continued by B.P. Straumal.

It was supposed that through the plant breeding of cotton varieties with colored fiber to attain developing varieties with a wide specter of various fiber colors: brown, green, yellow, blue, and the fabrics made of naturally colored fiber would better keep their color under the sun than artificially colored ones.

B.P. Straumal (1974) reported that the central breeding station had 187 samples of cotton with a brown color to use as the initial material. Out of them, 106 are made of Asiatic and Indo-china cottons (*G. herbaceum* L., *G. arboreum* L.),

54 belong to the species of *G.hirsutum* L., and 27-*G.barbadense* L. And one sample 02803 from the USA (*G. hirsutum* L.) with green stain.

Most of the scientists, as a result of studying the collection samples in 1940-1942, have come to the conclusion that it makes no sense to continue research with Asiatic and Indo-Chinese cottons because of their lowered yield, high response to temperature at the time of planting, short fiber length, and lowered fiber output.

Since 1943, variety breeding with colored fiber of the species *G. barbadense* L. has been discontinued. Because of the incorporation of brown color, the fiber length was reduced by 31-32 mm, significantly lowering technological quality. From 1942-1946, breeders watched the phenomenon of lowered productivity, weak rupture power, and bad fiber output on the green fibers. With the help of various methods, with the help of which scientists have tried to increase the yield, rupture power, and output and also stabilize the color, this trend of breeding was of no use.

Nevertheless, many cotton varieties with colored fibers have been developed during the past years of our cotton breeding history. S-4001, S-4017, S-4018, S-4028 (registered in 1945), S-4030, S-4037 (registered in 1949), S-4042, S-4043, S-4047, S-4050, S-4066, S-4081, S-4086 (registered in 1955), and S-4106 were among them. All the above registered varieties were the acknowledged achievements of the breeder B.P. Straumal. S-4001 was light brown; S-4028 was brown; S-4037 was brown; S-4066 was brown; S-4086 was brown; S-4106 was brown; S-4030, S-4047, and S-4066 were dark brown; and S-4081 was yellow greenish. We can see agro-economic and fiber characteristics of registered varieties with brown colored fiber (table 49).

Table 49. Performance of Uzbek cotton varieties with naturally colored fiber.

Varieties	Precocity, than its standard, +- in days.	Weight of one boll, g.	Fiber output, %.	Length of fiber, mm.	Rupture strength, g/s.	Metric number.	Relative rupture strength, g.s\text.
S-4028	-3 (108-F)	4.3-4.5	34-35	25.9	5.8	3860	22.4
S-4037	-3 (108-F)	6.0-6.5	34-35	32.0	4.8	5040	24.2
S-4086	-5 (108-F)	6.7	32-33	32-33	4.8	5100	24.4

It is a great shame that cotton breeding of naturally colored fiber varieties has historically not been continued by our younger scientists, owing primarily to industrial developments on the creation of desirable chemical pigments.

Today, in the light of the global movement of people to consume natural products at a lower cost, naturally colored cottons have made scientists think about their importance. That is why scientists of cotton growing in the countries of developed science have made efforts to revive research for the release of cotton varieties with naturally colored fibers. For example, Russian scientists S.V. Grigorev and K.V. Illarionova (2009) have begun studying "cotton breeding in the

improvement of the quality of the colored fiber." In particular, their objects of field study were introduced as samples of middle staple cotton, taken on the basis of interspecific and complicated inter-variety hybridization. The introduced samples came from wild *Gossypium anomalum*. *Gossypium areysianum*, with rose-bronze fiber and pubescence, *Gossypium areysianum*, with rose-bronze fiber and pubescence, *Gossypium areysianum*, with rose-bronze fiber *Gossypium harknessii* Brand. - light brown, *Gossypium triphyllum* Brandg. - light brown *Armourianum* *Gossypium* Kearney is a dark brown color. *Gossypium somalense* Hutch.-greyish-brown, *Gossypium klotzschianum* Andress.-greyish-green, *Gossypium sturtianum* var. *nandawarens* (Der.) *Gossypium davidsonii* Kell.-dark grain stain (Mauer, F.M., 1954). The results of the Russian breeders were multi-promising from the point of view of cotton breeding. Eventually, they figured out some of the bred cotton lines in comparison with the standard variety Ac5 (table 50).

Table 50. Indexes of precocity and productivity of cotton samples with colored fiber (2000-2002).

Lines and Variety	Colors	Share of plants with open bolls, %.	Number of bolls per 1 plant, units.	Yield per 1 plant, g.	Yield of fiber per 1 plant, g.	Weight of one boll, g.	Fiber output, %.
Kur 10	Brown	58.0	4.0	28.6	10.9	7.3	43
Kur N	Brown	47.0	3.7	20.7	8.3	6.0	29
Sf	Brown	67.0	5.0	22.3	12.4	4.6	37
Sfgr	Green	19.0	-	7.8	1.3	5.0	18
Ac5 (standard variety)	white	86.0	4.0	22.5	-	5.5	39

Textile characteristics of fibers of the best cotton lines were evaluated in 2003-2004 by the world known system for cotton fiber quality assessment instrument of Spinlab HVI 900 and GOST Uzbekistan 629 and 619 (O'zDSt). Taken data on the textile indexes of colored and non-colored fibers presented in the following table 51.

We can compare the data on every index of colored fiber lines with standard varieties grown in the region and even with the requirements of the Uzbek standard. According to our standards, all three selected lines belong to the 6th and 7th fiber types. While the Russian standard varieties correspond to the 4–6 fiber types. Similar differences can be found in other fiber quality indices (table ..51). To improve their fiber qualities, the scientists have made individual selections within plants of line Kur 10 and they could eventually form the promising new cotton line 3305 Maron. It has a marble-rose color of fiber. The bolls also enlarged up to 6.9 g., fiber output-38.2%, mic-4.9, higher index of fiber length uniformity-83.9%, gravity rupture strength-28.4 gs./tex. and other positive properties.

Table 51. Limits of value for indexes of colored and non-colored fibers (Data from Astrakhan region of Russia, 2003-2004).

Lines, varieties.	<u>Uhml</u>	<u>Unf</u>	<u>Str</u>	<u>Elg</u>	<u>Mic</u>	<u>O'zDSt</u>
<u>Kur 10</u>	25.8-26.4	78.7-83.8	23.7-28.3	7.5-6.2	3.1-4.8	6
<u>Kur N</u>	25.7-24.6	81.0-84.5	16.8-22.5	7.8-5.5	3.1-4.3	7
<u>Sf</u>	24.8-25.7	81.3-86.5	18.7-25.3	7.8-5.9	3.4-4.8	7
<u>Ac5*</u>	26.6-29.6	81.4-82.6	22.5-23.0	6.3-6.5	2.8-3.9	5-4
<u>Mikhaylovskiy*</u>	26.1-27.6	83.7-85.0	25.0-25.3	6.5-6.0	3.2-5.1	5-6
<u>Yugteks 1*</u>	27.8	82.0	19.9	7.0	2.9	5

Footnote. *- standard varieties; Uhml-mean length of the longest fiber, mm; Unf-index of uniformity on the length, %; Str-gravity rupture strength, gs\text; Elg-elongation at the rupture, %; Mic-micronair (fineness and maturity); O'zDSt-type of fiber (Standard of Uzbekistan).

According to the internet information, our researchers were also involved in experiments on the development of natural colored cotton. In particular, the "Cotton biotechnology" laboratory of the Ministry of Agriculture's Scientific Research Institute of Cotton Breeding, Seed Production, and Agrotechnology has begun experiments on the development of varieties with light and dark brown, yellowish, light green, dark green, and other colors.

Turkmen breeders also developed cotton lines with naturally colored fibers, which have noted their early ripening (124 days), small boll weight, and fiber length of 31 mm.

This direction of research in cotton breeding has significantly advanced in the developed cotton-growing countries (photo 78). For example, Australian scientists are concerned that spinning, weaving, and dying are polluting the soil and water and are harmful to the reproduction of dangerous substances in living organisms.

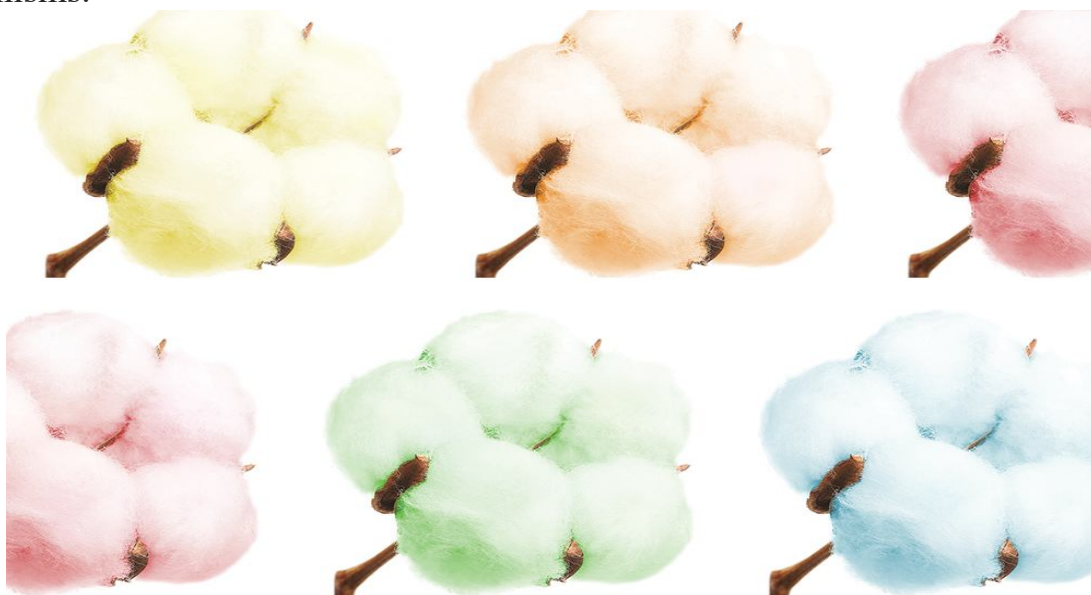


Photo 78. The color spectrum of cotton fiber in the minds of Australian breeders and genetics may look like this while on the plants.

Polluting the soil, water, and environment by reproducing dangerous substances against living organisms. In the opinion of doctor Colleen MacMillan from the Commonwealth Scientific and Industrial Research Organization (CSIRO), some cotton varieties have natural colored fibers but they are not strong enough to be used directly in industrial factories to weave into durable cloth. The scientists at

CSIRO informed us that they had learnt how to grow colored cotton right on the plant. Their genetics helped them greatly to change fiber colors and they hoped to sooner provide the fashion industry with naturally colored cotton fibers.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Breeding methods”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Untraditional methods			
2	Cold temperature			
3	Fiber color			
4	Wood forms			
5	Inter - population formation			

Chapter 7. Using biotechnological methods in cotton breeding.

Cotton breeding can be accomplished through many different techniques, ranging from phenotypic selection of plants (conventional plant breeding) with desirable characteristics for propagation, to the new methods that make use of knowledge of genetics involved in cell and chromosome, to more complicated molecular techniques. Plant genetics say that conventional plant breeding is often stipulated with hybridization and the selection of superior plants within its hybrid segregating populations. Although there have been historically significant strides in the improvement of economically important traits of cotton varieties, considerable difficulties are often encountered during conventional plant breeding. These difficulties are related to the interactions that occur between plant genotype and environment, which continue with the advent of time for line forming, testing procedures, and seed reproduction. Eventually, the whole process of cotton breeding will take 8–10 years, and the result is often unreliable and expensive. So, plant breeders are very interested in innovative technologies to speed up plant breeding processes and increase their efficiency.

In particular, since the 80s of the last century genetic scientists have started to use molecular markers in the plant breeding of agricultural crops. Its development was accepted with great enthusiasm as it was seen as a major breakthrough promising to overcome the above-mentioned problems. With the advent of DNA-based genetic markers, it has made it possible to identify some markers dispersed within the genotype of any genetic material of selected species of interest and use these markers to detect associations with traits of interest. This genetic approach has been formed into a marker-assisted selection (MAS). It involves the selection of plants carrying genetically important parts that are involved in the expression of traits of interest through molecular markers. Further development of an array of plant molecular markers and molecular genetic maps of plants and their availability has made MAS possible for all interesting traits governed by major genes and by quantitative trait loci (QTLs). The potential benefits of using markers by breeders are related to genes of interest in cotton breeding programs, eventually moving from phenotype-based selection towards genotype-based selection. Now the research in this approach is focusing on generating functional markers that can help identify genes that underlie certain traits, thus facilitating their exploitation in cotton variety improvement programs.

Moreover, the mapping of genes of interest controlling economic traits makes it easy to use simple sequence repeat (SSP) markers and quick DNA extraction techniques have begun to provide cotton breeders with a remarkable opportunity to use MAS methods in various cotton trait and property improvement research.

Today, more than 60 percent of gene-modified cotton is produced in the cotton-growing countries in the world through inserting foreign natural genes of insect toxins into biological cells. But according to the special remarks of the scientists of the Textile technologies department of Moscow Textile State University, Uzbek scientists could work out a more justified mechanism of

switching on or switching off the necessary gene of a certain cotton to modify plants. At this point, the foreign gene doesn't insert into the cotton cell structure. This technology is characterized as a universe to any gene of a living system and may find application to gene-modification of other important agricultural crops. And it is noteworthy that this technology was patented by Uzbekistan, the USA, and more than 140 countries in the world.

At this time, most of the biotechnological research is conducted in the Center of Genomics and Bioinformatics at the AS of the Republic of Uzbekistan, which has a trend of biotechnological research including: searching of genomes with desirable genes (figure 26), taking of new regenerators by the use of somatic embryo genesis and reproduction of cotton line seeds in its experimental seed production field. In particular, the aim of research is to be involved in the production of new biotechnological cotton varieties through RNA interference (RNAi) of the phytochrome B gene (PHYB) of cotton using artificial duplexes.

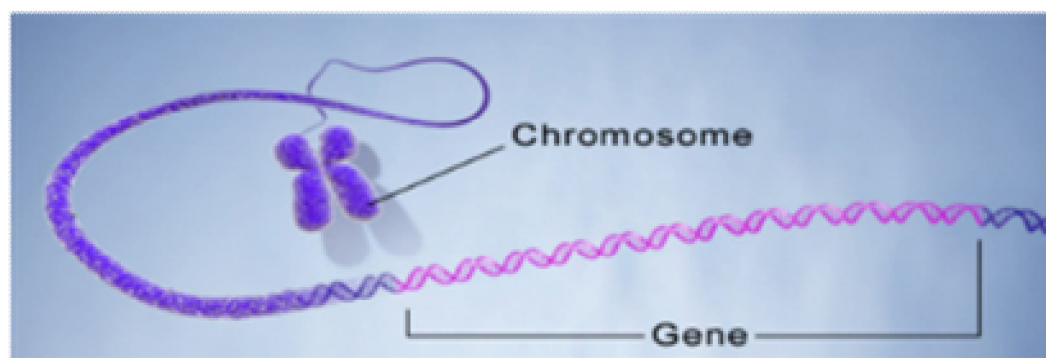


Figure 26. Schematic view of identifying interesting genes from the initial cotton genome

RNAi cotton varieties. RNAi is an advanced biotechnological method. It was used for the first time in the world by the scientists of our Center of Genomics and Bioinformatics for cotton breeding. This method involves the process of suppressing gene expression in the stages of transcription, translation, di-adding or degradation of mRNA with the help of the smallest molecule of RNA.

The first of all, this method was focused on improving the quality of our (home) varieties through the creation of early ripening and high productivity forms of cotton with genome phytochrome A1 cotton (PHA A1). The home cotton varieties (AN-Bayaut-2, Tashkent-6, S-6524, Namangan-77) of tetraploid cotton species were served as the object of research. Experimental plants have been grown in the conditions of a laboratory (in the phytotron). The technology of "Gene Knockout" consists of specially built plasmid construction, RNAi-construction of pHellsgate8: RNA1, to transform the tissue culture of cotton Cocer-312. New plant regenerants (photo 79) were crossed with home varieties. Hybrids of F₀ and F₁ –progenies were grown in the condition of phytotron, where the intensity of growth and development was controlled in detail. The plants of F₁-F₃ were early flowering, early maturity, and had a well-developed root system (photo 80).

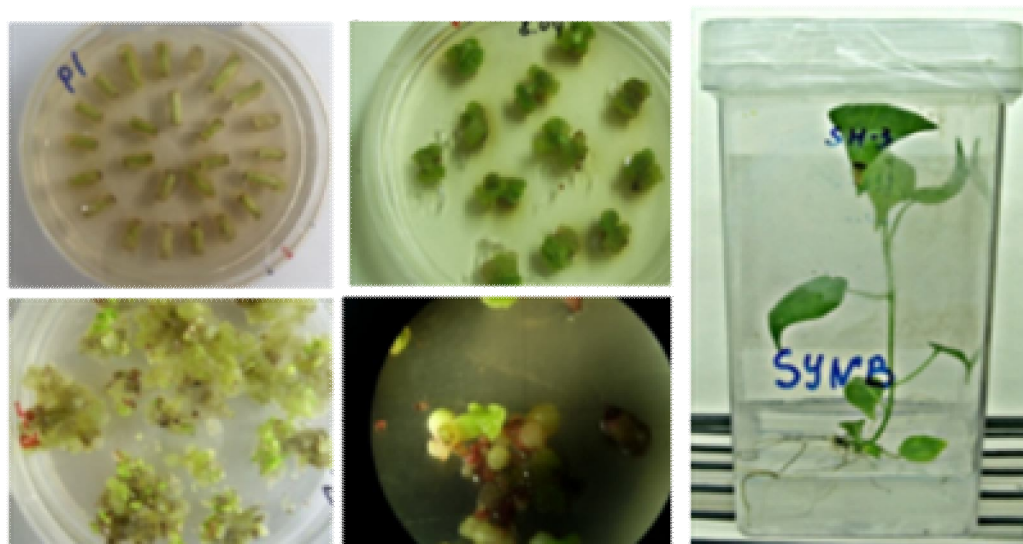


Photo 79. Stages of obtaining new regenerant embryogenesis using somatic embryogenesis

The quality indexes of fiber were high and the fiber length increased up to 2–8 mm (from conference materials, 2018). Purposeful selection and cultivation were implemented in the successive generations of the hybrid plants. Positive phenotypic results have shown that gene knockout plays a perfective role in the improvement of existing cotton varieties. This method can be applied to any commercialized cotton variety.



Photo 80. The difference in root development between the F_3 plant and the initial parent plant

Our scientists working at the Center of Genomics and Bioinformatics have continued perfection of the method of RNA interference and, on the basis of this innovative technology, they have successfully released new cotton varieties in the series of Parloq. They have fiber of fine quality and yield. Plants of these cotton varieties are resistant to all existing biotic and abiotic stresses as well as industrial demand. All of them have been patented and have seed reproduction possibilities. These cotton varieties, created on the basis of biotechnology, have been bred taking into account ecological adaptability. That is why their remarkable features are different from cotton varieties created on the basis of commonly accepted cotton breeding (on the basis of phenotypic selection). The varieties of Parloq are capable of not only tolerating but easily surviving under all expected

environmental stresses and performing their full development potential in the field conditions of Surkhandarya, Kashkadarya, Bukhara, Samarkand, Jizzakh, Syrdarya, and Tashkent regions of our republic. Besides, because of their distinguishable resistance to dramatically changing conditions, for example, worm desiccating winds in the conditions of Surkhandarya and salted land in the Syrdarya regions, they are able to form and maintain 18–20% more yield than many of the varieties developed through commonly accepted methods of cotton breeding. At the time of severely hashing weather in June and July in the Surkhandarya and Kashkadarya regions, the retained plants after seedling death in spring at the time of seeding due to applied agro-practices on time could maintain fruit elements and secure the required productivity per a certain area. At that time, the highest fiber quality of harvested raw cotton, as well as fine staple cotton, was being acknowledged by the world-famous cotton fiber consuming organizations. The rate of fruit element accumulation per every bush of cotton varieties of Parloq is made of an average of up to 30-40 units. The general characteristics of these cotton varieties given below may easily be compared with the indexes of any standard foreign cotton varieties advertised for seed export.

Parloq-1. This cotton variety was created by the scientists I.Yu. Abdurakhmanov and others through individual selection out of bred lines derived from crossing the RNAi plants of Cocker-312 with our commercial variety AN-Bayaut-2. It was registered in 2014 to seed in cotton production areas of the republic (photo 81).



Plant height	110-120 cm
Plant shape	conical
Boll weight	6,5-7,0 g
Vegetation period	110-115 day
Cotton yield	45-55.0 c / ha
Weight of 1000 seeds	140 g
Fiber length	37-38 mm
Fiber yield	34%
Type -	II type
Mic (microneir)	4.3
Str (strength, g.s./tex.)	36
Len (fiber length, inch)	1.27

Photo81. Farm valuable and textile indexes of the Parloq-1 variety

The medium pubescence of the main stem and woods distinguishes the plant bush phenotype. Leaves have a 3-5 lobed shape, a dark green color, and an average leaf thickness. The flowers have a pale-yellow color at the time of peak activity. The cotton bolls are pronounced by their enlargement, with an oval tip and five loculed. The root system is strongly extreme. The rest of the farm's valuable and textile-important indexes are presented in the advertising card of this variety.

Plants of line from other individually selected families out of hybrids are the result of the same crossings between RNAi plants and the plants of Cocker-312. It was registered to be commercially used in 2014.

The distinguishable differences of this variety in comparison with Parloq-1 can be seen in the plan shapes, which have a cylindrical form. In the economical and fiber textile indexes, the boll sizes have enlarged weights by +1.0 g., the productivity is slightly lowered by- 0.5 ton/ha, the weight of 1000 seeds is increased by +5 g., the fiber length is getting more similar (38-40 mm) as the fiber of fine staple cotton, but the micronair index is either lowered by -1 value.

A recommendation card with a full description of this variety and the cards for the next Parloq-3 and Parloq-4 varieties are presented in the appendix 15.

Using molecular plant breeding and the interaction of traits on resistance to biotic and abiotic stresses, new biotechnological cotton varieties with extra-early flowering and early boll splitting open, as well as high fiber quality and productivity, were developed today. The main stages of this research are conducting of directed crossings (photo 82):

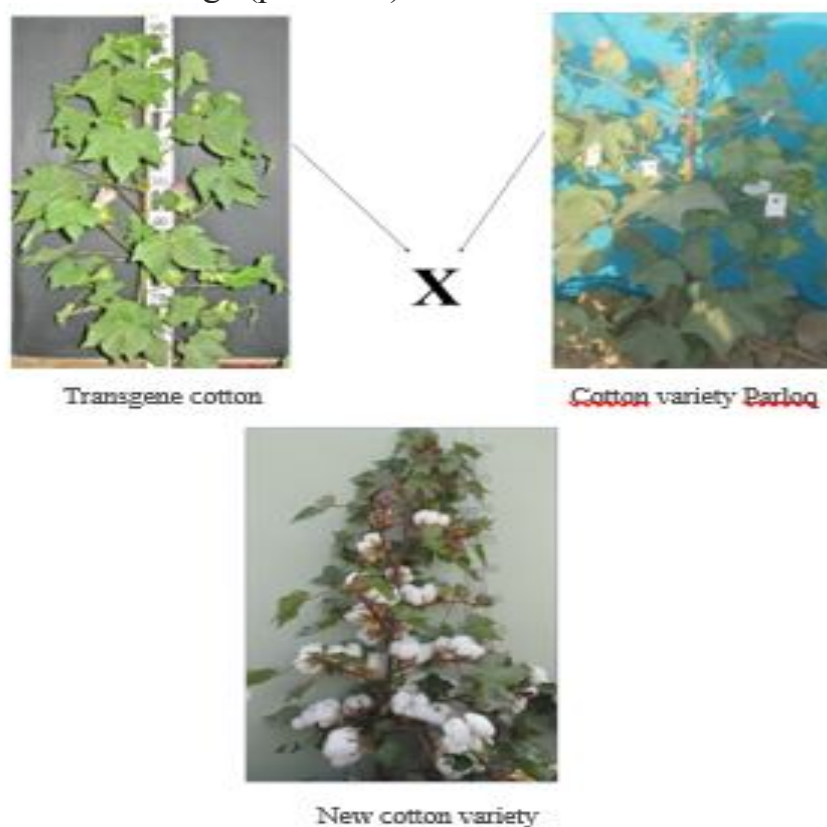


Photo 82. The scheme to develop biotechnological cotton variety.

- taking of the next generation;
- isolation of genome DNA;
- molecular – genetic analysis on the basis of PSR;
- gene typing (using a gene marker of interest);
- analyze the taken data;
- selection of genotypes to the next stage.

One female cotton bollworm can lay down an average of 500 to 3000 eggs. Its larva is able to injure 10 to 20 fruit elements for the period of its life and results in the loss of an enlarged part of the crop.

It is well known that biotechnological cotton varieties resistant to cotton worm can be created through the crossing of commercial variety Parloq with a transgene line of cotton, taken through the transformation of CryAB of the bacteria *Bacillus thuringiensis* into the cotton genome. Then these biotechnological cotton plants will produce toxic substance to caterpillars of cotton worm.

Historically (take a look at the materials of the teaching manual on the course of "General plant breeding" published by M. Ashurov, 2020), cotton bollworms caused a considerable loss to agriculture at the beginning of the 1990s. That's why governments of various countries have decided to streamline the research which would be promoted to create GM-cotton, resistant to pest. As a result, cotton varieties containing bacterial toxin emerged. This toxin gene, taken from *Bacillus thuringiensis*, is destructive to caterpillars of worms but harmless to other insects. This measure has not only helped to protect cotton from loss but has decreased pollution of the environment from insecticides, which had been applied before against this pest.

The method of transferring desirable genes from foreign organisms to grown cotton varieties can be described in this order (figure 27): Bacteria like *Bacillus Thuringiensis* produce endotoxin that destroys the guts of target insects, and it will be absolutely harmless to mammals. The gene expressing this toxin is extracted from bacteria and inserted into the plasmid of the soil bacteria *Agrobacterium tumefaciens*. Then, a piece of plant tissue of a cultural cotton variety, grown in the nutritious medium, is infected by this bacterium bearing genes responsible for producing toxins. Successively, the whole cotton plant regenerated from this tissue culture and its progenies in the fields will have hereditary toxic proteins in its organs.

Nowadays, transgenic cotton presents itself as a genetically modified organism (GMO Cotton). Plantations planted with GMO cotton have attained their top indexes—98% of total plantations in the USA. Then follow India, China, Brasilia, and Pakistan. Their share of the GM-cotton area doesn't decrease more than 90% of all fields intended for the planting of agricultural crops.

But in our country, the new biotechnological cotton varieties resistant to cotton boll worm will be developed for three years and then recommended for production in agriculture. According to the information genetic scientists published for the public's attention, the work involved in the release of new biotech cotton varieties had the following order: 1. In 2021, the resulting RNAi plant will be presented to the state Variety Testing committee and its biosafety will be evaluated. Primary seed production is organized into special seed properties. In 2022, the elite seed material of these varieties will be obtained; and 2. From 2023, selected elite seeds will be prepared for cluster farms.

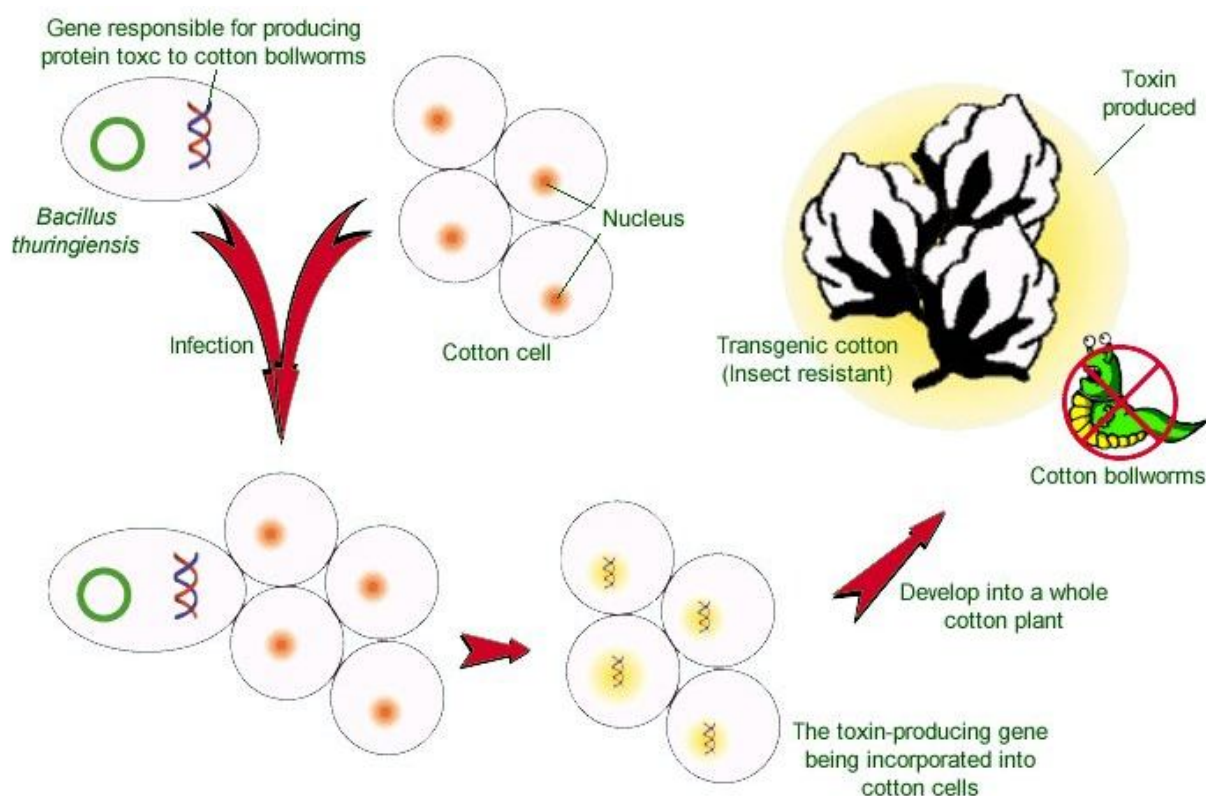


Figure 27. *Development of insect resistant transgenic cotton.*

In Uzbekistan, the laboratory of Marker Assisted Selection (MAS) was established in 2012 and during the past period has created cotton varieties (photo 83): Baraka (patented in 2016), Tafakkur (patented in 2017), Sakhovat (patented in 2017), Ravnak-1 and Ravhak-2 (patented in 2019). The number of these kinds of cotton varieties once more proves the possibility of biotechnological methods to create cotton varieties in a shorter period of time and their great efficiency. So, the MAS has also become one of the biotechnological methods to develop cotton varieties of extra-early ripening plants that have high productivity with a fine quality of fiber.

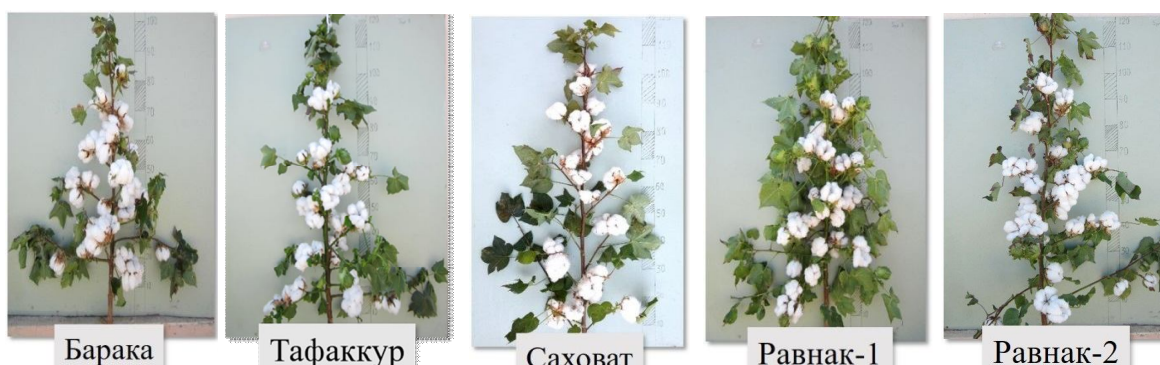


Photo83. *Cotton varieties developed through biotechnological methods.*

In one of the most recent reports by scientists from the Center of Genomics and Bioinformatics (Mukhtar M. Daminov and others, 2022), we are reminded of the MAS process used to obtain the two cotton varieties mentioned above: "one

targeted LD-blocks with its simple sequence repeat (SSP) marker(s), putatively associated with at least four different fiber quality QTLs such as fiber length, strength, micronaire, and uniformity." In order to target QTLs from a donor genotype to a cultivar of choice, they selected *G. hirsutum* donor genotypes L-141 and LN-1, possessing a fiber quality trait-associated LD-block from chromosome 716. Then they crossed the donor lines with local elite *G. hirsutum* cultivars Andijan-35 and Mekhnat as recipients. As a result, two segregating populations in the LD-block of interest containing QTLs were developed through backcrossing (BC) of F_1 hybrids with their relative recipients (used as recurrent parents) for up to five generations. In each BC and segregating BC 1–5 F_1 populations, a transfer of LD-block QTLs was monitored using a highly polymorphic SSP marker, the BNL 1604 genotype. The homozygous cultivar genotypes with superior fiber quality and agronomic traits, bearing a targeted LD-block of interest, were individually selected from self-pollinated BC 5 F_1 (BC 5 $F_{2.5}$) population plants using the early season PCR screening analysis of the BNL 1604 marker locus and the end-of-season fiber quality parameters.

Furthermore, it was also noted that "only improved hybrids with superior fiber quality compared to the original recipient parent were used for the next cycle of breeding. So, they successfully developed two novel MAS cultivars, named Ravnak-1 and Ravnak-2, formed from the BC 5, F_5 generations. Both novel MAS cultivars possess stronger and longer fiber as well as improved fiber uniformity and micronaire compared to the original parents, Andijan-35 and Mekhnat. " There was an approval that "their efforts demonstrated a precise transfer of the same LD-block with, at least, four superior fiber QTLs in the two independent MAS breeding experiments exploiting different parental genotypes. The results exemplify the effective feasibility of MAS in cotton breeding.

Review question:

1. What is the scheme of the cotton breeding process?
2. Can you describe the various kinds of schemes being used in the cotton breeding process?
3. Is there any importance to study foreign cotton breeding practices?
4. What parts of the cotton breeding plot do you know?
5. Which of these schemes is, in your opinion, the best one?
6. Do the schemes differ in their introduction into practice?
7. Are you able to imagine the advantages and disadvantages of biotechnology?

Chapter 8. Preliminary reproduction of varieties in plant breeding institutes.

The cotton bred materials come in two kinds: individual selections and family harvests are transferred to the preliminary reproduction. By the seeds of individual selections, the seed nursery and seed reproduction nursery are completed by the seeds of family harvests.

Preliminary reproduction of the new varieties which are being studied in the competitive variety of the cotton breeding institutions is conducted with the purpose of providing the seeds of the new variety in an amount sufficient to transfer to the state variety trial and to the farms for preliminary reproduction of new varieties.

Seed and seed reproduction nurseries are laid out for the preliminary reproduction of varieties.

These nurseries are disposed at a fairly large distance from hybrid and breeding nurseries to prevent natural out-pollination.

The area of a seed nursery is not more than 0.5 hectares. The patches have one row order and the plants are developed in a single stand. Special attention is to be paid to a high and uniform agro-practice background, facilitating normal plant growth and development. Chopping of cotton plants and defoliation are not conducted because these agro-practice measurements affect the phenotype of plants and make it difficult to select the typical plants of a definite variety.

The following work is carried out in the seed nursery: field inspections, rejection of off-type plants and those infected by the wilt, late ripening, and low-productive families. If the family has more than two types of offspring, it will be fully rejected (photo 84).



Photo84. One of the studied families with two off-type plants

100 boll samples are taken and remarked as individual selections out of non-rejected families. Breeders and seed producers should attentively look through the data on every family for the past years and make their own recordings done during this vegetation period until the start of selections in the seed nursery.

Individual selections must be fixed by taking account of fiber length, fineness, strength, and output by using visual and hand methods.

The thorough selection of the most valuable material considerably reduces the capacity of laboratory work on the assessment of the quality of breeding material. Breeders of the varieties are obliged to take part at the time of selection in the plot of preliminary seed reproduction. Additional rejection on the length, output of fiber, and weight of boll on the data of sample analysis (photo 85) is being conducted in the conditions of laboratory.



Photo 85. One of the cotton fiber testing laboratories

Individual selections out of the families rejected on the laboratory analysis will also be rejected.

The seeds of individual selections collected in the seed nursery are established in the seed nursery of the next year and the seeds of total family harvests are sown in the nursery of seed reproduction where every family occupies a patch of fewer rows depending on the amount of seeds.

Field observations, discarding of infected, less productive, late ripening, and no-type families are also carried out in the nursery of seed reproduction.

The seeds of all non-rejected nurseries of seed reproduction are united. The taken seeds represent themselves as the elite of the new variety.

We should not forget those quotes about the definition of plant breeding, which refer to the selection, creation, art, and science based on the principles of sciences like genetics, botany, plant protection, biochemistry, agriculture, seed science, seed production, and field experimentation. The knowledge that these sciences will bring together in the mind of the future breeder will become the core factor for all of the breeder's future achievements. Of course, not all breeders belong to this group. Because mastering even the only needed part of knowledge from these sciences is not easy, the promised breeder had to be indeed devoted, from his or her own younger years, to acquiring at least the necessary parts of that knowledge. And the use of the accumulated knowledge in the quality of art to achieve some results later is also too difficult in the plant breeding process. The difficulty is mostly related to the biology of local cotton plants. In particular, their genetic adaptability to growing conditions.

Cotton plant varieties in our republic are developed taking into account three regional growing conditions: 1. the South, with its hotter, drier conditions and a vegetation period of up to 140 days; 2. The moderate region; and 3, the north, where it requires more early ripening varieties to meet a relatively short period of vegetation (100-120 days). The selection work orders of famous breeders in different parts of our republic show that the most efficiency of selection depends on the time of day when the breeder observes visually breeding plants to select the best ones. According to their experiences, the daytime of middle summer, from 2:00 PM to 4:00 PM, is the best time to inspect plants. At this time, the weather of summer is the most critical and has crucial destructive effects on the maintenance of plant fruiting elements. This period of two hours clearly divides the needed and no need plants in the breeding nurseries. You know at first, must suffer the plants with genetic weak in regard of their resistance to natural stresses. On the contrary, some of the biotype plants, with the positive and negative (heterozygous) complexes of the genome also survive within the plants of the nurseries. Generally, plants with negative genomes mislead breeders' attention, demonstrating themselves as the best plant biotypes on the outlook to select. But the true breeder knows that only this situation gives the best chance to select true initial plants for the future multi-promising lines and varieties.

Unfortunately, not all breeders have their tolerance to work in the cotton breeding nurseries between 2:00 PM and 4:00 PM in the summer. That is why, many of the former cotton breeders have compared the activities of our breeders in the breeding nurseries with the works of a steel founder working at the scorching oven.

Part V. Cotton variety trial.

Chapter 1. Station testing.

Variety testing is a comprehensive assessment of the new varieties against the better commercialized (zoned) varieties.

In the chapter of the scheme of cotton breeding process, it was written that bred material, transferring from station testing to competitive variety testing and preliminary reproduction, presents itself as a new variety genotype and assumes a definite number on the basis of station testing. It is registered in the general catalogue of the plant breeding institute. As a result, station variety testing is critical in determining the outcome of the entire breeding process, which culminated in the development of a new, distinct cotton line, variety - a new, deliberately uniformed complex of fixed genes controlling stabilized economic traits and properties. That is why such cotton genotypes have a widely acknowledged prevalence by experienced world cotton breeders as a scientific breeding treasure with the most desirable potential to begin the next cotton breeding program.

Station testing is a measurement to reveal the potential of new cotton lines and their perspectives. It is organized by the authors of the cotton lines in their breeding departments at the cotton breeding institutions of Uzbekistan (figure ..). The method of testing is usually similar to that of competitive variety testing.

Generally, two kinds of variety testing are conducted at the cotton breeding institutions: station (enlarged) and competitive (Simongulyan N.G. and others, 1974; 1987).

Extensive variety testing. Otherwise, it was called a control nursery and was often organized in the sphere of the SRIs. An enlarged set of lines and varieties (about 30–40) from the breeding institution is studied. One third of them may be presented by other breeders and neighboring breeding institutions.

The lines and varieties remarked for the testing are singled out in the breeding nurseries and rare in the hybrid nurseries no earlier than F₄. The plot from which the variety testing is taken is according to the relief level and uniformity of the soil fertility. Agro-practices should be local to the area where breeding is taking place. All agro-practices in the plot of variety testing are implemented simultaneously and at the same time.

The station variety testing is laid out in six replications, which are located in one or a few tires. Usually, a pair or standard method is applied in the variety testing of cotton plants. Every variety occupies a two-row patch with 75 seeds per row. The standard variety is sown every 3–6 patches (6–12 rows). The varieties were dislocated between two standards made of a block. The combination and succession of varieties within similar blocks located in different replications must be constant. The disposition of blocks in replications may be very different. If all replications are placed in the same tire, the blocks in each replication may be placed in the same subsequent. Typically, the replications are disposed of in two or

three tires. At this point, the disposition of the similar blocks side by side in the vertical or horizontal directions is important.

Often, the chess-like disposition of blocks and replications is used in the two-tire and four-tire experiments. Randomized disposition or randomization of blocks in the replications is deemed the most perfect method (figure 28). Such a disposition allows the normal acts of systematic alteration in soil fertility to be leveled.

I	II	III
2 3 1 5 4	4 2 5 1 3	3 4 2 1 5
IV	V	VI
3 5 1 2 4	1 2 5 3 4	4 5 1 2 3

Figure 28. A simple schematic view of the randomized disposition of blocks with five plant varieties and six replications in two tires.

The varieties included in the enlarged variety trial may be united on the basis of precocity. Sometimes, it would be taken into account of other traits. For example, the type of branching Uniting into groups is pursued with the aim of differentiation of the agro-practices in correspondence with biological features of the varieties. For example, using various watering regimes for early and mid-ripening varieties

The following records and investigations are carried out in a station variety trial:

- 1.Beginning and 50% seedling emerge, flowering, and maturation;
- 2.State of plants on June 1, July 1, and August 1. On June 1st, the plant height, number of lives on the main stem, and height of the setting of the first fruiting branch are measured on 10 plants per replication. The plant height, number of fruiting branches and the number of fruit elements (buds, flowers, fruits) on the same plants on the 1st of July (photo ..). The height of plants, number of fruiting branches, and number of cotton bolls are determined on the 1st of August;
- 3.Percentage of variety purity at the period of flowering;
- 4.Percentage of plant infection with wilt and cotton blight bacteria;
- 5.The density of plant stands;
- 6.100 boll samples are taken from the first place of 2-4 fruiting branches of the plants of all replications to define the length and output of fiber, the weight of bolls, the absolute weight of seeds, as well as the technological properties of fiber.

Calculation of crop per hectare by taking into account the first harvests, until frost, crop out of all split open bolls and total crop. The gape (empty area—in the consequence of plant sparseness) of the row area is to be taken into account in the process of calculation. It involves areas where two or more nests without plants in succession. And the gape is taken into account when the gapes are the results of accidental causes and are not biological features of the varieties (lowered field

germination). The indexes of economic valuable traits are included in the main report (or database) of the enlarged variety testing (form 19).

Form №19. Main database (report) of enlarged and competitive variety tests of cotton plant.

*- physical parameters of fiber quality are given in the text, where were used data of Kh. A. Boltaboev and A.M. Ergashev., 2019

Crop data (until frost and total crop of the raw cotton) is treated by the method of dispersion analysis with the determining of total mean error, which is pronounced in the tons, experiment precision, and the least essential difference between variants at the level of probability of 0.95 or 0.99 (LED).

The new cotton lines are reliably superior to accepted standard varieties for two years of expanded testing results are transferred to the competitive variety testing.

Chapter 2. **Competitive variety testing and criteria of the new varieties submitted to the state variety trial.**

Competitive variety testing involves a small number of the best cotton lines from cotton breeding institutions. The economic dignity of a new cotton line is finally evaluated on the data of three years taken from competitive variety testing.

Competitive variety testing is done similar to the method of the State commission on the variety trial of agricultural crops. If the new cotton line shows a considerable advantage in the comparison with the standard (commercial) variety for the period of three years in the competitive variety testing, it will be transferred to the state variety trial. Concurrently, seed reproduction begins in the elite seed production farm. Since then, the breeding process has been completed, and seed production has begun. The name of the research institution where it has been created is added prior to the number of the new variety at the registration. For example, liter "S" from the Scientific-research institute of cotton breeding, seed production, and agro-technologies; "F" – Andijan branch of the Scientific-research institute of cotton growing; Exclusion can be seen in other cotton varieties bearing names like Gulbakhor, Sultan, and Yuldiz, which more probably have been descended with the author's enthusiasm.

The "Method of State Variety Trial of Agricultural Crops," published in 1983, is still the best guidebook for most cotton researchers and breeders to conduct competitive variety testing. Competitive variety testing is carried out in 2-3 tiers on a recording plot of 50 m². The patches with four rows have six replications each. The width of rows is set depending on the accepted depth of the district that services the variety trial. The patches of testing lines must have 2 meters of protection paths on both sides of every replication. A standard variety is also allocated at the beginning of the patches of testing lines or as the last one.

With the help of a common sowing machine, great attention is paid to the seed quality, which means fiber residue on the surface of naturally fuzzy seeds must be no more than 0.8%, on the naturally delinted – 0.4%. The seeds must be exposed to chemical or mechanical delinting and calibration (grading by size) at the planting of line seeds by the precision drill. At this, residual fiber (lint) on the surface of seeds must not be more than 0.2%.

The cotton lines are divided into groups in terms of maturing – early ripening, middle ripening, and later ripening; as well as on the branching types: zero, limited and spreading. The last has the first, second, third, and fourth subtypes, with corresponding plant stand densities for these kinds of cotton plants. Low-growing, dwarf, and semi-dwarf lines lie in individual experiments. Each group is laid out with their standard. Lines in the groups are allocated according to the method of randomization (figure 29).

Agro-practices directed to obtaining full and uniform seedlings are necessary to conduct in the period from seed sowing to seedlings, systematically inspecting their state and quality.

The sides of tiers are levelled by the help of a string after the emergence of massive seedlings. A path of not less than 1 meter is left at the beginning of the experimental area. Prior to the start of harvest, the registered parts of the plot are measured and separated from the completed protection path with the width of two intervals between plants in the row.

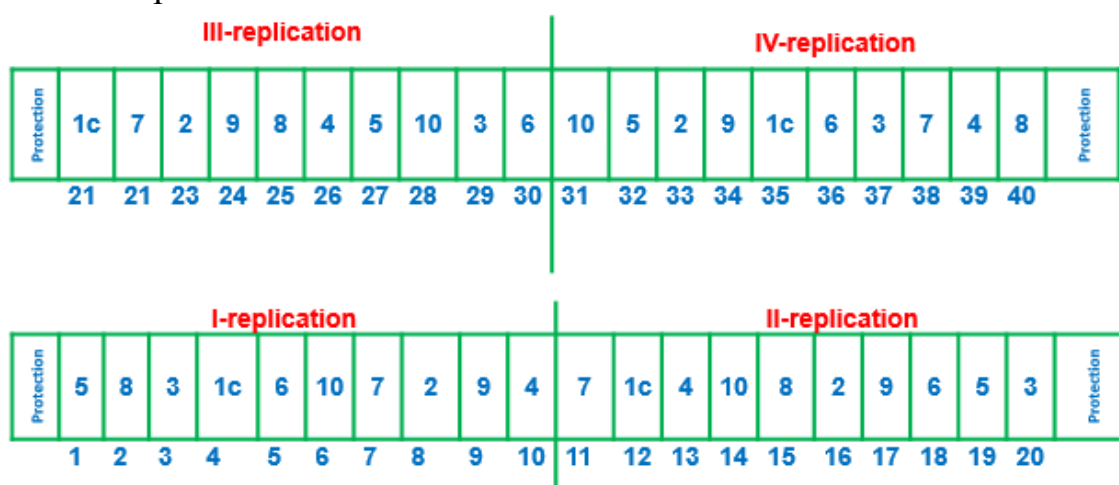


Figure 29. Schematic view of the experiment on the competitive cotton variety testing plot with an area of 50 m².

Replanting of seeds after seedlings emerge may be carried out as a result of significant stand thinness caused by hail, mad stream, gap in sowing, and other reasons unrelated to the biological characteristics of the lines. Under sowing is not carried out when the thinness of plant stand in the seedlings is connected with biological features of the lines (lowered field germination, infection with diseases and so on).

In order to secure a proper allocation of plants and a planned plant stand, verification of seedlings is conducted at the time of final plant thinning.

Cotton is chopped in fixed terms, taking into account the developing habit of each cotton line. The defoliation is permitted after the provision of seed raw-cotton and sample selections for technological analysis of fibers.

Observations and records Dates of field seedlings, massive flowering and the start of maturation are noted in **the phonological observations**.

The date of the massive seedling is registered when the rows are denoted in the whole patch. The survey is conducted daily.

Massive flowering is noted when 75% of the plants in the patch have flowers. The survey has been conducted daily since the moment a single flower appeared in the patches. It must be taken into account that the corolla of a cotton flower is withered, becomes rose-colored and less conspicuous on the next day after blooming, and in 2-3 days it dries and falls down or remains still on the top of young boll for a few of days.

The beginning of maturation is defined on the two middle rows of the patch along with all replications of the experiment. The surveying process begins when 20-30% of the cotton bolls on the plants split open. The opened boll is accepted when the fiber is seen through the cracked glumes of the cotton boll. A

survey is conducted every day. The day when even one cotton boll on 50% of the plants is open is guessed as the beginning date of maturation. Dates of maturation along the patches are summed up and calculated as an average date of cotton line.

The number of days from full germination to the beginning of maturation is characterized as the period of maturation of tested cotton lines.

Recording of plant stand is conducted after completing inter-row cultivations through counting all plants in every patch.

Resistance of lines to lodging discounts 5 days prior to the first crop harvest in all replications of the experiment in scores: 5-no lodged plant; 4-lodged up to 10% of plants; 3-lodged from 11 to 25% of plants; 2-lodged from 26 to 50%; and 1-massive lodging (lodge more than 50% of plants). The mean score of lodging on the line is calculated as the mean arithmetic with a precision of up to 0.1. The cause of lodging is pointed out.

The resistance of cotton lines to the falling of raw-cotton out of bolls is evaluated prior to second crop harvest in scores: 5-raw-cotton does not sag; 3-not more than 15% of raw-cotton falls down; 4-not more than 36% of raw-cotton falls; 2-raw-cotton falls down from 35-50% of plants; 1-massive falling of raw-cotton.

Assessment of lines' resistance to adverse environmental conditions (spring cold, rain precipitation, atmospheric drought) is conducted correspondingly to the general part of this manual.

Every harvest but frost, 100 boll probes are picked out of all replications (16-17 fully open bolls along all rows on the diagonal of the patch) of the experiment. For convenience in the counting and to prevent mistakes, the raw-cotton out of every boll is put in the cells of a special box, divided into 100 cells (photo 86, 87). The probes are dried and weighed. An average weight of raw cotton out of one boll is calculated by dividing the total weight of all probes on the line by the total number of bolls in the probes. The weight of probes is added to their corresponding raw-cotton harvests.



Photo 86, 87. Immature, matured cotton bolls and plastic box with 100 cells.

Harvest and recording of yield. At the time of all harvests, raw-cotton from protection paths is harvested 1-2 days earlier in order to prevent the mixing with raw-cotton from experiment patches.

The harvest of raw-cotton is conducted only out of perfectly opened bolls. To harvest immature raw cotton is not permitted. Raw-cotton is picked out of bolls attentively, minimizing the mixing with leaf and glume parts and other impurities.

The sacks for the harvest of raw cotton are prepared in advance. Every sack must have internal and external tags, on which are pointed out: the name of the cotton line or variety, Patch number, replication number, harvest number, and harvest date.

Raw-cotton from every patch is harvested in individual sacks, dried up to an air-dry state and weighed with an accuracy of 0.1 kg.

The first harvest of raw-cotton is carried out 10 days after that, as the date of the beginning of maturity in all replications of a definite line has been remarked. The second and subsequent harvests of the raw cotton are carried out depending upon the maturation of the cotton bolls, and one of the harvests is carried out on September 30th. The last prior frost harvest of raw-cotton crop is implemented 2-3 days after the start of frost, and the harvest after frost is raw-cotton out of split open bolls. Finally, after the frost, green bolls, but not yet open cotton bolls (photo ..). Results of weighing of raw cotton after drying are registered in the field journal.

Green bolls from every patch individually are harvested and weighed in their wet state. After that, all bolls from all replications are mixed and from these mixed weights are taken probes with a weight of 3-5 kg. Weighing accurately to 1 g, raw-cotton is cleaned out of boll glumes, dried and weighed again, and the calculated output of raw-cotton out of bolls is per every line and variety. The output of raw-cotton out of bolls per every patch is calculated on the percentage of raw-cotton output from probes.

Selection of raw-cotton samples for analysis. An average sample of raw-cotton with a weight of 20–22 kg and 2 kg is taken from the first harvest (after drying) to determine the physic-mechanic properties of the fiber.

Samples with a weight of 2 kg, at a term of 5 days after completing the first harvest on all testing lines, are sent to the technological laboratory of the institution, and samples with a weight of 20–22 kg, to the cotton provision point on the preliminary agreement with the ginning house.

The order of sending of samples from SRI to the trail of spinning quality of cotton fiber in Central SRI of cotton fabrics (take a look at the figure). Their accepting, ginning, and sending must be similar to the order to be used by the State variety testing plot. The order of these procedures is implemented according to the instruction about the accepting, ginning, and testing of raw-cotton and cotton fiber approved by the former Ministries of light industry and agriculture dated October 28, 1976.

The name of the line or variety, weight of raw-cotton, industrial grades, year of harvest, date of sending and designation of samples are pointed out on the tags attached to the sacks and put in them. The same marking is observed at the sending of the samples to the laboratory and the central SRI of cotton fabrics.

The weight of raw-cotton samples is included in the crop harvest on their lines and standard variety in the main database of form No. 19 of enlarged and competitive variety tests (presented in the text of enlarged variety testing).

Competitive variety testing fulfilled by scientists Kh.A. Boltaev and A.M. Ergashev (2019) would be the best example for supplementing with the latest accepted procedures, in particular the assessment of fiber quality of the above described process on the competitive variety test. In which 9 lines of new cotton plants were sown in the Namanghan scientific and experimental station's fields for competitive variety testing. The area of every patch of individual line is made of 50.4 m² with four replications. It has been noted that this experiment was implemented according to the "Instruction on the State variety testing of agricultural crops" published in 1986. Seed sowing has been conducted on the 90 x 10-1 scheme of planting. The following field observations were carried out at the time of vegetation: plant stand (before harvest); plant height (until August 1st); wilt infection rate (on September 15); variety purity (prior to mass flowering and maturation); 50% boll ripening; fiber quality determination; cotton productivity on September 30 and at the start of colds (1st harvest - 30.09; 2nd harvest - 10.10).

The fiber quality of cotton lines was evaluated by the system Uster HVI 900 SA; this is a semi-automatic system that measures seven physical parameters: length, strength, uniformity along the length, relative elongation, micronair, color, and contamination. All of these properties are important in determining fiber quality. It was specially remarked that this system for testing of fiber gives an opportunity of preciseness and reliability in the automatic state to give an assessment of the fiber quality of new cotton lines (figure 30).

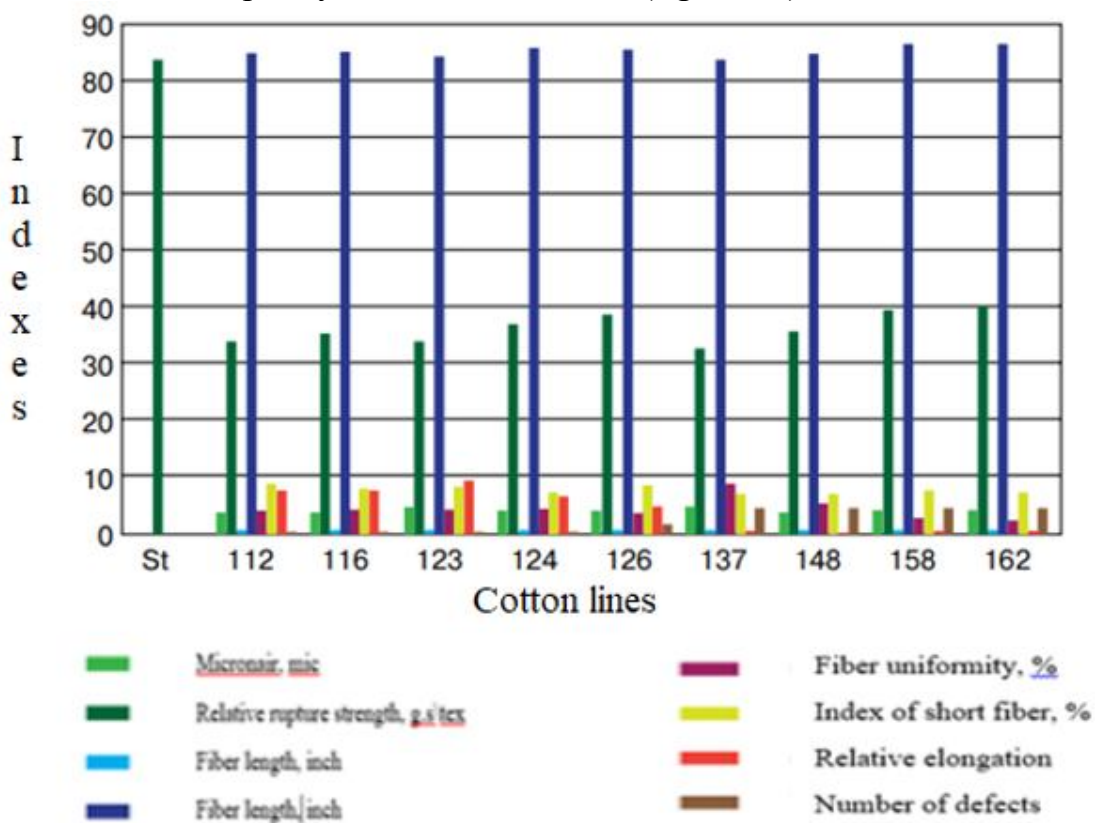


Figure 30. Technological indicators of fiber quality of new cotton lines (data of Boltaev Kh.A. and Ergashev A.M., 2019).

According to the results on the fiber quality, which were presented in the form of a diagram, the reader can easily understand the index values and even compare them with each other. The micronair of the lines 112 and 116 is made of 4.3-4.4, which is lower than the index of the used standard (Namanghan-77) -4.8. It explains that these lines have finer fibers, and that the lines 123 and 137 are higher than standard varieties by 0.4. In other lines, their mic indexes consisted of 4.5-4.6.

On the relative rupture strength all studied lines have indexes higher than standard variety (31.9 g.s.\tex): from 33.5 g.s.\tex in the line 137 to 40.9 g.s.\tex – in the line 162.

Fiber length in the all studied lines was 1.10-1.29 inches, what is longer than standard variety (1.09) by 0.01-0.20 inches. The top indexes on this index were taken in the line 158 (1.29 inch) and in the 162 (1.26 inch).

Uniformity has become one of the main fiber indexes. In the line of 137 it was equal to 83.1%, which is lower than the standard (83.9%), and in the other studied cotton lines it is higher by 1.1-3.3%. The top results on this index were obtained in lines 162 (87.2%) and 158 (87.1%).

Short fiber index (S.F.I) - normal fiber shorter than 0.5 inch, which does not occur during the spinning process and is removed in the event of withdrawals. Its amount is calculated in the percentages (relative weight), and available fiber shorter than 0.5 inches is defined as the amount of short fiber. This index is usually measured in the cotton varieties at intervals of 2 to 20%. The percentage of short fibers in tested new cotton lines ranged from 2.8 to 10.1%.

As a result of the above presented and discussed example of the latest experiments, the reader can either get information on the conclusion accepted by those scientists. It was so that the highest outcomes in the competitive testing of the new cotton lines on all technological indexes were taken in the lines of 112, 116, and 148. These lines on their fiber quality fully meet all requirements of the textile industry. And research in the scientific experimental station is continuing on the further perfection of these lines to the level of varieties and ensuring the cotton industry with varieties of the highest fiber quality.

Chapter 3. **State variety testing and commercialization of the cotton varieties.**

Final and comprehensive assessment of new varieties created by plant breeding institutions, isolating the varieties on the best complex of traits to introduce them into production, and identifying the regions to cultivate them is the object of state strain (variety) trials.

Newly developed cotton varieties in the cotton breeding institutions will be transferred to the state variety testing network to continue the testing process after they are released and have completed the testing stages. This is a testing system for the comprehensive assessment of new varieties of crops and their study with the aim of checking their fitness for certain soil-climatic conditions of cultivation.

The state variety testing network makes up the complex of state variety testing plots for the implementation of state variety testing. The state testing is conducted by the specialized organizations in the state variety testing plots according to defined methods and terms (from 3 to 15 years and more).

To test productivity, technological features, product quality of improved breeding, local and foreign varieties; to test hybrids on the tolerance to diseases and pests; to test new varieties in different agro-practices methods and soil-climatic conditions; to test prospective varieties in the conditions of production and their fitness for protection, and others are conducted in the variety testing plots (base farms) of the state variety testing network.

The elite varieties are evaluated and isolated, and by the State Commission of the Republic of Uzbekistan, the testing of agricultural crop varieties is included in the State Register for recommendation to plant in the territory of the Republic (take a look at the variety testing).

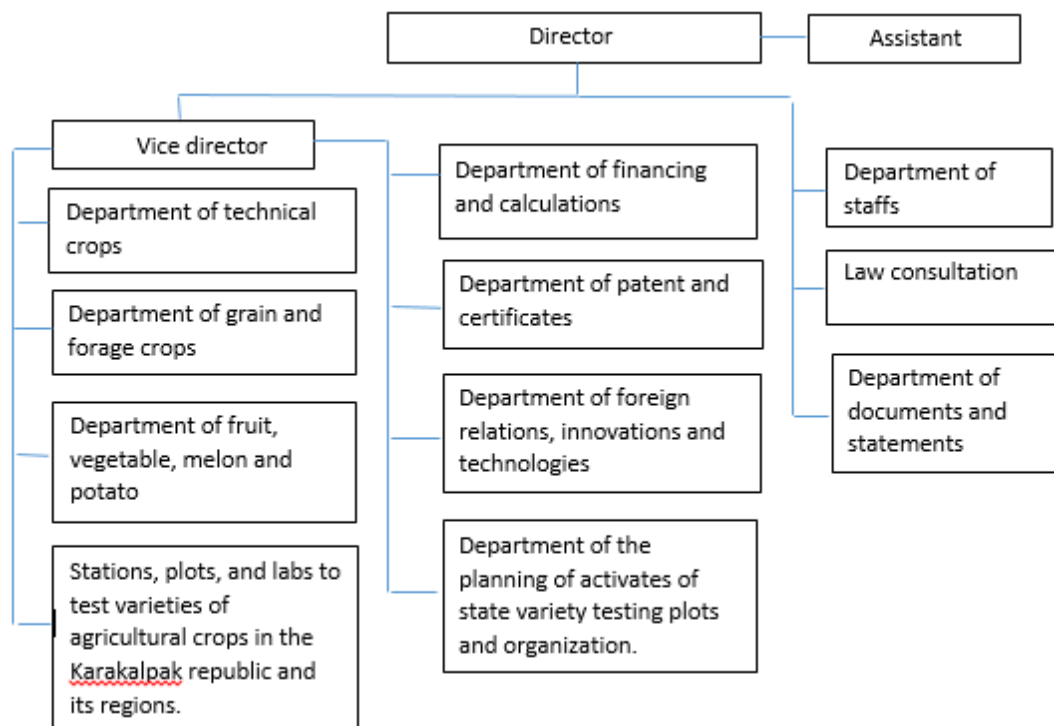
The primary formation of the variety testing network in Uzbekistan had begun since 1914 at the Mirzachol and Andijan experimental stations. There were 82 varieties tested, and 12 of them have been selected. In 1924, the first state variety testing network was established at the People's Commissariat of former Soviet Union land works. Since 1926, this network has been under the governance of the All Union Plant Growing (AUPG) Scientific Research Institute. Since 1937, the state variety testing network has been transferred from the AUPG to the People's commissariat on land works of the USSR structure (later transformed into the Ministry of Agriculture and Provision) and named after the State Commission on the Testing of Agricultural Crops.

Since 1937, the state commission on the testing of grain crops, oil bearing and forage crops, technical crops, cotton varieties, or a single state commission on the testing of agricultural crop varieties has functioned. During that period, the inspection office of the State Testing Commission on agricultural crop varieties and the variety testing network (plots) of this commission have operated in all union republics and particularly in Uzbekistan along the former Soviet Union.

A state testing commission for agricultural crop varieties was established in Uzbekistan at the beginning of 1990. In the light of the adoption of state laws on

the "Achievements of plant breeding" (August 30th, 1996) and "Seed production" (August 29th, 1996) in Uzbekistan, the tasks of the stations of the state variety testing network have also been extended. Since 2018, it has been reformed into the Center for the Testing of Variety in Agricultural Crops (its functional structure given below).

According to the resolution of the Ministry Cabinet (No. 282 on May 13, 2019), the functioning structure of the Variety Testing Center of Agricultural Crops at the Ministry of Agriculture of the Republic of Uzbekistan consists of: 58 variety testing plots are located and worked throughout the regions of the republic.



Work to test the new varieties of cotton plant, sugar beet, wheat, barley, corn, oil bearing, bean grain, vegetative melons, forage crops, fruit trees, vines, sub-tropical fruits, and others is conducted on the farms selected to the state variety testing network.

New cotton varieties are studied in the 33 variety testing stations and plots located in various soil-climatic conditions in the regions of the republic (2020). Below we can see one of the usually accepted placards, which has been installed by the side of the gate to the testing plot of the variety testing center for agricultural crops (photo 88). According to the data on this placard, this variety testing plot was established in 2003. It serves to test cereal crops, epsilon, alfalfa, vegetable-melon crops, and cotton.

Acceptance of cotton varieties in the state variety testing program is implemented by definite order. Only those varieties are recommended to the state variety testing program that have consistently been superior to the standard on productivity and other farm-valuable traits during the last three years of competitive variety testing at the plant breeding institution and are sufficiently uniform.



Photo 88. A view of one of the regional cotton variety testing plots at the Center on the variety trial of agricultural crops

Plants' uniformity is evaluated on the basis of soil control data (look at the glossary). The special card is performed for every variety that was noted to transfer to the state variety testing, in which the number or name of the variety, botanic species, authors and coauthors, the origin of the variety, and the years of testing are written, fully described all phenotypic and special traits to clearly distinguish the variety from other varieties.

Data for three years on the competitive variety testing of the new variety and standard on the all-important economically valuable traits; raw cotton harvest of the first, until frost and total harvest; fiber yield for until frost and total; fiber output; its length; rupture strength; liner density; precocity; resistance to diseases; and absolute weight of seeds are presented.

The results of the assessment of the spinning properties of the fiber are presented separately.

The breeder-author of the variety presents recommendations on the variety's agro-practices as well as the districts to test the variety. He is obligated to provide the state variety testing program with the seeds of the new variety in an amount of 20 to 25 kilograms per plot and to send the seeds to the address of the variety plot.

The seeds are provisioned from the variety plot to test in successive years, according to the statement of the approval. Here N.G. Simongulyan (1987), who was one of the famous genetic and cotton breeders, has underlined that to seed with the seeds provisioned from preliminary variety seed reproduction farms would be more correct, because of inevitable biological contamination and possible mechanical mixing of the seeds of testing varieties at the provisions on the variety plot.

Other crops are not tested on the variety plots for cotton plants. The testing is implemented in the testing stations and plots (state documents for 2019 and 2020).

Beside functioning plots, there are phyto plots, where cotton plants very precisely evaluate their resistance to diseases, in particular wilt. The method of variety testing in the phyto plots is the same as in common plots, but all work is conducted in the background, which is infected artificially by the disease-causing agents. Races of fungus collected from different regions are mixed in the soil to build a hand-made infected background. The method for preparing the hand-made background of wilt has been described in the chapter on "Evaluation of breeding material" of this textbook. The plot of variety testing (trial) is singled out of the constant plot with its rotation (cotton plant—alfalfa). The soil of the plot must be typical to the region and have a plain soil surface and good soil fertility. Background on the agro-practices should be typical to the foremost farms of the district.

The varieties must be grouped according to their agro-biological features to differentiation of agro-practices. Mainly, the varieties are grouped depending on the precocity and types of branching. The standard variety – variety introduced into production of this district is included to each group. If, the varieties are more than ten, the standard is included twice.

The State trial conducts two type of testing: **competitive** – in the small patches and production – **in the enlarged**.

Competitive variety testing in the small patches is laid in 6-8 replications. Every variety occupies a patch of 100 m². The replication is placed in the one, two, rarely in the three belts. The following records and monitoring (observations) are conducted: initiation and 50% of germination, flowering and maturing; development state of plants on the 1st of June, 1st of July and 1st of August; percentage of variety purity in the period of flowering; percentage of plant infection by diseases – wilt, bacterial blight of cotton, microspores and black root rot.

Full statistical treatment of the data on the crop is conducted by the method of variation analyze with determination of experiment preciseness and the least difference and groups on the crop.

The varieties showing clear advantages on the small patches are noted to be tested in the enlarged plots, in which only 2–3 new varieties are tested in comparison with the standard. The experiment is laid out in two replications. The area of the recording plot on every variety must be at least 1.5–2 hectares. Both replications are usually located in the same tier. Agro-practices in the enlarged plots to cultivate the varieties are held in accordance with the breeders' recommendations. Plant density (stand) is one of the major factors defining the dimensions of the crop per a certain area. Consequently, taking the normal plant stand is a big task for the specialists of the variety plot.

25-boll samples are taken to determine the technological qualities of the fiber. A 200-boll sample is collected from all plants to define the boll weight,

length, and output of fiber, as well as the absolute seed weight. yield of first, until frost and total harvests are taken into mind. Because the raw cotton crop is harvested by machine harvesters, it is possible to assess the cotton variety's fitness to be harvested by the machine harvesters.

The fiber quality (length, fineness, rupture strength, and spinning quality) is analyzed according to commonly accepted methods in locally existing technological laboratories and with the help of modern instruments like the USTER® HVI 1000 (photo 89) to identify world market cotton fiber indexes as:

UHML (upper half mean length), the average length of the longest fibers, which constitute half of the tested sample by weight and are expressed in mm or inches. This term is also known as "the upper half of mean length" in the correct translation;

Staple length, 32 nds, is a fiber length that a classifier defines visually by a staple of parallel fibers laid out by him or her manually. It is expressed in 1/32 inch (for example, 1 1/32) or by a code equal to the number of intervals in 1/32, in the example given, code 33;

Micronaire is the characteristic of cotton fiber fineness and maturity, which is defined by the air-flow method. (A micronaire reading below 3.0 is considered very fine, and 5.0 and above is considered coarse; 3.5 to 4.9 is the most desirable range for upland cotton varieties);

Mean Length (the average length of all fibers in the sample);

The **Uniformity Index** (the ratio of fiber mean length to upper half mean length expressed in percentage);

The **Short Fiber Index** (a percentage of short fibers in a sample with a length of less than 0.5 inches (12.2 mm);

Reflectance (the percentage of light reflected by the surface of the tested sample);

Yellowness (the amount of yellow color in the tested sample);

Trash Code (a non-fiber contamination characteristic defined by multiplying the area of admixtures by ten). For example, if the portion of the admixture area is 0.4%, the trash code is 4);

Trash Area (the ratio of the accumulated areas of all the trash particles measured instrumentally on the HVI machine by scanning a sample surface to the area of the viewing window expressed in percentage);

Trash Count (the number of individual trash particles in a sample of 0.01 inch (0.25 mm) or greater in diameter);

Strength (the strength of cotton fiber expressed in the graduation of HVI) and

Elongation (the cotton fiber elongation to the moment of its breakage on the dynamometer of the HVI system, expressed in percentage).

Cabinet of the Ministers of the Republic of Uzbekistan in 2021 has adopted resolution No. 158 dated March 27th, "About improvement variety testing systems of agricultural crops." The aim of this resolution is to organize **testing works** on the economically useful traits and properties of the varieties of agricultural crops

by utilizing modern testing methods and technologies from around the world, as well as bring legal order from the **State Register** on the agricultural crops recommended to plant in the regions of the republic. According to this document, experimental areas separated to test varieties of agricultural crops are not planned, and these areas are placed and introduced to the rotation system through the allocation of variety testing centers for agricultural crops at the Ministry of Agriculture.



Photo 89. Uster HVI 1000 accurate fiber classification system.

The Center for the Variety Trials of Agricultural Crops has a vast network of variety testing stations and plots (a total of 59) that are disposed in various zones of the cotton-growing regions of the republic. They are: 1-Karakalpakistan, 2-Andijan, 3-Bukhara, 4-Jizzakh, 5-Kashkadariya, 6-Navoiy, 7-Namangan, 8-Samarkand, 9-Surkhandariya, 10-Sirdariya, 11-Tashkent, 12-Ferghana, and 13-Khorezm.

Productivity, period of vegetation, resistance to diseases and pests, different soil-climatic conditions, as well as product quality and other traits of the varieties, make for useful farm variety traits. Farm-useful variety traits of agricultural crops are studied in the variety testing stations, plots, and selected areas by the breeder, which are located in the various regions of different natural soil-climatic conditions according to the order set by the **Variety Testing Center**. Moreover, the specialists of the center conduct **expert assessments** on the test results presented by the different applicants or breeders. Herein, the State Re-establisher is used to systematically organize the following works:

Chapter 4. Genetic uniformity of new cotton lines.

It was earlier underlined by many geneticists, plant breeders, and seed producers that the majority of new lines transferring to the State Variety Trial did not confirm their higher quality and became worse than standard variety on individual or most economically valuable traits. The major cause here was related to the very high productivity (Symongulyan N.G. and others, 1987) of the contemporary commercialized varieties, but this cause is no single. The main cause is a lack of uniformity in some of the new cotton lines on economic traits and in the first turn on productivity and fiber quality.

The most important feature of the new cotton variety is its genetic uniformity on phenotypic and economically valuable traits. Non-uniform heterozygous line-varieties will lose their initial quality during the reproduction process and testing as a result of splitting and will frequently be excluded from future seed reproduction.

Usually, the rate of variety purity identified by the approval of the phenotypic traits is judged by the uniformity of the varieties. But it is not enough. Varieties that are uniform on phenotypic traits may not be uniform on economically valuable traits in the near future. The cause of the non-uniformity of the new varieties is that the objective criteria for their uniformity were not used in the process of variety development.

N.G. Simongulyan and Yu. Kurepin developed a special method and statistical criteria to determine the uniformity of the varieties on economically valuable traits at the time. It is advised to use it at plant breeding institutions until the new variety lines are transferred to state variety trials. The uniformity of the new variety line on its concrete traits was defined using that method in comparison to the variety standard, a home variety growing in the production, through which a continuous elite-seed production was carried out. Assessment of the varieties was carried out in two phases:

*During the first phase, the uniformity of the new variety-line was studied in a field experiment spanning 0.2-0.3 hectares depending on the number of testing lines. Randomized samples of 120 plants were collected in the autumn of last year from seed reproduction nurseries of a new variety line and the elite of a home variety. The seeds of selected plants are sown individually as families in three- to four-fold replications. The families are allocated according to the principle of randomization, and at this point their average indices on length, fineness, strength, fiber output, and other traits are determined.

*In the second phase, the indexes of every trait of the families of cotton lines under study will be individually subjected to statistical treatments of quantitative variation and dispersion analysis. Here, using B.A. Dospekhov's statistics would be more preferable and more known for our cotton breeders because of the understandable order of the arithmetic treatment, which is divided into groups: the first group involves quantitative traits for variation value treatments, and as the

second group, we can use dispersion treatment for our productivity data taken from lines and standard varieties.

If the coefficient of variation is less than 10%, statistical treatment is considered insignificant. middle if it is over 10% but not more than 20%, and considerable if the coefficient of variation is more than 20%.

Sometimes using of the value, supplementing the value of variation coefficient up to 100 is purposeful to characterize the grade of material uniformity. This index is called a coefficient of uniformity and is determined on the equality of: $U = 100 - V$.

Furthermore, non-uniformity of studied traits of the line variety is obvious if the difference in families of the standard variety is insignificant, whereas it is significant in the new line based on trait variation and the least significant difference (LSD) at 0.1 and 0.5 levels. If the difference between families of a standard variety is also considerable, the genetic variation coefficient is calculated and compared. If the coefficient of genetic variation of the new line variety is higher than that of the standard variety, the new line variety is to be returned for further improvement.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton variety trial”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Station testing			
2	Competitive variety trial			
3	State variety testing			
4	Variety commercialization			
5	Genetic uniformity			

Chapter 5. Agro-practices, field observations, selection, and harvest in the cotton breeding plot.

In general, all practical works ranging from field selection to cotton breeding experimentation, seed sowing, carrying after plant vegetation, vegetation observations on plant developments, rejection or selection of superior breeding plants, harvest of selected seed raw cotton out of selected plants over the cotton breeding plot, transportation to terminal conservation, laboratory analysis of raw cotton selections, seed separation (ginning), late seed analysis and seed provision to new plantations are remained in traditional accepted method's without considerable changes.

Cotton breeding plot agro-practices begin with **the location of the breeding plot and the pre-planting treatment**. As is widely known, breeding plantings (collection, biological and breeding nurseries, stations, and competitive variety trials) are allocated in the fields after the cotton – alfalfa rotation.

To simplify mechanical work in the plantation, the plot is chosen with an even and regular configuration. The plot must have minor incline to improve the irrigations inside the furrows, must be conducted winter plow with additional application of fertilizer until advent of the next spring cycles of works as: ploughing or chiseling, harrowing and toothless dragging (photo 90, 91, 92).



Photo 90, 91, 92. Technics and order of field preparation to seed planting.

Prior to sowing, after measuring the plot, it was divided into lots (the big field layout). Their lengths depend on the planned number of seed nests in the row and the distance between them, which corresponds to the accepted scheme of the seed sowing (photo 93, 94).

Row-line allocation with a single stand of plants in the seed nest has been considered the most rational scheme for allocating the plants to cotton breeding plantations. At this date, the schemes of seed planting involve two groups of interrow widths: 90 and 60 cm. Any of these schemes are made of three numbers (like 90 x 7 x 1 or 60 x 20 x 2). The second and third numbers in both planting schemes are changed depending on the plant texture or branch formation types and even the recommendations given by the new variety authors. That is why the distance between seed nests and the number of plants per nest have variable characteristics in every breeding nursery. The number of nests along the identified seed rows also depends on the amount of seed in the seed sack. At this point, it is important to remember that there must be a greater number of plants in the registered rows to be studied during vegetation.



Photo 93, 94. Seed sacks are laid out along the protecting path, and their row nests are used to plant selected seeds in the breeding nursery and breeding pegs.

A 0.5 or 1.0 m internal protecting path is left between nurseries. Measured lots are marked by the pegs. Marking must be conducted very attentively in order to ensure the normal and efficient working of machines at the time of interrow care for plants. Following the placement of field pegs with order numbers (small pegging out) in accordance with the sowing list. The pegs must be set not at the beginning of each row, but in the fourth or ninth row to every tenth.

Preparation for seed planting. The seeds are ready for planting after carrying out the laboratory discarding of individual selections based on fiber output, length, and sowing list (Appendix 4,5). which includes row numbers for the coming year, initial row numbers from the previous year, order numbers of seed sacks, order numbers of cotton hybrid combinations, families, or lines, and notifications on fiber length and output of some selections. Every ninth row contains the standard variety. The seed sacks of specific selections are sewn up one by one with twine in accordance with the seeding list. Every sack garland, which is usually made of 50 seed sacks, has a wood tag attached with a marked number and the name of the nursery. The marks on the first and last seed sacks are next to them. The sack garlands are placed in the jute sacks.

One or two days prior to sowing, the planting material is disinfected with a solution of formalin. 40% formalin is used for disinfection and is mixed with water in a 1:90 ratio. Disinfection is carried out in the enamel bath or wooden troughs. The seed garlands are sunk into solution for 10 minutes and then taken out, placed into sacks, and left to languor under the shade for 3 hours.

Under the act of formalin, the pathogen causing bacterial blight disease is dead for this period of time. Following the languor, the seeds are soaked for a day or two in running water.

In ripe soil, seed sowing is done at the optimal time to avoid seedling deaths due to late frosts. If the soil has dried, watering is preferable either prior to planting or after planting. Seed sowing is done by hand (photo 93) or by a specific cotton seeder (phot ..). Even if the seed is laid at the same depth, ensuring vigorous seedlings is critical when hand-planting. Planting depth is varied from 3 to 5 cm, depending on the soil moisture. The seeds dropped into the soil next must be

pressed to the humid soil and covered with humid soil. It is widely assumed that 5-8 seeds are laid down in each seed nest. The additional seed of *G. herbaceum* or red leaf cotton varieties is applied to the nests of the first progeny of hybrids and collection sample nurseries where seed scarcity (only 2-3 seeds per nest) is encountered.

Agricultural practices after seed sowing. The clods formed by the occurrence of heavy showers are removed to strengthen soil aeration. The smoothing of the interrow soil surface and around the seed nests is conducted carefully by the hand hoes. Thinning in the breeding nurseries is carried out in two or three stages: the first thinning is done at the 1-2 leaves, the second at the 4-5 leaves. The plants that have been removed are being buried. Only one plant is left per nest at the last thinning of biologic and breeding nurseries. In the variety testing experiments, a greater number of plants remained according to the accepted scheme of planting in production. In order to provide an even leaf surface area per hectare, one plant is left per nest in the varieties of limit compressed plant texture studied in the variety test as the plants of production condition.

As previously stated, the breeding plantation plot provides a high agro-background for all vegetation periods. It is also desirable to complete the breeding nurseries for the groups of vegetation periods and types of plant texture. This enables differentiated agricultural practices and variety testing in plantations. They are very important because of the diverse range of agro-practices. It allows for a correct imagination of the heredity of new lines and varieties, as well as their potential ability in terms of productivity and other economic indices.

The varieties capable of yielding a high economic yield in agro-conditions, according to their hereditary stipulates, react not only with capability, but usually cede to standard in the condition of a template agro-practice cultivation and withdraw from variety testing as the less productive.

Because of the intensive exchange process in the early ripening group of varieties, the first vegetation watering and top-dressing must be performed a little earlier and with a few more watering amounts. Top-dressing at the time of planting is especially important for these varieties. Limited-type branching varieties respond too early and often to watering. A restricted area of leaf surface defines the necessity of a thick planting per unit of area.

Late-ripening varieties with a strong root system require more late watering in August, as well as a more careful nitrogen fertilizer application scheme, which, when combined with excessive watering, leads to overgrowth and prolonging of the vegetation dates.

The chopping of cotton plants in the biological and breeding nurseries is not recommended and may be applied only in a special situation. Chopping can be conducted in the parental plant forms, where it speeds up the maturity of pollinated bolls.

Methodology of the field records and observations. The number of field records and observations in the different nurseries is not similar and depends upon the designation of nurseries and the stages of breeding work.

The main kinds of field records and observations are:

- *beginning and 50% of seedlings emerging,
- *starting and 50% of budding,
- *beginning and half-way through flowering,
- *beginning and 50% maturation,
- *record the height of the setting of the first fruiting branch,
- *keep track of the rate at which buds appear, flowers bloom, and fruits ripen,
- *fruit setting record,
- *progress in plant growth,
- *record of plant infection by wilt,
- *record of plant infection by bacterial blight,
- *record of plant density,
- *raw cotton yield record until frost,
- *record of gross raw cotton yield,
- *phenotypic inspections of plantations.

The most difficult records, for example, those of the rate of flowering and maturation, fruit formation, first fruit branch setting, and progress in growth are conducted selectively on the 10 plants in the plant families, taken successively.

Seedling records. The day the first seedlings appear in the registered rows, seedling records are started. It is conducted every day or over two days. There is a special form to register all collected data in it: nursery name, order number of rows, date of planting, number of nests, dates of recording, and number of nests with seedlings on a certain date and note (Form 1).

Form 1. Exemplary view of the working form in the field notebook to record the seedling emergence of collection samples.

Collection n nursery.	Order № of registered rows.	Date of plantin g.	Numbe r of nests.	Dates of recording							Sum.	Notes
				21. 04	24.0 4	27.0 4	30.0 4	03.0 5	06.0 5	09.0 5		
520\USA	121	15.04.22	25	3	3	5	7	8	10	12		
-\\-	122	-\\-	-\\-	4	5	5	10	13				
-\\-	123	-\\-	-\\-	2	5	8	12					
-\\-	124	-\\-	-\\-	3	4	5	8	10	13			
-\\-	125	-\\-	-\\-	1	3	4	9	11	12			
-\\-	126	-\\-	-\\-	1	4	4	7	12				
-\\-	127	-\\-	-\\-	4	5	5	6	11	13			
225A\India	128	-\\-	-\\-	3	3	6	8	11	13			
-\\-	129	-\\-	15	0	1	1	3	3	3	5		Later
-\\-	130	-\\-	-\\-	2	2	3	3	6	6	6		Later
Totally:												

The recording is complete when the number of nests with seedlings in all registered rows reaches 50% (25 in rows of 520 in the United States or 15 in rows

of 225 in India). Obligatory records of field observations on breeding plants or hybrids are defined by the cotton breeders and noted in the working programs of every research project in the departments of the SRI. Newly introduced samples from the collection department of the SRI are excluded from this rule because their economic traits and properties are mostly not yet known to the breeders of the department, and that is why all of them are subject to these records.

This record, because of its work-consuming character, is being conducted selectively by the decision of the breeder. Monitoring begins the day the first flower buds appear and continues on a daily or weekly basis after that. Taking into account the number of plants that visually have one or more remarkable buds. It should be noted that the number of nests is not as important here as the recording of seedlings, but rather bud-forming plants. So, if the nest has two plants, both will be taken into account. All collected data is included in the same form as the record of seedlings. At this point, the number of plants in the rows is counted until the observation and recorded in the form, followed by the date of records and the progressing number of plants with buds on the cells of each date.

Records of flowering and maturation Keeping records of flowering and maturation is important in all nurseries, with the exception of F_2 hybrid nurseries, depending on the possibility. They are carried out selectively, by the breeder's order, in the next nurseries of the elder hybrid generations. Primarily in phenotypic uniformed families. Phenological observations on the flowering and maturation are obligatory in all kinds of lots, and at this point, if the lots have two or four rows, only one row is registered for the record of flowering (N.G. Simongulyan, 1987). Flowering observations, like other phonological observations, are made on a daily or weekly basis. The results of the data are included in the same forms used in the records of seedlings and bud formation. I wrote down the total number of plants in the row until the beginning of flowering, the date of record, and the number of plants with flowers or buds. The record is complete when 50% of plants flower. If more than 50% of plants with flowers were on the last date, the missed day is accepted as the date of 50% of flowering. For example, if there were 20 flowering plants on the 5th of July out of 50 plants in the row, and 30 on the 7th of July, the 6th of July is guessed as the day on which 50% of flowering has launched. Similarly, I observed the maturation through phonological means.

Observations on phenology during hybridological analysis. The tags are attached to every noted plant (photo95) since the beginning of vegetation along the row, and they are renewed before every field record. This method provides a hybridological analysis of plants in hybrid families, including the length of their developmental phases and the total number of days required to reach full maturity. On the tags will be written successively the dates of the first bud appearing (photos95 a and b), the first flower, and splitting open the first cotton boll. The duration of phase development and vegetation period for all plants in the row is recorded on these tags.

Determining flowering and maturing rates. The following order determines flowering and maturation rates, or the duration of the short and long

lines in flowering and maturation: The ten tags are sequentially placed on the ten flower pails (photo 95: a-c). The tag includes the date of flowering, the number of fruiting branches, and the location on the branch. The maturation rate is determined similarly to the rate of flowering. In the autumn, all tags are selected, and the duration of the short and long orders of flowering and maturation is recorded in days. It should be noted that the duration order does not change significantly when a bud or young boll falls.

Determination of the setting height of the first fruiting branch (hs). The recording of the setting height of the first fruiting branch is being conducted selectively on the 10 plants in the registered row. Setting the height of the first fruiting branch shows how early the plants are; otherwise, this is the time when the generative stages begin. It accounts in nodes, beginning with the cotyledon node and ending with the node on which the first fruiting branch develops.



Photo 95: (a, b, c, d). *Tagging of cotton plants and their fruiting elements to field records.*

Usually, the setting of the first fruiting branch is determined prior to flowering. But N.G. Simongulyan and others (1987) suggested that it would be more correctly done if this recording was done together with a budding record. Because late-germinated plants frequently lag behind in the early period, their lag is compensated for by lowering the setting of the first fruiting branch. Furthermore, when recoding this trait in later terms, there is frequently a disparity between the height of the setting and the age of the plants. Nodes determine the setting height of the first fruiting branch, which must be distinguished from centimeters from the soil surface, which determines the setting height of the first fruiting branch. The last index has important significance for defining the fitness of the plants for machine harvesting. Varieties with genetically lowered first fruiting branches or those planted closer to the soil surface have lower mechanical harvesting fitness. As a result, the bolls on the lowered branches will fall unnoticed by the harvester's mechanisms. The height disposition of a first fruiting branch emerging from the soil is determined by its node height and length.

Fruit setting record. The breeder's instruction is used to implement a record of fruit setting in various nurseries. At this point, 10 plants out of the registered rows are tagged (photo 95, a). It is usually held in September, until the first frost arrives. The number of bolls, split open or not, and the locations where they fell down are all counted. Accounting of bolls is done in the following order: at the

beginning, counting and writing down the number of fruiting elements on the monopodial, then on all simpodial branches from the first until the last. For this, count up the number of bolls on the first fruiting branch by holding the main stem. Then, not letting the hand out of the main stem, she starts moving the hand up on the second fruiting branch and counting the boll numbers. Is the continued accounting of fruiting elements from branch to branch up on the stem similar? The left hand is always catching the stem, so don't miss the simpodial or count up twice the boll number on it. The same method is used to determine the number of fallen places. The node of the fallen place is simple because they are disposing of every leaf on the simpodial once more. Accounting for the number of split open bolls, not split open bolls, and small bolls separately can be done in order to total the number of saved fruiting elements.

Phenotypic inspections. Inspection of breeding materials for phenotypic traits is conducted in all nurseries. So, at the inspections of hybrid families, lines (photo 95, d) and varieties are studied in regard to their general development, phenotypic uniformity, productivity, earliness, resistance to diseases, and other economic traits. At the inspection of families on their uniformity, attention is mainly paid to the following phenotypic traits: type of branching, pubescence on the plants, size and shape of leaves, and size and shape of bolls (photos 95, a, b).

The fine-stapled cotton varieties are taking into account the size of spots on the petals, the character of the surface of bolls, and the color of fiber.

The forms of limited and unlimited types of fruiting branches are differentiated based on the type of branching during the phenotypic inspection. The last may be compact or spread. Pubescence is classified as strong, mean, or weak; the leaves can vary in size, have a smooth or wave-like surface, or be a bright green or yellow color. Bolls are also classified according to their size; their shape can be a circle, an oval, an egg, with or without a tip, with or without a star, and their surface can be smooth or wrinkled. Phenotypic inspections are conducted three times: in June, July, and at the end of August or at the beginning of September. At the last inspection, the complex of traits and uniformity of the rows were the best. They are noted by the breeder in the field register designated to take probe samples and family raw cotton harvests.

A full description of variety samples' phenotypic and economic traits is carried out in the collection nursery.

The description of varieties on the standard sample is implemented in the competitive and enlarged station trials.

Plant height measurement. The measurement of plant height is conducted on the 10 plants in the row by taking all plants, one after the other, beginning with the 5th. Plant height is typically measured three times: in June, July, and at the end of August, with the same plants measured each time.

Records of plant infection by wilt and bacterial blight in cotton. The experiments were carried out in a plot that had been artificially infected with disease pathogens in the middle of July and August, as well as at the end of September. Taking into account the total number of plants infected by wilt at the

general degree (weak infection) and at the strong degree. At a low level of infection, the entire leaf or the edges begin to dry up (wither) and fall; as the bolls dry up and fall from the surrounding part of the plant, the plant yields little. At a strong degree of infection, the plants lose all leaves and all productivity.

Cotton infection by bacterial blight is recorded twice: once in May, shortly after seedlings emerge, and again at the end of August. Infected plants are detected by the presence of oil spots on the cotyledon leaves (the cotyledon form of the infection), on the stems, and on the cotton bolls. Accounting for the total number of infected plants regardless of their level of infection in the records.

Plants hold the record. The number of plants in the rows is determined before conducting every phenotypic observation: bud formation, flowering, and maturation. Before the beginning of maturation, repeated accounting of plants is essentially obligatory; this is necessary to correctly identify the date of maturity and to count the yield of raw cotton per plant. The number of plants per unit of area (a hectare) is used to determine plant density in variety trials.

Raw cotton yield recording In the breeding plantation, yield is harvested in the following sequence: picking up probe bolls; picking up individual selections; general harvests of rejected row yields; general harvests of raw cotton out of registered rows: until frost; after frost.

Picking up individual selections. Individual selections are made by the breeder when six to eight split open bolls are available on the plants (photo 96, 97). If the selections are made at the end of the growing season, when the majority of the plant's bolls have opened, the breeder will be unable to identify early-ripening plants. On the other hand, if selections were made at the two-to-three split open boll stage, there is no way to account for plant maturity rates.

That is a common method used by cotton breeders in our republic to select plants: either the plant tops are broken down (photo96) or the same plant tops are wound up by raw cotton (photo97). They make it simple for the assistants to locate specific and noted plants. The breeder points out these selected plants according to row numbers and the number of selected plants in his field list on the breeding plot. Before beginning to pick individual selections, the assistants are guided by the breeder's remarks in the field list and remarked plants in the registered rows, and they then arrange individual sacks on the remarked plants in the growing number. Of course, the sacks have numbers, and the quantity of sacks prepared must be sufficient to cover all nurseries. So, the sack numbers of individual selections for a certain year are different. Their numbers are noted sequentially in the field list as the assistants distribute these sacks along the selected plants. Subsequently, the picking of individual pieces of raw cotton from selected plants is started by another assistant. Hand harvesting is only done on fully matured bolls.



Photo 96, 97. Approaches to mark individual selections of plants in a cotton breeding plot.

In some cases, harvesting is accomplished by counting the number of bolls picked from plants. The sacks of raw cotton are strung together to form a garland (photo 96). Then, garlands with 100 sacks are put into an enlarged jute bag. These sacks also have tags and strings prepared and attached in advance. At the end of the work day, they transported it to the dry barn.

Before the laboratory analysis, five seeds with fibers (puppis) of individual raw cottons are collected in the winter and weighed. They will be used to analyze the fiber length (photo 99); in this, six locules are singled out from different parts of raw cotton, and also from the middle of each of them, one pupus is taken. The six puppies chosen are placed on the paper pages (photo 100). The pages have the numbers of the row and the sacks of the individual selection. At the same time, these data (of the lines and even varieties) are entered in the special list, and then the pages with the list is delivered to the analysis in the technological laboratory.



Photo 98, 99, 100. Cotton breeding sacks, selected raw cottons and selected puppus to measure of fiber length.

The raw cotton in the sacks is weighed using technical scales with a precision of up to 0.1 g. The data on the weight of selections entered in the special form. Seed separation takes place in the 10 saw-fiber cleaners after the raw cotton

is weighed and sent to ginning. Then, the isolated seeds from every individual selection or raw cotton harvested from rows are weighed. If only the seeds are weighed, the fibers are united at the time of ginning.

The base weight of raw cotton and the weight of seeds determine the fiber output of each selection. In general, the fiber output can be defined based not only on the weight of seed but also on the weight of fiber. The weight of raw cotton out of selection is accepted at 100% to determine the fiber output, and the weight of fiber is a percentage of it. Data on the fiber output must be included in a special form for individual selections, and here must be included the fiber length data taken from the technological laboratory.

Picking up the probes. The probe samples are picking up until the harvest of individual raw cotton selections. The probe bolls are taking the first and fourth plant branches to determine the possibility of all plants in the breeder-marked rows. Each plant must yield not more than one, but two bolls.

It was accepted that the numbers of boll probes differ in the following order:
25 boll probe samples are taken from the collection nursery.

10 boll probe samples are taken from the nursery of the first hybrid progeny.

25–50 boll probe samples are taken from the breeding nurseries, depending on the length of the row.

100 boll probe samples are taken from every row of the station variety trial.

200 boll raw cotton probes in the rows of competitive variety trials are taken from mature bolls of all plants, regardless of their disposition on the plants. At this point, this number of probe bolls in every replication are harvested in succession.

The probe bolls are picking up in a special box made of different light materials with isolated cells (take a look at photo 55 and 56 of the manual on the conducting of practical and laboratory trainings in cotton breeding and seed production published in 2022). Every boll removed from the plant is placed in one of the cells numbered in ascending order. Usually, it is made with 100 cells, which will be very convenient to use for all cotton probe boll numbers. From the fill- up box, the bolls are put in advance- distributed sacks with numbers along the registered rows. A tag is put in every sack with a record of the year, the, name of the nursery, the number of rows and the number of this sack (photo 98). Simultaneously, the number of rows, sacks, and cotton lines are written in the form to probe samples (form 2). The sacks containing probe samples are also garlanded, placed in enlarged bags (appendix 8), and transported to the SRI's heated barn.

Form 2. Field lists to boll probe selections and their economic characteristics.

Row №	Nursery	№ of sack	№ of bag	Number of boll probes	Weight of raw cotton, g.	Size of boll, g.	Fiber length, mm.	Weight of fiber, g.	Fiber output, in %.	Notes
1	Collection	1	1	25	170	6.8	36.2	58.9	34.5	
2										
3		2		-\\-	155	6.2	35.8	59.1	38.1	
4										
5										
6		3		-\\-	191	7.6	34.3	71.6	37.5	
7										

8										
9		4		-\\-	202	8.1	35.7	73.7	36.5	
10										
11										
12		5		-\\-	160	6.4	36.0	56.0	35.0	
13										
14										
15		6		-\\-	183	7.3	33.4	63.9	34.9	

Row №	Nursery	№ of sack	№ of bag	Number of boll probes	Weight of raw cotton, g.	Size of boll, g.	Fiber length, mm.	Weight of fiber, g.	Fiber output, in %.	Notes
143	Hybrids	115	2	10	82	8.2	37.2			
		116	-\\-	-\\-	79	7.9				

Row №	Nursery	№ of sack	№ of bag	Number of boll probes	Weight of raw cotton, g.	Size of boll, g.	Fiber length, mm.	Weight of fiber, g.	Fiber output, in %.	Notes
415	Breed-ing	612	6	50	355	7.1	38.2			

Row №	Nursery	№ of sack	№ of bag	Number of boll probes	Weight of raw cotton, g.	Size of boll, g.	Fiber length, mm.	Weight of fiber, g.	Fiber output, in %.	Notes
624	Station variety testing	743	7	100	650	6.5	36.0			

As from collection probes, 22 puppus are isolated from probe samples of breeding nursery. One puppus is taken out of middle part of every locules. 44 puppus are isolated from probe samples of station and competitive variety testing nurseries. The puppus of every probe samples are put on into the special pages which have to bear records on the № of sample, row and sack (photo 101).

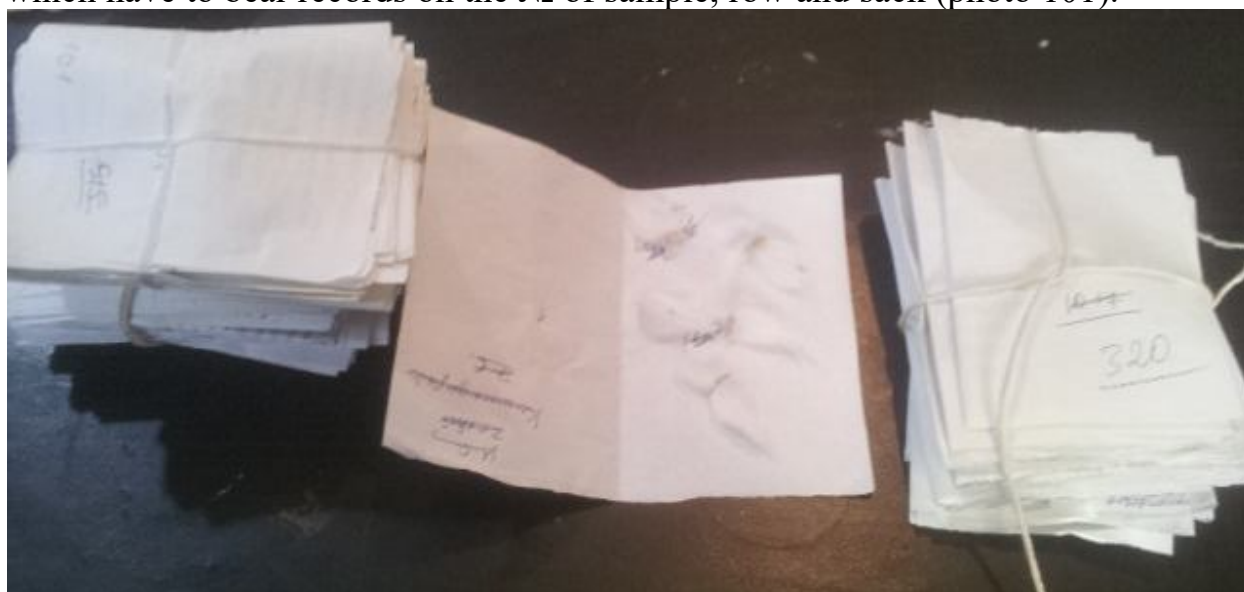


Photo 101. Preparation of the puppus to measure the length of fiber.

All of this information is recorded in the breeding list and forwarded to the technological laboratory. This list has blank cells to fill in with data from analysis. You can get acquainted with the content of this table from the same manual, page 190, form 5. It will be very interesting for those who are going to engage in cotton breeding in the near future.

The probe samples, after isolation of the needed pupus to measure the fiber length, are weighed, and the weights are written in the above-presented forms. Weighing is performed on technical scales with a precision of up to 0.1 g. On the basis of the collected data, the mass of one raw cotton ball is defined. They delivered all materials to the ginning house after weighing them all. The separated fiber and seeds have to stay together in their sacks. When the samples come back from the ginning house, they are weighed separately. Of course, here, on the basis of the weighed seeds and fiber mass, we may also sum up the fiber output and write it down in the presented cells of these forms.(appendix)

The data taken back from the technological laboratory on the fiber length of samples is also rewritten in these forms for further breeding procedures. Family harvests of raw cotton crops are harvested before (1st and 2nd harvests) and after frost after picking individual selections. The first harvested raw cotton from the best families of the breeding nursery is saved for testing and seed reproduction. The rest of the raw cotton is also harvested, weighed on the field, and sent to the institute's crops for technical purposes.

Crops from all harvests are brought together in advance-laid-out bags with their tags running along the rows. Their tags are labeled nursery, row, and bag. All of the data from the tags and weight of raw cotton are written down in the harvest form, where all of the data of family harvests is collected, when weighing the bags of raw cotton in the field. If the crop of one or another bag is to be kept, after the registration of the needed data, these bags are bound together (10–15 units of garland) and put in a jute bag also with corresponding tags and delivered to storage in the heated barn.

Selection of samples to a full technological analysis. After selecting probes in the plot of competitive variety testing based on the size of the bolls, probes of 500 g are taken for the full technological analysis; bolls from the first place of the fourth and sixth sympodial branches are included in the probes. The probes for full technological analysis are taken from the probe samples in the rest nurseries.

The method for the determination of the staple length, rupture strength, fineness or line density, relative rupture strength, and maturity of fiber was described in the "Instruction of Scientific-Research Institute of Cotton-Paper Fabric Industry" (1981). Nowadays, the Uzbek Center for Certification of Cotton Fiber ("Sifat"), under the Cabinet of Ministers of the Republic, renders services to all cotton breeders to identify the fiber quality. This center has a modern laboratory equipped with the latest modifications of USTER instrument-based cotton classing. Using a 70-gram fiber sample, it is possible to produce the most accurate and

repeatable test results in the world (take a look at photo 82 in the same manual mentioned above).

Indeed, some of the extraordinarily important plant cultivation works in the cotton breeding plots are still fulfilled by hand. Handmade tools (photo 102, 103, 104) created for field work are different depending on the kind of tasks involved in carrying out plant development. Even according to the opinion of some cotton researchers, breeders, and elite seed producers, handwork with these tools is more time-consuming and backbreaking but considerably more reliable.



Photo 102, 103, 104. Some of hand made tools to do field works in the cotton breeding plots.

That is why most cotton breeders rely more on the accuracy of handwork than tractor means. They prefer hand sowing of collection samples and hybrids with not enough seeds. The first tools (photo 102, 103) is used to loosen dried soil and clods around the seed nest of young seedlings. The third tool (photo 104) is needed to close seed nests with soil and open the young seedlings from clod caps, which are covered by the working organs of the tractor cultivator after their treatment. Weeding within young plants and taking ridges to watering, next weeding after watering, until the plants' age when they shade the soil and not allow the weeds to grow again are still left to be implemented, usually by the young scientists. Of course, there are some of the specially developed field tractors with organs to do these works, but using them requires significant expenditures that are not always affordable to all breeders.

Chapter 6. Copyright for the cotton variety.

It is simple to explain the copyright for the cotton variety by learning about the concept of "Protection of new plant varieties," which involves a system of right norms in which plant varieties released by breeders are the object of intellectual property.

New cotton varieties as the plant breeding achievements undergo to the protection by the corresponding state laws (The Law Uzbekistan on: "Copyright and Typical Rights" adopted on March 23, 2006 and Citizenship Codex of the Republic of Uzbekistan). As a result, the new cotton varieties must have some additional characteristics or otherwise meet the law's ability to protect criteria. They are as follows: the novelty of bred achievement, its distinguishing characteristics, uniformity, and stability, where the novelty of bred achievement takes first place. At this:

- The variety is guessed as the new one if the variety was not sold yet or delivered for commercial use until the date of the presentation of a claim.
- The variety meets the condition of being distinguishable if it is clearly distinct from any other variety that is commonly known.
- The variety is considered uniform if all plants remain similar (uniform) on the main traits pointed out in its description, taking its reproduction into account.
- The variety is considered stable if its main traits, noted in the variety's description, remain unchanged after continued reproduction or, in the case of a special cycle of reproduction, at the end of such a cycle.

Property rights of the owner of the plant variety.

The property right of the owner of a variety is its exclusive right over the use of its own variety and over the permission or prohibition of the use of the plant variety by other persons. The exclusive right of the variety's owner on the permission or inhibition of its use means that no one acts on the relation to the variety's material without his or her permission, such actions as:

1. Production or producing (for the purpose of reproduction);
2. Improving the condition in order to reproduce;
3. Proposal to sell;
4. Trading or other commercial activity;
5. Export to other countries;
6. Imports into the country;
7. Conservation for any purpose

The owner realizes the property right at his own discretion, without violating the property rights of other plant variety owners.

Inspection of novelty of the variety.

Expert evaluation of the novelty of the variety is conducted chiefly on the basis of information analysis, which was presented by the applicant in the claim, relatively first use of the variety. However, the governmental service on plant variety copyright (the government variety service) can accept any official

information about the first use and also use the information that has come before the government variety service in the form of an objection, namely the registration of the variety from a third party.

The right to new varieties of the plant was clearly described in the 63rd chapter of the Citizenship Codex of the Republic of Uzbekistan:

The clause of 1091 protects the right to new plant varieties.

*author's right to benefit from breeding achievement under 1092 clause;

The copyright for the new varieties of the plants **is protected only after they get a patent.**

The right and obligation of the owner of a patent are approved in clauses 1093 and 1094.

The fee for an author's merit to develop a new variety, its amount, and payment conditions are set on the basis of an agreement between it and the patent owner (photo 105).

At this point, according to the law, the owner of a patent has special rights to use breeding achievements. And, in particular, his obligation consists of: keeping the traits of the registered plant variety during the period of the patent's validity.

As the latest example, we can consider the cotton variety S-2615, which was released in 2015, and its patent. Its breeding process took place at the Scientific-Research Institute of Cotton Breeding, Seed Production, and Production Technologies. Multiple individual selections out of a complicated hybrid combination of [(Omad x Namangan-77) x (S-2609 x S-9082)] have been used to develop it. Its variety characteristics are: vegetation period-115-118 days, height of plants-115-125 cms, productivity-4.0-4.5 tons per hectare, weight of raw cotton per boll-6.0-6.5 g., weight of 1000 seeds-120-125 gs., fiber output-36.0-38.0%, fiber length-35-36.0 mm (1.15-1.17 inch), mic (4.3–4.5), fiber type-IV and relative fiber strength-30.5-32.3 g\text.

A brief information about the variety's agro-practices. Plant densities of 95–105 thousand plants per hectare in fertile soil are required, as are plant densities of 105–110 thousand plants per hectare in heavy soil with deep groundwater levels, which is less fertile and more susceptible to salinization.

In meadow soils, fertilizers at rates of 250 kg/ha nitrogen, 180 kg/ha phosphorus, and 120 kg/ha potassium are beneficial. Topping is preferable to do at the time of setting of 14-15th fruiting branches and defoliation is being suggested to do when the 45.0-50.0 % of cotton bolls have opened.

2. Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton biology”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned

1	Germination			
2	Seedling formation			
3	Budding			
4	Flowering			
5	Maturation			



Photo 105. Patent taken for the developed cotton variety S-2615 by the cotton breeders P.Sh. Ibragimov, B.O. Urazov and others, 2015.

Part VI. Cotton seed production.

Chapter 1. Cottonseed, its economic importance in the seed production.

From a scientific point of view, the seed is an embryonic stage of the cotton plant's life cycle. The perfectly developed cottonseed figuratively has an egg or an incorrect pear like shape (figure 32). Its shape, outlook can be inconsiderably varied within domesticated cotton plant species and are characterized literarily is pointed on one end (the micropyle) and rounded on the other upper end- chalaza.

The structure of cottonseed is made of seed coat with two envelopes embracing it. Outer envelope has a hard-wooden structure often with pubescence, internal envelope has membrane-like structure, folded cotyledon, embryo (epicotyl), hypocotyl, radical (seedling root).

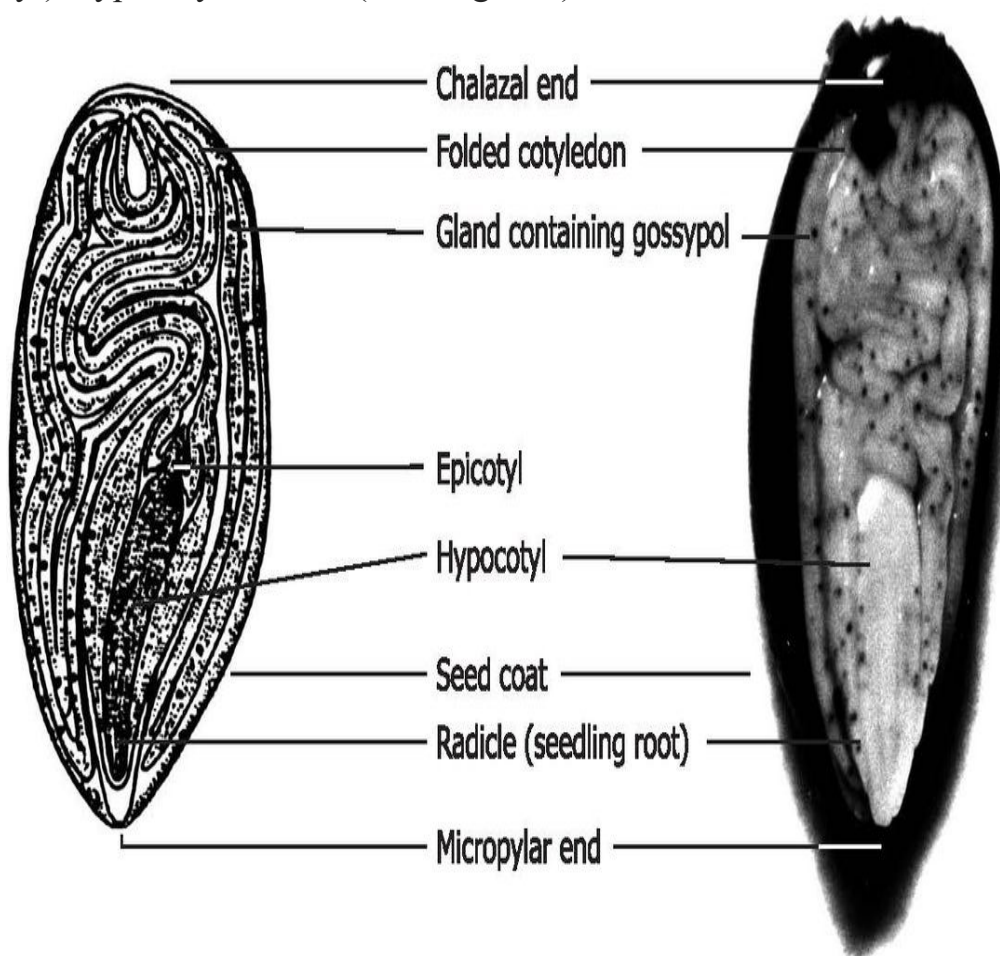
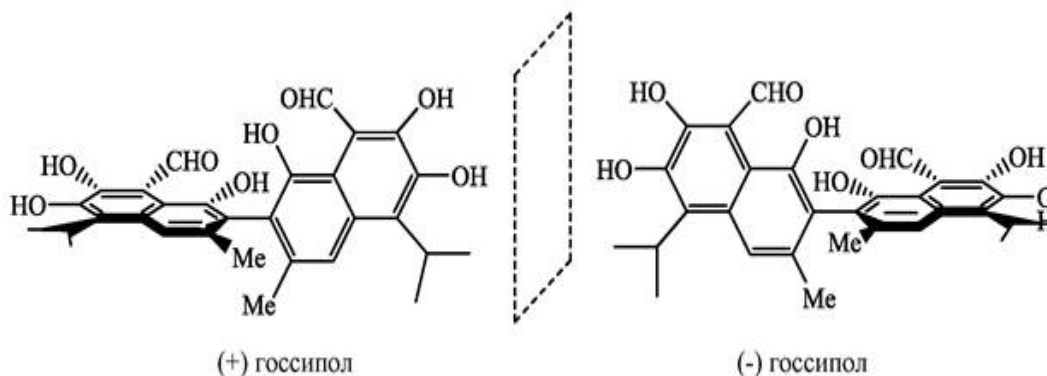


Figure 32. Anatomy and morphology of the cottonseed.

The chalaza of the seed is the primary site of water and oxygen absorption just after planting, and the tip of the primary root (radical) is the first part of the seed to emerge through the micropyle.

The gossypol glands are visible on the surfaces of the internal parts of the seed, and they will be visible on the tissues of the foliage and floral organs of developed cotton plant. It is a chemical compound found in cottonseeds. Chemically, it is classified as a polyphenolic binaphthalene-dialdehyde, which has toxic and antifertility effects with respect to cotton pests. Later, it was also discovered that the molecule of gossypol mainly consists of two similar fragments

connected to each other with C-C links and establishing two side angles between planes of naphthalene cycles. Gossypol also belongs to chiral compounds and presents itself two enantiomer forms (+) – and (–) – gossypol, which shows different level of biological activity. At the extraction of gossypol out of cotton plant, which presents itself racemic mixture (+)- and (–)- gossypol (figure 33). And besides, (–)- enantiomer gossypol exceeds on its activity and toxic index above the (+)- enantiomer and racemic mixture.



Figure

33. Polar groups of gossypol, containing 6 hydroxyl and 2 aldehyde groups, gives it melting possibility in the different organic solvents as methanol, ethanol, isopropanol, acetone and so on.

The surface of the cottonseeds is covered by the pubescence (linter) and the long fibers. Their diversity is specific to the samples of different cotton plant species. The longest fibers developed on the surfaces of cottonseeds belong to two species: *G. hirsutum* L. (middle staple cotton varieties) and *G. barbadense* L. (long staple cotton varieties). Indian and African cotton plants *G. arboreum* L. and *G. barbadense* L. usually characterized by mixed: long and short cotton fibers.

The size of cottonseed depends upon the cotton species, place of seeds in the cotton boll, place of bolls on the maternal plant and the quality of agro-practices. The length of seed makes of 5-14 mm, width – 6-8 mm in the cultivating cotton plants and 2-4 mm –in wild cotton forms.

The weight of a single seed ranges from 50 to 200 mg. At this point, the weight of 1000 seeds in the middle-stapled cotton varieties is 90–160 grams, and in the fine (long) staple cotton varieties, it is 120–150 grams.

In terms of seed science, it is a reproduction unit, capable of developing into a new cotton plant progeny. The embryo (further - germ) exhibits figuratively the tiny plant (figure 34) with a root and two cotyledons. Main inherited designation of the last ones like endosperm is to nourish the young seedling with nutrients.

At this point, seedlings with a hypocotyl below them will be ready to elongate and push the seedling up through the soil. Their supply lasts until the formation of the first true leaves, which will initiate the photosynthetic activity of the plant to begin self-feeding.

The nutritive substances have aleuron spot shapes; beside them are oil drops and starch. Cottonseeds can contain between 20 and 25% plant oil. The oil accounts for 40% of germ weight. Cotton plant cultivation *G. hirsutum* L. The

seeds of the varieties of *G. barbadense* L. have the highest oil content, followed by the seeds of the varieties of *G. hirsutum* L.

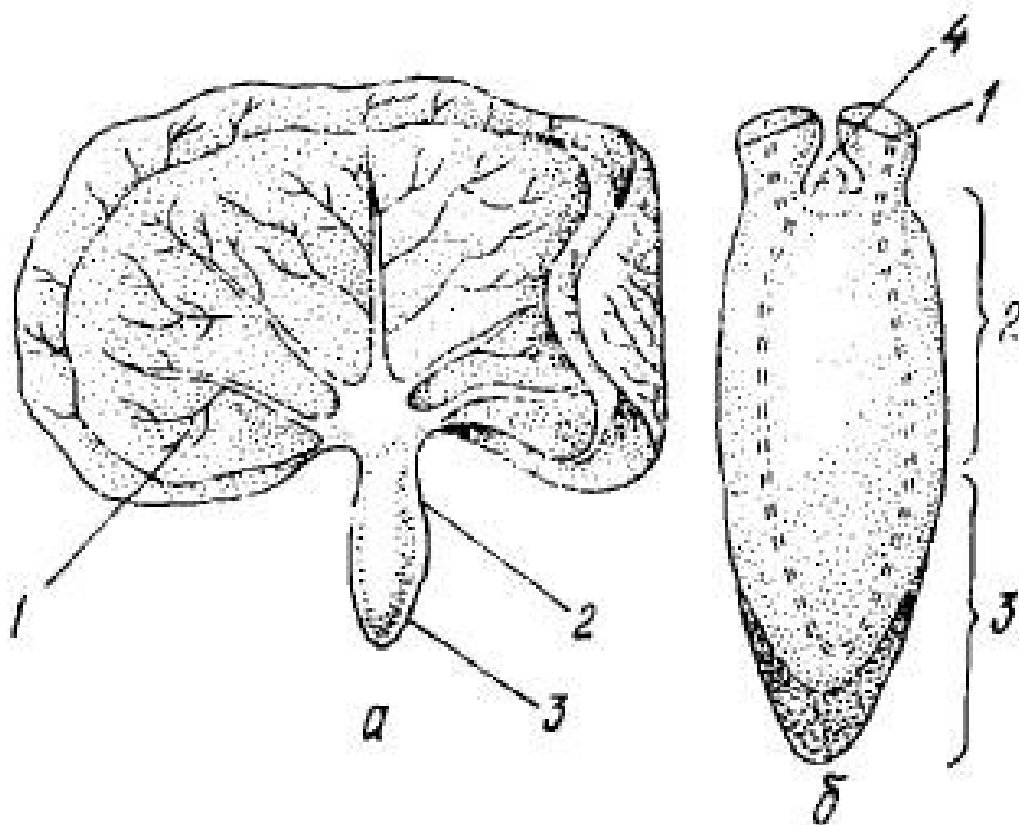


Figure 34. Structure of cottonseed germ: a-germ with unfolded cotyledons; b-longitudinal section of axis organs; 1-cotyledons (cotyledons were cut in the figure of b); 2-under cotyledon knee; 3-radical (primary root) with cover at the end; 4-shoot apex or upper bud to grow.

Cottonseed also comprises 20-22% of protein in its structure, and some of the world collection samples have up to 40%. This index is growing in the production of cottonseed meal, which reaches up to 55-60%.

The development of the cottonseed starts with the fertilization of the egg cell in the ovule of the ovary and continues according to the development of the cotton boll, which in turn lasts 50–60 days.

One of the foreign scientists whose explanation about cottonseed development was described is Thomas L. Rost (1998). First edition. Section of Plant Biology, Division of Biological Sciences University of California, Davis. According to this scientist's research, the cottonseed's development was divided into six steps (figure 36):

Step 1: Two synergid cells in the embryo sac of the ovary begin to wither and die after the pollination of a young cotton flower. The pollen tube grows along the style and penetrates through the lower ovule stalk (figure above) of the ovary and integument layers. It bears two sperm cells inside the ovule and releases them. One of them travels to the egg cell and fuses with it, giving rise to the second zygote. The other one remains and fuses with the central cell to produce the third

endosperm. So, double fertilization occurs in cotton flowers. We can see the figure below, which depicts the cotton ovule after its double fertilization.

Step 2: The second step characterizes the formation of the zygote nucleus, which will divide to form embryonic development, along with the dividing of the endosperm nucleus to form developing endosperm.

Step 3: The above-mentioned divisions of the zygote result in a proembryo and suspensor cells.

Step 4: In this step of cottonseed development, the zygote continues to undergo mitotic divisions. One of the cells will elongate and form the suspensor, which will support the young embryo in the media of the endosperm.

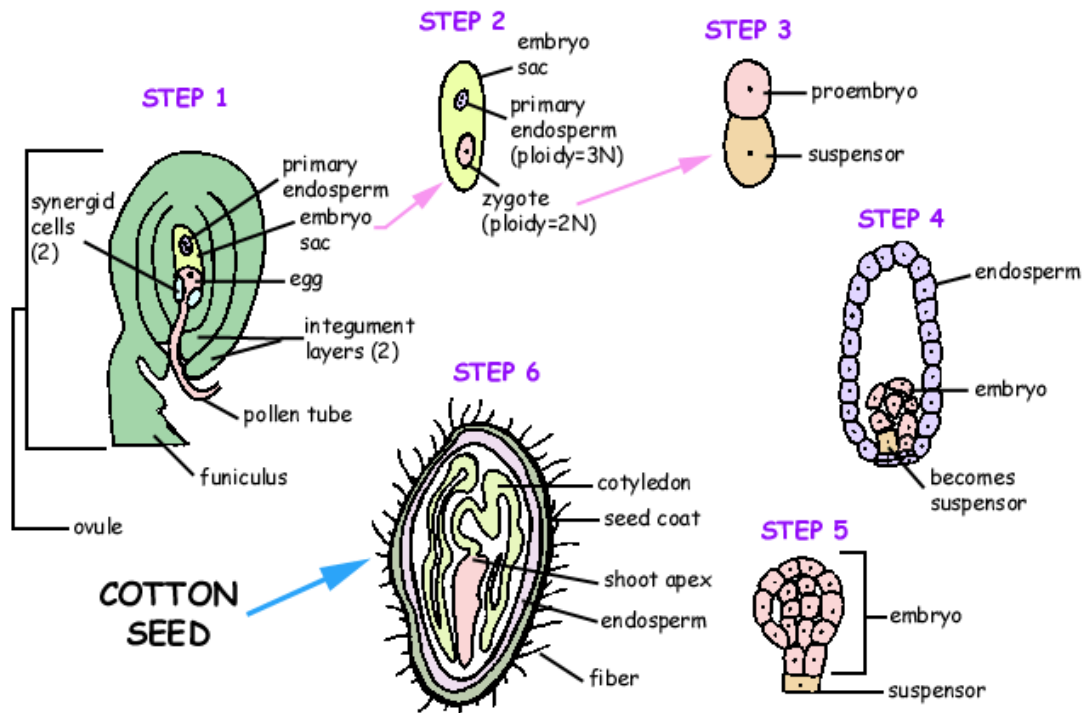


Figure 36. *Cottonseed development* (Thomas L., Rost. 1998.).

Step 5: As a result of successive mitotic cell divisions, the cotton seed embryo reaches its globular stage. The division then continues and differentiation begins, eventually resulting in the formation of two cottonseed cotyledons (see Figure 1 above).

Step 6: The cottonseed has reached maturity over time. Taking place are the formation of cotyledons, the seed coats (outer and internal), endosperm, shoot apex (the upper bud to grow), radicals, and fibers.

Observing the cotton seed after imbibing water in the laboratory (figure 37) dishes or examining the seeds that have just been started to grow under soil conditions has made it possible to find the essential inside parts of the cotton seed that form the mature plant easily and clearly.



Figure 37. The internal parts of cottonseed.

There are two well-developed folded cotyledons that form the seed leaves first. These seed leaves, after growing up out of the soil and returning to their normal state, will produce food for young seedlings. In the previous figure (4), shoot apex or upper bud refers to an epicotyl located between folded cotyledons; not visible here is a shoot that will form the main stem. The next visible part is the hypocotyl; this will be the first plant part seen above the soil in the emergence process. And the tip of the examining seedling is referred to as a radical. This is the first part to emerge from the seed coat and will ultimately evolve into the roots of the cotton plant.

The coat of cottonseed, or hull, was very strong and kept the viability of cotton seed for a long time. Famous genetic scientist N.G. Simongulyan also stated (1987) that cottonseed is capable of keeping its germination properties for a long time. For example, according to the data of Shleycher, the seeds of cotton variety 2034 have shown vigorous germination after 6 year of storage. The healthy seedlings in the collections of N.N. Konstantinov and F.M. Mauer also were taken from the cottonseeds and had been kept for 10-15 and even 30-35 years.

From an agricultural point of view, cottonseed is an important means of agricultural production. Crop size and quality largely depend on the variety and quality of the seeds planted. The high quality and variety seeds can be produced only at the conditions of severely taken special measurements, in totality involve in seed production. So, cottonseed production presents the system measurements on the producing a definite amount of variety seeds of high quality.

Chapter 2. **History of cottonseed production in Uzbekistan.**

Date of the commence of organized seed production on agricultural crops in Turkistan (the territory in which lived peoples of Middle Asia) dates back to the years of governance of Russian Tsar's Government. Namely, the first attempts to run the reproduction of cottonseeds of bred varieties had been implemented in the territory of Turkistan by the Tsar's government of Russia. In 1910, the first state seed stock cotton plantations of 70 hectares were established. It was increased to 280 hectares in 1913. It was also specifically noted in the literature that this small area of seed stock plantations had no significance in relation to the number of cotton plantations occupied at the time, which was around 700 thousand hectares. That is why, despite the availability of their own highly valuable cotton varieties at the time, the peasants used the seeds called "plant mixes" of American cotton and local guzs.

Later, the Great October Revolution took place in Russia, leading to the establishment of the former Soviet Union. Furthermore, the history of cottonseed production in Turkistan, which had left as a part of the Soviet Union, was closely connected with all cotton growing in the Soviet Union. The first decree about the reconstruction of cotton growing in Turkistan and Azerbaijan was published in November 1920 under the signature of V.I. Lenin. The rapid reconstruction of plant breeding works and the organisation of cotton plant seed production were emphasized in this decree. The major cotton committee (Glavkhlopcom) has been set up at the VSNKh since September 1921, with a location in Moscow.

Turkestan Plant Breeding Station, led by G.S. Zhaytsev, was established in 1922 for the reconstruction and development of plant breeding and seed production on the cotton plant. In its early years, this station carried out significant work on the registration and reproduction of bred variety seeds released prior to the revolution: Navrotskiy, 169, 182, 508, which later occupied all areas under cotton plant in the USSR.

In 1924, special trest of governmental seed farm-"Semkhlopok" led all seed production works on the reproduction of variety cottonseed. In 1931, it was reorganised as "Sovkhozkhlopok". It expanded the work on commercially bred cotton seed reproduction in all governmental farms under its supervision.

It should be noted that in 1924, the Turkestan plant breeding station had organised a network of variety trial plots on the cotton plant throughout all of Middle Asia and Kazakhstan. The collected scientific and practical data deserved to be the basis for the proper commercialization of available cotton varieties at that time in history.

The first seed-control station to determine the planting qualities of cottonseed was set up in 1924 in Tashkent by the Turkestan Cotton Committee. However, due to a lack of methodical manuals for conducting laboratory analysis of cottonseeds and even qualified specialists, this station was unable to complete its tasks. That is why, in 1925, it was reorganised into the seed control department of the Turkestan plant breeding station. This department has worked out the methodical manual to determine the planting quality of cottonseed as well as the

economic quality of raw cotton and the properties of cotton fiber. Simultaneously, it gave the first assessment of the cotton seed stock used for planting.

The seed-control department, with all its staff and equipment, was handed over to the agricultural government of "Glavkhlopcom," which had just moved to Tashkent, with the aim of operational management and the assessment of the seed fund for cotton plants. In 1930, branches of the seed-control department were set up at the enlarged cotton ginning houses in Andijan, Kagan, Urgench, Dushanbe, and Chordjau to manage the direct provision of seed stock and determine its quality. Later, they were reorganised into seed-control laboratories, and their numbers were increased.

After seed producing agronomy had been introduced at the enlarged cotton ginning houses in Andijan, Namangan, Kokand, Bukhara, Chordjau, Urgench, simultaneously with the organisation of seed-control affairs in 1925. Seed producing agronomy manages all measurements on the seed production in the cotton ginning houses and in the fields of peasants, and at last they watched as only variety seeds were sown in the fields, controlled the movement of only the best batches of variety seeds, and visited the peasants' plantations to explain the seed production rule and best seed selection.

However, in the beginning of the 1920s, seed production works with cotton plant had meant to simple reproduction of variety seeds, the special steps to maintain the variety clearness didn't conducted. That is why, since the middle of the 1920s, it has been obvious that seed stock is very contaminated by the off variety plants, where the variety indexes fall by 40 to 50%. Since 1925, hand clearing of seed plantations from impurities—naked (black cottonseed) and bright green (blue cottonseed)—has been practiced in all peasant and government farms to improve the variety grade of seeds. Such kind of seed clearing was used in the practice annually until 1937 when was the full replace the varieties of Navrotskiy and other varieties developed prior to the Great October Revolution. Field variety clearing in the variety of Navrotskiy from impure plants (blue and black seeds) was conducted for the first time in all seed producing state farms in the autumn of 1925. But these measurements do not lead to improving of the variety clearness of the seed fund. Consequently, since autumn of 1926 there were begun the preparation of the laying out of elite nurseries. Prior to this, the collaborators of the Turkestan plant breeding station carried out individual selections in the seed producing farms on the varieties of Navrotskiy, 169, 182.

In 1927, the first elite plantations in elite-seed producing farms were established with seeds of individual selections. So, already in 1927, the main system for correctly leading the production of seed with cotton plants, elite-seed producing farms, and seed-control points was established. Furthermore, only the development and refinement of their method, as well as the management of their works, are required. But, at the beginning of the 1930s, it was seen that there were some organizational hitches in the structure of cottonseed production. The reproduction of seed stock did not follow the state plan: elite seeds were produced only in state seed producing farms, and their subsequent multiplication

(reproduction) did not correspond to the general demand for planting seeds. Organs of cotton clearing industry – Republican cotton trusts managed above the provision of seed stock (fund), determining planting quality and distribution the seeds to plant.

Testing and the commercialization were under the guidance of the plant breeding – experimental establishments. This has rise no use and harmful multi-variety order.

In 1932, the State Cotton Inspection (SCI) program was set up with the aim of improving the quality of raw cotton, cotton seed, and fiber. Seed-control laboratories and classification points of cotton ginning houses are involved in the authority of the SCI. Production-control laboratories were set up in the cotton ginning houses at the base of these organizations. The methodic guidance outlined above for these laboratories was implemented by the Central Seed Control Technological Laboratory. But this between-organizational organ was non-purposeful, and since the second half of 1933, the SCI has been liquidated. And the control for the quality of raw cotton, fiber, and seeds was assigned to the cotton ginning industry.

And at this period of cotton growing history, planning and managing above all agricultural production, including cotton growing was concentrated in the organs of Narcomzem and the planning and managing of the cottonseed production were also handed under their governance.

This reform could considerably improve the organizational aspects of cotton seed production, but not entirely. Because, seed fund provision and seed-control were fully isolated from Narcomzem and concentrated in the organs of the cotton ginning industry. Absence of single supervision, an inadequate network of elite-seed production farms, multi-variety order, and continuous mixing of seeds at the cotton ginning houses (plants) lead to contamination and biologic segregation of the main mass of cottonseed fund. The degree of variety indexes of seed fund fell to 42% in 1933, with a simultaneous worsening of fiber quality.

The confusion of the seed affair on the cotton plant and grain crops, as well as the need to bring it under control, were emphasized even at the country's XVII (th) congress of the All Union Party, which took place in January 1934. In August 1934, the Sovnarcom USSR adopted the resolution "About measurements on the improvement of cottonseed production works," which put the beginning of the correct organization the system of cottonseed production under the single supervision of Narcomzem. The scheme of five-year renovation of seeds has been accepted, elite-seed production farms build up in the collective and soviet farms, as well as set up cottonseed laboratories of Narcomzem at the cotton ginning plants and republican seed stations, the state variety trial handed over to Narcomzem leading.

In a short period of time, the widening network of seed production organizations engaging with the accelerated reproduction and introduction of highly productive cotton varieties into production has been unrolled. Planned reproduction of variety seeds and state control on the all stages of seed production

have provided the improving of seed material quality, variety clearness of cotton seed fund since 1937, its rate has rose up to 97%. In addition, the seed planting quality of seed fund has been increased over 90%, plantations of cotton plant were planted with the seeds of first and second seed classes on the germination over 90%.

According to the data presented in the first, widely known textbook on "Genetics, Cotton Breeding, and its Seed Production," published by famous geneticists, cotton breeders, and seed producers N.G. Symongulyan and others (1987), the process of seed production of the cotton plant had passed through three historical stages:

The first stage. The seed-controlling affair has only recently begun to develop since the period from 1922 to 1925, which was exclusively characterized by the simple reproduction of variety seeds in state seed producing farms without the use of special, scientifically substantiated seed production procedures.

The second stage. The period from 1927 to 1934. This period is characterized by the creating of elite-seed producing farm networks in the state seed producing farms, organization of seed-control establishments. Elite seed production did not coordinate with the total demand for seeds for cotton planting. Leadership over the production of seeds, their provision, and their distribution was in different organizations: their production—in the system of land farming organs and provision, quality definition, and distribution—in the cotton ginning industry. The cotton variety trial was, in the beginning stages of organization at the plant breeding station.

The third stage. This stage had begun in 1935 and continued until 1991, when our republic adopted its independence and started new reforms in agriculture. It was the creation of successive system of cotton seed production, involved in two relatively connected divisions:

1. Private seed production on the five-year scheme of seed renovation;
2. The seed affair – selection and seed fund provision, determination of seed quality, and distribution of the seeds for planting.

The deepest reforms of all cottonseed production systems, implemented in 1935–1936, not only sharply improved the planting and variety quality of seed fund also ensured the rapid extension of high-quality varieties developed by Soviet plant breeding. In its turn, this made possible a considerable increase in the productivity and quality of cotton products. If the first variety change occurred during the first period of seed production organization (1922-1930), and each of the next three variety exchanges occurred between 1935 and 1950, due to the proper organization of all seed production systems, only three years were required.

Moreover, it was specially noted that four variety changes passed on since 1922 to 1950 have provided an increase in productivity on average of 30–35% and significantly improved the economic quality of planting cotton varieties: on average, the size of mature bolls increased from 4.5 g in 1914 to 7.2 g in 1970; fiber output has also increased respectively by 29–30 and 34–5%; and the length of fiber has also prolonged from 26–28 to 31–33 mm.

Since 1970 to 1973, the system of cottonseed production has undergone its fifth variety change. During the three years, the main cotton variety 108-F was replaced on an area of 1 300 000 hectares with new wilt-resistant Tashkent varieties (see the chapter on cotton variety changing).

Historically, a great regulatory role in the enhancement of the cottonseed production system of the republic has been working out the scientifically substantiated cottonseed documents. In particular, the Ministry of Agriculture of the USSR has approved "Instruction on the determination of cottonseed planting quality," which was prepared by the Seed governance and published in 1963. These documents were a major source of guidance in the preparation of new methods and manuals for annual planting seed provision until the advent of the contemporary seed production industry in Uzbekistan.

By the way, our republic has adopted its independence (since 1991) and started reasonably decreasing the cotton planting areas by extending plantations under grain crops. This new situation with agricultural reforms leading to transformation of production process management from state monopoly into marked orientation required the new reconstructions of seed production.

In 1995, the State Center for the Certification and Quality Control of Agricultural Crops ("Uzdavurugnazoratmarkaz") on the Base of Republican Cottonseed Production and its Centers in the Karakalpakstan Republic and in other regions were established (photo 106).



Photo 106. The main entrance of the office of "Uzdavurugnazoratmarkaz".

In 1996, the national law on the seed was adopted by the government of Uzbekistan, and it was amended in 1997.

Functioning GOST standard 5895-75 of the USSR on "Cottonseed," Variety and Planting Quality of Cottonseed (1976), was replaced with the new standard of O'z DSt 663-2017 on the planting of cottonseed.

Further perfection of the functioning seed laws took place depending on the deepening of agricultural reforms in the new Uzbekistan. The last contemporary

law **"About seed production"** has entered into practice in 2019. In particular, its aim is to put into order the relationship in the field of seed production.

Its 3rd clause concerns the definitions of approval, hybrid seeds, original seeds, patent owner, population, seed reproductions, seed stocks, genetic (variety) quality of seeds, planting quality of seeds, seed planting quality, seed stock heap, seed production, and elite seeds. 4th clause: producing categories like origin, elite, and reproductions. 5th clause: variety, hybrid, population, and seed stocks are given a new interpretation and are very important for students and teachers to use in their educational programs.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton seed production”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Cotton seed			
2	Formation of cotton seed			
3	Economic importance of cotton seed			
4	History of seed production			
5	State law on cotton seed production			

Chapter 3. Theoretical basis of seed production.

Genetics is the theoretical basis of cottonseed production, as with other agricultural crops. As a result, all genetically identified principles of heredity and variability serve as the fundamental foundation for all cottonseed production actions. Ignoring of principles of genetics by the breeders and cottonseed producers leads to the unavoidable mistakes, which is particularly not acceptable in the seed production, which is correctly connected with the production.

The task of seed production is consisting of the reproduction of high quality, variety seeds with keeping all phenotypic, economic-valuable, biological traits and properties, relevant to the certain variety. To give a precise definition in the understanding of the term "variety" is very important in the correct organization and conduct of all methods for the multiplication of variety seeds. Usually, **variety** is defined as the totality of typical plants based on their phenotypic- biological, and economically valuable traits and properties. But, this kind of definition does not give a presentation about its genetic structure, which depends upon the way of propagating this crop.

Based on their genotype, self-pollinating crop varieties form a population with relatively homozygous lines, whereas out-crossing crop varieties form a heterozygous population. In this case, it can be easily believed, as an example of segregating heterozygotes. All varieties of agricultural crops are created through selection. Gradually, due to self-pollination, the transition from heterozygous to homozygous forms takes place in the process of selection and variety formation. N.G. Simongulyan (1987) explained that the heterozygous state of the initial material is defined by the one pair of alleles Aa.

At the self-pollinating, as heterozygous and so homozygous individuals appear in the result of segregation from such heterozygous plants. Percentage in every sequenced progeny getting down, what can be traced by following scheme of segregation:

$$\begin{array}{l} \text{P} \quad \text{Aa} \times \text{Aa}. \\ \text{F}_1 \quad \text{AA} + 2\text{Aa} + \text{aa}. \\ \text{F}_2 \quad 4\text{AA} + 2\text{AA} + 4\text{Aa} + 2\text{aa} + 4\text{aa} \text{ or } 3\text{AA} + 2\text{Aa} + 3\text{aa}. \end{array}$$

With all individuals having similar fertility and self-pollination, the number of different genotypes (table..) in the offspring of one plant that was heterozygous for one pair of alleles can be easily calculated.

The number of different genotypes (table 52) in the offspring of one plant which was heterozygous per one pair of alleles at the similar fertility of all individuals and in full of self-pollination can easily be calculated by the next formula:

$$(2^n - 1) \text{AA} : 2\text{Aa} : (2^n - 1) \text{aa}; \quad \text{where } n - \text{number of progenies.}$$

Table 52. Determination of genotypes in the progenies of one cotton plant (N.G. Simongulyan and others, 1987).

Genotype	Offspring									
	1	2	3	4	5	6	7	8	9	10
AA	1	3	7	15	31	63	127	255	511	1023
Aa	2	2	2	2	2	2	2	2	2	2
Aa	1	3	7	15	31	127	127	255	511	1023
Heterozygous in %.	50	25	12.5	6.2	3.1	0.8	0.8	0.4	0.2	0.1

According to the data in the table, the number of heterozygous individuals remains constant, the number of homozygous individuals increases continuously, and the percentage of heterozygous individuals decreases gradually from progeny to progeny up to two times before reaching 0.1% in the tenth progeny.

The same process is slipping away along with all other alleles of heterozygous initial material. The most valuable economic and biological traits and properties of homozygous cotton lines will be retained in the population through artificial and natural selections. Consequently, for the self-pollinating plants, owing to their way of multiplication, the maximum homozygous state is a natural normal state. Their viability is defined by the favorable combination of homozygous genes. That is why, as a rule, selection in the genetically uniformed varieties of self-pollinators does not give expected results and consequently is inefficient.

New cotton varieties can sometimes be created by selecting different biotype plants from the offspring of even genetically uniformed cotton varieties that arose as a result of natural crossing or mutation and have significant differences from the initial variety on one or more desirable traits. A bright example of such facts is the long-cultivated cotton variety 108-F, which was registered in 1947 and used in production until the 2010s. Its origin is described as the result of natural out-crossing of different variety diversities and selection. And another variety A-40 registered in 1960 was created through the way of selection of desirable biotypes out of the variety population of 108-F in the condition of lowered temperature. The cotton variety AN-209, registered in 1961, was also developed similarly from another variety, S-1225. Later, in 1991, cotton variety Avval-1 was registered, which was also created through selection from the cotton variety population.

It is widely known, that the heterozygous state is kept by the continued crossings within the variety population in the outcrossing crops. They also confirm that due to this phenomenon the action of recessive harmful alleles is suppressed by which usually all out-crossing populations are being satisfied. Selections are being made in the out-crossing crops, as cotton plants give some positive results. Here, the creation of the same cotton variety, 108-F (photo ..) and selections done continuously by the breeder L.V. Rumshevich can be learned as a good historical example. This variety was the result of selections made from a heterozygous cotton population between Acala and Cook. It had become a main cotton variety between 23 middle cotton varieties commercialized in the fourth strain changing (1947-1970) and highly valued by the peasants for its good advantages on its superior

adaptation to environmental adverse conditions, for 6 to 8 days earliness, 15-20% more yield before coming of the first colds and 0-5% more by entire crop than the major variety (S-460) of the third strain changing. It was planted not only in our republic but also in the areas of neighboring cotton growing countries, with the total area, reaching 1.6 million hectares in 1976.

The overwhelming majority of self-pollinators are also capable of outcrossing over time. This property has been elaborated in the process of evolution and necessary for perfection of species and formation of new species in natural conditions and as new genotypes establish and increase possibility of natural selection. Heterozygous biotypes with new combinations of alleles from such crosses will be exposed to the effect of selection either at this time or after transitioning into a homozygous state.

Apart the out-crossing, mutation is formed as in the self-pollinators and so in the cross-pollinators during the reproduction. Most of them as stated N.G. Simongulyan (1987) effect negatively on the vitality of organism. Negative recessive mutations in the self-pollinators transferring into a homozygous state appear phenotypic, and under the action of selection, they get away from the population of varieties. Harmful dominant mutations that appear phenotypically will rapidly throw out populations of varieties. Consequently, the population of self-pollinators are free from load of harmful lethal and semi-lethal mutations, as it has a place in the cross-pollinators (as these mutations as rapidly transferred into homozygous state, appear phenotypically and get rid in the process of selection). Exactly that is why, prolonged self-pollination in the self-pollinators does not lead to depression in the state of biological useful and economic-valuable traits and properties. Cross-pollinating crops lead themselves entirely other way. Due to continuous crossing of harmful mutations, leaving in recessive, in heterozygote state does not appear in them, and at the compulsory self-pollinating they transformed into homozygous state – appear and gives depression in the relations of useful traits and properties.

As seen visually, self-pollinating varieties are worsened not under effect of prolonged self-pollinating as it is representing by some scientists but for other reasons. These reasons—biological and mechanical contaminations of varieties that progress gradually in the absence of selection, as in the self-pollinators and the cross-pollinators.

Biological contamination. It rises as a result of natural crossing with other varieties as well as continuous mutation, which is not affecting its vitality but, without selection, gradually contaminates the variety.

"Mechanical contamination of the variety" means the accidental mixing of the seed of one variety with the seed of another variety. It can happen at the cotton seed ginning house and farms when several planting seed materials are stored together in one barn, when those materials are transported with different kinds of devices and mechanisms, when two varieties of seeds are planted with one seeding drill, and so on. Mechanical contamination depends on the organization and accurate conduct of all seed production measurements, and by fulfilling the

rule of seed production, it can be brought to a minimum. There is no possibility to liquidate biological contamination because it does not depend on man. Biological and mechanical contamination of the varieties leads to the loss of productivity properties, resistance to diseases, and worsening of the product qualities.

Variety renovation is conducted in order to combat variety contamination through regular renovation of the seed material through the production of elite seeds.

Elite seed – foundation of seed production in agricultural crops, the initial phase of which begins the process of planting seed fund. Consequently, the quality of seed for planting mostly depends on the qualities of elite seeds and the methods of their reproduction. There are arguable moments in the elite cottonseed reproduction methods and before all about purposefulness of conducting inter-variety crossings. According to the authors of the last well-known textbook on the "Genetics, breeding, and seed production of cotton plants" (1987), they were recommended by some of the scientists as the means to fight cotton variety degeneracy at its self-pollination. They also added that in order to answer this question correctly, it is primarily necessary to decide: to what crop does the cotton plant belong? - self-pollinating or cross-pollinating. Their criteria may be the possibility or impossibility of the plants getting pollinated by themselves or by other plants. It can be classified as self-pollinating if the crop at the compulsory self-pollinating does not try any depression.

Experiments on the compulsory self-pollination of cotton carried out in our country and foreign countries showed that multi-year self-pollinations (10 or more years) had no depressive effects on any single or many economic traits. Some decrease in productivity as a result of compulsory self-pollinating has a modification character and is explained by the possible worsening of planting seed quality as a consequence of the oppressive action of the isolator, as well as the restricted landing of pollen on the stigma due to its position with regard to the stamen and its absence under the isolator. As a result, the absence of depression during the multi-year self-pollinating stage allows cotton plants to be considered as a self-pollinating crop. At the same time, some researchers identified the ability of the cotton plant to cross-pollinate (up to 10% and more). Moreover, the availability of insect attracting bright color in the internal base of the flower (photo 107, 108, 109) and the nectar extraction points around predict the inevitability of cross-pollinating. The medium of cotton plant population is a habitat of an earthly paradise for various insects and flies to development. Their activities as pollen carriers during the vegetation period transform cotton plants into a facultative cross-pollinating crop.

Cotton varieties, as the any other self-pollinating crop represent itself a population out of relatively homozygous, close lines on their genotypes and exist under the principles of self-pollinating population. The rising of heterozygous on the account of mutation and cross-pollination transfers into homozygous state and perfects by the selection. In the absence of selection, the heterozygous forms and

mutants contaminating the variety will be slowly accumulated in the cotton variety populations.



Photo 107, 108, 109. Some of representatives of natural cotton flower pollinators.

They say that the question of variety renovation remains one of the most important puzzles in seed production. That is identifying the term "seed stock" using: "For how many years do the same seeds not worsen their variety and planting qualities? To our great surprise, so far this question has not yet been resolved for any crop. The identified terms are exemplified and experimentally not well-investigated. So, the five-year scheme for cotton variety renovation established in the 30s of the past centuries had not been theoretically elaborated. While, the terms of variety renovation have a huge economic significance for cottonseed production. Because, the calculations stated that prolonging of the term for only one year admits the decreasing of the planting areas by the minimum of five-fold. This considerably improves the quality of elite seeds while lowering the heavy expenses associated with their production.

Chapter 4. System and scheme of seed production

We know that every cotton variety passes through three main phases: first-development of the new cotton variety at the cotton breeding institution and its preliminary reproduction (seed multiplication); second-comprehensive assessment of the variety on the economic traits and biological properties in the networks of state variety trial; third-seed multiplication of commercialized variety in the seed production farms and extension it into production plantations. The last phase (third) presents itself as the seed production.

According to previously created textbooks on the cotton breeding and its seed production, the seed production of cotton plants begins after the commercialization (extension into industrial production) of the new variety. That is its approval of production plantations in the definite districts. Cultivation, provision, and delivery of high-quality seed material to the farms with saving of all traits and properties relevant to the certain variety are the main goals of seed production. It is also known that cotton varieties and other crops contaminate the process of reproduction in both biologic and mechanical ways. That is why, periodical replacing of such seeds of varieties to the new, high quality ones is necessary. Accordingly, the execution of two main claims is the mission of seed production

1.Replacement of the seeds of one variety with another commercial variety. This measurement is called **the strain change**.

2. Replacing contaminated seeds with pure variety seeds of the same variety. This is called **variety renovation**.

A system of cottonseed production is existing to fulfill these claims, which together with cotton breeding and variety testing make up the following sections:

*new bred variety released at the cotton plant breeding station simultaneously transferred to the preliminary reproduction and state variety trial;

*preliminary reproduction of the new variety (until its commercialization) is conducted in the specially singled out for this intention, elite-seed production farms of preliminary reproduction, located in the farms. Here, the new variety finishing up and being propagated;

*the new cotton variety passes through the state trial by being planted in the plots of the state variety trial, located in the farms, where it is comprehensively evaluated on the biological and economical traits. The new variety showing advantages over an old variety is commercialized and approved for sowing in the definite districts

Since this moment, the seeds of the newly commercialized variety have been transferred from preliminary reproduction farms to seed producing farms for bulk propagation.

Seed production – producing the seed material of commercialized variety – implemented in the following **system** (figure ..):

Elite farms – production of the elite and the I reproduction.

Seed producing farms – production of the seeds of II (and III) reproductions.

Newly coming seeds of a new commercial variety from preliminary reproduction (figure 38) are seeded in the elite nurseries of elite-seed production farms, located in the farms of those districts to which this variety has been commercialized. The seeds taken from elite plantations are sown the next year in the same farm, and these plantations are called the I reproduction.

Section of system	Object of section	Executor
Plant breeding	Releasing of new varieties	Scientific-research institutions
Preliminary reproduction	Preliminary reproduction and finishing up to the new varieties	Elite farms of preliminary reproduction in farms and in the scientific-research institutions
State variety trial	Objective, comprehensive assessment of the new variety and recommendation to use it in the certain districts	Variety plots of state commission on the variety testing of agricultural crops
Seed production (production of seed material)	Elite seed production and I reproduction of commercialized variety Seed production of II, III reproductions of commercialized variety	Elite seed production farms in the production farms Seed production farms in the production farms
Seed affair (selection and provision of seed fund)	Choosing of seed plantations (approbation) Provision, finishing up, storage, preparation to planting and distribution of seeds to sowing. Control above the using of seed material in the farms, provision points and cotton seed ginning house. Assessment of seed sowing quality and distribution to farms	Organs of agriculture, farms State provision points and cotton ginning houses under control of cotton and seed laboratory Raw cotton and seed laboratories and seed quality controlling organs of agriculture
Methodic management and control	Methodic management and control for the works of elite farms and seed-raw cotton laboratories	Republican raw-cotton and seed stations of agriculture

Figure 38. *The system and scheme of cottonseed production in Uzbekistan.*

The seeds from the I reproduction are called the seeds of the I reproduction, they are sown the next year in the other farms and these are called II reproduction and so on. Now, the seeds taken from II reproduction are not used in the further sowing and are send for conversion into plant oil and other products. So, the whole cycle of cottonseed reproduction, from elite to 2nd reproduction lasts three years. The seed reproduction of the one cotton variety on this scheme goes on continuously, until that time so far this variety is being sown in the cotton growing farms. The elite nurseries are the starting point of seed reproduction of commercialized varieties which are laid out annually in the elite seed production farms. Here, two main activities are conducted continuously:

1.Elite seed production.

2.Selection of progenitor plants, the seeds of which will be used in the restoration of elite nurseries in the next year.

Seed affair – selection and provision of seed fund (seed stock) which involve the measurement to hold an election of fields (approbation), harvest and provision of seed material, reprocessing it in the seed clearing plants, storage, determination of sowing quality, and distribution along the farms.

By the decision of the Ministers Chamber of the Republic of Uzbekistan dated June 9, 2022, seed stock relevant to the original, elite and following generations is produced in the seed producing farms, which have the right to cultivate seed stock agricultural crops.

Such a right is obtained through the election of competitive farms throughout the agricultural regions. **The objects** of the winner farms are:

- *on the basis of a definite agreement to produce the necessary amount of the varieties' seeds and their generations to meet the requirements of the standard O'z DSt 633-2017;

- *to provide the sowing only seeds relevant to one generation of the one variety;

- *to maintain valuable economic traits and technological properties of the reproducing variety;

- *to produce seed generations possessing high quality and variety uniformity;

- *to observe the order of seed generation producing and instructions;

- *to provide conducting of agro-practices in terms and in a proper quality on the basis of recommendations worked out by the variety originators.

The functions of winner farms in the right on the cultivation of seed stock agricultural crops are:

- *disposition of crops to produce seed stock in the high fertile, convenient to treatment by the help of mechanisms, adequately provided with water, salt free and even fields;

- *mapping out the tables on the carrying out of crop rotation and agro-practices in time and fulfilment in the practice;

- *provide the farm with a professional agronomist;

- *sowing of seed stock materials treated (disinfected) with chemical preparations admitted to use (special elite producing farms are excluded);

- *to clean the areas planted to seed stock out of unwanted varieties and weeds;

- *do not plant the seeds of disease-causing plants around the seed stock areas, as well as not admit to crossing with other varieties;

- *to conduct cotton defoliation after fully harvesting the cotton seed stock crop in the cotton seed stock planted areas;

*picking up raw cotton in the seed stock area of middle staple cotton varieties by hand when available in fully split open bolls on the 1-2 places of the 3-8th fruiting branches and in the 3-13 fruiting branches of fine staple cotton varieties. Harvest with the help of machine harvesters is to be done at the 60-65% boll opening;

*to deliver harvested seed stocks of agricultural crops to the provisional organizations based on the seed stock generations correspondingly to the state standards.

Scientific-research institutions and their scientific-experiment stations, higher education institutions and elite seed production farms in the structure of the center engaging with the preliminary reproduction of new, perspective varieties of agricultural crops have the right to cultivate original and elite seed stocks of agricultural crops without taking part in the elections

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton seed”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Cotton seed in Uzbekistan			
2	Theoretical bases of cottonseed production			
3	System of cottonseed production			
4	Scheme of cottonseed production			
5	Elite seed production			

Chapter 5. **The methods to produce elite seeds and successive reproduction seeds of cotton plant.**

As we studied above, the newly developed cotton varieties will be transferred to the specially functioning elite seed producing farms, which are engaged to produce their elite seeds and their progeny seeds (reproduction seeds). The first elite farms were discovered in our cotton-growing history in 1927, when the seeds of individual selections were laid out on the first elite plantations in the elite seed-producing farms. The breeders and seed producers of those times, in order to strengthen and enhance the efficiency of the elite farms, had started the elaboration of a methodical manual. The created method by them for the producing of elite seeds of cotton plant had been constructed on the base of two principles:

1. Individual selection with inspection along the progeny.
2. Cultivating the seed stock plants in optimal conditions.

With the advancement of the entire cotton breeding process and the efficiency of elite farms, the new technique of inter-variety crossing was added to this method in 1951. The instruction was approved by the state agricultural industry of the former USSA in 1967 for a single seed nursery. The seed nursery of the 2nd year was introduced by the state agroindustry of the Uzbek SSR to elite farms in Uzbekistan. Initiation of the inter-variety crossing on the commercialized varieties with the agreement of variety authors and breeding establishments was set by the state agro-industries of the cotton growing republics and approved by the state agro-industries of the former USSA. This instruction on the production of elite cotton seeds was issued in 1981.

The last methodical manual on the production of top seed stock generations of registered cotton varieties in the elite seed producing farms was prepared in 2021 by the specialists and scientists of the Ministry of Agriculture of the Republic of Uzbekistan, the Center for Seed Production Improvement, the Center for Services in the Agro-Industry Complex, and the SRI of Cotton Breeding, Seed Production, and Production Technologies.

In accordance with this manual, the main objects of elite seed production farms on the registered (commercialized) cotton plant varieties are: maintaining characteristic properties on the variety canopy (variety typicality), good, valuable economic traits, textile properties of the variety's fiber, providing elite (selected) seed stocks possessing sowing quality properties, and fitting variety renewing (variety renovation).

Historically, elite and its reproduced seeds were provisioned in accordance with a 5-year scheme, taking into account that the seed amount would be enough to sustain variety renewal in every region:

The first year - production of elite (selected) seeds in the specially isolated elite seed production farms,

The second year - production of the first reproduction seeds,

The third year - production of the second reproduction seeds,

The fourth year - production of the third reproduction seeds,

The fifth year – the fourth reproduction is sown in the farms as the technical cotton.

In this new manual, it is underlined that elite seeds of cotton plant varieties are reproduced on the three-year scheme via the method of "inspection along the generation and individual selection without application of the method of intra-variety crossing." At this point, a first-year seed stock nursery, a second-year seed stock nursery, and a seed reproduction nursery are established. The individual selection is carried out in the second-year seed stock nursery.

The number of workers in the elite seed producing farms is defined by the number of families and the area under cultivation: one specialist (seed producer) is assigned per 8–10 hectares of land.

Reproduced seeds from individual and family harvests are used to produce elite seeds of the newly commercialized cotton varieties, which are received from preliminary seed reproduction farms. Data from the laboratory analyzes of the families are also delivered together with the preliminary seed materials (6 and 9 forms). Variety characteristics and recommendation on the agro-practices are presented by the author of the variety. Here, the indexes of laboratory analysis help to define the special features of selection and discarding out of elite materials in the field condition. The photo of the new variety is attached to the variety characteristics.

Seeds obtained from elite seed producing farms and first reproduction plantations should meet state standard requirements for variety and sowing properties.

Form 6. Register for harvest of individual selection samples and analysis.

Order number of families	Order number of individual selection.	Weight of individual raw cotton, g.	Weight of seeds, g.	Fiber length, mm.				Totally	Mean length of fiber, mm.	Marks on the seed discarding	Aim to isolate of samples	Order number of families in the last year.

Form 9. Properties of cotton plant variety sown in the elite farm.

Cotton plant variety _____

Initial year of working with this variety _____

Variety property

To prepare the primary material to sowing. A separate Form 1 register is created with indexes of harvested seeds from individual selections and families to sow in each nursery. The order of recording elite materials depends on the kind of planting method.

A plan of disposition for families is made for the seeds taken as the result of individual selections out of the first-year nurseries to be sown with the help of seed drilling or special equipment for hand sowing corresponding to the direction of the planter's movement;

At hand sowing, the seed sacks are placed in the garland view according to the order of sowing;

The beginning point of every garland is noted in the sowing register. Seed sack garlands are placed in the garland sacks, and the tags with garland numbers are tied. Sowing in seed nurseries can be done by tractor drills or by hand in the second year. But sowing of the seeds in the reproduction nursery is done only by mechanical seed planters. The seeds are disinfected prior to planting because non-disinfected seeds are not admitted to seeding.

Preparation of the field and sowing. For the first- and second-year seed stock reproduction area, the more favorable part of the field in terms of weather effects, shade, ease of watering, road communications, and control is chosen.

The seeds of reproduction and the elite of the growing variety are sown around the family plantation;

The area prepared for sowing with special devices is measured and divided into plots (parts) using a type-measure. Their board is marked with phosphate lines. Internal paths between lots must be between 0.8 and 1.0 meters wide.

with mechanical drill will be marked the lines of rows to hand planting, then rows with necessary length are divided into needed lots with the help of a cord or type-measure;

After dividing the area, the numbered wooden pegs are distributed along their future rows on the beginning rows of the families and on every fifth row of the individual selections. At the time of distribution of seed sacks along the plot,

the correspondence of the numbers of list in the sowing register, row number, pegs' number, seed sacks' number are inspected attentively by the senior seed producer;

At the time of seed planting, all the pegs of registered rows are set in by the side of internal path on the beginning part of the rows with the help of a building hammer, and the correctness of this marking is checked just after ending the seeding of all seeding materials.

The displacement of the nurseries must be subsequent, without gaps. The part of the plot needed for one full passing of the drill or two is preferable to choosing one for every family in the seed reproduction nurseries.

According to the scheme of plant disposition, interrow distance in the family and seed reproduction nurseries is formed depending on the plant architecture: 60 cm for zero-branch plant varieties with 20 cm for nests; 1 and 2 types of branching at 30 cm and 20 cm for all varieties with 90 cm between rows.

Single stands of plants are obligatorily ensured in all nurseries, like seed reproduction nurseries;

The return of the tractor during drill seeding and interrow cultivation is not permitted. Loading the seeding materials above the seeding equipment by the assistant staffs at the time of seeding must be done on the basis of the calculation that the seeds are enough until two movements—up and down;

The placement of seed sacks on the seeding apparatus at the beginning of seeding is compared with nurseries' plans. Immediately after the end of the seeding of every lot, the feeder of the seeding apparatus is cleaned out of seed residue.

The field designated to be planted under elite seed production in the coming year is compulsorily cleaned out of plant residues and their roots. Except for this, the fields with fertile soil that may produce bumper yields are isolated to be planted under elite seed production and provided with enough elite seed material.

Agro-practice features of elite seed production plantation. The plan of agro-practice measurements conducted in primary materials and elite plantations is annually composed by the head of the elite seed producing farm. This plan is approved by the head of seed production for the government of the region. Agro-practice measurements for every nursery are taken into account separately in the special notebooks.

In the nurseries, two methods of plant thinning (photo 110, 111) are conducted. The first is conducted at the time of one or two true leaves forming by leaving two units of seedlings per nest, and the second is conducted when two or three true leaves form by leaving only one healthy seedling in the nests. At the plant thinning, the first must be removed: disease-infected plants or plants delaying their development (take a look at the data in tables 11, 12, and 13 presented in the teaching manual of cotton breeding and seed production, published by M. Ashurov and others in 2022).



Photo 110, 111. Cotton plant thinning in Burkhan farm, located in the district of Okkurgan, Tashkent region designated to produce of high cotton seed generation of the variety of S-6524 (2018).

Replanting in the sparse seedling rows is allowed only in the nursery for seed reproduction. At this point, the seeds of test samples (harvested probes) are used. The replanted parts of the seed reproduction nurseries and dates are noted in forms 1 and 2 of the field register.

Form 1.

Field register.

Number of family in this year.	Number of individual selection	Number of families in the past year.	Weight of seeds, g.	Number of rows in the family.	Number of seeds planted in the nest.	Notes.	Number of family in this year.	Number of individual selection	Number of families in the past year.	Weight of seeds, g.	Number of rows in the family.	Number of seeds planted in the nest.	Notes.

Form 2.

Field register.

Period of flowering _____

1-date of field observation _____

2-date of field observation _____

3-date of field observation _____

Number of families in this year.	Number of families in the past year.	Number of rows in the family.	Total number of plants in the family.	Results of the field observation (number of plants)						Discarded for sparse seedlings.	Number of discarded plants.	Discarded plants in the selected family.	Discarding reasons of family.	Number of selected plants.	Number of bolls harvested from 1 st year nursery.	No of samples of the individual selection.
				Sterile plants.	Removed		Disease infected									
					Number	Off type plants	With bacterial blight.	With wilt.	With pest.							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Plant topping is prohibited in the nurseries. Because it is difficult to inspect elite material to evaluate phenotypic and economic traits, topping of plants in the seed reproduction nursery is allowed after variety cleaning, in accordance with the center for seed production's improvement.

PRODUCTION OF ELITE SEEDS THROUGH INDIVIDUAL SELECTION

1st year seed stock nursery.

At least 1500 individual selection seeds from samples produced in the individual selection method from the 2nd year seed stock nursery of the previous year are sown in the 1st year seed stock nursery. At this point, the seeds of every individual selection are sown in individual rows with 40 nests.

In the nurseries, three types of field observations are carried out: the first at the beginning of flower formation, the second during the mass flowering period, and the third before harvest, at the beginning of boll maturation. The results of field observation are recorded in field registration (form 2), which is composed on the basis of the sowing register.

The typicality (genetic identity) of families to variety, general development, precocity, susceptibility to diseases and pests, productivity, and other economically valuable traits are evaluated by thoroughly taking account of the growing conditions of plants. Some of the plants encountered in the family, which are not typical of the variety, are removed. Discard (rogue) the families if they have more than two off-type plants (5 percent of the total number of plants).

Discarding off-type plants from the variety is the main objective of the 1st and 2nd field observations, along with the removal of off-type plants from the selected families and the evaluation of the growing condition of each family.

The total number of plants is defined before the first field observation. The second observation on the following main phenotypic traits defines the plants' and family's typicality to the variety: size of leaves, shape and view, pubescence of the main stem and leaf, branching type, flower leaves, and plant architecture. The availability of the special stain on the base of the petals of the flowers and their color are additionally taken into account when conducting field observations on the fine staple cotton varieties.

Growing condition of the cotton plant and its influence on the phenotypic traits is to be taken into attention at the evaluation of the plants' typicality to the variety. They are compared to the normal developed plants at the time of evaluation of the typicality of the plants to the variety and discarding.

Additionally, cotton ball size and shape are taken into consideration at the time of the third field observation. The main assessment of elite materials on economic traits is given on the basis of the results of the second observation. Assessment is done on the typicality of the variety, accumulation of fruiting elements, boll split opening and enlarging rate, resistance to diseases and pests, and other economically valuable traits.

Families that are more susceptible to diseases, severely harmed by pests, low yielding, and non-typical to the variety than the norms accepted in the manual on the approval of the second group of fields are also discarded at the end of the third field observation period. The red label with the mark "discarded" is attached to the first plants of discarded families.

Additionally, the non-typical plants for the variety are removed in the third field observation, and the families that have more than two non-typical plants over the course of two field observations are entirely discarded. Simultaneously, the numbers of plants subjected to wilt, bacterial blight, and root rot in the selected families are counted.

The infected plants by the diseases are marked by the breaking down the plant top and (photo 53) and their raw cottons are picked up separately to the discarding. Calculated the number of plants in the selected families remained for the provision of seed stock raw cotton.

Crop of seed stock raw cotton in the 1st year seed stock nursery is harvested in the following order:

Totally, 700 selected families with 150–200 bolls of raw cotton are harvested for family harvests out of the first-year seed stock nursery. Testing samples are picked up out of normally and healthy grown plants along the family of the 2nd year seed stock nursery. At this point, raw cotton from 1 and 2 bolls located on the first and second places of 2, 3, and 4 fruiting branches is picked up;

Seed stock raw cotton is harvested individually on the selected families and placed in the sacks. On the sacks are written the family numbers;

To meet the requirement, 50 bolls of raw cotton are collected for testing samples from each selected family in the first-year nurseries of middle staple cotton varieties and 100 from fine staple cotton varieties. Throughout the family, testing samples are collected from normally and healthy grown plants. Picking up is done out of normally developed bolls located on the first and second places of 3rd and 4th branches of every plant;

To count the harvested bolls, they are placed in boxes with cells or counting bags (photo .87). Testing samples harvested from every family are placed into a special sack with the family number;

Testing samples, discards, and family harvests of seed stock made from raw cotton are implemented under the straight guidance and control of the staffs of an elite seed production farm. Raw cotton of the unfitted and discarded families is harvested as the technic raw cotton.

The 2nd year seed stock nursery.

At least 400 families are sown in the 2nd year seed stock nursery. Seeding of every family is conducted depending upon the seeds' amount to the several rows with 100 nests each one.

In the 2nd year seed stock nursery, the formed raw cotton crop is harvested in the order of: testing samples (sample harvest), individual selection samples, family harvest of seed stock raw cotton, as well as technical raw cotton from discarded plants.

Three field observations are conducted in the nurseries: the first time when the plants figure out how to flower, the second at the time of mass flowering, and the third – before boll maturation, that is, before crop harvest. The results of the field observations were entered in the field register.

The similarity of all planted families to the variety, general development, precocity, susceptibility to diseases and pests, and other economic peculiarities are carefully observed in the field and evaluated while taking the cultivating condition into account. Encountered non-typical plants to the variety are removed and the families having more 2% non-typical plants than total number of plants are discarded and not to be harvested as the seed stock raw cotton.

The major goal of the field observation is to discard non-typical families for the variety, remove non-typical plants from the varieties in the selected families, and assess the growing condition of the family;

The number of plants infected by wilt, bacterial blight, and root rot in the fitted and selected families is counted. Disease-infected plants are marked by breaking down the plant top in order to harvest their crop.

On the selected families, the number of plants left for the provision of seed stock raw cotton is calculated (without repeated counting of plants in the field).

The first, second, and third field observations are conducted in the same manner as the observations in the first-year nurseries.

Growing conditions and their impact on the phenotypic traits of this variety must be considered when assessing the plants' similarity to the variety.

Isolation of individual selections is started after field observation work is completed. Plants that are disease-free, typical of the variety, and have a sufficient accumulation of fruiting elements are marked. Isolated plants for the individual selections are marked with their own raw cotton, and their number is written on every family in the field register.

The number of samples prepared using the individual selection method is defined by considering the task of seed production improvement center on the variety's seed multiplication and the plant's decision to send the seed to other elite farms. At least 3 to 5 thousand (3 000 – 5 000) individual selection samples are being provisioned in every elite farm.

Individual plant selection is carried out by government specialists and agronomists from the elite seed producing farm. Individual selections are marked in 90% of all planted and not discarded families.

Just before harvesting individual selection samples, the plants are inspected again by government specialists and agronomists of the elite seed production farm, and plants that are non-typical to the variety, late ripening, or prone to diseases are discarded. The field register is marked with the results of the repeated inspection. 300, not discarded families of cotton varieties with at least 18–20 kilograms of raw cotton are harvested and taken to the seed reproduction area of the 2nd year seed stock nursery. Seed stock raw cotton is harvested individually on every family and placed in the sacks. The family numbers are written on the sacks.

100 bolls of raw cotton are picked up from every selected family to test samples. At this point, 1-2 units of raw cotton harvested from bolls on the first and second places of the third to fourth fruiting branches of disease-free and normally developing plants from all families are harvested for testing. And the first-year seed stock nursery is placed in the special box or counting bag to count harvested bolls. Then these testing samples from every family are placed in the sacks with the families' numbers.

Harvesting of the crop of individually selected plants is started after opening the bolls formed on the 8th fruiting branch of the variety of middle staple cotton and the 10th fruiting branch of the variety of fine staple cotton. At this point, the numbers of sacks containing crops of individually selected plants are recorded in the field register by family.

Some plants that have changed phenotypes and are susceptible to diseases are marked with special signs during the field observation period, and their crop is harvested after the harvesting of raw cotton from typical plants to seed stock and combined with raw cotton from discarded plants to produce technical raw cotton.

Each selected family's seed stock of raw cotton is harvested individually and placed in the sacks. The family number is written on the sack.

Raw cotton seed stock is harvested only from bolls that are normally mature, developed, disease-free, and pest-free, and are set on the first and second places of the 3-8 fruiting branches. Picking up the seed stock of raw cotton from bolls set on the third to tenth fruiting branches of the fine staple cotton varieties is permitted.

Testing, individual selection samples, discarded plants, and family harvests of seed stock in raw cotton are conducted under the strict control of workers at an elite seed planting farm.

The productivity of the seed stock is calculated in kilograms per row and in grams per plant. Productivity on the seed stock raw cotton per family includes testing raw cotton, raw cotton from individual selection samples, and raw cotton from family harvest (3rd form of crop register).

The seeds from the test samples are saved to plant in the families that emerged from the seed reproduction nursery the following year.

seed reproduction nursery

At least 250 family harvest seeds prepared from 2nd-year seed stock nurseries are sown in the seed reproduction nursery.

Two field observations are carried out in the nursery: the first, before mass flowering, and the second, before harvest, which is when boll maturation begins.

Field inspection and work on the cleaning of admixtures in the seed reproduction nursery are conducted before approval. At this point, non-typical plants are removed in order to fully clean out non-typical plants of the variety and get them together off the field.

Form 3.

Register for counting of seed stock crop.

Order № of family in this year.	Numbers		Weight of testing sample, kg.	Sample weight of individual selection, kg.	Weight of family raw cotton harvest, kg.	Weight of family's total raw cotton crop, kg.	Weight of seed stock seed of family harvest, kg.	Seed stock crop			
	Plant.	Rows.						Per one plant, g.	Per one row, kg.	Tonn \ ha.	

The variety purity is again determined by the regional government specialists of the seed production development center after cleaning the variety purity of elite areas from admixtures.

If the disparity between variety purity of the elite areas and standard requirements is fixed by the specialist, the term for repeated cleaning of these areas is defined, and then variety purity is determined one more time;

The results of the determination of elite areas' variety purity are documented in the statement and approved by the regional government of the seed production development center.

A seed reproduction nursery's seed stock, raw cotton, is harvested by hand under the direct supervision of an elite seed production farm's specialties. Picking up raw cotton seed stock from good, ripened bolls set in the middle tier of plants is required at this point.

Elite seed stock raw cotton is harvested from well-ripened bolls set in the 3–8 fruiting branches of middle staple cotton varieties and in the 3–10 fruiting branches of fine staple cotton varieties.

Crops from the lower and upper tiers of plants are harvested for technical raw cotton, as are discarded, disease-infected plants from seed reproduction nurseries.

Elite seed raw cotton is dried in the special areas and placed in the new special sacks provided by the elite seed production farm.

The workers of the elite seed production farm, taking into account the numbers of sacks with elite seed raw cotton, put them in a storehouse with a covered roof and conserved them in the defined order.

For the farm's first- and second-year nurseries in seed stock disposition, the seed reproduction nursery must occupy the entire area surrounding it.

Defoliation measurements in the cotton plantations of elite seed production farms are categorically prohibited until the end of the seed stocks' harvest.

LABORATORY ASSESSMENT OF SEED STOCK RAW COTTON AND FIBER QUALITY

Kinds of analysis on the individual selection and testing samples.

The weight of raw cotton out of one boll (later boll weight), fiber output and fiber length on the pappus (a seed with its fiber) of test samples taken by the method of individual selection out of the 1st year seed stock nursery of elite seed production farm and additionally UHML-Upper Half Mean Length, Str-Strength, Elg and Mic indexes on the testing samples taken in the 2nd year seed stock nursery are determined using of HVI (High Volume Instruments) in the laboratory of state uniter enterprise “Agro-industry complex service center” (photo 117).

The weight of raw cotton crop and seeds on the individual selection samples and their fiber length are determined by the help of vilvet board and the results entered in the form 12 (appendix 6).



Photo 117. Agro-industry complex servic center.

Picking out the samples for different types of analysis.

Isolation of sample to test the crop of raw cotton.

Samples from each family tested on the four replications are collected, combined, weighted, and adequately mixed before being spread out on the table at a 6–8 centimeter thickness and leveled. After that, it is divided into 16 equal parts along the two longitudinal sections.

4-5 locules (locks in the appendix of 6) of raw cotton (totaling 66 locules of raw cotton) were isolated from every 16 parts for testing samples to determine

rupture strength, metric number, and relative rupture length of fiber. One pappus is taken from the base part of the second locule's row. The rest is added to the testing samples. A sample of 66 papayas is used to determine fiber length. Further, another sample is isolated to determine the fiber output.

In the experiments with middle-stapled cotton varieties, 9–10 locules of raw cotton samples were isolated from each of the 16 parts, totaling 155–160 locules. The pappus is taken in the manner described above. The rest of the locules (66) are used for the HVI, fiber length, and fiber output analyses.

The raw cotton from one boll and fiber output in percent are recorded on a regular basis in Form 4.

In working with fine staple cotton varieties, there is an opportunity in the taking of two distinct samples from a few masses of raw cotton (for fiber output determination and inspection in the HVI system). The pulp samples for fiber length determination are distinguished from the test samples. The rest of the locules are added to the raw cotton sample, and this sample is cleaned of impurities. The sample is then weighed to determine the fiber output. And now it is ready to gin (fiber separation) with the help of 10 saw laboratory gin installations. The samples of fiber for testing through the HVI system are isolated. And every testing sample is again combined, weighed, and counted up in the fiber output.

Documentation of the distinguished samples Every isolated sample is placed in a package made of thick paper. The nursery's family number and the name of the elite seed production farm are written on the package, which has been enrolled and wrapped in paper.

Packages and samples wrapped in paper are piled up in the groups. Every pile contains 10 samples of families with their order numbers. The pile number, nursery name, and name of analyze are written on the upper pouch.

Materials for analysis, samples harvested from the second year nursery, and a register (form-7) filled up with their order numbers are sent to the "Center of Agro-industry Service Complex" until November 15th. The center sends the results of the technological properties of fiber on a special table to an elite seed production farm for assessment.

Selection of samples for test analysis. Samples for testing at the elite seed production farm are collected as follows: In addition to the fiber length analysis samples, 35-40 pappus (100-105 pappus are used to replace the original 66) are distinguished. In the elite seed production farms, a 50-150 g ginned fiber sample taken just after ginning from cleared fiber is also taken to determine fiber output, along with a sample for the HVI analysis.

Samples taken by the all methods to conduct laboratory analysis are conserved until approving of elite material selection and discarding by the commission of Seed production improving center and "Agro-industry service complex center".

quality. For this, 1 kg of a cotton crop of a reproducing variety in the elite seed farm is ginned. And two seed samples of 10 g each are singled out of prepared seed according to the O'ZDST 21820.3-76, and the fiber residue amount on the seeds is determined.

The amount of fiber remaining on the surface of the seed after ginning must be not more than 1% in varieties of medium staple cotton and not more than 0.6% in varieties of fine staple cotton.

To determine the fiber output, the weight of the testing samples on the families is made similar grams: 250, 300, 400, or 500. The exact weight of the testing sample for every nursery will be decided by the assistant of the Seed Production Development Center.

Two testing samples of 500 g each are taken to determine the fiber output of the combined samples out of four replications in the elite testing experiment. The weight of raw cotton before ginning and the seed and fiber immediately after ginning are used to calculate the fiber output. Weighing precision is to be at 0.5 g.

The ginning of testing samples, harvested seed stock cotton, and individual selection samples are fulfilled under the control of the regional assistant of the Seed Production Development Center.

Seed cleaning is continued until it is lower than the standard index, which is prepared by the elite seed production farm to determine the cleanliness degree and fiber amount of the seed stock.

The fiber output of test samples is calculated using the following formula:

$$T_{\text{ч}} = \frac{T_o \times 100}{\Pi_o}$$

Where: $T_{\text{ч}}$ – fiber output; T_o – fiber weight; Π_o – raw cotton weight.

Fiber output accuracy on the seeds is checked with this formula:

$$T_{\text{ч}} = \frac{(\Pi_o - Y_o) \times 100}{\Pi_o}$$

Where: Y_o – seed weight.

Following ginning and weighing, the seeds of test samples, family harvest, and individual selection samples are placed in sacks and numbered in the garlands.

The fiber of test samples, after weighing and taking a sample for analysis of the technological properties of fiber, is combined, and the fibers of family harvests and individual selections are combined after ginning.

Determination of fiber length on the pappus Taking little bundles to measure fiber length. Bundles are singled out before the determination of fiber length. At this point, the sharp tip of the pappus is directed at oneself and taken in the left hand. Fiber root groups are discovered as they pass from the micropyle to the halaza of the seed skin. And the fiber of the seed is divided into two parts along the fiber roots. Little bundle is singled out from 13 of the right halves of the seed,

halaza, which is the wide part of the seed. The width of the bundle must be 2.5–3.0 mm and the thickness 1.5–2.0 mm (photo 118). All the other fibers of the seed are united. So, 40 papus are prepared on this order from every sample and put in the paper package. And at last, packages with papayas are grouped (take a look at photo 88 in the manual of this text book, published in 2022).

Preparation for the measurement. The packages are taken out of the package group according to the written order of registration. The suitability of the bundles' preparation is inspected before putting them on the velvet border. At this point, not all of the perfectly prepared bundles can be corrected or replaced with other ones in the sample. The velvet board is to be held in its right state with regard to the assistant at the time of putting papayas on its velvet face and during the other works. The putting order of the papayas in the cells of the velvet board must be similar to that shown in the photo of 119, 120. At this point, the bundles must be tightly placed on the velvet surface.



Photo 118, 119, 120. Prepared papuses and their disposition on the surface of the velvet boards

The fiber length of families and united samples in the elite testing experiment is determined by two tests of 20 papules each. Other papayas remain in the packages for repeated measuring and are saved in their packages until the approval of the act on the discarding of the elite materials.

You see, beside the velour board, there are also a tooth brush and a plastic ruler with millimeter indexes. At this point, a tooth brush is needed to correct the fiber bundle on the velvet surface and a ruler to measure the length of the fiber.

Fiber length in individual selection samples is measured using five pappuses (photo 120). At this point, four samples' pappuses can be placed on the surface of a velvet board at the same time. Usually, a team consisting of seven assistants is organized to check the length of the fiber. Two of them place the papuses on the velvet board; the third, fourth, and fifth brushes correct the bundles on the velvet surface with the tooth brush, and they verify the correctness of the works. The

sixth, seventh, and eighth are doing the measuring of the fiber, writing the result in the register, and so on.

Measuring the fiber length. The fiber length is measured with the help of glass or plastic rulers with millimeter indexes (photo 119, 120). At the time of measuring, the ruler is gently put above the bundle. The end of 2–3 single fibers is accepted as the end of the fiber bundle.

5-form (appendix 9) is used in the recording of the length of pappus taken out of test samples. The basic fiber length is selected before measuring the variety:

*for the middle staple cotton variety – 30 mm;

*for cotton varieties up to 40 mm of fiber length and for fine staple cotton varieties – 35 mm;

*40 mm, for varieties of fine staple cotton varieties with fiber length of longer than 40 mm.

The length of basic is accepted as the zero and all measured results depending on their + or – values are calculated. The measured results of pappus is recorded corresponding cells of the form with points as following: the first position •, the second -••, the third ••, the fourth -•••, the fifth -•••, the sixth •••, the seventh ••••, the eighth ••••, the ninth -••••, and the tenth -••••.

Then the fiber length on all 20 pappuses is calculated. At this, the number of every cell position is multiplied to the difference out of basic length of fiber and taken value, no matter it is positive or negative is added.

The little value gets out of big value of all differences and taken value divides to number of pappuses in the testing. And this remained a value depending on whether its + or – value is added to or subtracted from the basic fiber length. The difference between two tests must not exceed 1 mm. If it occurs, the third test is conducted, and the mean length is taken from the closer indexes of the first two tests.

At the time of measuring the fiber length of individual samples, the absolute values are written in the form-6 and the total length of the pappuses' fiber out of the individual selection samples is divided by 5. The value taken is the index of the mean fiber length of individual selection samples.

Discarding of elite materials and selection for sowing. In the period of laboratory analysis, variation rows are composed to characterize all indexes of raw cotton yield on individual selection and family harvests, and mean indexes reflecting the quality of the elite material of variety in each nursery are released. The following traits in the variation rows are distinguished into groups.

1. On the seed reproduction and second year seed stock nurseries' families:
a) weight of one boll raw cotton; b) fiber output; c) fiber length; d) fiber rupture strength; e) metric number of fiber; f) relative rupture length of fiber; h) seed stock raw cotton crop; in grams per one plant, on rows – in kgs.

2. On the individual selection samples: a) weight of seeds; b) fiber length.

3. The indexes of one trait are distinguished into classes of variation row on all families and individual selection samples. A certain rate and class boarder have

been accepted for every trait. 0.5 g. is the rate of a class on the one boll raw cotton weight for the middle staple cotton varieties.

Form 6. Register for harvesting of individual selections and analysis.

Order number of families.	Order number of Individual selection.	Weight of raw cotton yield, g.	Weight of seed, g.	Fiber length, mm.					Totally.	Mean length of fiber, mm.	Discarding sign of seed stock.	Purpose of sample distinguishing.	Last year order number of families.

4. The borders of variation rows may be pulled up to the small or big site out of the indexes of variation rows, depending on the biologic properties of the varieties.

5. Indexes are marks with the help of points (like values of fiber length measurements). Then the number of frequencies in every class is multiplied by the corresponding mean value, and the sum of the values taken for all classes is divided by the total number.

6. The agronomist of the elite seed production laboratory and his assistant discard unfits, taking into account all data concerning family and plants, field and laboratory observations, as well as their complex traits such as productivity, weight of one boll raw cotton, fiber output, length, rupture strength, metric number, relative rupture strength, and micronaire.

In 2021, 21 registered and prospective cotton varieties have been sown in 2164 hectares of 49 elite seed production farms and have produced 3 680 tons of elite seed stock raw cotton generations on the basis of this method and its instructions.

Chapter 6. **Approbation procedures of stock cottonseed plantations.**

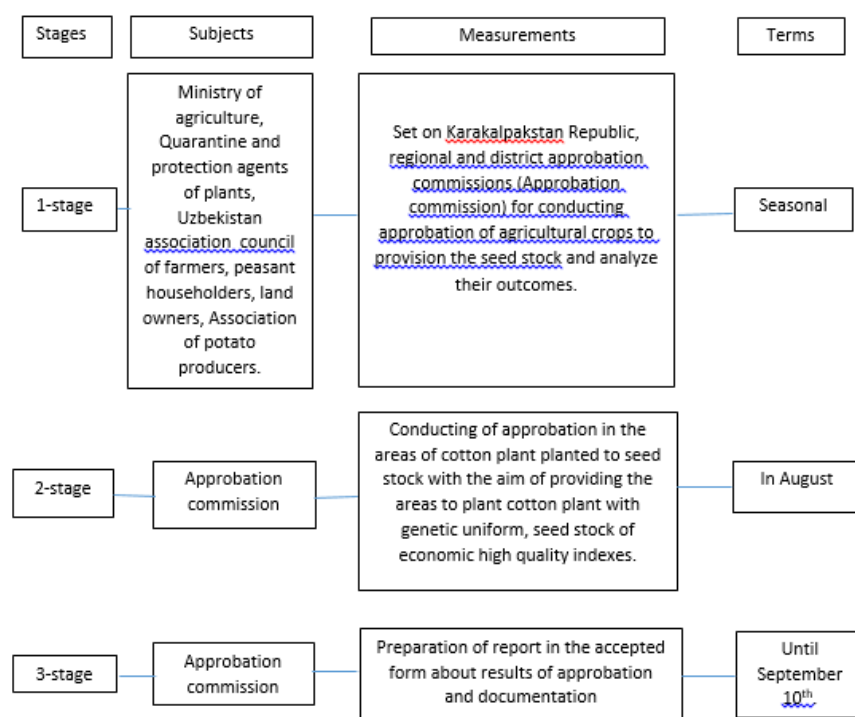
Approbation according to the state law "about seed production" published in 2019 refers to the inspection conducted in the field to determine the genetic (variety) uniformity of plants, damage by pests, infection by diseases, and general state of seed stocks before sowing.

Since 2022, 100 thousand hectares of land with high soil fertility and adequate water supply are planted for the production of seed stock raw cotton in the republic. Herein, 15 early ripening and 3 middle ripening varieties are cultivated in the 51 elite seed production farms functioning in the system of the Seed Production Development Center (Center) for the purpose of primary seed stock production.

Annually, approval procedures are implemented by the Ministry of Agriculture of the Republic of Uzbekistan. Provision of quality and quarantined seed stock out of cotton varieties in the seed stock producing enterprises of agriculture is the aim of the approval. «Uzagroinspection» - Inspection on the control of agro-industrial complexes under the Cabinet of Ministers of the Republic of Uzbekistan and its regional and district departments control approval quality and fulfilment in time.

The new instruction on the order of approval in the fields of agricultural crops planted to seed stock provision was adopted by the Cabinet of Ministers on October 12, 2021, under No. 641. According to this instruction, approval in the fields planted to the seed stock is conducted with the following scheme:

Approbation scheme of areas planted to seed stock of cotton plant.



Cotton approval is conducted from the first half of August until the 1st of September, which is the time prior to the mass harvest of raw cotton. The results of

approval are handed to the seed producers in order to compose the seed stock production plan. The approval is fulfilled by the agronomist-approbators, who passed through 3-5 days of a special preparation. The order of works must be done by them:

1. familiarity with the documents concerning the sown seeds of a farm;
2. Discarding unfit and selecting good seed stock plots;
3. Determination of plant infection by wilt and bacterial blight in order to enter every plot into a definite group depending on the infection degree;
4. Remarkable variety uniformity of cotton seed stock plots;
5. Determination of expected gross and seed stock raw cotton yields;
6. Documentation of information about approval results

Agronomist—approbatory after getting acquainted with the documents given to sown seeds will start approving. First, he inspects all cotton plantations planted for seed stock production. And discards the fields with plants of other varieties, other reproductions, fields delayed in development, less productive, and fields considerably effected by pests and diseases.

Approbation is conducted in the response limited elite farms and in the productive areas of elite, first, second, and third generations of subjects are passed through tender to seed stock production.

Determination of seed stock field's damage by wilt (photo ..) and bacterial blight (photo ...) is the important task of Approbation. This work is done through the taking of plant probes and accounting for the number of infected plants. The probes are picking by the chess method from all points of the field:

10 probes with 10 plants each are taken from every hectare of the area planted to the first reproduction;

1 probe is taken from every hectare of the area planted for the second and next reproduction.

The numbers of plants infected by wilt and leaves and stems infected by bacterial blight are calculated individually to determine infections by wilt and bacterial blight. Only the indexes of the last two plants are in the probe: it takes into account if the flower bract and scape were infected by the bacterial blight. The data on infected plants by wilt and bacterial blight (leaves, stems) are gathered individually (photo 121, 122) and sum up the percentage of the infected plants by wilt and bacterial blight in this field. In this order,

All cotton bolls out of all probes are gathered together, a defined number of infected bolls are counted, and then the percentage of boll infection is determined. Approbation is fulfilled in every plot if the farm field consists of several plots.

The fields are divided into **two groups** as a result of defining the percentage of disease-infected plants.

The fields with healthy, infected plants due to wilt and bacterial blight make up only 5 percent of **the first group**. The fields with plants that have infections of bolls caused by wilt and bacterial blight are not included in the first group.



Photo 121,122. Symptoms of bacterial blight on the leaves, stems, and bolls of the cotton plant

The second group comprises the fields that have infections by *Verticillium* wilt (5–15%), *Fusarium* wilt (up to 3%) and bacterial blight (5–10%), and bolls with bacterial blight (up to 1%).

The fields with a higher percentage of plants and bolls infected by the wilt and bacterial blight than the second group are rejected. The disease infection degree is again defined if the infection grows after approval and the field enters one of the above-mentioned groups or is discarded.

The variety purity or uniformity of the fields isolated for seed stock purposes is noted in the fields specially singled out for this purpose. One field is isolated in the first reproduction for every 10–20 hectares. Every one of the two fields of the farm are isolated for the second and other reproductions. The determination of variety purity in the isolated field is conducted in the two rows of considerably typical parts, which are 20 meters apart from each other. 100 normally developed plants are picked out of each of these rows, and the amounts of typical and non-typical plants for the variety are determined. The mean percentage of typical plants in a certain field out of two probes is calculated, which means the variety purity of the seed stock field is determined. At this point, variety purity, admixture content, and boll absence (sterility) are identified on the basis of these main phenotypic traits:

- a) size of cotton leaves; shape; color; smoothness or waviness of surface;
 - b) shape of the main stem, color, pubescence grade;
 - c) type of fruiting branch and architecture of the plant bush;
 - d) colour of the petal;
- size of bolls, shape, surface smoothness, and shape of tips

Besides the listed traits, the colour and the spot on the base of the petal in the flowers of fine staple cotton varieties are also taken into account.

The growing condition of cotton and its effect on the phenotypic traits of the variety under consideration should be kept in mind. Out of the characteristics given to the variety as well as hybrids, sterile plants are included in the group of off-variety plants. Variety uniformity percentages of plants taken from two places are compared to check the correctness of the defined variety grade. The tags with

records of 1 and 100 are hung on the first and hundredth plants in every row (photo 123, 124).



Photo 123, 124. Approbation tags and cotton field is ready to approbation.

Uniformity (or sort grade) of cotton plants Now variety uniformity indices of seed stock must be according to the state standard O'Z DSt 663:2017 requirements:

- *in the fields for elite plantations, 100 percent;
- *in the first reproduction plantations, 99 percent;
- *the second reproduction field: 98 percent;
- *And in the third reproduction field, not less than 96%.

The limit of admitted differences between two observations on the variety of purity samples may be:

- *1 percent at the variety purities of 95-100%;
- *2 percent of the variety of purities of 90–94%;
- *4 percent when the varieties are 90 or less percentages.

If the difference between two observations is greater than the fixed index, then the third row will be selected, and the analysis must be done in it. So, the mean arithmetic value of two or three observations is accepted as the index of the field's variety purity. The variety and reproduction purity are presented in the documents as whole numbers.

Less fertile, not irrigated, infected by bacterial blight, verticillium, and fusarium wilt, and with other diseases more than fixed rates, and variety uniformity doesn't meet O'Z DSt 642, planted two or more bred variety seed stock areas are remarked as unfit for seed stock provision and moved aside from seed stock provision.

The definition of the expected total and seed stock crop of raw cotton is carried out through calculation and the definition of all elements that make up yield: the number of plants per hectare, the average number of cotton bolls per plant, and the weight of raw cotton per boll. The number of plants per hectare is the most constant value out of these listed elements and has the fewest changes during the vegetation period. An average number of bolls depends on the time of year and changes during the season. The weight of one boll is a difficultly defined value that depends on the place, cultivating conditions, and time of the first cold. When calculating the expected yield, only count the bolls that are at least 10 days

old based on the size of the flower bracts. The most difficult aspect of crop forecasting is determining the average weight of raw cotton from one boll. The inconsiderable mistake in the determination of boll weight has a great impact on the result of forecasting. An average weight of boll for this variety accepted in this district is used to prevent anticipated mistakes. By the way, the weight of the boll changes as a result of the cultivation conditions, which is why a correction of the current year into accepted average weight, agro-practices, and the anticipated date of the first cold is made. The supposed productivity of raw cotton is defined for every plot. Herein, accounting for the number of plants and number of bolls on them is done in the rows with a length of 10 m in different parts of every plot. These probes are laid out through the diagonal of the plot from one corner to another, entering the plot via 10 rows each time. accounting for the number of plants along the 10 m. and the number of bolls on them. The calculated number of bolls is divided by the number of plants, and an average number of bolls per plant is used in the probes. After identification of the number of plants and bolls in the probes, we calculated the average number of plants and bolls per hectare of this plot or field. Knowing an average number of bolls per plant and an average weight of raw cotton per boll, it is calculated an average weight of the expected crop of raw cotton in gross and until frost per plant. On the number of plants per hectare, the expected crop until frost and gross are calculated.

Forecasting order of expected crop on the base of the new instruction (2021) has a special feature. It involves the determination of bolls number per plant by dividing the mean arithmetic index of bolls' number of the last two plants in the probes for each area into two. In the result of this, the expected total productivity per hectare is determined by multiplying the raw cotton yield from every plant in every area by the number of plants in the area.

Number of plants (stand density) per hectare. Plants' numbers in two from every 10 probes of elite and first reproduction (generation) and one from every probe on the next reproductions; in the 16.6 m when the row apart was 60 cm; in the 13.1 m when the row apart was 76 cm; in the 11.1 m when the row apart was 90 cm are calculated, and the mean arithmetic index of plant density is multiplied by the 1000 (length of row per hectare) in order to simultaneously define the **plant stand density** in the seed stock cotton field with cotton approbation. For example, plant number is 80 which is multiplied to 1 000 and gets 80000 plants.

40-45 percent out of forecasted total crop at the process of approbation makes of seed stock raw cotton. For example, the mean number of bolls was 22 units out of 2 plants in 80 units of probes in an 8-hectare area planted to the first reproduction of the variety An-Bayaut-2. Plant density was made of 80 thousand plants with a boll number per plant of: $22:2 = 11$ units. If the weight of one boll is equal to 4.0 gram, the crop of one plant will be $11.0 \times 4.0 = 44.0$ gram.

The plant density (number of plants per unit of area) is multiplied to crop expecting from one plant to determine the total crop per hectare:

$$80 \times 44 \text{ gram} = 3\,520\,000 \text{ gram or } 3\,520 \text{ kg or } 3.52 \text{ ton.}$$

40-45 percent out of expecting total crop is taken to define the amount of seed stock raw cotton. For example, $3.52 \text{ ton/ha} \times 40:100 = 1.4 \text{ ton/ha}$. And $3.52 \text{ ton/ha} \times 45:100 = 1.58 \text{ ton/ha}$.

The second example, 78 plants were in the 16.6 meter of row bed. It will be multiplied by 1,000, and the result will be 78 000. This is the number of plants per hectare. Then, the number of bolls per 10 plants is calculated. The calculation showed that there were 123 bolls, or one plant has 12.3 bolls. The weight of one boll was 3.8 g.

The calculation of the crop is done so: the weight of one boll (3.8) is multiplied to 12.3 and will be taken 46.7 g. of raw cotton per one plant. Further, 46.7 g are multiplied by 78 000 and taken as 3 642 600 g. or divided by 1000 and taken as 3643 kg. of raw cotton. The total productivity makes of 36.4 centner/ha. The seed stock raw cotton is prepared from half (50%) of the total crop. In this example, it consists of 18.2 c/ha or 1.8 ton/ha.

Documentation of the result of approbation. Approbation statement on the forms of 2 (Statement No. 2) is filled out individually for every farm and contains all the information characterizing the seed stock plot or field on every farm, individually for every reproduction and variety grade. The statement is prepared in three copies: one is remained in the farm, the second handed to provisional point and the third – cotton seed stock laboratory.

Beside that statement, form No. 3 is also filled out in every district. It contains of seed stock fields' characterization on every farm of the district. It has three copies: one for the agricultural governance of a district, the second for the regional agricultural governance, and the third – the raw cotton ginning house (plant). Moreover, specialists of the district agricultural department, related seed producing subjects and regional department of agro-inspection or district department are formed a report about the results of approbation on the evidence of statement about the conducted approbation and this report not late of three days after finishing of approbation handed over the regional governance of agriculture, Center and seed stock provision subjects.

Approbation statements are the major documents characterizing seed stock fields planted for seed fund provision. On the basis of these statements, a plan will be worked out for the provision of seed raw cotton and its delivery over agricultural governance systems across the republic to fix out the places of storage at the provisional points and the order of its reprocessing in the raw cotton ginning houses.

Form 2. **An example statement on the identification of a seed plantation's sort grade.**

Statement No 2. identification of sort grade.

Prior to blooming _____ 20__y.

Farm _____

Plantation _____

Agronomist _____

With the person who is responsible for seed production _____

And representative _____ from "Uzagroinspection."

Seed plantations have been inspected, and the following have been identified:

1.The area of plantation _____ ha

2.Place of area: farm _____, plot No.

3.Previous crop _____

4. The main and supplementary dressing methods, kinds, and rates

5. Time of planting and method _____

6.Distance between rows _____ and between nests _____

7.Damage caused by weeds: strongly, weekly, or mean (by leaving which one)

Occurrence of quarantine weeds _____

8. Loosing state of plants (% less than planted) _____

9.Agro-practices _____

10. Damages caused by diseases and pests _____

(kinds) _____

11. Amount of watering (and kind of method)

12. Development stage at the inspection _____

13.State of seed plantation: excellent, good, tolerable, bad (by leaving which one)

Signature of the responsible person and seal:

Chapter 7. Harvest, provision of stock seed of raw cotton, documentation and provision of seed before sowing.

Harvest of the seed stock of the raw cotton crop. Crop harvesting of seed stock (raw cotton) is the most complicated and responsible agricultural work. This is a very responsible and crucial period for creating high-quality seed stocks of cotton plants.

The distinctive characteristic of the cotton plant compared to other field crops is that the bolls of the cotton plant mature gradually, not all at once. This considerably complicates the harvest of raw cotton, especially seed stock. The quality of seed stock for raw cotton depends on the location of the plant bush and its damage by pests and diseases. The most valuable bolls are formed on the lower and middle part of the bush, on the first, second, and partly on the third cone (figure 39).

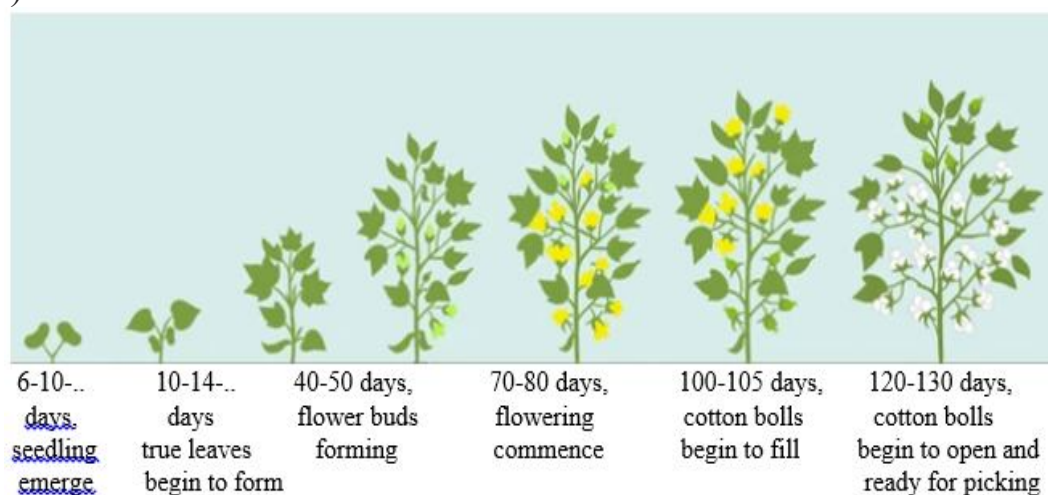


Figure 39. .*Figure out the development sequence of cotton fruiting elements.*

These bolls have time to mature until the first frost and give mature fiber and seed. Pests and diseases have a significant impact on seed supply and raw cotton quality. The bolls, damaged by rodent insects, rotted or gave raw cotton of lowered quality; the raw cotton in them has a yellowish, gray, or creamy color. Cotton aphid makes fiber dirty by secreting sticky extract and forming "white sticky mass" on the fiber. Then the specific fungus will develop on this mass and form a "black sticky mass". They significantly worsen the fiber's seed stock quality (raw cotton).

Bolls infected by the bacterial blight give immature, yellowish, don't burst raw cotton of lowered quality, and the plant infected by wilt, especially at the early growing period (June–July) also gives fiber and seeds of inferior quality. Furthermore, at the exceeded humidity of the air surrounding the cotton plants, fungus settles on the split open bolls, causing different colours on the fiber. The fibers in such bolls don't loosen, and their quality and seed are considerably lowered. Seed stock raw cotton is harvested out of healthy, normally split open bolls for the provision of high-quality seed stock raw cotton without admixing it with raw cotton of lower quality out of immature, infected by boll pests and diseases. This is the meaning of differentiated harvesting. Differentiated harvesting is fulfilled only by hand picking. Every cotton picker will be given a special apron

with two-three pockets in which to place raw cotton extracted from abnormal, immature, or infected bolls. In order to observe the rule of differentiated harvest in the seed stock field, the norm of harvest is decreased by 20–25% in comparison to the raw cotton harvest. The harvest of raw cotton seed stock is done in one or two sittings.

*The first harvest has started when there are 3-5 fully mature, normally opened bolls on the cotton bushes. Raw cotton out of only fully opened bolls is harvested; don't let harvest come out of immature, damp raw cotton out of semi-opened bolls;

*The second harvest is also conducted with the availability of 3–5 fully split open bolls on the cotton bushes. It coincides with the calendar date of October 10th, and at this time the first boll opens on the sixth- to eighth-fruited branches.

According to the new instruction (2021), the harvest of elite seed stock, raw cotton, and reproductions is done by hand, and at this:

*A) Seed stock raw cotton is harvested once; the first harvest is to be begun when there are 8–10 mature bolls on average on each plant. Prohibited the picking up of seed stock raw cotton from immature and not fully opened bolls;

*b) seed stock raw cotton out of matured, fully opened, healthy bolls, free of verticillium wilt or fusarium wilt, bacterial blight, and other diseases, is harvested individually on the groups of cotton fields and delivered over raw cotton accepting points as the seed stock raw cotton;

*c) the crop out of plants infected by verticillium wilt or fusarium wilt as well as bacterial blight is individually harvested prior to the beginning of seed stock raw cotton harvest and delivered over the raw cotton, accepting points as the quality of technical raw cotton;

*d) If the humidity of harvested seed stock raw cotton exceeds standard indexes, it must be sun-dried until the remarked amount is reached before being delivered to mill accepting points.

* Seed stock raw cotton for the provision of high-quality seed stock raw cotton is to be harvested as much as possible at the earlier terms: the Republic of Karakalpakstan, Khoerm, and Samarkand not later than the 10th of October. Harvest in all other regions is continued until the 1st of October and delivered over the raw cotton points;

* The terms of seed stock, raw cotton harvest, and provision for the regional and seed-producing subjects are fixed by the district agricultural departments.

According to the old instructions, damage to seeds in the seed stock of raw cotton at the time of machine harvest was admittedly not more than 0.5%, and humidity for the republic of Middle Asia was not more than 9.5%, not more than 10.5% in the Azarbayjan, Karakalpakstan, and Samarkand regions. The humidity of the seed stock raw cotton in the handpicking process must not be more than calculated norms (8% in the republics of Middle Asia and Kazakhstan and 9% in Azerbaijan, Karakalpakstan, and the Samarkand region of Uzbekistan).

Provision of seed stock (raw cotton) Proper storage of seed stock raw cotton in the squares of farms until delivery over the provisional point has a great importance to the seed quality. The constant place taken away from the main square is used to store raw cotton harvested from disease-effected and abnormally opened bolls in order to store seed stock raw cotton individually (photo 125).

Seed stock was raw cotton exposed to sun heating for one to two days on the square before handing over the provisional point. This sitting improves considerably the quality of seeds by accelerating their full maturation and enhancing their growing energy and field germination. The workers of the seed-producing farm periodically loosen embankments of raw cotton with the help of a pitchfork to ensure the uniform drying.

Seed stock for raw cotton, depending on the progenies, is divided into: originals, 1, 2, and 3 reproductions.

In farms where the workers are not enough to harvest all the seed stock, raw cotton, the harvest is done by special mechanical harvesters on the plant storage. Harvest of raw seed stock by common mechanical harvesters is allowed at the maturity of half but not more than 60% of bolls. But, the hand harvest of raw cotton from all plants and bolls of abnormal plants, infected by diseases and pests, is conducted prior to the machine harvest of seed stock raw cotton singled out for the machine harvest. A special attention is paid to the prevention of mechanical damage to seeds during the period of machine harvest.



Photo 125. Loosening of seed stock raw cotton to improve the quality of drying.

On the old instruction, the dispatching of seed stock raw cotton over the provisional point is accompanied by an invoice for the identified form, having a literal red strip for hand harvest and a green strip for machine harvest, in contrast to the invoice designated for the dispatching of goods (technical) raw cotton, which does not have these strips.

Elite seed stock raw cotton is placed into the new sacks (photo 126). One out of two tags with records of cotton variety, reproduction, group of fields, and site of provision is put in the sack, another is adhered to the sack, and the sacks are dispatched over the provisional point.

Raw cotton harvested from cotton balls abnormally developed and infected by diseases and pests is dispatched over the provisional point individually from seed stock and handed over as the goods.

Acceptance of the seed raw cotton to the provisional basis. According to the former rules, the acceptance of the seed stock raw cotton to the provisional basis (or procurement station) was implemented accordingly with a plan on the seed provision and approval results of cotton plantations. The correctness of the records in the invoice of the seed stock raw cotton and their correspondence to the approval statement were examined at the acceptance. Seed stock raw cotton on its quality should meet the first grade on the GOST of 16298-81 and have a humidity of 8% in the raw cotton of hand harvest in the republics of Middle Asia and Kazakhstan and not more than 9% in Azarbayjan, Karakalpak, and the Samarkand region. The machine harvest, correspondingly, was not more than 8.0 or 9.0%. Accepted seed stock, raw cotton, from every farm as a rule, piled up in the separated point (photo 127).

Raw cotton probes were taken simultaneously with the acceptance of seed stock raw cotton by the department of technical quality (DTQ) of the ginning house from the accepted raw of every farm to determine the maturity, germination, moisture, and mechanical damage of the seeds in the raw cotton and cotton seed laboratories.



Photo 126, 127. Packing and storage of seed stock raw cotton in the provisional basis.

A sample is also taken from each vehicle carrying raw cotton for quality analysis (the rate of raw cotton moisture and contamination, raw cotton class, bred and industrial grade and other traits). This sample is taken by the laboratory assistant at least three points and out of different depths. The weight of sample will not at least 2.0-3.0 kg. And another sample of 1 kg. into jar with tight lid for the determination of raw cotton moisture. The laboratories have all devices and specialists to conduct analysis in time. (table 53).

Table 53. Possibilities of the laboratory of procurement stations for determining the quality indicators of raw cotton (2018).

Total amount of the raw cotton, annually, 000 ton.	Laboratory drying device SKhL-3, unit.	Moisture measuring device, BKhS-M1 "Sifat" USKh-1, unit.	Device to analyzing the contamination, LKM, LKM2, unit.	Lab gin, PPV, unit.	Cotton grade analyzing device, LPS-4, PAM-1, ACKH-1, unit.	Electron lab scales CAS MWP-600, VLKT-500, unit.	Lab staffs, number.	Sampler, number.
3-5	1	2	2	2	1	3	4	-
5-7	1	2	2	2	1	3	5	1
8-10	2	3	3	3	2	5	7	1
10-12	2	4	3	4	2	5	8	1

The results of these analyses were considered the preliminary (forecasting) and service data necessary to select the best seed stock raw cotton batch in the necessary amount to fulfil the identified plan of planting seeds. Seed stock raw cotton was stored only in the new sacks that were accepted from the farm. Only one raw cotton batch of similar quality was stored under one barn to prevent the possible mixing of raw cottons of different qualities. And the postcards—the card-passports—were installed on every point or barn with the following indexes: no. of batch, bred variety, industrial grade, reproduction, variety grade, group of fields, no. of barn, weight of batch, starting and ending of formation, hand or machine harvest, and surname of expert on merchandise. The temperature was measured every 10 days during the conservation for control of raw cotton seed stock with the help of a thermometer. If the temperature in the 3meter depth of seed stock raw cotton becomes higher than 30°C, this raw cotton was reprocessed during a period of 2–3 months or subjected to active ventilation to decrease the temperature. The transport of raw cotton from the provisional point to the ginning house was made possible with the special containers.

Requirements to the quality of seed stock, raw cotton Since 2021, seed stock of raw cotton has been accepted and piled according to the technical order of normative documents. The indexes of contamination (weight ratio of rubbish), humidity (weight ratio of moisture), and mechanical damage of seeds are also noted on the base of normative documents to get into technical order and divided into two classes: if the moisture, contamination, and mechanical damage norms exceed the norms of the 1st class, it transfers into the 2nd class, and if it exceeds the 2nd class, it will be excluded from seed stock raw material as well as transferred to the technical raw cotton on the base of normative documents. Raw cotton accepting ginning house enterprises, cluster cotton textiles, and seed producing clusters (organizations) are specially prepared for accepting seed stock raw cotton and storing it prior to the beginning of a cotton harvesting season. For this aim, relevant barns and roofs are cleaned without fail from the remained raw cotton and seed residue as well as chemically disinfected against pests.

The provisioned amount of seed stock raw cotton, their grade, class and progenies (reproductions) is identified by the Center (Seed Production

Development Center) at the Ministry of Agriculture of the Republic of Uzbekistan on the results of approbation conducted in the seed stock areas. This information is delivered to all republican agricultural governances via the unitary enterprise of the "Service Center of Agricultural Complex" not later than September 1.

Seed stock raw cotton is accepted by the seed cotton accepting organizations on the basis of an invoice (1-CX form), statement of approbation and is gathered together in piles (photo 128, 129). Pile fields are established in the distance between every farm, occupying the square sizes of 25 x 14; 22 x 11; and 11 x 10 meters. They have to be 40 cm higher than ground level. The weight of piles should not exceed 250-300 tons, depending on the situation.

Breeding variety, reproduction, purity of variety, group of field, industrial variety, origin, and class. The height of every pile is achieved at 8.0–8.5 meters. Daily, test probes at the base of technical documents are isolated by the laboratory assistants of the provisional organizations from pilings of seed stock and raw cotton. The probes are submitted to the laboratory of the service rendering center for the testing of seed planting quality indexes, determining variety purity, and determining seed mechanic damage to agricultural crops. The humidity of the keeping raw cotton must be remain as the GOST levels: I grade of raw cotton –not more 9.0%; II grade -10.0%; III-grade -11.0% and the IV grade -13.0%.



Photo 128, 129. Piling up the seed stock raw cotton in the accepting and conserving organizations.

Raw cotton in passport form in sizes 8-XL is adhered to the conservation barn or pile. It contains records about the number of barns or piles, weight, breeding and industrial grade, class, reproduction, variety purity, field group after approbation, and name of the accepted person.

Elite seed stock, raw cotton of commercialized, prospective, and new breeding varieties, is conserved in the new sacks, which have internal and external tags, and in closed barns equipped with ventilation systems. The sacks are placed on the special wooden stands. The middle part of the sacks is left open.

The first and next reproductions of the seed stock raw cotton are piled up individually, covered with tarpaulin, and fastened with ropes to prevent moisture absorption and spoiling. The tunnel along the piles, with a height of 1.8–2.0 m and a width of 0.8–1.0 m, is dug over five days after pile building is required (photo).

The whole state of the pile, which is made of seed stock and raw cotton stored, is watched continually, and the internal temperatures are measured every fifth day. The results are recorded in a special journal as follows:

Temperature from a 4-metre depth at 8 points around the pile. The ventilation is switched on if the temperature at this point rises higher than 30°C.

Seed stock raw cotton is kept in the piles for a period of 1.5–2 months in order to reach full physiological maturity of cottonseeds and is then transferred to the reprocessing departments for producing sowing (planting) seed stocks.

Reprocessing of seed stock made from raw cotton at the ginning houses and provision of planting seed Reprocessing of raw cotton seed involves the following: handing over, drying, cleaning out trash, ginning, seed linting, packaging, and transporting to temporary storage places. Separation of seeds from cotton fiber through the use of saw or roller gins (fiber separators). Raw cotton of the varieties of medium-staple cotton is reprocessed with saw gins, and raw cotton of the varieties of fine-staple cotton is reprocessed with roller gins (photo). Residual fiber on the seeds and partial pubescence are separated from the seeds with the help of double linter in the linter-fuzz separators (photo 130, 131).

The contemporary provisioning of the seeds in the reprocessing of seed stock raw cotton for main seed sowing is implemented until February 15th. Reprocessing of batches of raw cotton seed starts with a special printed order – production task. All premises of the gin house building, technological facilities, and ways of transferring raw cotton and seeds were thoroughly inspected, cleaned from goods (technical) and raw cotton and litter prior to starting reprocessing. The seeds for the first 10 minutes of working of the gin house at the time of reprocessing are transferred to the goods (technical). The seeds of the first 10 minutes is added to the seeds previous batch in the case of reprocessing of seed stock raw cotton after reprocessing of other seed batch but with planting quality and better reproduction.



Photo 130, 131. Cotton saw gins and linters functioning in the ginning houses.

The seed stock raw cotton is exposed to the influence of working parts of gins and linters in the process of reprocessing. Protection of the seeds from the damage of seed stock cotton reprocessing is conducted by using a smoother technological regime, than goods raw cotton, with a lowered output of saw gins, not more than 560 kg of fiber per machine in an hour. Lintening of planting seeds

is carried out two times (double) on the saw linters with a total removal of 5.5%, here: in the first removal – 2.5%, and the second, 3.0%.

The technological regime for reprocessing the raw seed stock of fine staple cotton on the saw or roller gins is set individually for every variety. On the indexes of pubescence and damage to seeds, the work of technological equipment is systematically controlled at the beginning of every work shift.

Fuzzy and delinted (naked) seeds are the result of the ginning and linting of raw cotton seed stock. Almost all middle-stapled cottons give fuzzy seeds, and fine-stapled cottons – naked seeds (photo 132, 133). Their mechanical damage doesn't be more than 4.0 %.

Further provision of seeds in the ginning houses involves operations aimed at improving their sowing quality. First, the fuzzy seeds are specially treated to remove the pubescence and enhance their flow ability. Then followed seed sorting and calibration to create precise seeding mechanisms. Chemical treatment (photo 134) is obligatory against agents of diseases and microorganisms causing plant diseases or the rot of seeds in the soil after sowing.

Seed sorting. The preparation of fuzz seeds at cotton ginning plants entails seed sorting with the aid of ESKhB-4 and treatment with chemical preparations to disinfect against pests and diseases, as well as prevent root rotting and damage caused by harmful microorganisms in the soil. The part of the fuzzy seeds that is specially delinted (free from pubescence) to give them friability in mechanical or chemical ways, or wrapped up in the special preparation-coated.

Mechanical delinting is implemented by some machines. SOM-4 is deemed one of the most perfect. It almost fully removes pubescence from seeds. But it has a disadvantage in that it does considerable damage to the seeds.

Chemical delinting. Exposing seeds to strong sulfuric acid is a well-worked out method that can fully melt the pubescence. Exposing seeds to the mixed vapours of acids is a chemical way of destroying pubescence, in particular. This way of delinting takes place with less seed damage.



Photo 132, 133, 134. Outlooks of prepared cotton seeds.

Seed coating. Seed coating is the treatment of seeds with bio-active, water soluble, ecologically safe polymers by establishing a thin layer on the seeds with

the aim of improving the planting quality of seeds. The seed coating in the fuzz seeds is applied by special machines. It involves wrapping up the mixes of different fungicides with adhering substances. This method attracts great interest because of the friability that lets the seeds save longer than commonly prepared seeds, and they will not be damaged sooner under soil.

Simultaneously, the seeds are treated with fungicides to prevent from developing diseases and rotting in the soil. The establishment of a fungicide layer on the seeds is the result of the coating being firmly kept on the seeds, and after planting, they melt from the soil moisture. But seed coating could not get a wide spread because of the difficulties and impossibilities of seeding with the precise seed drills.

Continues research in the trend of application of water soluble and environmentally safe polymers on the base of natural local poly carbohydrates enhanced by the creation of preparation UZKHITAN. This is a protectant with stimulating effects that was registered by the State Commission of the Republic of Uzbekistan for use in the agro-industrial complex. Its effectiveness in comparison with one of the latest used preparations can be seen in the table presented below (table 54).

Some of its efficiencies in the results of cotton research are: optimization of the precise seed sowing (15-30 kg\ha), increasing field germination by 7.4 percent, plant disease suppression, increasing productivity by 0.5 ton\ha, enhancing the quality of plant products, and replacing toxic chemicals.

Sorting and calibration of delinted seeds by the grid machines (photo 135, 136) **with corresponding sizes of sieve holes.** Small, light, and defective seeds are separated during the seed sorting process. Seeds are divided into enlarged, middle, and small fractions. The middle fraction of seeds with a size of not less than 94% uniformity is used to plant by the precise seed drills.

Table 54. **Rate of use per 1 ton delinted seeds of cotton.**

Name of preparations.	Unite of measuring.	Outlay.	Price per unit (sum).	Totally (sum).
Dronopol	Kg	7	8 175.6	57 229.0
UzKHITAN	lkg	20.04	1 500.0	30 000.0

The seed is put through a salt solution of a certain concentration to sort the seeds by weight. The majority of the seeds (drowned) are chosen for planting. But this machine also did not get widely spread because of the amount of labor consumed and expenditure. For the latter, a special machine like the KCM (calibration-sorting machine) was constructed to conduct this process.

Many engineers (Mamajonov V.D. and others, 2018) propose new and more efficient modifications to calibrate and sort cotton seed (as DKCM). They allow for increased seed planting quality by removing waste (using technical demand), immature, and damaged seeds. In particular, the weight of 1000 seeds of the planting fraction in the DKCM increases by 4–14 g in comparison with the SOM-4. The germination of seeds is enhanced by 4–9%, which is the result of the early

appearing seedlings by 0.5–1.3 days compared to the control. All these indexes are able to affect the rise in productivity by 0.2-0.4 tons per hectare.

Seed disinfection. The use of chemicals and chemical treatment procedures is implemented with the permit of the Ministry of Agriculture and the recommendations of the State Chemical Commission. Commonly, seed disinfection is carried out using the dry or half-moisture methods. In the first method, the fuzzy seeds are disinfected usually using the preparation of TXFM and then disinfection is completed by using the machine SP-3M. The average consumption of preparation is 7 kg/ton. The preparation of Fentiuram is used in the half moisture method. It has a complex fungicide bacterial effect, suppressing bacterial and fungus-inducing diseases. Besides, it affects soil infection-causing agents like Verticillium and Fusarium wilts of cotton plants.

All chemically disinfected seeds packed in three layer paper sacks (photo 137) with the stamp "Disinfected-Poisonous" and marking the following records: the name of the ginning house, the number of the batch, the variety, reproduction, variety pureness, seed germination, net weight, and the designation of the GOST. The delinting and treating methods are also indicated on the tags of naked seeds. The second tag with an identified form and the same data is put inside the sack. The sack weight is not more than 30 kg. The tags have a size of 110 x 77mm and, corresponding to the reproduction, have different colors:

- *elite seeds – yellow;
- *first reproduction (R1) – red;
- *second reproduction (R2) – blue;
- *third reproduction (R3) – green.

Brand name "Uzbek seeds" is adhered to the sacks at the time of exporting them to foreign countries.

The new tags of chemically treated, delinted, and coated planting seeds have records on the information of: name of enterprise, name of product, year of crop, no. of barn or pile, plant variety, reproduction, % of germination, name of chemical preparation, weight, normative standard; in the case of exporting – the sign of "Made in Uzbekistan."

A reference is given to every batch after finishing the reprocessing of seed stock raw cotton by the seed cotton laboratory about the data on the cleaning, which services as the document for registration of the seed amount and to give the certificate on the seed.

The sacks of seed stock cottonseeds are stored apart, on wooden pallets placed 1 meter from walls and other piles. Sack putting is done in the order of cross to cross (photo 137). The pile size in meters does not exceed the following indexes:

Name	Length,	Width,	Height, meter

	meter	meter	
Fuzzy seeds	20	15	3
Delinted seeds	18	12	3
Less downy seeds	18	12	3

All above listed technological processes on the provision of quality sowing cottonseed have to be fulfilled according to the normative documents worked out by the “Scientific center of Cotton industry”



Photo 135, 136, 137. Calibrate-sorting, packing machines and placement of the seed sacks on the pallets.

The total amount of the preparation for planting cottonseeds varies annually depending on the republican agricultural strategies. For example, the enterprises of "Uzpakhtasanoat," which specialise in the provision of seed stock, had a task to clean and calibrate 81 020 tons, delint 21 860 tons, and disinfect 59 490 tons to ensure farmers' and raw cotton clusters' demand for high-quality cotton planting seeds.

Registration of seed stock (cottonseed) and dissemination to the farms. Accounting of the seed stock cottonseed based on its actual weight is done by the bookkeeper of the seed provision department in the form of 47-XL, "Barn accounting book of seed stock cottonseed."

Imported seed stock batch is accepted by the farm on the basis of the sender's invoice and a copy of the seed stock cottonseed certificate in the form of an XL.

A 1-TXL goods-transport invoice for every pile of seed stock cottonseed is printed in three copies. The first of them is submitted to the bookkeeper with a confidential letter. The second copy will be an accompanying document for seed sent to the farm, and the third is a pass for conveyance from the seed provision department.

Part VII. Raw cotton and cottonseed marketing.

Chapter 1. Cotton textile-clusters in Uzbekistan.

The decision "About regulations on the order of organization cotton textile clusters" of the Cabinet of Ministers of the Republic of Uzbekistan dated November 16th, 2021 organized the expansion of the cotton textile-clusters' activities.

According to this document, **cotton textile clusters**" refer to the production complex involving the cultivation of cotton plants and/or the buying of raw cotton by one or several enterprises on the basis of an agreement and deeply reprocessing procedures in cooperation with other farming subjects (photo 138, 139). There are three kinds of cotton textile clusters:

- *producing raw cotton through the leasing of agricultural plots;
- *purchasing of raw cotton from farmers or other raw cotton producing farmer subjects on the basis of an agreement without leasing of agricultural plots;
- *producing raw cotton through leasing of agricultural plots as well as purchasing raw cotton from raw cotton producers on the basis of an agreement.



Photo 138, 139. Textile-cluster in cotton growing and its production and reprocessing spheres.

The organization of the activities of the cotton textile cluster is implemented by the Cabinet of Ministers on the basis of a decision by the coordination commission for the activities of the cotton textile cluster. So, a cotton textile cluster is established in the land plots designated for the production of raw cotton across all regions of the Republic of Uzbekistan.

On the basis of the data of the "Uzbekpakhtasanoat" association, it was noted that since 2021, 100% of all cotton growing in the areas planted to cotton has been carried out by cotton textile production and cluster enterprises.

Historically, in the consequences of a long period of cotton monoculture the majority of agricultural lands in the Republic had been exhausted and soil fertility had been considerably degraded. Many types of agricultural innovations have been initiated as a result of the state reforms implemented following the country's independence, particularly in agriculture. A textile-cluster was within them. The primary textile-cluster as the new experimental technology and innovation was established in 2017 in Kiziltepa district of Navoiy region.

Progress in this trend shows that only 0.9% out of total produced raw cotton in our republic had made of the share produced by textile production enterprise "Bakht textile" in 2017. The further progress has begun to grow: 15 cotton-textile

production and clusters were organized in 2018 and their raw cotton production makes of 15.1%. In 2019, the number of the initiated clusters increased to 74, and their production share was 68%. In 2020, the number of textile clusters reached 95 and their share in the raw cotton production in the republic was 91%. And it was mentioned above that since 2021 the share of their production result in 100%.

In 2022, 122 textile-clusters will function in a total of 1033 thousand hectares of area and have activity on the basis of inter-farm cooperation in 28,600 farming acres. By the way, our own raw cotton production has been put on hold by the clusters on 161 thousand hectare of cotton plantations. These clusters have bought more than 14 thousand expensive techniques of high efficiency for a total of 3.6 billion (trillion) sum (at currency level of 1\$ equal to 10 000 sum) including 660 cotton harvesters worth 1.2 trillion sum (photo 140, 141).



Photo 140, 141. Modern cotton harvesters.

In addition, 160 000 hectares of land have begun to be irrigated using water dropping technology. This project cost 320 dollars in the United States.

The textile clusters, with the close support of the Uztextile Association, have established relations with highly reputed enterprises such as: German "Hohenstin" and "GIZ", Netherlands "Control Union," and Belgian "Amfori" in order to introduce modern innovative technologies into their raw cotton production to meet international standards and to obtain special certificates.

Today, more than 7000 enterprises are successfully functioning in this field of production. At this they severely observe that don't let themselves planting more than 5 variety in the region and not more 2 in the district.

World data stated that the best quality of harvested raw cotton is expected from hand harvest. That is why, hand harvest is used by the cotton producing enterprises. It is also encouraged by the annual rise in the cost of hand harvested raw cotton. For example, 1200 sums were paid for the 1 kg of hand harvested raw cotton in the first harvest and 1500 sums to the 1 kg of the second harvest in the year 2021. The payment indexes grow year by year depending on regional possibilities. For the crop year 2022, it was planned to pay 1500 sum per 1 kg of hand harvested raw cotton and 1800 to the second harvest.

According to the information of the ministry of agriculture, the minimal price of 1 ton of middle staple raw cotton makes of 10 25000 sum and 1 ton of fine staple raw cotton – 15120000 sums in 2022.

By the initiatives of the state and cotton-textile clusters, the price of the produced seeds is decreasing annually, taking into account currency depreciation. There is an information that the price of 1 ton of technical seed at the Uzbek trade marketing was decreased up to 38.7% by the cotton-textile cluster suppliers and made of 2 933.3 thousand sums (May, 2022). The current trend of sold technic seeds' price at the trade marketing can be seen in the following figure 40.

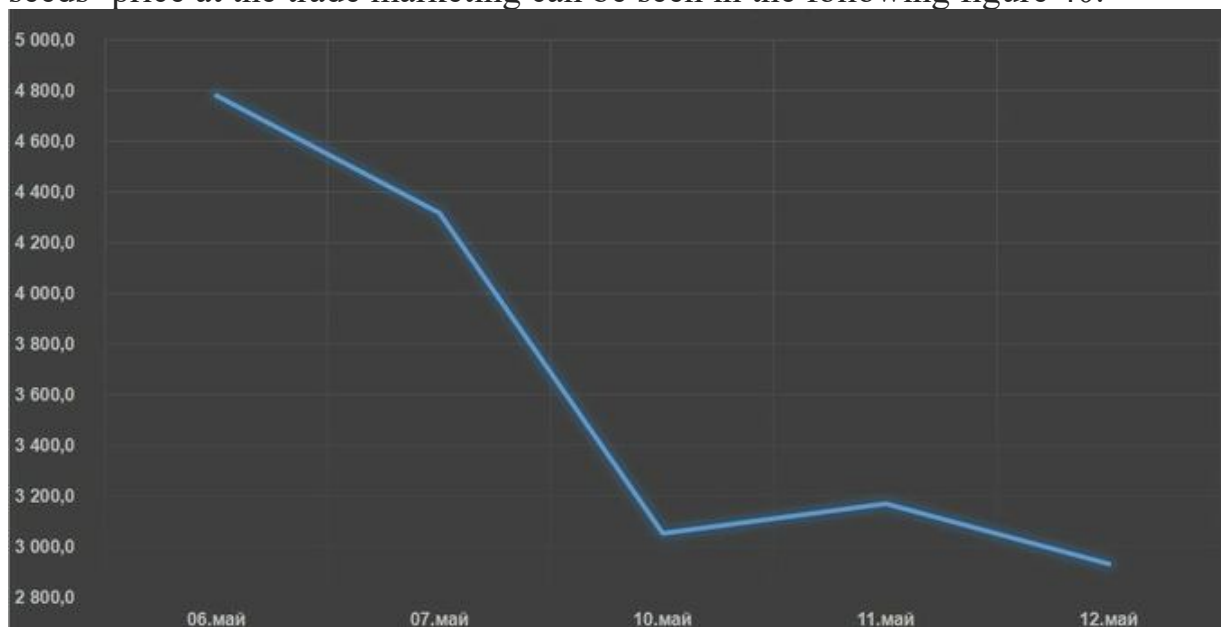


Figure 40. Tendency of the starting prices of technical cottonseeds.

Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton clusters”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Cotton clusters in Uzbekistan			
2	Cottonseed production in clusters			

Chapter 2. Cotton fiber and cotton seed marketing.

The cotton boll in which cotton fiber develops is divided into four carpels (locks, or locules) with about 32 seeds. The number of fibers per seed ranges from 13.000 to 20.000. So, each healthy lock (photo 63) typically produces six to nine seeds with normally formed cotton fiber. It was found that a pound (453.592 gr.) of ginned cotton may contain 100 million individual fibers. They are natural hollow fibers (photo 36, step 6), strong, dye-absorbent, and have structural components of cellulose – 94%, protein-1.3%, pectin -0.9%, minerals -1.2%, waxes-0.6%, organic acids-0.8%, sugars-0.3% and others-0.9%.

Cotton fibers present themselves as the natural hollow fibers: they are soft, cool, known as breathable fibers, and absorbent. Also, the research results state that cotton fibers can hold water for 24–27 times their own weight. Physically, they are strong, dye absorbent, and can stand up against multi-abrasion, long wear, and high temperature. Since cotton fiber wrinkles, it is easy to mix it with polyester or apply some kind of permanent finish to give it the proper properties for cotton garments. Commonly, cotton fibers are often blended in textile spinning with other fibers such as nylon, linen, wool, and polyester to achieve the best properties of each fiber and to increase the spinning feasibility of coarser yarns. So, cotton is the most desirable raw material for textile manufacturers, and that is stipulated also by the permanent growth of the marketing demand for cotton fabrics in the world. Consequently, statistics on the cotton marketing industry worldwide have been of notable interest to those who are related to the field of cotton growing.

According to internet information, the export indices of the top ten cotton exporting countries of the world are shown in the following figure 41:

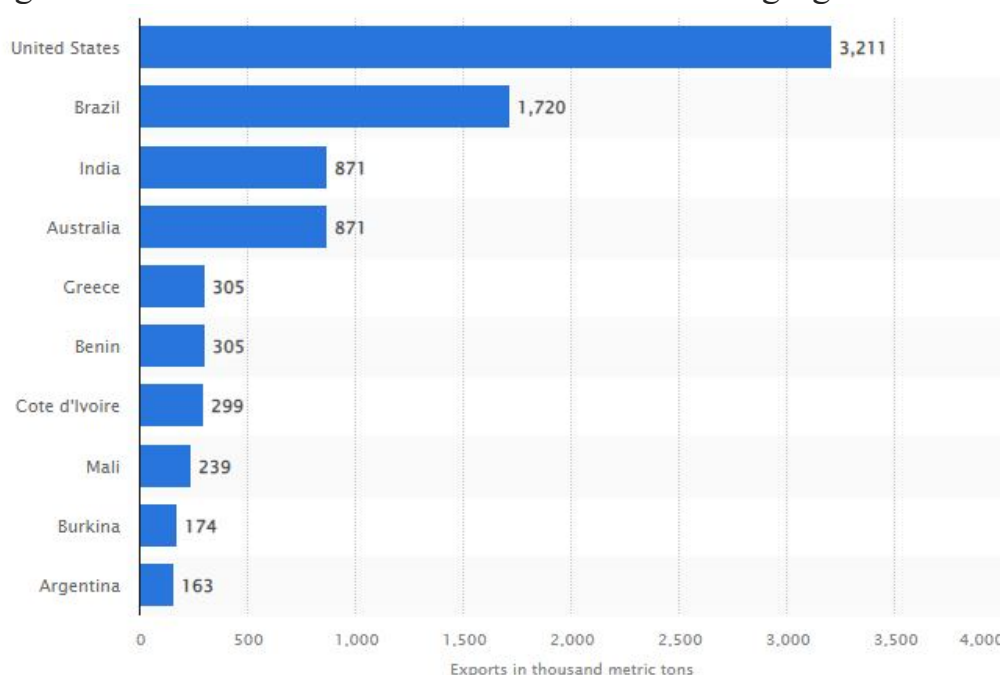


Figure 41. Leading cotton exporting countries in 2021\2022 (in 1.000 metric tons).*

Export of cotton fiber in Uzbekistan is implemented by the joint stock company (photo 142, 143) of "Uzpakhtasanoat" on the basis of "Regulation about order of cotton fiber realization and accounting" approved by a resolution of the Ministry Chamber dated February 12th, 2018 under the No. 106. It realizes and exports cotton fiber produced by the suppliers according to the agreement concluded between them. The payment by the company to suppliers is done in national currency approved by the Ministry of Finance. The commission money reward for "Uzpakhtasanoat" consists of 1% (without accounting for NDS) of the realized cotton fiber cost.

The obligations of the realising sides are: the suppliers have to produce quality goods; delivery of cotton fiber (in the accepted bales) from the warehouses of the suppliers to terminals; and insurance at the transport and storage in the share of the "Uzpakhtasanoat".



Photo 142, 143. Joint stock company of "Uzpakhtasanoat" and the warehouse of one of the cotton terminals.

The terminal is the third side, which has responsibility for temporary storage and an obligation to insure exports from acceptance to shipment to foreign countries or local enterprises.

Suppliers present cotton fiber pressed in special cotton bales (photo 143). A cotton bale is also the standard trading unit for cotton on the wholesale national and international markets. Their appearance, weight, and size of cotton bales may vary depending on the countries accepted standards. For example, in the USA, suppliers produce cotton fiber in cotton bales, which is usually measured at approximately 0.48 cubic meters and weighs 126.8 kilograms. In India, the standard bale size is 170 kilograms. Bale weights in countries like Australia, Egypt, and South Africa are made of, correspondingly, 227, 327, and 200 kilograms. Advances in the standardization of the world are reducing the variation in weights, sizes, dimensions, and densities of cotton bales.

The Uzbek cotton fiber suppliers (cotton ginning houses) are guided by the standard O'zDst 841:2011 in preparing the cotton bales for marketing. At this point, the total weight of the bale, pressing strength, and material under press should coincide with the values shown in the figure. where: l. length: 960 $\pm$ 5 mm; b. width: 595 $\pm$ 5 mm; h. height: 780 $\pm$ 80 mm; and in the figure 42 and its table .

Identifying the costs for cotton fiber Generally, the "Uzpakhtasanoat" realises cotton fiber exports, and it determines the cost in foreign currencies for cotton fiber. The basic cost has been identified based on the fixed grade "Birinch", class "Middle", 4th type, code 36. The costs for other grades, classes, and types with used coefficients are identified based on the consequences of this basic cost. The order of cost fixation, condition of payment, and shipment are identified in the contracts (agreements) of cotton fiber exporting.

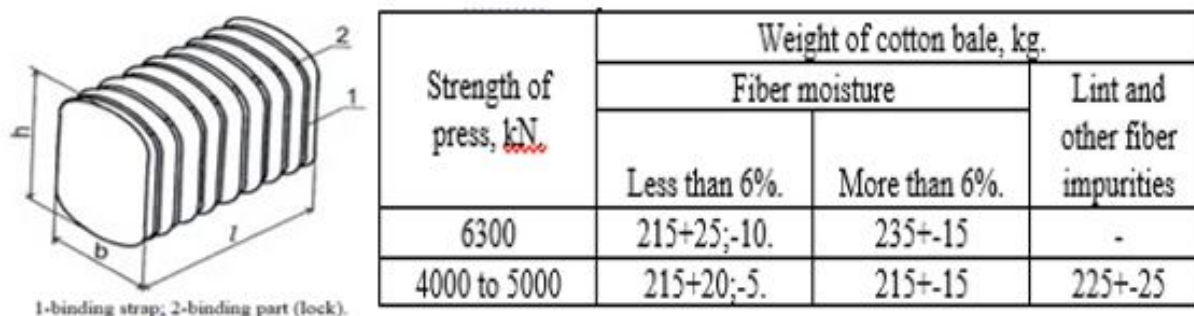


Figure 42. Structure of physical characteristics of cotton bale.

No doubt, price of exporting cotton will be identified correspondingly with cotton prices in the international trades. Progress of cotton marketing and cotton prices (figure 43) can be found in the annual reports of the world organizations like ICAC (International Cotton Advisory Committee).



Figure 43. Global average price of cotton from 1990 to 2021 (in the USA cents per pound).
Where, 1 pound = 0.453 kilograms; 100 cent = 1 dollar.

The fiber prices in the international cotton trade often differ, depending mostly on the exporting fiber quality in the countries. For example (quoted cotton price in cents per pound in 2022), Australia: -83.4; US: -75.4; West Africa: -73.4; Brazil: -70.4; and India: -66.0. In particular, the indexes of micronaire (Mic) and

g/tex (cN/tex-fiber strength) are the most attention attracting fiber properties to the cotton buyers. International contracts for the purchasing of cotton fiber are typical for the cotton fibers with micronaire between: 3.8-4.6 unit. In determining the price of cotton fiber, the basic breaking load is considered to be in the range of 23.5–26.4 g/tex. Above this range, for each 1 g/tex, an extra payment is applied to the price, and below - a discount.

Textile indexes of cotton fiber played a key role in the assessment of cotton fiber quality at internal fiber supplies to local textile industries for their reprocessing in the previously coexisting republics of the former USSR. They were: **fiber length, fineness, strength (rupture strength), rupture length, elasticity, twisting, maturity, and glittering.**

The fiber length in the cultivating species of cotton plant varies in the range of 20 to 60 mm. The longer the fiber is, the higher will be the strength of the produced yarn.

The fineness of the cotton fiber is characterized by the index of a metric number.

Metric number: this is the summary length in meters of one-gram fibers. The metric number of growing varieties of middle-strength cotton in our region is equal to 5000–5500, and varieties of fine-strength cotton have 6500–7000. The finer the fiber, the finer and stronger the yarn and fabric that can be manufactured from it. So, the finer fibers have the varieties of G. Barbadense. L.

Strength or rupture strength—this is the possibility of the fiber to resist the rupture efforts directed to the fiber axis. These indexes of fiber pronounce in the grams (4 to 7 g.).

Rupture length is determined by the multiplication of the strength by a metric number, and it is expressed in kilometers.

Rupture length of fiber that its theoretical length, at which it is being hung by one end, ruptures under the influence of its own weight. Longer, finer, and stronger fibers present the most value to the textile industry.

Line density (finest) characterizes the finest of fiber and figures out how many millimeters of fiber are contained in 1 gram.

Cotton fiber maturity depends on the grade of filling up the cavity of the fiber with cellulose. All properties of fiber are defined by the quantity and structural construction of cellulose accumulated in the fibers. They depend on the cotton varieties, species, and cultivating conditions.

Fiber output is also a special index in the public assessment of different cotton varieties. It is determined as the ratio of net fiber weight to raw cotton weight, which is expressed as a percentage. Conventionally, fiber output is divided into lowered – less than 30%, mean – 30 to 33% and higher above 33%. Fiber output is stipulated by the weight of 1000 seeds and the fiber index.

Fiber index: weight of fiber (in grams) out of 100 seeds.

Since the reforming of our agriculture and advances in the adoption of modern innovative technologies to manage production in agriculture and the textile industry have led to a gradual decrease in cotton exports, Cotton was exported in the amounts of 416 000, 278 900, and 115 600 tons in 2016, 2017, and 2018. In terms of currency indexes, in 2020, the US profit consisted of 78.87 million dollars when the exports decreased by 65.35%.

Here, the decrease in cotton export amounts is stipulated by the state policy on increasing textile goods' manufacture and exporting them with their additional currency benefits. Herein, the published news out of the Ministry of Investments and Foreign Trade in 2019 enlightens the predictions that Uzbekistan will stop exporting cotton fiber, which will result in gaining 8 billion dollars from the USA annually since 2025 from targeted textile goods exports.

Our seed producers are working mainly to ensure local cotton growers receive quality seeds annually. The quality of provisioned seeds meets state standards, and their productive potential is not inferior to any foreign cotton seeds, which explains why there is not yet a demand for cotton seeds from foreign suppliers.

Chapter 3. Extra payment to raw cotton and stock seed.

The order of extra payment for high-quality stock seeds, raw cotton, and stock seeds was worked out on the basis of the 8th supplement to the decision under No. 491 of the Cabinet of Ministers of the Republic of Uzbekistan dated November 25, 1998.

100% of extra payment to the reproduction of elite seed stock raw cotton; 75% to I reproduction; 50% to II reproduction; and 25% to III reproduction were defined since the crop year of 1999.

According to the results of a multiyear analysis of seed stock production, elite seeds account for 1%, seeds of I reproduction account for 10%, II reproduction accounts for 44.6%, and III reproduction accounts for 44.4% of total seed production.

Since 1998, 20% of elite and I-reproduction seeds, 15% of II-reproduction seeds, and 10% of III-reproduction seeds have received extra payments in addition to their purchase prices in order to encourage the interest of seed plant growers and seed suppliers in the provision of high-quality seed stocks.

Extra payments to the seed plant growers and originator-scientific establishments of the varieties, all participants in the processes of seed cleaning, sorting, and packaging, are implemented in two stages. At the first stage, 50% of the extra payment (money) is paid to the seed stock-producing farms at the time of the purchase of the seed stock raw cotton. In the second stage, the remaining part of the extra money will be taken into account as 100% of it is paid to all seed stock producers who took part in the process of seed production after improving the seed germination up to the first class and getting the seed certificate in the following order: 50% to the seed stock raw cotton growers; here, 20% of this goes to elite seed laboratories located closer to seed producing farms; 30% to the variety originators and breeder scientists; 10% to the cotton ginning houses (plants); 10% to the republican seed producers and their regional departments.

These extra payments are paid after cleaning, sorting, and getting the certificate (appendix 11) for the seed's quality analysis from "UzAGROINSPEKSIYA". The extra payment singled out to the variety originators and cotton breeding institutions is divided into three parts: 40% is paid as an incentive to the breeder scientist depending on the amount of provisioned seed from his created variety; 30% as an encouragement to the breeders who are working to develop new perspective cotton varieties; 30% to the support of technical security at these institutions. If the seed stock is of second-class quality, the second part of the extra payment is reduced to 50%.

Annually, the price of cottonseeds is determined by the Ministry of Finance (data from 2006), taking into account the following categories: 1000 US\$ ton for breeder seed (BS); 650 US\$ ton for foundation seed (FS); and for reproduction seeds: R-1, R-2, and R-3, correspondingly: 383, 350, and 283 US\$ ton, and is being approved by the resolutions of the Cabinet of Ministers.

Chapter 4. Briefly about cottonseed production in the abroad.

The wide scale planting and production of superior new varieties developed as the result of the breeding process obviously cannot be realized until sufficient high-quality seed has been produced to permit commercial production in the regions. In spite of the fact that the primary function of plant breeders is to create new varieties, they usually also carry out an initial small-scale seed increase at their research institutions or field experimental stations. Seed thus produced is called **breeder seed**. Each seed bag of the breeder seed has been properly stitched along with a yellow seed tag issued by the seed certification agency and sealed (photo 144).

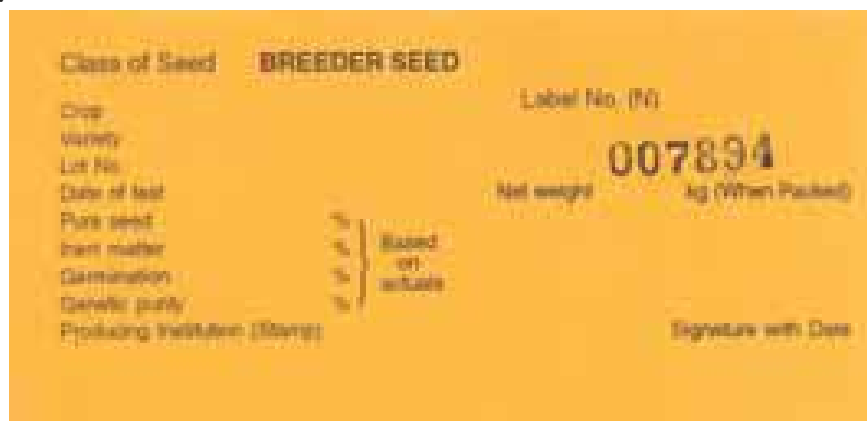


Photo 144. Tag and color of breeder seed.

Then, the breeder seed is reproduced in the stage of multiplication and produces **foundation seed**. This process is hard and time consuming that is why, usually carried out by seed associations or plant breeding institutions. All these activities are regulated by the relevant government agencies. The watcher can differ the foundation seed bag for its white marketing tag (photo 145).

 APSSCA HYDERABAD	CERTIFIED SEED
	Class of Seed FOUNDATION
TAQTO N: 309809	Certificate No.
Kind	Date of issue of Certificate
Variety	Date of Test
Lot No	Certificate Valid up to
(Provide seeds stored under cool and dry environment)	
Seed Certification Officer (Name and Place)	
Validity of Certificate further extended up to	
Seed Certification Officer (Name and Place)	
Name and Full Address of Certified seed Producer	

Photo 145. Marketing tag for foundation seed and its color.

Further, the foundation seeds are reproduced in large areas by specialized seed producers. The progenies of these seeds are called registered and even certified seeds and are produced for general sale to peasants and farmers. The bags of registered and certified seeds bear purple and blue coloured tags (photo 146, 147) with necessary records on them made by the seed agencies. The seeds bearing these purple and blue tags differ from each other depending on the producers and

provisionary methods. The purchaser can read on these tags about the seed producer and seed quality indexes, the term of viability, and the chemicals by which these seeds were treated.



Photo 146, 147. Tags of registered and certified seeds.

These registered and certified seeds for their planting quality must meet the requirements of the corresponding standards. That is why they must be produced and handled while strictly adhering to the standards set by the certifying agencies. These kinds of certifying agencies involved in seed producing associations have nationwide acknowledgement and bear the responsibility for maintaining the seed and veracity purity of all crop varieties cultivating in the fields of a certain country. So, certification of the seeds of new varieties released for commercial production is guided by the seed associations.

Commercial plant breeding companies distribute their newly developed plant varieties through seed associations. There are also many reputable seed companies, like our agricultural clusters today, that market their seed products without following the official certification process. According to information from internet sources, we can see the brand names of some world-famous seed distributing companies. They are:

- Bayer Crop Science AG. Establishment: functioning since 1863 (photo 148).
- Corteva Agriscience. Establishment: since 2019.
- Syngenta AG. Establishment: since 2000.
- BASF SE. Establishment: since 1865.
- Limagrain. Establishment: since 1965.
- Sakata Seed Corporation. Establishment: since 1913.
- AgReliant Genetics, LLC. Establishment: since 2000.

In some foreign countries, particularly in Europe, new plant varieties can be patented for periods up to 15 years or more, during this time the breeders have an exclusive right to reproduce and sell the seeds of their variety.



Photo 148. Main office of the Bayer Crop Science Faculty located at 1740 Whitehall Road in Muskegon.

2. Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton biology”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	Germination			
2	Seedling formation			
3	Budding			
4	Flowering			
5	Maturation			

Chapter 5. Achievements of cotton breeding and seed production in Uzbekistan.

According to the specific analysis of the historically released varieties of cotton plant by the Uzbek cotton breeders, there were 586 middle staple cotton varieties and 81 fine staple cotton varieties from 1913 to 2012. 70 and 18 of them, respectively, have been successfully registered in different historical periods of cotton growing and were adopted to all soil and climatic conditions of the regions of Uzbekistan. Since 1913, they have made significant contributions to the reconstruction and development of our national cotton growing industry, as well as to the entire republic in its various national industries.

Herein, the first historically notable and complimentary event took place at the turn of the 20th century when the first three native **Golodnostep, Turkestan, and Andijan** stations set up cotton breeding operations in the territory of our republic in the years 1910–1913. The first pioneer cotton breeders, M.M. Bushiev, G.S. Zhaytsev (photo 149, 150), and R.R. Shreder, worked fruitfully there and could develop the first native varieties: Navrotskiy, Triumf Navrotskiy, Djura (182), Batir (508), and Dekhkan (169). These cotton varieties have facilitated the replacement of **all old, local**, peasant-based "Plant Mix" cotton varieties and paved the way for the development of industrial-based cotton growing in our country. These new varieties were more uniform, short, durable, productive, and adaptable to different parts of the republic than plant mixed diversities. Especially, the fibers were developed by the breeders in order to be mostly compatible with the introduced textile equipment and reprocessing.



Photo 149, 150. Building of Central breeding station of All Union Scientific-Research Institute (1929) and Gavriil Semenovich Zhaytsev-the first director of Central (former Turkistan) Breeding Station in 1922-1929.

Due to dedicated efforts of our breeders and seed producers were purposefully developed and introduced into production of new, genetic distinguishing cotton varieties in time to decide state and farm important problems of our republic. One of them was the periodical rise of distractive diseases in the cotton fields. Commonly, their pathogens, Verticillium wilt, had specific features of rapid spread over the cotton-growing plantations in the past but were still young

in the cotton-growing sector in the 1940s and 1970s. To overcome the threat of this disease and other problems occurred in cotton growing of the republic were planned and implemented **six state important strain changings** in our country. Every time we were required to introduce into production perfectly new genetic make-up cotton varieties with the strength to withstand any new distractive effects of pathogen races:

*the first strain changing took place in 1922-1931 years and were replaced all local "Plant mixtures" with new more productive bred cotton varieties of Novrotskiy, 169-Dekhkan, 182-Okjura and others;

the second strain changing in 1932-1941. The new, longer-fiber, more productive varieties were needed. The varieties of "8517", "8582", "1919" and "2134" were introduced.

*The third strain change took place in the years 1941-1946 with the new cotton varieties "S-460", "1819", "1298", and others. The main task of this strain change was to suppress wilt diseases.

*The fourth strain change was implemented in the years 1947-1970 with the introduction into production of the varieties "108-F", "175-F" "AN-402,"", and others.

The fifth strain change was in 1971-1981. The varieties "Tashkent-1", "Kizil-Ravot," and others were highly resistant to the new, more aggressive race of wilt and productive. They were derived from the hybrids of remote crossings with semi-wild cotton species, which have genetically high resistance to the diseases.

*The sixth strain change in our republic has happened since 1981 with the cotton varieties "Andijan-9", "S-6524", "Oktyabr-60" and "AN-Bayaut-2". They could fully meet all contemporary requirements due to their resistance to the environmental stresses and industrial caprices of the textile industry, and so on.

Elite seed production methods and farms were elaborately organized since 1927 and further perfected in the years 1951, 1967, 1981, and 2021. At this point, the methods of elite seed production were gradually based on: individual selection with inspection of the elite plants along the progenies; cultivation of the seed stock in the optimal growing conditions; introduction of inter-variety crossing and seed nurseries of the first and second years; and seed multiplication nurseries.

The more remarkable merits of our cotton breeders were noted in the years of the Second World War and then in the years of industrial reconstruction. During those periods, all workers and scientists in agriculture had been charged heavily by the government to obtain increased products and specially modified qualities of plant products for the needs of the front and its supporting industries. That situation was also obvious in the development of the new cotton varieties as one of the strategic points of view to support our nation in its victory over fascism. Our cotton breeders have fulfilled their tasks with great honor. This can be seen as evidence that our government well-deservedly rewarded the merit of our breeders. In particular, one of the cotton breeders, **Sergey Stepanovich Kanash** (bunch of photo 151), was awarded Stalin's Prize in 1941 for his merit in the development of cotton varieties: 8517, 8582, -460, 18819, S-450, S-450-555 (in the 2nd and

3rd strain changing) and S-1225, S-1472, S-1579, S-1622 (in the 4th strain changing) resistant to diseases and



*Photo 151. S.S. Kanash (1896-1975), A.I. Avtonomov (1898-1968), L.V. Rumshevich (1905-1953), Yu.P. Khutornoy (1921-1979) and S.M. Mirakhmedov (1926-1988).
fiber of high output.*

A.I. Autonomov was also awarded that highest decoration, Stalin's prize of our country, in 1943 for his merit in the primarily developing of **the fine staple cotton varieties**: 35-1, 35-2, 2836, 2850, 10964, -6002, and others in the history of our republic. The latest were the most resistant to the arising disease of Fusarium wilt. Under his guidance were worked out fine staple cotton breeding methods.

L.V. Rumshevich was awarded this state decoration in 1948. The cotton varieties developed under his scientific guidance (108-, 137-, 138-, 147-) were resistant to the wilt, early ripening, and highly productive. There are data showing that the area planted to these varieties in the years 1942–1986 totaled more than 42 million hectares. At this point, only 108-F had occupied 36 million hectares in its years of cultivation.

Yu.P. Khutornoy is the coauthor of the varieties S-6002, S-6015, and S-6022 and the author of the varieties S-6030, S-6034, S-6035, S-6037, and S-6038. These varieties of fine staple cotton were used in practice and as valuable initial materials in the breeding process to develop the new varieties. He was awarded the State Prize (the former Stalin's Prize) in 1973. In this year, **S.M. Mirakhmedov** also was awarded this decoration for his merit in the cotton breeding. His remarkable merit consisted mainly of working out the method to **overcome the non-crossings** between cultivating cotton varieties with geographic diversities and developing wilt-resistant varieties. In particular, he has created four middle-stapled cotton varieties: Tashkent-1, Tashkent-2, Tashkent-3, Tashkent-6, and Uychi, on the basis of a cross between cultivating early-ripening cotton variety S-4727 and remote *G.hirsutum* L. ssp.*mexicanum*.var. *nervosum*.

Our republic was the whole country's cotton base in the former USSR until adopting its independence in 1991. Because, cotton areas in the republic had extended more than 2 million hectares and the production of raw cotton annually, an average consisted of 4.5 million ton. The share of the republic in the supplying of cotton fiber to enterprises in the USSR was 60%. In that period of cotton growth, the cotton breeders had a specific task beside improving earliness, productivity, and resistance to biotic and abiotic stresses. That was decreasing the

period of the cotton breeding process (8–10 and more years), which has prolonged depending on the parental materials—their genetic shortsightedness.

Unfortunately, the harmfulness of the biotic stresses increased with the creation of the new contemporary cotton varieties, and the hope of the breeders in creating a desirable new variety was mostly dependent on the use of the remote or wild relatives of the cotton species. Undoubtedly, it prolongs the breeding process.

All efforts of the government as the major initiator and the scientist-breeders as the researchers have been focused on the working out of the highly efficient and short period methods of cotton breeding. The years of research were not in vain. One of the innovative methods on the reduction of cotton breeding process was created by the breeder **Yu. Ikramov** (photo71). He introduced the using of the different new techniques in the breeding plot and mainly used the green house possibilities. The cultivating forms (variety of F-149 and cotton line L-06) of cotton species *G.hirsutum* and wild form *G. tricuspidatum* ssp. *purpurascens* were attracted into breeding process. In the point of view of common breeding methods, this breeding process and its results would be anticipated in 15 or more years. But, Yu. Ikramov and his colleagues in the result of researches, based on the latest outputs in the cotton genetics and its plant breeding science could get a great achievements.

Primarily innovative, **the combination of field and greenhouse intensive schemes** with remote geographic crossing and inter-species hybridization has promoted considerably decreasing and improving the traditional cotton breeding process. In fact, several backcrosses were carried out over three years, resulting in six vegetations of the cotton plant. They guaranteed that three years of the breeding process would be shortened as a result of these cotton breeding schemes. At this point, the comparable longer period in the breeding process from the choice of initial materials up to the realisation of a new cotton variety decreases closely to the level of widely promising short breeding periods possible on the basis of innovative biotechnological approaches.

Since the 1980s of the last century, genetic scientists around the world have stated that they will use marker-assisted selection (MAS) of biotechnology in the plant breeding of agricultural crops. It involves the selection of plants carrying genetically important parts that are involved in the expression of traits of interest through molecular markers. Our geneticists and cotton breeders, working in close cooperation, launched the research on this new trend in cotton breeding and could get some surprising results. The benefits of using markers by breeders are related to genes of interest in cotton breeding processes, eventually moving from phenotype-based selection towards gene-modified-based selection.

It must be emphasized that today, more than 60 percent of gene-modified cotton is produced in the cotton-growing countries of the world by inserting foreign natural genes of insect toxins into biological cells. In this sphere of research, our scientists could also work out a more justified mechanism for **switching on or switching off the necessary gene** of a certain cotton to modify

plants. At this point, the foreign gene, or toxin, doesn't insert into the cotton cell structure. They say that this technology is characterised as a universe for any gene of a living system and may find application to the gene modification of other important agricultural crops. Moreover, it is noteworthy that this technology was patented by Uzbekistan, the USA, and more than 140 other countries in the world.

At present time, most of the biotechnological research on cotton breeding is conducted in the Center of Genomics and Bioinformatics at the Academy of Sciences of the Republic of Uzbekistan (photo 152, 153), which has a trend of biotechnological research including: searching of genomes with desirable genes, the taking of new regenerators by the use of somatic embryogenesis, and the reproduction of cotton line seeds in its experimental seed production field.



Photo 152, 153. The main gate of the Center of Genomics and Bioinformatics and the cotton variety Parloq-1.

In particular, the aim of research is to be involved in the production of new biotechnological cotton varieties through RNA interference (RNAi) of the phytochrome B gene (PHYB) of cotton using artificial duplexes.

The following cotton varieties: Parloq-1, 3, 4, Baraka, Taffakur, Sakhovat, Ravnak-1 and Ravnak-2 were successfully developed in the results of these biotechnology-based methods and registered for growing in the cotton plantations of the republic.

The reserve of world cotton collections at the depositors of our scientific-research institutes related to cotton breeding is another more important achievement in cotton breeding, as it provides the breeders with any desirable genotypes (initial material) to improve growing cotton varieties. The amount of this world gene fund collection of cotton in 2022 was 32 580 samples, presenting: *G.hirsutum* 24571 samples; *G.barbadense* 4190 samples; *G.arboreum* L. 1623 samples; *G.herbaceum* L. 1292 samples; and other species: 937 samples. They present themselves as the unequally-valuable initial materials on their genetic adaptation to all ecologically diverse cotton growing continents over the world, with corresponding performances of traits and properties. Five scientific-research institutes are engaged in the conservation and renovation of their seeds:

1. Scientific-research institute of cotton breeding, seed production, and agrotechnology of cotton – 12800 samples.

2. Institute of Genetics and Experimental Biology of Plants at the Academy of Sciences of the Republic of Uzbekistan: – 7509 samples.

3. Scientific-research institute of plant genetic resources – 6071 samples.

4. Center of genomics and bioinformatics – 5238 samples.

5. National University of Uzbekistan – 1181 samples.

They are extraordinary and essential sources for cotton breeders in our republic, which is a matter of pride. Because they are one of the key factors allowing breeders to make decisions regarding problems and the creation of new cotton varieties that are competitive with any world standard ones.

Furthermore, the security of the young scientists, cotton breeders, and seed producers with literature concerning the development of all theoretical and practical spheres was the basic matter to provide the above mentioned achievements. Many of the scientific research institutes related to research to develop cotton varieties in Uzbekistan have their own scientific libraries (photo 154). One of them, the Scientific Research Institute of Cotton Breeding, Seed Production, and Growing Agrotechnologies (SRICBSPGA), is the most priority, and in its history, it was even the Coordinating Center for the cotton breeding research and its seed production throughout the cotton-growing republics of the former Soviet Union. Now its library is the richest one in terms of volumes of books (13 591 units), journals (2 600 units), and dissertations (874 units), embracing all aspects and problems relevant to cotton breeding and its seed production.

The author of this textbook, M. Ashurov, has also always benefited from the possibilities of this library; he was fond of and stayed deeply grateful for the assistance of the generous librarian Atakaeva Irisoy Tursinbaevna (photo 155) who has devoted more than 50 years of her age to the proper functioning of this invaluable scientific treasure.



Photo 154, 155. Exterior view and registration table of the SRICBSPGA and librarian Atakaeva Irisoy Tusinbaevna.

2. Pedagogic technology – “BBB” technology.

Read the text under the topic of “Cotton breeding achievements”, divide the taken information into individual terms. Fill in the table BBB at the base of the marks fixed by the pencil.

BBB table

№	Questions about the text	Know	I want to know	I have learned
1	The first cotton breeding stations			
2	G.S. Zhaytsev			
3	A.I. Autonomov			
4	L.V. Runshevich			
5	S.M. Mirakhmedov			
6	S.S. Kanash			
7	Yu.I. Khutornoy			
8	Yu. Ikramov			

Glossary of some key terms.

Name of terms	In English	In Uzbek	In Russian
Approbation –	Research, conducting in the field with the purpose of determination the genetic purity rate (grade) of plants, resistance to diseases, pests and the general state of seeds, designated to the planting.	O'simliklarning genetik (nav) jihatdan kanchalik toza ekanligini, kasalliklarga, zararkunandalarga chidamligi va ekishga mo'ljallangan urug'likning umumiy holatini aniqlash maqsadida dalada o'tkaziladigan tadqiqot.	Исследование, проводимое на поле с целью определения генетической (сортовой) чистоты растений, устойчивости к болезням, вредителям и общего состояния семян, предназначенных для заготовки посевных семян.
Biological impurity of the variety –	Natural pollination of the variety with other variety or crop taking place in the result of accidental mutations.	Navning boshqa nav `ki ekin bilan tabiiy changlanishi va kichik mutatsiyalar natijasida kechadigan ifloslanish.	Загрязнение, происходящее в результате естественных скрещиваний одного сорта с другим сортом или культурой и случайных мутаций.
Bred variety –	The variety, developed at the scientific research enterprises on the base of scientific selection methods.	Ilmiy-tadqiqot muassalarida seleksiyaning ilmiy usullari asosida yaratilgan nav.	Сорт, созданный в научно - исследовательских учреждениях на основе научных методов селекции.
CMS –	Cytoplasmic male sterility (infertility), that is pollen grains inability to impregnation.	Sitoplasmatik erkak sterilligi (pushtsizligi), yani chang donachalarining naslsiz (puch) bepust bo'lishi.	Цитоплазматическая мужская стерильность (неспособность к оплодотворению), то есть, пыльцевые зерна неспособные к оплодотворению (щуплые).
Coefficient of propagation –	Ratio of conditioned seed stock yield to the amount of planted seed stock.	Konditsiyali urug'lik hosilining ekilgan urug'lik miqdoriga nisbati.	Соотношение урожая кондиционных семян к количеству посеянных семян.

Dominancy –	The privilege of one over other on allele traits in the heterosis organism.	Geterozigota organizmda allel belgilardan birining ikkinchisidan ustun turishi.	Преимущество одного над другим по аллельным признакам в гетерозисном организме.
Elite –	Seed stock, produced from propagation of the best plants, belonging to the variety, which inherited all characteristics to the next generation.	Navga hos eng yahshi o'simliklarning tanlab, ko'paytirib olgan urug'ligi bo'lib, navning barcha irsiy belgi va husissiyatlarini keyingi bo'g'inlarga o'tkazadi.	Семена, полученные путем отбора и размножения от наиболее типичных для сорта растений, которые передают все наследственные признаки и свойства сорта следующему потомству.
Emasculation –	Nipping off (removing) grain pollens from flowers of maternal plant.	Ona sifatida olingan o'simlikning gulidagi changdonlarni terib olish (yulib tashlash).	Удаление пыльников из цветков материнских растений.
Family –	Progeny of one cross pollinating plant, taken via propagating.	Chettan changlanuvchi bitta o'simlikni ko'paytirib olingan avlodi.	Потомство одного перекрестно опыляемого растения, полученного путем размножения.
Heredity –	Transferring of trait and properties of the organism from generation to generation.	Organismdagi belgi va hususiyatlarning nasldan naslga o'tishi.	Передача признаков и свойств организма от потомства к потомству.
Heterosis –	Becoming vigorous, viability and productivity of the first hybrid generation (F ₁) comparing with parental organisms.	Birinchi bo'g'in (F ₁) duragayining ota va ona organismlarga nisbatan kuchli, hayotchan va mahsuldor bo'lishi.	Мощность, жизнеспособность и продуктивность первого поколения гибридов (F ₁) по сравнению с родительскими организмами.
Hybrid –	A new generation, distinguishing with hereditary traits and properties taken by	Irsiy belgi va hususiyatlari bilan farq qiladigan ikki va undan ortiq organismlarni chatishtirib olingan	Поклоение, полученное путем скрещивания двух и более организмов, отличающихся по

	crossing of two and more organisms.	yangi bo'g'in.	наследственным признакам и характеристикам.
Hybrid population –	Totality of organisms differing from each other on hereditary sign, taken in the result of crossing.	Chatishtirish natijasida olingan irsiy jihatdan bir-biridan farqlanuvchi organismlar to'plami.	Совокупность организмов, полученных путем скрещивания, отличающихся друг от друга по наследственному признаку.
Hybridization of remote forms –	Hybridization of plants different in their species and genus.	Turlari yoki turkumlari boshqa boshqa bo'lgan o'simliklarni duragaylash.	Гибридизация растений от разных видов и родов.
Industry based seed breeding –	Specialization, seed stock material concentration in a specialized production, meeting the requirements of the State standards on variety, seed stock and crop quality, and also seed breeding organization on the base of all technological processes of mechanization and automation, using the least labour expenditure.	Nav, urug'lik va hosil sifatlari bo'yicha davlat standarti va tehnik talablarga javob beradigan urug'lik materiallar mahsus ixtisoslashgan ho'jaliklarda ishlab chiqarishni ixtisoslashtirish, konsentratsiyalash, barcha texnologik jarayonlarni mexanizatsiyalashtirish hamda avtomatlashtirish asosida eng kam mehnatni sarflab urug'chilikni tashkil etish.	Специализация, концентрация производства семенных материалов в особо специализированных хозяйствах, отвечающих техническим и государственным стандартам по сортовому, посевному и урожайным качествам, а также организация семеноводства на основе механизации и автоматизации всех технологических процессов, используя наименьшие затраты труда.
Insurance seed fund –	Seed reserve (stock), established at the state depositories or directly in the farms to use at the time of natural disasters. Its amount	Tabiiy ofatlar vaqtida foydalanish uchun to'g'ridan-to'g'ri ho'jaliklarda yoki davlat jamg'armalarida yaratilgan urug'lik zahirasi. Uning miqdori urug'lik	Запас посевных семян, созданный из непосредственно хозяйственных или государственных закромов, для их использования во время природных катастроф. Его объем различается в

	is different, depending on the various sections of seed stock system. For example, Insurance fund in the primary seed sections makes 100 % in ratio to seed stock necessity, depositing amounts are consisted for super elite - 50 %, elite and 1 reproduction – 25-30 %.	tizimining turli zvenolarida har hil bo'lib, masalan, birinchi urug'lik zvenolarida ehtiyot fondi urug'likka bo'lgan ehtiyojga nisbatan 100% miqdorda, superelita uchun 50%, elita va 1 reproduksiya uchun 25-30% miqdorda jamg'ariladi.	зависимости от звеньев в системе семеноводства. Например, объём набора страхового фонда в звеньях первичного семеноводства составляет 100% от их нужд в посевных семенах, для супер элиты 50%, для элиты и 1 репродукции 25-30%.
Intensive type variety –	The variety, possessing by high photosynthesis capacity, possibility in effective using of environmental factors (soil, water, fertilizer and light) and also resistant to lodging, diseases, pests and adverse external stresses and give capability to bumper crop with quality products.	Fotosintetik qobiliyati yuqori bo'lib, tashqi muhit omillaridan (tuproq, suv, ug'it va yorug'likdan) unumli foydalana oladigan, hamda yuqori agrotehnika sharoitida yotib qolishga, kasallik, zararkunanda va boshqa noqulay tasirlarga chidab, mol hosil va sifatli mahsulot beradigan nav.	Сорт с высокой фотосинтетической способностью, отзывчивый к условиям внешних факторов (почва, вода, удобрения и свет), устойчив к полеганию, болезням, вредителям и другим стрессам и способный дать большой урожай и качественную продукцию.
Introduction –	Bringing of the species and varieties of plants from other territories.	O'simliklarning tur va navlarini boshqa joylardan keltirish.	Привоз видов и сортов растений из других территорий.
Mechanical contamination of the variety –	Seed stock's mixing (pollution) with other variety or crop at harvest, renewing,	Hosilni yig'ish, yangilash, tozalash, tashish kabi jarjayonlarda urug'likning boshqa vav yoki ekin	Загрязнение посевных семян семенами других сортов или культур во время сбора урожая, обновление,

	purification, transportation processes.	urug'iga aralashib ketishi (ifloslanishi).	очищение и транспортировки.
Modification variability –	Not hereditary (phenotype) variability.	Irsiy bo'lmagan (fenotipik) o'zgaruvchanlik.	Ненаследственная (фенотипическая) изменчивость.
Mutational variability –	It arises by the external influences and does not transmit from generation to the generation.	U tashqi sharoit tasirida uzaga kelib, bo'g'indan-bo'g'inga berilmaydi.	Она возникает под влиянием внешней условия, но не передается по наследству.
Mutation –	A sudden (by spasmodic way) hereditary altering of traits and properties in the organism.	Organismdagi belgi va hususiyatlarning tasodifiy (sakrash yoli bilan) irsiy o'zgarishi.	Случайная (неожиданная), наследственная изменчивость признаков и свойств организма.
Phenotype –	Sum of external and internal traits (properties), formed together in the organism in the result of interactions of organism's genotype and environmental conditions.	Organism genotipi bilan tashqi sharoitning o'zaro tasiri natijasida organismda shakllanadigan tashqi va ichki belgilar (hususiyatlar) yig'indisi.	Совокупность внешних и внутренних признаков (свойств), сформировавшихся в результате взаимодействия генотипа организма и условий окружающей среды.
Population –	A group of plants, spreading in a certain areal (territory), belonging to one species, freely mats within species, but differs in regard of heredity.	Muayyan arealda (territoriyada) tarqalgan, bir turga mansub bo'lgan, o'zaro erkinchatishadigan, lekin bir-biridan irsiy jihatdan farq qiladigan o'simliklar to'plami.	Группа растений, распространённых в определенном ареале (территории), относящихся к одному виду, свободно скрещивающиеся между собой, но наследственно отличающиеся друг от друга.
Polyploids –	Hereditary variation depending on multiply	Organism gaploid hromosomalar yig'indisining karrali ortishi bilan	Наследственная изменчивость, связанная с кратным увеличением

	increasing the haploid chromosome sum of organism.	bog'lik bo'lgan irsiy o'zgaruvchanlik.	гаплоидных наборов хромосом организма.
Reproduction –	It means copy taking, that is a consecutive seed obtaining by propagation of elite seeds, taking of 1-reproduction through planting of elite seed stocks, and from it to produce the 2-reproduction, from this to produce the 3-the last reproductions.	Nusha ko'chirish degan manoni bildirib, elita urug'larni ko'paytirib olingan urug'lik, yani elita urug'lik ekilib 1-reproduksiya urug'lik, undan esa 2-reproduksiya, undan 3 va so'nggi reproduksiya urug'liklar olinadi.	Означает снятие копии, т.е. последовательное получение семян, посевная от размножения элиты, 1-репродукция от посевов элиты, далее 2-репродукция, 3-и последняя репродукции.
Seed control –	A system of measures, directed to inspect seed sowing suitability at the time of producing, storage and releasing from warehouses.	Urug'ni etishtirish, saqlash va amborlardan chiqarish vaqtlarida urug'likning ekinboplik husisiatlarini tekshirishga qaratilgan tadbirlar tizimi.	Система мероприятий, направленных на проверку посевных свойств семян во время выращивания, хранения и выноса их из хранилищ.
Seed production –	It is the special branch of agricultural production, the main aim of which is to mass multiplication of zoned and registered into state register seeds of growing varieties in peasant, farmer and community farms through maintain their variety purity, biologic and farm properties.	Qishloq ho'jalik ishlab chiqarishining mahsus tarmog'I bo'lib, uning asosiy maqsadi dehqon, fermer va jamoa ho'jaliklarini rayonlashtirilgan, Davlat reestiriga kiritilib ekilayotgan navlarning urug'ini nav tozaligi, biologic va ho'jalik hususiatlarini saqlab ommaviy ravishda ko'paytirish.	Являясь специальной отраслью производства сельского хозяйства, её основной целью является сохранение сортовой чистоты, биологических хозяйственных свойств и массовое размножение сортов семян, районированных в дехканские и фермерские хозяйства, включенных в государственный реестр.

Seed production scheme –	A complex of inter linked nurseries and seed stock plantations, designed to renew (reproduction of seed stock) of the variety via purposeful order of selection and propagation.	Muayyan tartibda tanlash va ko'paytirish bilan navni yangilab turishga (urug'likni qayta etishtirib turishga) qaratilgan o'zaro bog'langan pitomniklar va urug'lik ekinzorlarining majmui.	Комплекс связанных между собой питомников и семенных посевов, направленных на сорто - обновление с определенным порядком отбора и размножения (перепроизводство посевных семян).
Seed production system –	A complex of inter linked production nets, providing all crop plantations with excellent quality seeds of one or several crops. according to the state plan.	Davlat planiga muaffiq barcha ekin maydonlarining bir yoki bir qancha ekinlarning a'lo sifatli urug'lari bilan ta'minlab turadigan, bir biri bilan o'zaro bog'langan ishlab chiqarish tarmoqlarning majmui.	Комплекс производственных отраслей, связанных между собой и обеспечивающих все посевные площади высококачественными семенами одной или нескольких культур, соответственно с государственным планом.
Strain –	Progeny of one, self-pollinating plant.	O'zidan changlanuvchi bitta o'simlikning avlodi.	Потомство одного самоопыляющегося растения.
Strain changing –	Changing of one elder variety of the crop, grown in the industry, by the new more productive and fine quality product variety.	Biror ekinning ishlab chiqarishda ekib kelinayotgan eski navini serhosil va mahsulotning sifati yahshiroq bo'lgan yangi navi bilan almashtirish.	Замена старого сорта одной из культур, высеваемого в производстве, новым сортом с лучшими по урожайности и качеству продукции характеристиками.
Super elite –	Seed stock of superior productivity, grade and planting attributes. It is produced from the nursery of family multiplication,	Mahsuldorligi, nav va ekinboplik hususiyatlari eng yuqori bo'lgan urug'lik. U elita urug'lari etishtirish jaroyonida tashkil etiladigan oilalarni ko'paytirish pitomnigidan	Посевные семена с наивысшими продуктивными, сортными и посевными свойствами. Она получается путем размножения семей, созданных в процессе

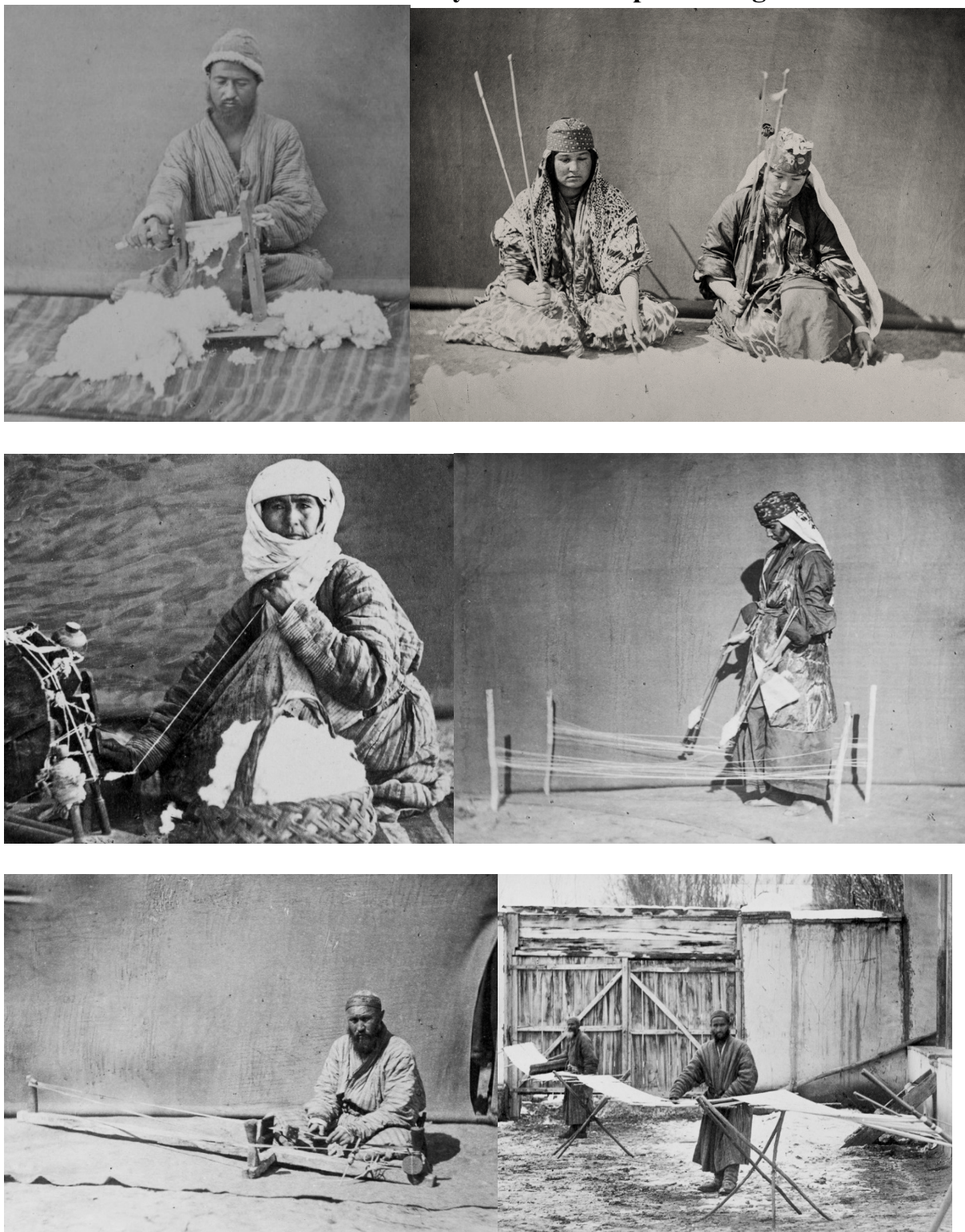
	established at the process of elite seed production.	olinadi.	производства семян элиты.
The plant breeding –	The creation of the new varieties (hybrids) in the farming branch and the science about the methods of improving the varieties under production.	Dehqonchilik sohasida yangi navlar (duragaylar) yaratish va ekilib kelinayotgan navlarni yaxshilash usullari to'g'risidagi fan.	Наука о методике улучшения высеваемых сортов и создания новых сортов (гибридов) в отрасли земледелия.
Triticale –	56 and 42 chromosomal wheat - rye amphidiploids.	56 va 42 hromosomal bug'doy-javdar amfidiploidlari.	Амфидиплоиды пшеницы и ржи, состоящие из 56 и 42 хромосомов.
Variation –	Quality and quantity altering of traits.	Belgining sifat va miqdor jihatidan o'zgarishi.	Качественные или количественные изменения признаков.
Variability –	Difference of organism progeny from own ancestors on some of characteristics and properties.	Organizm avlodining o'z ajdodlaridan qandaydir belgi yoki hususiyatlar bilan farq qilishi.	Отличие потомства организма от своих предков по каким-нибудь признакам и свойствам.
Variety –	A group of plants, created by the method of selection, which have a certain hereditary, morphologic, farm, biologic trait and attributes	Seleksiya usullari bilan yaratilgan, aniq irsiy morphologic, biologic, ho'jalik belgi va hususiyatlarga ega bo'lgan o'simliklar guruhi.	Группа растений, созданная методом селекции, обладающая определенной наследственностью, морфологией, хозяйственно биологическими признаками и свойствами.
Variety control –	A system of measures, directed to the full provision of all cropping fields by high quality seed stock, on the base of state standard requirements,	Dala aprobasiyasi yordamida amalga oshiriladigan barcha ekin maydonlarini davlat standarti talablari asosida yuqori sifatli urug'lik bilan to'la ta'minlashga	Система мероприятий, направленных на полное обеспечение всех посевных площадей культурами с высококачественными семенами, на основе государственных стандартов,

	realizing with the help of approbation.	qaratilgan tadbirlar tizimi.	осуществляемых путем апробации.
Variety renewing –	Rotation of high planting quality seeds of the same variety after diminishing its crop, seed planting qualities and biological attributes in the result of growing in the industry.	Bir nav ishlab chiqarishda ekilib, uning hosili, urug'likni ekish sifatlari va biologik hususiyatlari pasayganidan so'ng shu navning urug'lik sifati yuqori bo'lgan urug' bilan almashtirib ekish.	Замена семян сорта, высеваемых в производстве, после того как у них понизилась урожайность, посевное качество и биологические свойства, семенами этого же сорта, обладающих высокими семенными качествами.
Variety trials –	Conducting of preliminary (small), competitive (enlarged), ecologic industrial, dynamic and state trials in the process of new variety creation.	Yangi nav yaratish jarayonida shu navni dastlabki (kichik), konkurs (kata), ecologic ishlab chiqarish, dinamik va davlat nav sinashlaridan o'tkazish.	Проведение предварительных (станционный), конкурсных (расширенный), производственно-экологических, динамических и государственных сортоиспытаний в процессе создания нового сорта.

Appendixes

Appendix 1.

Historic ways of cotton reprocessing.



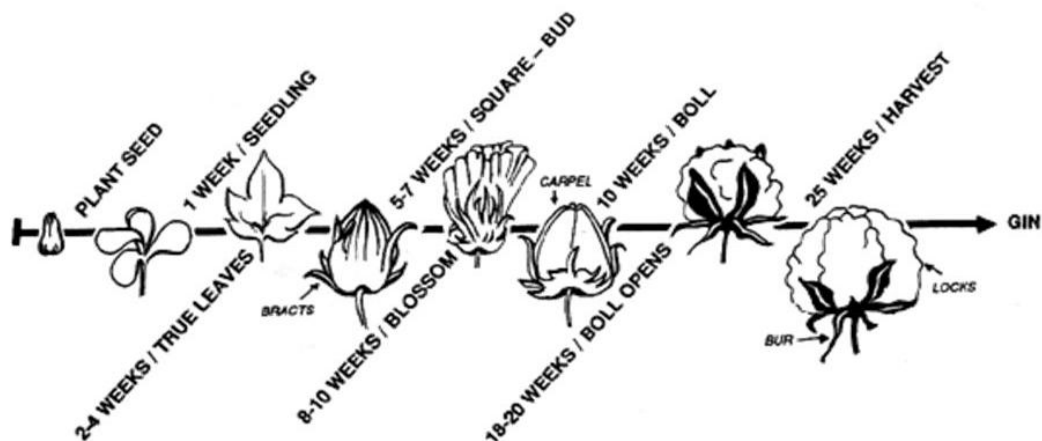
Appendix 2.

Products derived from cotton plant.



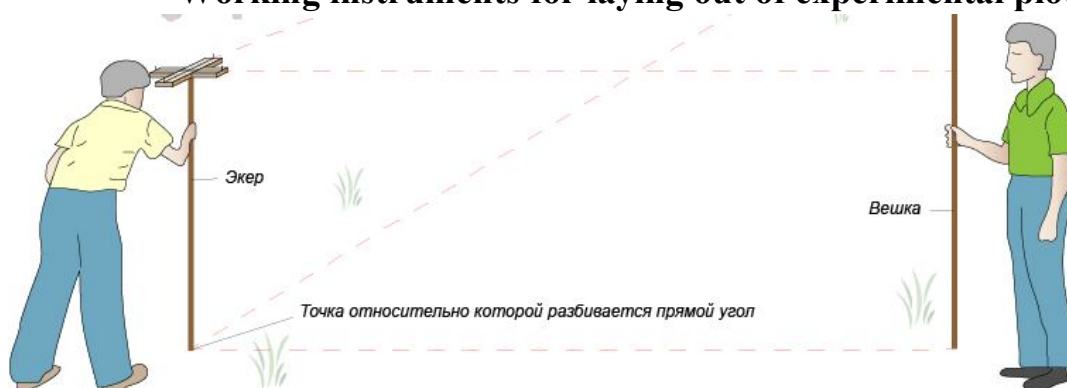
Appendix 3.

Growth cycle of cotton plant



The growth cycle of the various cotton species vary in length, but the sequence of fruit production remain the same. Weather, insects and moisture can adversely affect optimum conditions for plant growth and it is the farmer's responsibility to adjust to these conditions to optimize yield.

Working instruments for laying out of experimental plot.

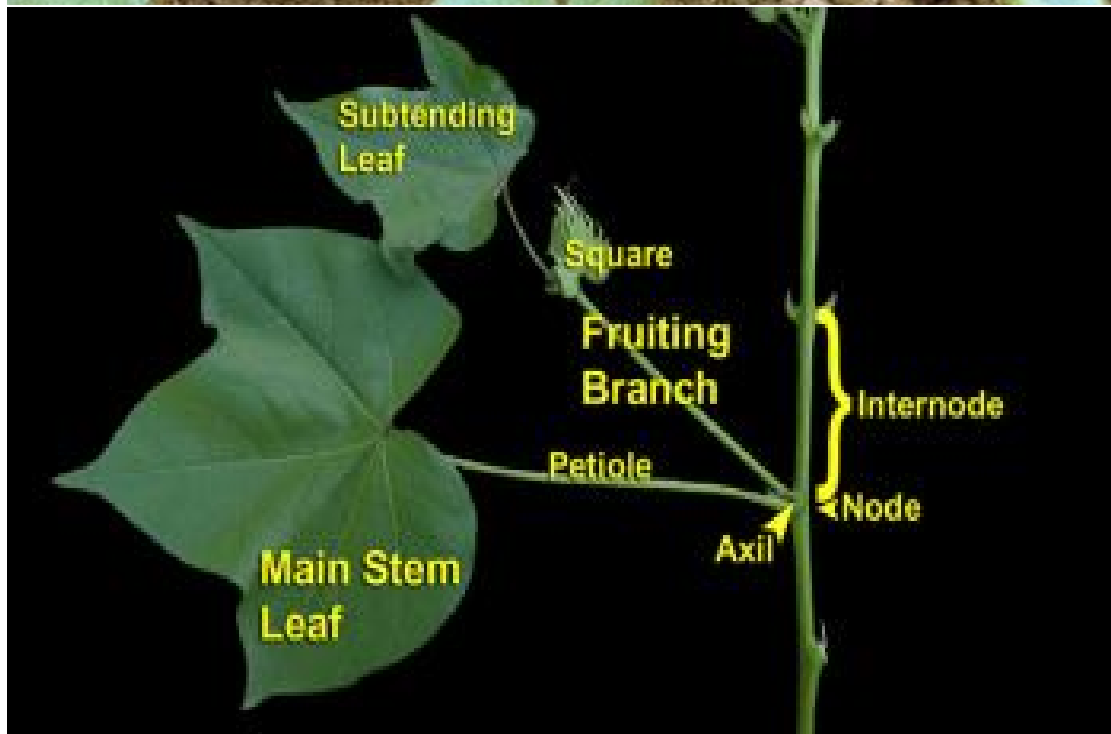
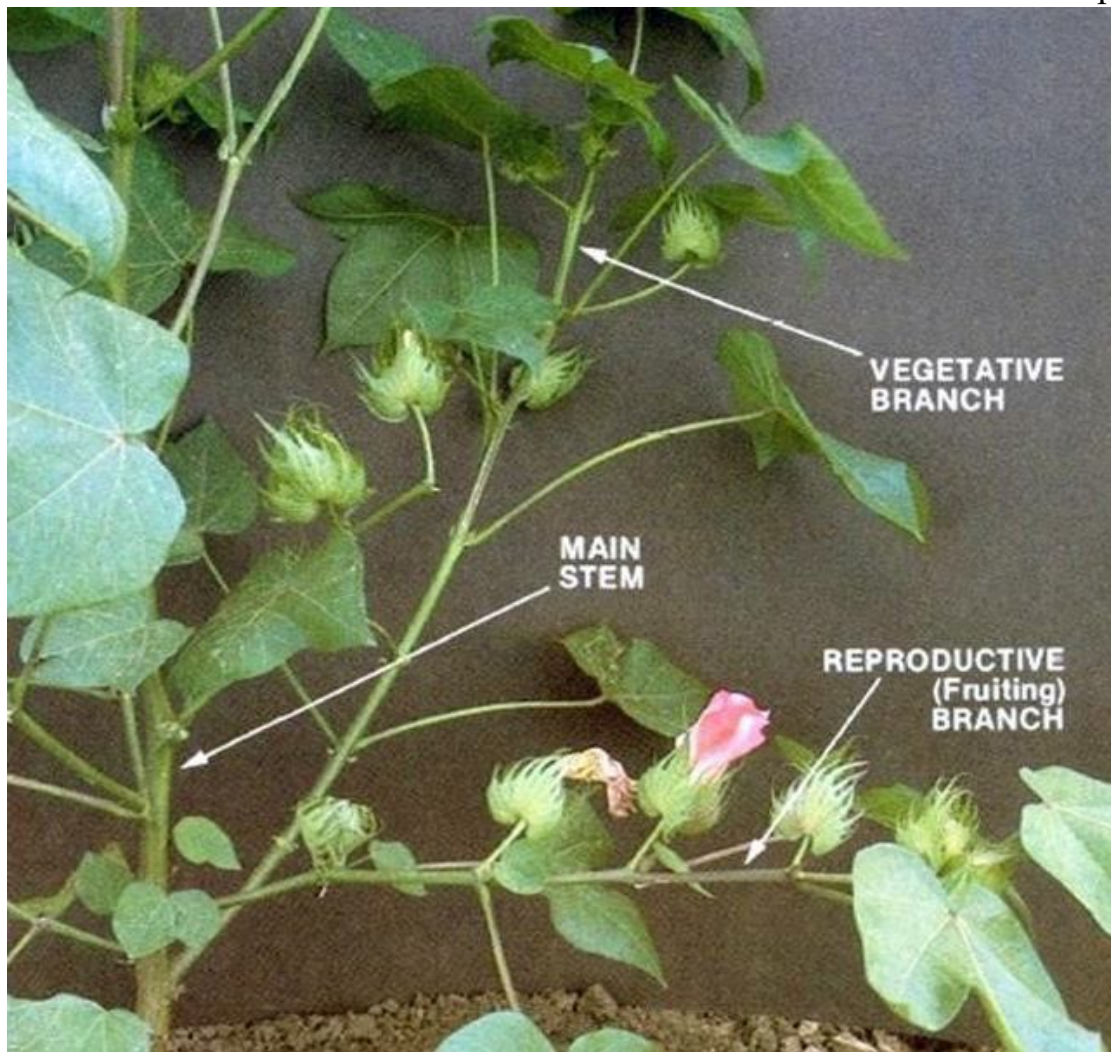


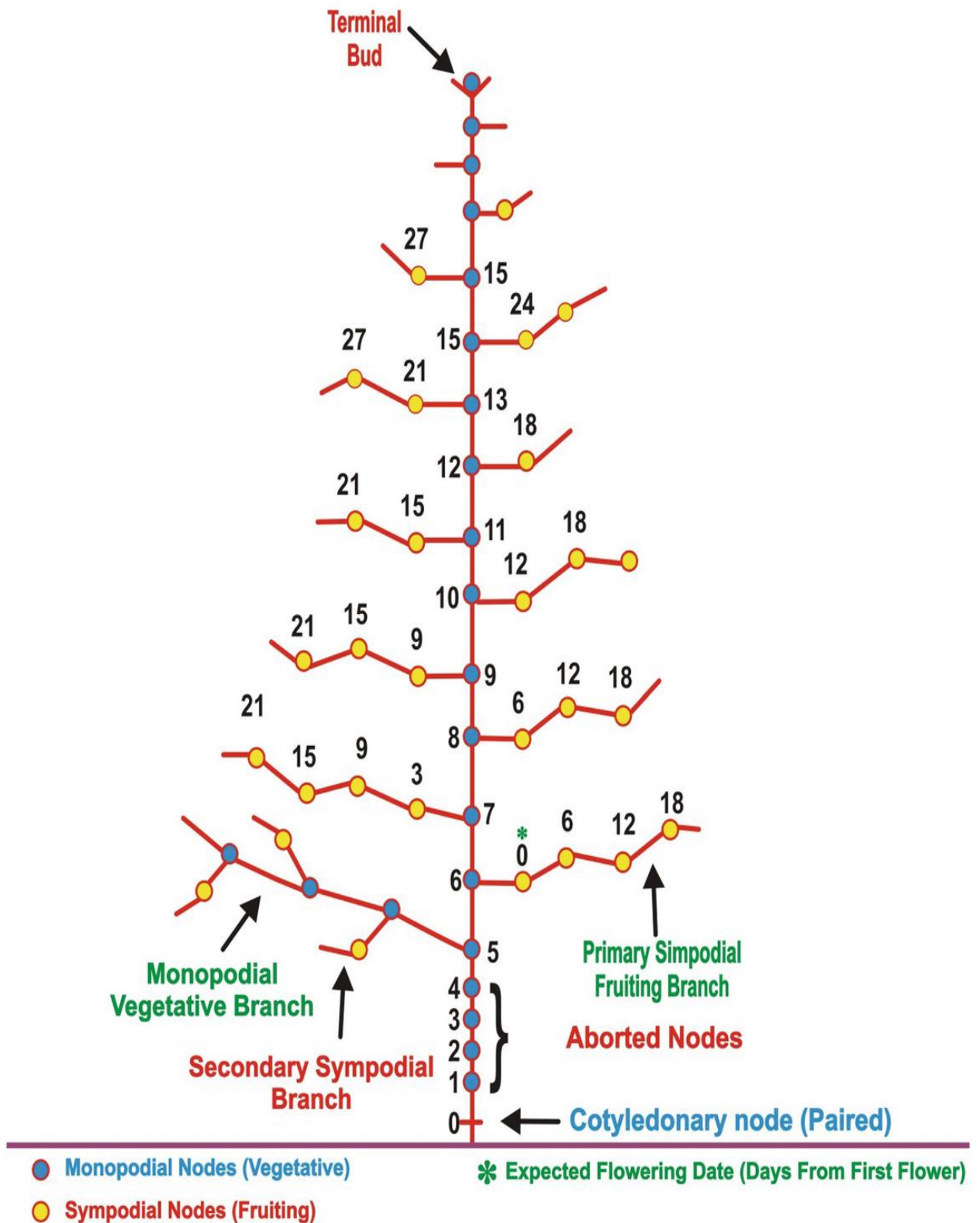
Filled image of seed planting list.

Date of planting	N of row	N of sample bags for individual selections	N of row in the previous year	N of tags and notices
14.04.20	1	2	3	
-\\-	2			
-\\-	3	5	5	
-\\-	4			1 and 2: plants of early flowering.
-\\-	5			
-\\-	6	8	5	
-\\-	7			
-\\-	8	10	7	
-\\-	9			3, 4, 5: plants of enlarged bolls.
-\\-	10			
-\\-	11	14	9	
-\\-	12			
-\\-	13	18	9	
-\\-	14			
-\\-	15			6: plant with closed flowers
-\\-	16			
-\\-	17	21	10	
-\\-	18			
-\\-	19	22	10	
-\\-	29			
-\\-	21			
-\\-	22	25	11	8, 9: plants of compact architecture with hair covered woods.
-\\-	23			
-\\-	24			
-\\-	25	30	11	
-\\-	26			
-\\-	27			
-\\-	28	33	14	
-\\-	29			
-\\-	30	35	15	
-\\-	31		16	
-\\-	32			
-\\-	33	39	16	
-\\-	34			
-\\-	35	43	19	
-\\-	36			10: plant with serrated leaf.
-\\-	37			
-\\-	38	45	20	

Diversity of special breeding bags to use in the cotton breeding process.







List of crossing combinations, 2020

N rows and names	♀					N rows and names	♂				
	Date of pollination and						number of pollinated flowers				
	29.06	29.06	30.06	1.07	Σ		2.07	3.07	4.07	5.07	Σ
125- 137 Karpurik-6	5	16	14	20	55	161- 168 MN-108	25	10	15	-	105
161- 168 MN-108	10	15	10	7	42	138- 145 AW-68	16	20	10	15	102
146- 160 C-6041	12	13	20	1	46	183- 193 C-6002	20	10	10	-	100
169- 175 C-6041	9	11	10	20	50	201- 210 C-6022	17	13	10	10	100
176- 182 C-6030	5	15	17	13	50	191- 200 C-6041	10	10	13	10	93

Form 12. **Characteristics of individually selected samples.**

Main quality indexes	202	202	202
1.Total number of selected samples.			
2.Selected samples to plant.			
3.Discarded samples on the families.			
4.On the fiber length, mm.			
5.On the fiber output, %.			
6.On the phenotype.			
7.On the seed weight.			
8.Samples left for reserve.			
9.Origin of samples			

Mean quality characteristics of individually selected sample.

	202	202	202
1.Mean weight of seed stock sample, g.			
2.Mean fiber length, mm.			

ЎЗБЕКИСТОН РЕСПУБЛИКАСИ СЕРТИФИКАТЛАШТИРИШ МИЛЛИЙ ТИЗИМИ

(Сертификатлаштириш идораси номи, манзили, Давлат реестридаги рақами)

МУВОФИҚЛИК СЕРТИФИКАТИ

№ 2524672

20 йилдан
сон билан
Давлат реестрида рўйхатга олинган.
Амал қилиш муддати
20 йилгача

ТИФ МН коди (маълумот учун)

(корхона, фирма, ишлаб чиқарувчи мамлакат)

Ушбу сертификат тасдиқлайдики, тегишлича идентификацияланган маҳсулот:

(миқдори ёки серияли ишлаб чиқарилиши) (номи, тури, хили, русуми)

меъёрий ҳужжат талабларига мувофиқдир.

Сертификатлаштириш схемаси:
Буюртмачи (тайёрловчи, сотувчи) (кераги тагига чизилсин)

Сертификатга асос бўлган: (манзил)

а) ҳужжатлар

б) намуналар синови

в) ишлаб чиқаришни текшириш далолатномаси
Инспекцион назоратни

даврийлик билан амалга оширади.

Алоҳида ёзувлар:

Мувофиқлик белгиси қўйилади:

Илова: Мувофиқлик сертификатининг нусхаси фақат сертификатлаштириш бўйича идора ёки асл нусха эгаси томонидан муҳр билан тасдиқлангандан сўнг ҳақиқийдир.

Сертификатлаштириш идораси раҳбари М.Ў. (имзо) (Ф.И.О.)

Эксперт М.Ў. (имзо) (Ф.И.О.)

References.

1. Avtonomov A.I. Questions on the study of Egypt cotton. Tashkent, publisher NIKHI, 1930.
2. Avtonomov A.A. Fine staple cotton breeding “Fan”, Tashkent 1973, 148p.
3. Ashurov M. and others. Cotton breeding and seed production. Teaching manual. Tashkent 2022. 224 p.
4. Carliane Rebeca, Francisco Jose, Liziane Maria and Gilvan Alves. A review on evolution of cotton in Brazil: GM, white and colored cultivars. Article in Journal of Natural Fibers. March, 2020.
5. Cook O.F. Cotton improvement through type selection with special reference to the Acala variety. U.S. Dept. Agric. Tech. Bull, no.302.p.62. 1932.
6. Cronn, R.C., R.L. Small, T. Haselkorn, and J.F. Wendel. 2002. Rapid diversification of the cotton genus (*Gossypium*: Malvaceae) revealed by analysis of sixteen nuclear and chloroplast genes. *Am. J. Bot.* 89:707–725. doi:10.3732/ajb.89.4.707
7. Egamberdiev A.E., Tishin A.I., Efimenko B.M., Narimanov S.N. Cotton breeding, seed production and agro-practices of new varieties. VNIISKh Uz. ASKh., 1992, 74p. In Uzbek.
8. Fryxell P.A. 1969b. The genus *Hampea* (Malvaceae). *Brittonia*. V. 21, №4, p. 359-396.
9. Gubanov G.Ya. Wilt of cotton plant. Publishing house “Kolos”, Moscow-1972. 335 p.
10. Hutchinson J.B., Sillow R.A., Stephencs S.G. 1947. The Evolution of *Gossypium* and the differentiation of the cultivated cottons, Oxf. Univ. Press, London-New York – Toronto.
11. Jonathan F. Wendal and Corrinne E. 2015. Taxonomy and Evolution of the Cotton Genus, *Gossypium*. Published April 23, 5015.
12. ICAC Researcher of the year 2016. Dr. Jack C. McCarty, Jr. U.S. Department. The ICAC Recorder vol XXXIV №2. June 2016.
13. Ikramov Yu. Scheme of plant breeding by the using of artificial climate chamber (Phitotron) and green house to accelerate cotton breeding process (methodic recommendation). Tashkent 1991. 32 p. (In Russian).
14. Iksanov M.I. Cotton varieties’ catalogue. (Tashkent: RZNTI. “Uzinformagroprom”, 1993. -132 p. (In Russian).
15. Iksanov M.I., Amanturdiev A.B., Narimanov A.A. Catalog of cotton varieties in Uzbekistan (1913-2012). The 3rd issue. Publisher “Fan”. 2012. (in Russian).

- 16.Iksanov M.I. Genetic geneiology of main cotton plant varieties of Uzbekistan. Tashkent, 2016. 30 p. (In Russian).
- 17.Kedir Wolchafo Hussen (2019). Review Paper on Genetic Diversity and Domestication of Cotton (*Gossypium* ssp.L).
- 18.Loka D.A., Oosterhuis D.M., Ritchie G.L. Water-deficit stress in cotton. In: Stress physiology in cotton. Number Seven. Referens book series/ Edited by Derrick M. Oosterhuis // The Cotton Foundation. Cordova, Tennessee, USA. 2011. P.37-72.
- 19.Muhammad Naved Arshad. Cotton breeding studies in Turkey: history and future trends. December 21, 2018. <https://icac.org>
- 20.Saunders, J.H. 1961. The wild species of *Gossypium* and their evolutionary history.Oxford Univ. Press, London.
- 21.Smith C.W. 1995. Cotton (*Gossypium hirsutum* L.). Chapter 6. In: Crop Production, Evolution, History and Technology. John Willey and Sons, Inc., New York. Pp287-349.
- 22.Symongulyan N.G., Mukhamedkhanov S.R., Shafrin A.N. 1978. Genetics, plant breeding and seed production of cotton plant. Tashkent. 309p. (in Russian).
- 23.Thomas L., Rost. 1998. First edition. Section of Plant Biology Division of Biological Science. University of California, Davis.