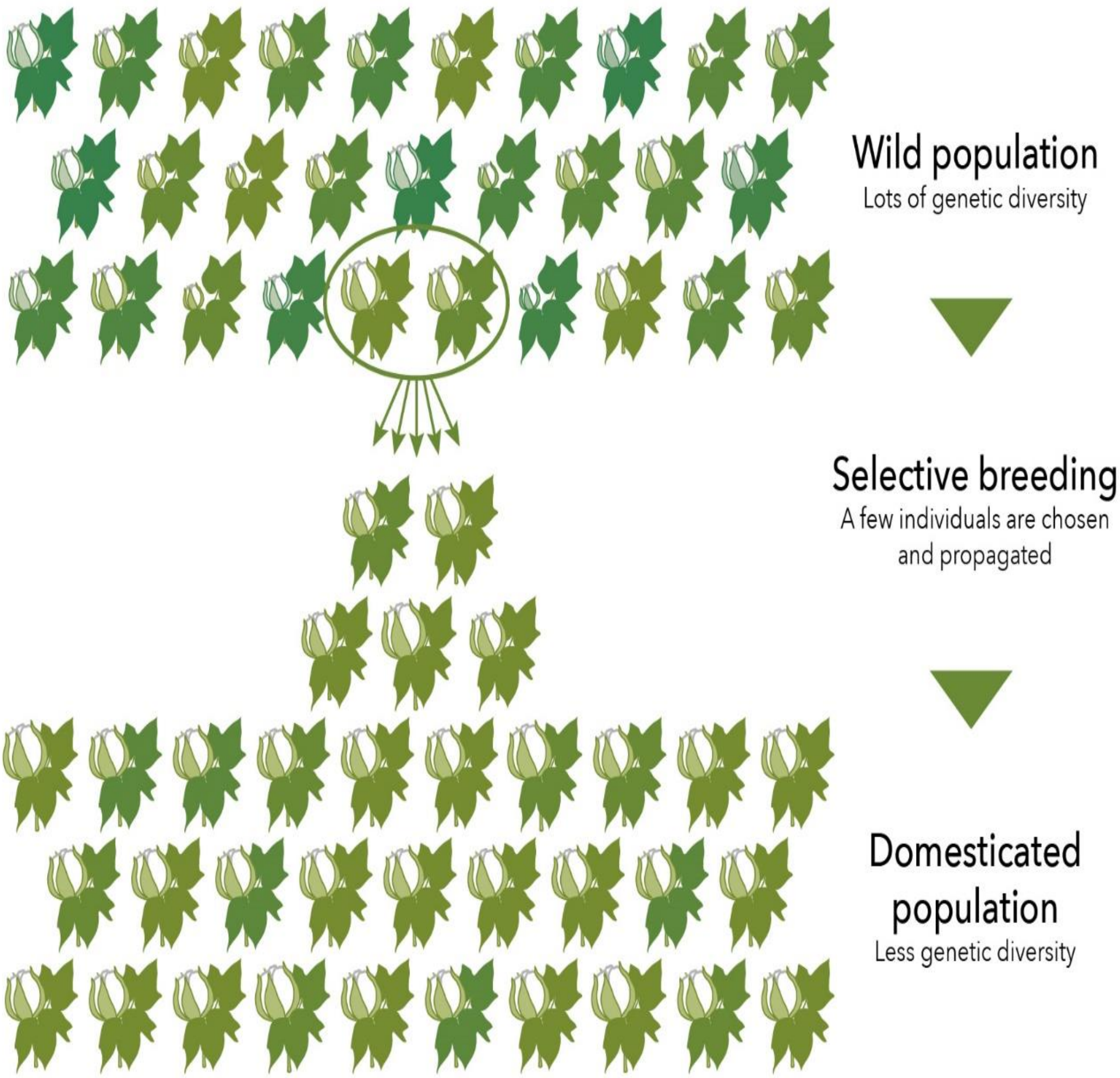
M.E.ASHUROV

GENERAL PLANT BREEDING AND SEED PRODUCTION



THE MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION OF THE REPUBLIC OF UZBEKISTAN

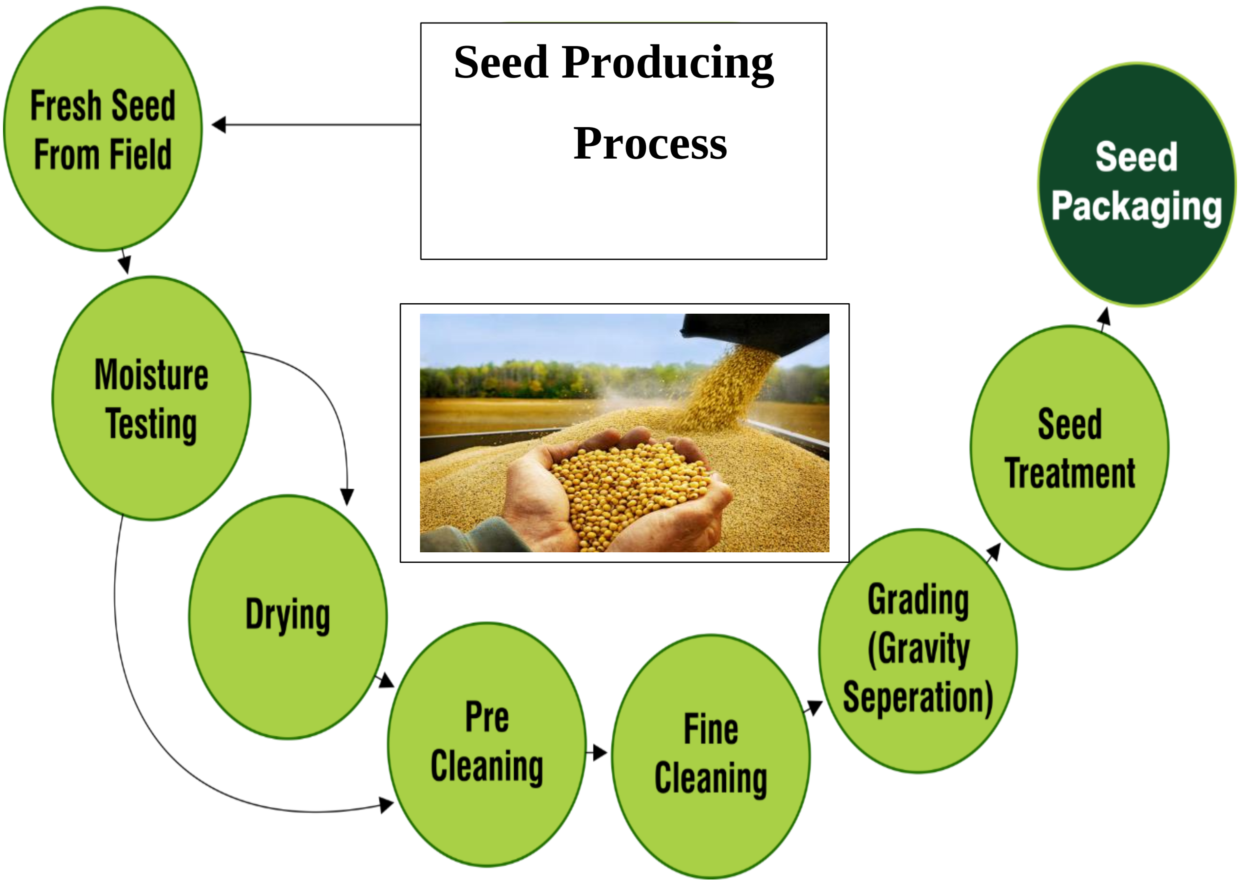
TASHKENT STATE AGRARIAN UNIVERSITY

M.E.Ashurov.

5410400 - Selection and seed production of agricultural crops

The teaching manual on practical and laboratory lessons on the subject

General plant breeding and seed production



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The manual **“General plant breeding and seed production”** is targeted to conduct practical and laboratory classes for bachelor students of agricultural educational establishments.

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

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Annotation

This manual has been intended for the students being educated on the direction of 5410400 - Plant breeding and seed production of agricultural crops at the higher establishments.

Teaching manual has been prepared on the base of working program on the subject of general plant breeding and seed production of all agricultural crops, department of Genetics, plant breeding and seed production of agricultural crops, TSAU.

Taking into account expecting changes in the working program relatively to the sizes of themes the supplementary trainings have also been added.

The teaching manual focusing on the conducting of practical and laboratory trainings on the subject of general plant breeding and seed production of farming crops includes the following questions: importance of crop diversities, the aim of the trainings, necessary aids for performing trainings, conducting order of trainings, analysis and analysis outcomes, the questions and tasks for every theme of trainings.

The themes in the manual embrace the most of knowledge to be studied on the subject of general plant breeding and seed production of farming crops, they are necessary for young field scientists, breeders, seed producers and farm managers.

Аннотация

Ушбу қўлланма қишлоқ хўжалиги олий ўқув юртлари 5410400 - Қишлоқ хўжалиги экинлари селекцияси ва уруғчилиги йўналиши бўйича таълим олаётган талабалари учун мўлжалланган.

Ўқув қўлланма ТошДАУ, Қишлоқ хўжалиги экинлари генетикаси, селекцияси ва уруғчилиги кафедрасида Умумий селекцияси ва уруғчилиги фани дарслари учун тузилган 2019-2020 ўқув йили ишчи дастури асосида тайёрланган. Ишчи дастурда кутиладиган маълум ўзгаришларни эътиборга олган холда мавзулар хажмига нисбатан қўшимча машғулотлар билан ҳам таъминланган.

Қўлланма Умумий селекцияси ва уруғчилиги фани амалий ва лаборатория дарсларида экин турларининг аҳамияти, машғулотнинг мақсади, машғулотни ўтказиш учун керакли бўладиган ўқув қуроллари, лаборатория асбоб-ускуналари ва машғулотнинг ўтказилиш тартиблари, таҳлил натижалари, ҳар бир мавзу учун саволлар ва топшириқлар билан ҳам таъминланган.

Қўлланмадаги мавзулар умумий селекцияси ва уруғчилигида ўрганилиши керак бўлган барча билимларни ўзига жамлаб олган бўлиб, соҳанинг ёш тадқиқотчилари, селекционерлар, уруғчилар ва фермерлар учун ҳам керакли адабиёт ҳисобланади.

Аннотация

Настоящее пособие предусмотрено для студентов, обучающихся по направлению 5410400 - Селекция и семеноводство сельскохозяйственных культур в сельскохозяйственных высших учебных заведениях.

Учебное пособие подготовлено на основе рабочей программы по предмету Общая селекция и семеноводство, кафедры Генетика, селекция и семеноводство сельскохозяйственных культур, ТашГАУ. С учетом ожидаемых изменений в рабочей программе относительно объема занятий, также добавлены дополнительные темы.

Учебное пособие, являясь предназначенным для проведения практических и лабораторных занятий по предмету Общая селекция и семеноводство, охватывает нижеследующие вопросы: значение разновидностей культур, цели занятий, необходимые предметы для проведения занятий и порядок проведения занятий, анализы и их результаты, вопросы и задачи для каждого занятия.

Темы в пособии охватывают много информации для изучения по предмету общая селекция и семеноводство и являются необходимой литературой для молодых ученых отрасли, селекционеров, семеноводов и фермеров.

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FOREWORD

Our republic had outlined the attaining of grain independence as one of the prestigious challenges from the time of achieving its independence and the great works have been implemented in this field.

Various crops of cotton plant, field and grain crops are grown in our republic. The demands of neighboring and worldwide countries to the products of agricultural crops are also being increased. Our government pays great attention to this field of agriculture in order to meet the requirements in these crop products. Today, the highly qualified and world out looking specialists are needed to manage the works of plant breeding and seed production on the base of novel, up to date technologies. The potential in deeply mastering of foreign languages will give them opportunity to be competitive to world specialists in international experience and knowledge. Including the extension of learning the principle sciences in English language would be a great factor for youth in strengthening of the relations in science, economy and social fields with overseas specialists in the nearest future. Such trend of development has been specially emphasized by the decree of the President of the republic of Uzbekistan on the number of PK-1875, dated December 10, 2012 “On measurements of further improvement of learning foreign languages”.

The teaching manual “General plant breeding and seed production” in English is the necessary work – book, designated for the teachers to conduct practical and laboratory trainings for students who are taught in this group. The manual, corresponding to the working program on science, is planned for 40 hours of practical and 26 hours of laboratory trainings and was compiled by the specialist, giving the lessons on the direction of plant breeding and seed production of farming crops.

The manual has been provided with additional 6 hours trainings taking into account of expected changes in the teaching and working programs of the subject.

1st laboratory training.

Phenologic observations conducting in the breeding nurseries

The aim of the training. To acquaint students with the growth stages and kinds of phonologic observations conducting in the breeding nurseries is the aim of this training.

Necessary teaching aids: internet access to the computer information on agricultural crops, tables on the growth stages of crops, plant herbariums, seeds, copy books, lecture materials, pencils, and erasers.

Growth stages of the cereal crops are divided into 10 distinct developing phases (figure 1). The main of them are:

1-Seedling growth.

2-Tillering.

3-Stem elongation.

4-Booting.

5-Awn emergence.

6-Flowering (anthesis).

7-Milk development.

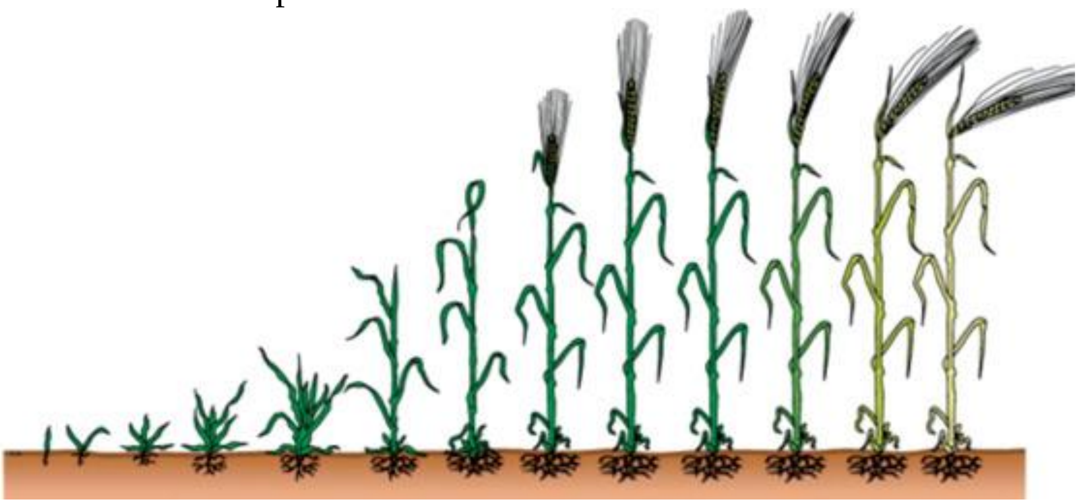


Figure 1. **Growth stages of cereal crops**

Observations are conducted with the purpose of defining the beginning dates of plants' developing phases are called **phenology observations.**

The period between the phases of plants varieties even belonging to one cereal species will be different in various cereal crops. From this point of view, observations on defining the beginning dates of these periods should be always carried out in the uniform plot of plantation. Phenologic observations in the plantations designed for experiment are carried out solely for various variants and replications.

Date of the beginning of a certain developing phase is the time when 10% of plants have entered into that phase and the time, when 75% of plants have entered into that phase is considered as a top period of this phase. Beginning and top date of every phase can be defined by visual way. In order to define more precisely, the plants picked out (and marked by special tags) for this purpose are accounted.

No less than 50 plants in every farm are picked out without selection from five places, 10 plants per place. The same number of plants is picked out from every replication of corn or at least two variants, along the diagonal of lot area and 100 plants are picked out from sorghum experiments.

Calculations of the numbers of plants entered into the subsequent phase of development are carried out every day or in 1-2 days.

Obtained data from field experiments promote the calculation of the periods between developing phases and duration of every developing phase as well as to determine the duration of the whole vegetation period of crops (table 1).

Table 1. **Phenological observation of the cereal plants**

Crop ________, cultivar ________, date of planting ____ ________ _____.

Variants of experiment	Date of seed planting	Replication	Beginning time of phases										The days from seedling to maturity
			Seedling growth			Stem elongation	Awn emergence		Full flowering	Full ripening			
			Starting	Full sprouting	Tiller starting		Starting of booting	Forming of full earing		Milk maturity	Wax maturity	Full maturity	
1		1											
		2											
		3											
		4											
2		1											
		2											
		3											
		4											
3		1											
		2											
		3											
		4											
4		1											
		2											
		3											
		4											

The table helps students to preliminary acquaintance with conducting of phenological observation in the experimental plantation of cereal crops such as corn, wheat, barley, rye, oat, millet, rice and sorghum. Even it can be helpful for students to study in the conditions of class room (theoretically) on availability of full information on the duration of vegetation phases of cereal crop varieties.

By writing freely the imaginary dates against the column of date of seed planting every student can theoretically calculate durations of every developing phase of crops. At this case necessary to use information from literature on the days consisting of inter - stage durations of crop varieties.

At the time of field - experiment based on training, students have to understand that agricultural cereal crops are differ in terms of vegetation period. Depending on the duration of vegetation period they have distinct from each other inter – phase period groups:

1.Early maturing (short period) varieties, vegetation period lasts up to 180 days.

2.Mid (moderate) ripening varieties, vegetation period lasts up to 210 days.

3.Late maturing varieties which need up to 240 or more days to produce yield. These data would be necessary to the students to check their results after filling in the table 1 at the field experiments.

The students will be able to conduct phenological observation in the certain breeding nurseries. For example, using the table 2, they can observe and inspect collection nursery at the stage of tillering. The blank table will help them in gathering the samples' data on tillering correctly in the working table and do summary (notes) on the experimenting samples. This table can be used for other phonologic observations too.

Table 2. **Monitoring of tillering stage (_______year)**

Sam-ples' №	Number of plants	Tillering stage							Days or date	Notes
		Date	Date	Date	Date	Date	Date	Date		
1										
2										
3										
4										
5										
6										
7										
8										

At the end of field trainings, the students will be able to make the full conclusion about the vegetation periods of crops. To make the conclusion about the varieties, hybrids and etc., the students can use table 3. In this table will be written data collected by the help of table 2. Here, the stage days in the columns of table 3 show not only the beginning of all stages but duration of every phases and whole vegetation too. The column of notes will be devoted to the records about early or late ripeness of observed varieties.

Table 3. **Development stages of cereal crops**

Varieties or ……….	Seedling growth	Tillering	Stem elongation	Boot- g	Awn emer- gence	Flower- ing	Milk devo- lep- ment	Wax develop- ment	Full maturity	Notes (earli- ness)
1…….										
2……										
3……										
4……										
5……										
6…….										

Tasks to review the text:

1.What aim is used table 1 and describe the result after filling it.

2.What aim is used table 2 and describe the result after filling it.

3.What aim is used table 3 and describe the result after filling it.

4.Consolidate of acquired knowledge on the base of pedagogical method of opinion, reason, example and generalization (OREG):

1st task. Report your opinion about the conducting of phonological stage over the theme "Seedling growth of corn varieties" on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

2nd task. Report your opinion about the conducting of phonological stage over the theme "Tillering of rye and barley varieties" on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

2nd practical training.

Traits and properties of plants

The aim of the training is to study traits and properties of agricultural crops.

Necessary teaching aids: text books or lecture materials on plant breeding and lecture note-books, plant herbariums, placates, seeds of different crops, pencils and erasers.

Plants in nature are always subjected to changes. As a result of this, morphologic, physiologic and biochemical differences arise between them. These differences are used at the choosing of new varieties by the farmers and concentrated in the process of breeding the new varieties by the side of breeders and seed producers. The traits of plant components like ear size and density, number of grains per ear, availability of awn, stem length, shape of leaves, size and color of grains, characterizing varieties outlook and farm value, as well as their effect on the properties in regard of reactions to different environmental biotic and abiotic stresses (photo 1). The quality of new varieties is estimated by their traits and

Photo 1. **Farmers are choosing new varieties according to the traits and properties.**

properties.

The traits of varieties refer to the outlook of morphologic features and external architecture.

Trait or property of the plants is a unit of morphologic, physiologic and biochemical division acts.

Any form of plants or varieties is characterized by some traits and property complexes. The traits of plants are determined by weighing, measuring and visual approaches.

Stem height, stem thickness, length or shortness of nodes, buds number, largeness of ear, cobs, bolls, tubers, pods, availability or absence of ear awns and others are involved in the plant traits (photo 2).

Photo 2. **Ear and grains of wheat plant.**

Economic significance of various traits is distinguished. Some of them are the most important, meanwhile others may be less important.

The plant traits provisionally divided into two types: quantitative and qualitative.

The traits which can be determined by their differences with the naked eye are called qualitative traits. For example: the availability or absence of ear awns, the colors of flowers, the availability of peel (or capsules, skins), the shape of fruits and others.

The quantitative traits refer to the traits which cannot be determined visually. In this case measuring, counting and weighing are needed. For example: the number of grains on the ear, number of kernels on in the corn cob, tuber and boll weight, seed size, height of stem, its thickness and others.

To divide the traits of plants as above pointed out is provisional. Any qualitative traits can be quantitatively characterized, but mostly this is not applied, because enough precision can be achieved through visual evaluation. If visual definition is not sufficient, the difference on the qualitative traits are marked by the corresponding quantitative measuring units. For example, two of the wheat spikes – when comparing the presence and absence of awn visually it can be easily characterized. If they are from awn containing spike varieties, it would be difficult and it needs quantitative characterization. Here, the difference between their awn length is compared.

Beside this, usually, the traits pertaining to quantitative ones are determined through visual evaluation. For example, the height of some varieties' plants characterized as tall, moderate, dwarf. The same evaluation concerning the size of grain named as enlarged, moderate and small.

Physiologic, biochemical and technologic peculiarities of plants are called their properties. Plants resistance to drought, winter, cold, diseases and pests, reaction or response to light, agro technique, application of fertilizers or irrigation are included into physiologic properties.

Biochemical properties are starch, albumin, sugar, fat, vitamins and others.

Technological properties are connected with their suitability to industrial reprocessing techniques and others.

Traits and properties of plants characterized as phenotypic and hereditary. Phenotypic traits can vary significantly by changing the environmental conditions and form the new plants. Meantime, hereditary traits of plants are not subjected to changes and retain parental traits in the progenies.

Questions for review and develop the studied material:

1.What is the importance of traits and properties of plants in agriculture?

2.Does exist any effect of ear trait on the value of new wheat variety?

3.Describe the difference between trait and property of plants?

4.How can we distinguish phenotypic and hereditary traits or properties of plants?

5.Review over the traits and properties of cotton varieties: S-6524 and Bukhara-102 (on the base of pedagogical method of "Resume"):

Topic: Farm valuable traits and properties of the variety of S-6524	
Advantages	Disadvantages

Topic: Farm valuable traits and properties of the variety of Bukhara-102	
Advantages	Disadvantages

3rd laboratory training.

Kinds of nurseries.

The aim of the training is to get acquaintance with kinds and goals of nurseries used in the process of plant breeding.

Necessary teaching aids: lecture notebooks, placards devoted to plant breeding process, practical and lab copy books, pencils and erasers.

The following nurseries are essential to carry out traditional plant breeding process on the grain crops in the Commonwealth Independent Countries:

*Nursery of collection;

*Nursery of hybridization (F_1-F_2);

*Nursery of selection (F_3);

*1st year breeding nursery (F_4);

*2nd year breeding nursery (F_5);

*Control nursery (F_6);

*Preliminary variety testing nursery (F_7);

*Competition variety test nursery (F_8);

*Special variety test nurseries (industrial variety tests, regional variety tests, agro-technician study, dynamic variety testing);

*Nursery for multiplication of perspective variety seed stocks (chart 1).

Generally, breeding accessions are attracted from various collection sources. Selection of breeding materials is conducted by the method of pedigree. And often, because of different studies concerning them, they are involved in breeding process at different stages. Less studied accession is attracted since the collection nursery. Of course, the adequately and comprehensively studied material will be included in the breeding process from nursery of hybridization.

Incorporation of desirable traits and properties of primary accessions in one plant is the main goal of hybridization nursery. In some cases, hybridization is used to increase hybrid progenies, in order to select necessary plant forms from broadened trait variations ….. on the productivity, drought tolerance, cold resistance, resistance to diseases and pest and etc.

All plants of F_1 are characterized as heterozygous on the major traits and the selection of desirable plants is left to the subsequent generations (F_2-F_3). If the parental forms were closely related to each other, then homozygous plant forms on major traits have started to build up since F_2 generation. Homozygous plants from combination of parental traits are established and assortment like di-hybrid and three-hybrid crossings takes place. Hereinafter, selection and marking of lines can be made after F_4 selection.

Rice breeding process, depending on the order, accepted for self-pollinator crops consists of:

*Nursery of initial material and it includes:

a) collection nursery;

b) mutants' nursery;

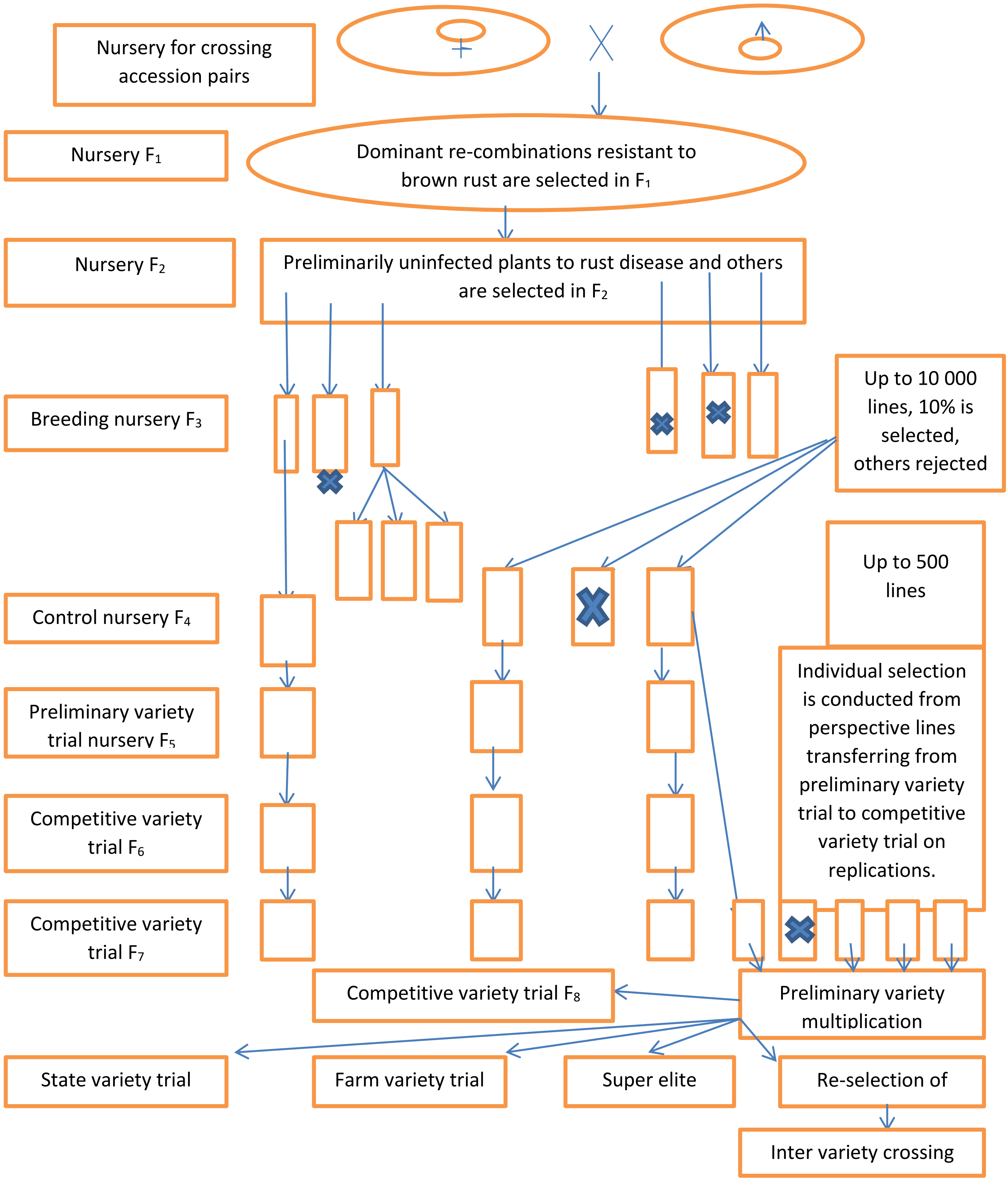


Chart 1. Sequence of winter wheat breeding (by P.P.Lukyanenko).

c) nursery of parental form pretenders;
d) nursery of hybridization;
e) nursery of hybrids F_1-F_6.

*Breeding nursery;

*Control nursery and other subsequent nurseries, in most experiences their order of continuation is similar to wheat breeding scheme (photo 3).

Photo 3. **Crossing of plants in the nursery of hybridization during the rice breeding process.**

Questions and tasks to expand and firm the mastered knowledge on the kinds of nurseries:

1.What is the importance of collection nursery in the plant breeding?

2. What is the importance of nursery of hybridization in the plant breeding?

3. What is the task of 1st year breeding nursery (F_4) in the plant breeding?

4.Find out an information about the works implemented in the control and other subsequent nurseries of wheat and add them in your synopsis.

5.Look through literature about the rice breeding process and expand your synopsis on kinds of nurseries and works which should be done in them.

6.Consolidate of acquired knowledge on the base of pedagogical method (OREG):

Report your opinion about the kinds of breeding nurseries over the theme "Nurseries in the breeding process of oat" on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

4th practical training.

Selection of parental pairs.

Aim of the training is to study the bases and principles of parental pair selection at the breeding process.

Necessary teaching aids: lecture note-books, placards on the origin of domesticated plants, plant herbariums, seeds of different crops, copy-books, pencils and erasers.

The breeder should determine in what direction of breeding he (or she) is going to work before to start it, in order to decide the major goals in the plant breeding. In majority cases of plant breeding, productivity, shortening the vegetation period, quality improvement of plant products, resistance to biotic and abiotic stresses are the major problems to be solved by the breeders. Principles of selection parental pairs to hybridization worked out by many of scientists individually for certain crops.

According to the principles of selection of parental forms, breeder should choose pairs deliberately on the base of natural selection, laws of heredity and origin of domesticated crops by Ch.Darvin, G.Mendel and N.I.Vavilov (figure 2).

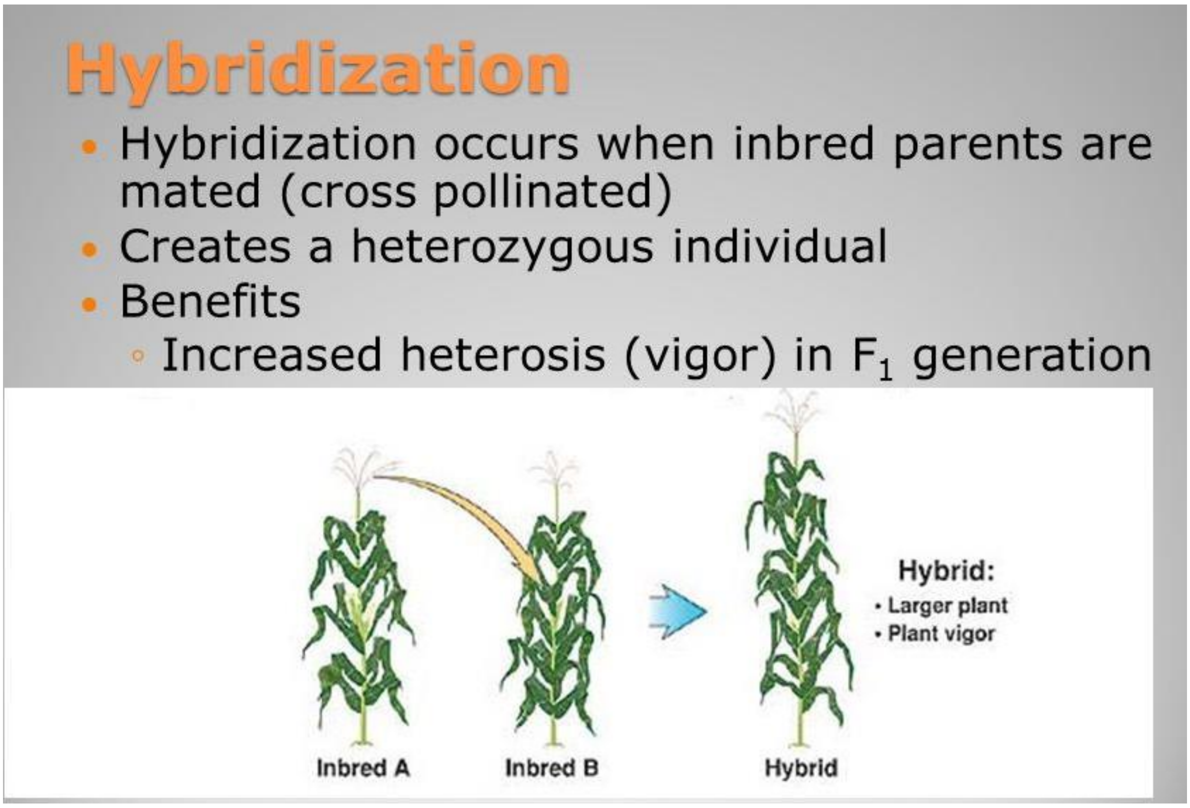


Figure 2. **Progeny impacts in the result of hybridization**

Breeder must comprehensively study available initial materials, to find among them the samples, which have desirable traits and properties and then, after self- crossing for getting homogeneity, to attract them to purposeful hybridization. Along this it needs to keep in mind that all desirable traits and properties of parents do not impart (or transferred) to progenies.

Hybridization is considered as a complicated process on forming the new organisms by development of genotype under the effect of endless external environmental variations.

Today, the breeders on the base of regional growing peculiarities, particular theory of trait inheritance in the hybrids, heredity principles of population have worked out the below listed rules of parental form choosing:

-on the ecologic-geographic base;

-on crop components structure (photo 4);

Photo 4. **Setting of fruit components on cotton plant.**

-to choose female or male parent sample on the base of combination ability;
-to select pairs depending on the durability of vegetation period;

-to select parents for hybridization according their resistance to diseases and others.

The method of parental pair selection on the base of ecological-geography has been worked out by I.V.Michurin. According to his experiments, directed to enhance the winter resistance, he selected maternal pair from cold region conditions and paternal was selected from the local variety with good quality and high productivity.

This combination of parents has helped him to manage the dominancy of winter resistance inherited from paternal variety in the progenies of hybrids.

Selection of parental pairs in regard of region, where the plant breeding works are carrying out, is conducted differently. Because, depending upon difference of various climatic conditions, the yield components of crops have either the different importance. For example, productivity of cotton plant in the typical soil conditions is particularly determined by the enlarged size of bolls, while in the condition of salinity it determines by the number of small bolls (photo 4).

Which one taken as the maternal pair in the hybridization has a vital importance in the forming of the new plants. Because, the result taken from crossings in different direction of combinations (A x B or B x A) between two parents varies notably. In the report of V.S.Pustovoit, famous breeder of sunflower, it was underlined that the oil production per hectare will be different in the consequences of direct and indirect hybridization between parental pairs' combinations. Such kind of behavior in regard of inheritance of traits is explained by the combination abilities of selected pairs.

Questions and tasks to consolidate knowledge on the principles of selecting parental pairs:

1.How would selection of parental pairs affect the plant breeding?

2.Why is hybridization of plants conducted?

3.Why hand hybridization is bad for you?

4.Describe selection of parental pairs depending on the durability of vegetation period and point out the rule which gives the best outcome.

5.Find out the features of semi wild accessions of domesticated plants to promote the increase of growing varieties resistance, susceptibility to diseases in the result of selecting and including them in hybridization.

6.To firm mastered knowledge on the base of pedagogical method of "Thick and thin".

Questions of "Thin"	Questions of "Thick"
What is maternal plant? Which parent is best for you? Which parents are bad for you? How would wild species affect to select parental pairs? Is there any variety in your region best to parental form for improving your crop?	How is parental pairs selected? Does paternal plant affect positively to form disease resistance? What is productive component of parents? Which properties are important for maternal parent?

5th laboratory training.

Determination of seeds' planting rate.

The purpose of the lesson. The students learn calculation of planting rate and how to convert the kilogram of grain into million units. Besides, they will estimate the number of seedlings per hectare.

Necessary aids for training: lecture note-books, practical copy-books, seed planting instructions, seeds of different grain and grain-bean crops, seed scales, pencils, rulers and erasers.

Precision of calculation is needed at the time of determination of planting seed rates. Because, every crop has its special rate of seed for planting. And in addition to this, seeds of agricultural crops have various morphologic performances (photo 5).

Photo 5. **One of the seed drills designated to plant seeds of grain crops.**

Some corrections are needed to do over the accepted weight rates of certain crop's seeds because of their current vitality (germination percentage) and necessary to take adjustment at the time of planting. The seed drills also needed to be adjusted solely to the certain varieties of crops. Defining the seeding rate on the base of million seeds per hectare is used throughout the world. In the condition of agricultural industry, million seeds at the seeding rate are to be converted into kilograms. The following formula is used for this intention:

$K = M \times A / 1000$; $M = K \times 1000 / A$

In this: K – seeding rate;

M – seed number in million units;

A – weight of 1000 seed units.

If, there was recommended seeding of 3 million barley seeds (photo 6) per hectare with 40 gram of 1000 seeds’ weight at the 94% of germination. The seeding rate per hectare in kilograms would be:

K = 3 million x 40 / 1000 = 120 kilograms.

In view point of germination ability of seeds, below founded amount of seeds is sown per hectare: 120 x 100 / 94 = 129 kilograms.

Here, the amount of germinating seeds per hectare will be:

M = 129 x 100 / 0,040 = 3,23 million.

Photo 6. **Seeds and ears of barley plant.**

To define germination in the seed stock plot has either an important role and this index is determined as presented below.

For example, seeding rate of barley is 140 kg\ha, weight of 1000 seeds is equal to 56 grams, germination of seeds in the condition of lab is made 98%. In this, the amount of germinating seeds per hectare makes:

140 000 / 56 = 2,500 000 seeds totally and at germination of 98%, it will be: 2,500 000 x 98 / 100 = 2,450 000 units of seedlings per hectare. And every m^2 of land will have 245 units of seeds planted or in the weight it makes: 245 x 56 / 1000 = 13,7 grams.

So, planting rate of seeds for experimentation in the conditions of field or green houses is fulfilled on the base of established recommendations on seeding rates to certain crops. Number of seeds per square meter or hectare and expected seedlings per unit of area are easily can be calculated on the bases of weight of 1000 seeds and germination ability of seeds identified by lab analysis.

Questions and tasks for consolidation of learned knowledge:

1.What seeder of crops is used in your farm?

2.Does the kind of seeder affect the quality of seeds planting?

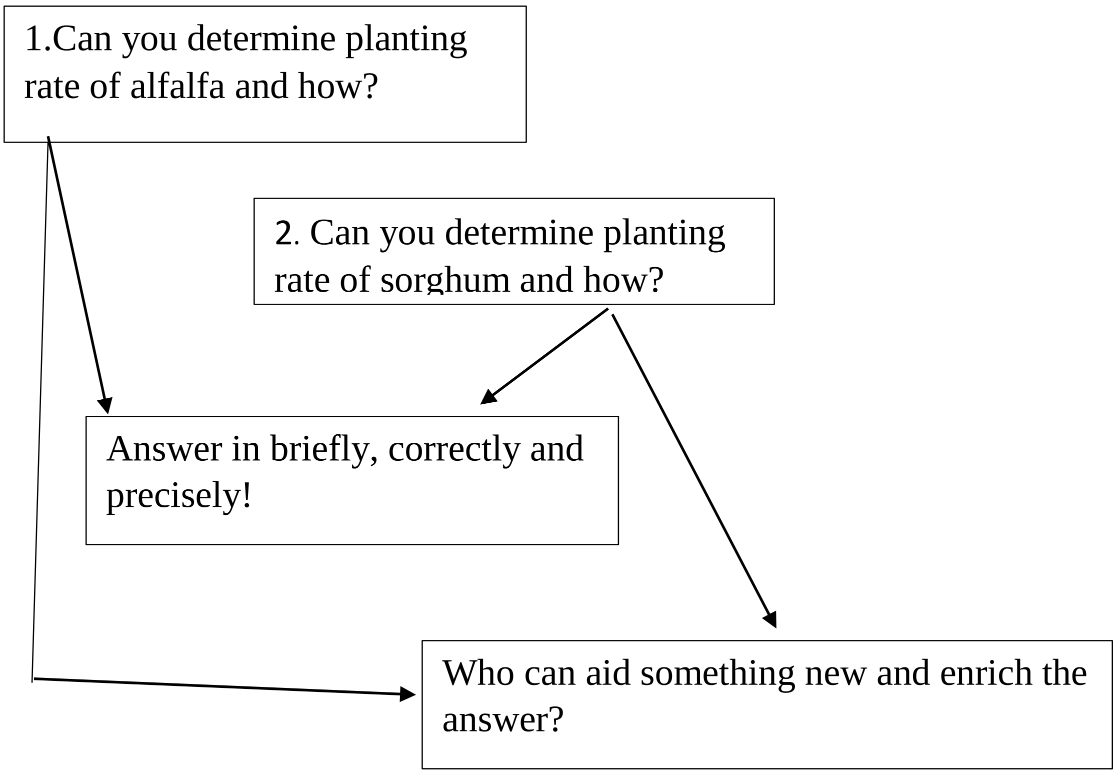
3.What is seeds' planting rate?

4.How would the quality of seeding affect the productivity of crop?

5.Determine the expected amount of seedlings of rye per square meter and hectare with the available data of: recommended seeding rate – 160 kg/ha with 25,5 grams of 1000 seeds weight and germination of 95%.

6.Calculate the planted seed rate of oat variety Dustlik per hectare according to the density of plants per square meter? Available data: weight of 1000 seeds makes 32,5 grams, lab germination is equal to 98%.

7.Train your knowledge development via answering the questions according to the method of "Blitz question"



The 6th practical training.

Hybridization in the plant breeding and study of their kinds.

Study of hybridization between plants in the process of plant breeding and the ways of hybridization the is aim of this training.

Necessary aids to conduct this training: lecture note-books, practical copy-books, plants with flowering buds and crossing kit which involves us, fine pointed scissors, forceps, washing tanks, a small elegant brush, crossing bags, tags and labels, ties, pencils and erasers.

Bred varieties of agricultural crops drive from natural populations by the method of selection, characterize their productivity, quality of product, resistance to lodging and biotic stresses at the variation of parental potentiality. New variety with the traits beyond parental varieties' variation can only be evolved in the result of hybridization between the varieties (photos 7 and 8).

Photos 7 and 8. **Breeders conduct crossings of sorghum and corn plants.**

Hybridization is divided into two groups: natural and artificial. Natural hybridization is happened everywhere. Plants, growing side by side, cross each other, freely forming natural hybrids. This process occurs not only between plants, belonging to one species, but between plants of different species too.

That is why, I.V.Michurin, famous Russian breeder, underlined that hybridization is the mighty method of plant breeding. So, a new organism, arising in the result of crossing, is called **hybrid**. Hybrid organisms possess by genetic properties of organisms which took part in the crossing. Step by step artificial hybridization has become a leading method of plant breeding and it promotes to create new initial material for breeding works. Breeder brings the desirable properties of parental organisms into one organism by the way of its hybridization and on the base of this he achieves of new accessions development.

Hybridization of plants cannot be considered as the simple joining of traits and properties in the plants. This is a process of recombination and transgression (gathering of polymer genes) on the base of formation of new accessions. Due to the complicated course of generates formation the possibility of forming of new accessions with radically new qualities has born. For example, it can be observed that winter forms of barley appear from the F_2 hybrids of two spring barley varieties crossing (N.I.Vavilov).

Currently, the most of growing corn crops in the republic of Uzbekistan and around the world are characterized by their hybrid origination. They present diversities of many varieties belonging to popcorn, sweet corn and flower corn. Their seeds must be generated each year. Commercially growing corn plants are hybrids of two and more inbred lines. Since corn is an open pollinated crop, pollination in a field will be random and unpredictable. But the positions of male and maternal parts of corn plant inspire with hope the breeders on future working out of the ways for industrial getting of mass, deliberately directed hybrids (photo 9). It has enabled to the agricultural industry to enlarge corn plantation with cheap hybrid corn seeds.

Photo 9. **Corn hybrid production technology in the industrial scale.**

In the condition of lab class, we can practice artificial hybridization by the help of flowering plants. We have crossing kit which has sharp scissors, forceps, brush, crossing bags, ties, tags and pencils.

This will be lab-made artificial pollination leading to simple hybridization. So, we are going to conduct an artificial pollination and for this we are going to take the F_1 generation. This process begins with taking of pollens from selected flower by the help of brush and their application on stigma of the other plant's flower. This flower should be emasculated prior to pollination. Emasculation is the removal of stamens from the second flower. It should be done very carefully with forceps, without damaging the female reproductive organs, to prevent self-pollination. Then the pollens taken from the first flower are applied on the female part of the second emasculated flower.

Now, we carry out bagging of the flower which was artificially pollinated. The bag prevents from random crossing of the flower with other flowers. The next work is tagging and labelling of the flower. Tagging is done to record information on this pollination. Records consist of: name of the second – female plant, and male plant also, date of hybridization and date of emasculation.

The questions for consolidation of information on hybridization:

1.What is hybrid?

2.Can you explain the process of industrial corn hybrid seed production?

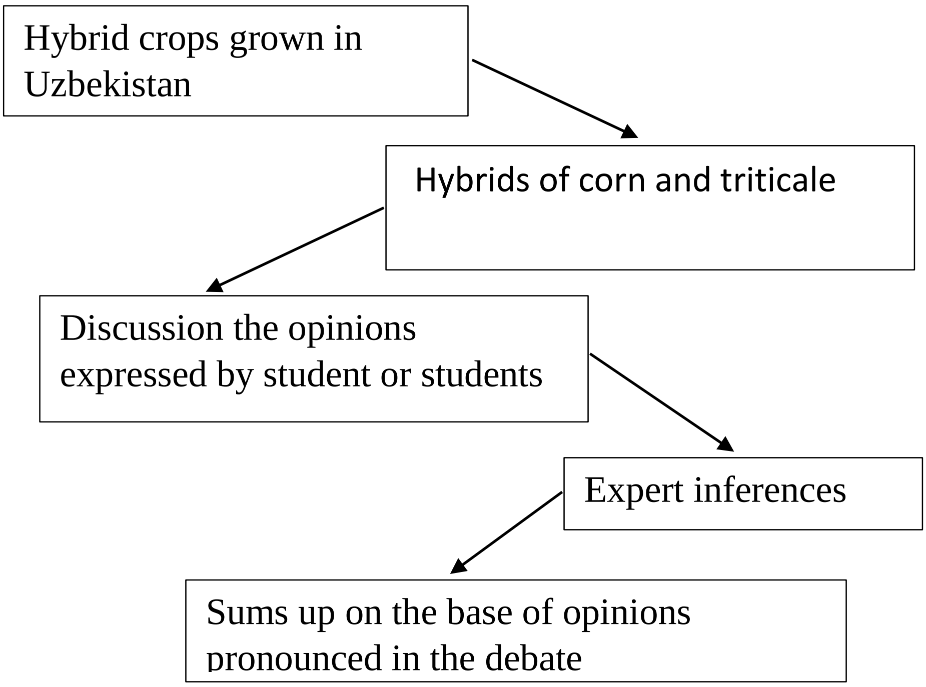
3.Does artificial hybridization effect on the development of agriculture?

4.Does hybrid crop effect impacts of quality commodity production?

5.What kinds of sub-methods of hybridization do you know?

6.Why hybridization is used in the plant breeding?

7.On the base of pedagogical method “Debate” organize question and answer exchange with your friends about studied material.



The 7th laboratory training.

Crossing orders in agricultural crops.

The aim of the training. To study the crossing (pollination) orders on the example of one agricultural crop is the aim of this training.

Necessary teaching aids to conduct this lab training: corn plant herbariums, immature and mature cobs of corn, scissors, forceps, brown paper bags, small white glassine bags, permanent markers, sturdy staplers, small blunt knives, aprons and a pencils.

The agricultural crops significantly differ on the formation of reproductive organs (female and male flowers) and biology of pollination. In some of them, like cereals and cotton, formation of reproductive organs takes place in every flower while in corn, sorghum they are forming separately in various parts of one plant (photo 9). They are open pollinated crops and their pollination in a field condition will be random and unpredictable.

The male flower (scientifically it calls as tassel) of corn is formed at the top of plant and produce pollens. The anthers of tassels are started to produce pollen grains as they emerge from the glooms. They dry rapidly and disperse by the help of wind and flying insects (photo 10).

The female flowers of corn plant produce seeds. They can be seen on the

Photo 10. **Corn cob unsheathed from its glooms.**

side of stem, between leaf and stem. It calls an ear. Each plant can form several ears. From the top part of every ear grows a long specialized stigma called silk. These stigmas consist of several hundreds of tubes and each one leads to a single egg. Each egg after fertilization grows into an individual maize kernel.

Artificial crosses can be done easy by the help of means, listed in the necessary aids. The order of crossing in the corn breeding consists of the following successive works:

1.To inspect the availability of rain resist brown paper bags to collect pollen from tassels.

2.To inspect the availability of rain resist white glassine bags to protect the silks from foreign pollens.

3.To examine readiness of permanent marker, sturdy stapler, knife and apron.

4.Ear silks are the first to emerge and these silks must be protected from foreign pollens (photo 11). In the field condition, this is done just after the blade of

Photo 11. **Protection of silks by the white bag.**

the leaf on front of ears will be pulled downward. Open the white bag and slip it over the silks to keep pollen from falling on the silks. Here, if the silks are too long, you can speed up the process by cutting off the tip of silks and husk with your knife.

5.Check the tassels. Anthers of tassel are gradually beginning to make pollens. But some of them still waiting to emerge and produce fresh pollens. Active pollen shed happens only for a few hours in a day. Collecting of the pollens is done by putting the pollen bag over the tassel (photo 12).

Photo 12. **Technic assistant puts on the pollen bag over the tassels.**

6.Do not confuse, brown tassel bag must be clearly labelled with the name of female plant receiving the pollen is put on the top and the male underneath.

7.Place the bag over the tassel, fold in half at the bottom and up from the bottom diagonally. This work helps you to keep the pollen in the bag and prevent from falling out.

8.Before taking off the bag the next morning, hit it several times to release the pollens from all anthers. Then remove the tassel stable and take the bag off, without letting the pollens fall out of the bag.

9.In order to pollinate the silks remove the white bag from the ear. And dump the pollens keeping in the brown bag on them. Place the labeled tassel bag over the ear and staple the corners together on the other side of the stalk, leaving a little free. This will allow room for growing ear (photo 13).

10.Now, you have finished with your crossing works. Pull off the plants with labelled bags when ears fully matured and set seed. Then these plants set somewhere to dry.

Industry scale of corn hybrid producing technology has seed drying facility to make this process go too faster.

Controlled or artificial crossings (pollinations) in other crops are also done in general similarly to above listed hand works excepting some of the differences depending on flower structure and shape. You can remember the morphology of flowers like sorghum, cotton, wheat, rice, peas, common bean,

Photo 13. **Dumping the pollens from brown bag on the silks of maternal plant.**

alfalfa, tobacco. Their flowers have some morphologic and structural distinguishes and that is why special crossing approaches to them will be used.

The questions for consolidation of the mastered knowledge:

1.What parts of plants are called reproductive organs?

2.Can you describe the works on corn crossing in order?

3.Do other crops' crossing differ from corn crossing and why?

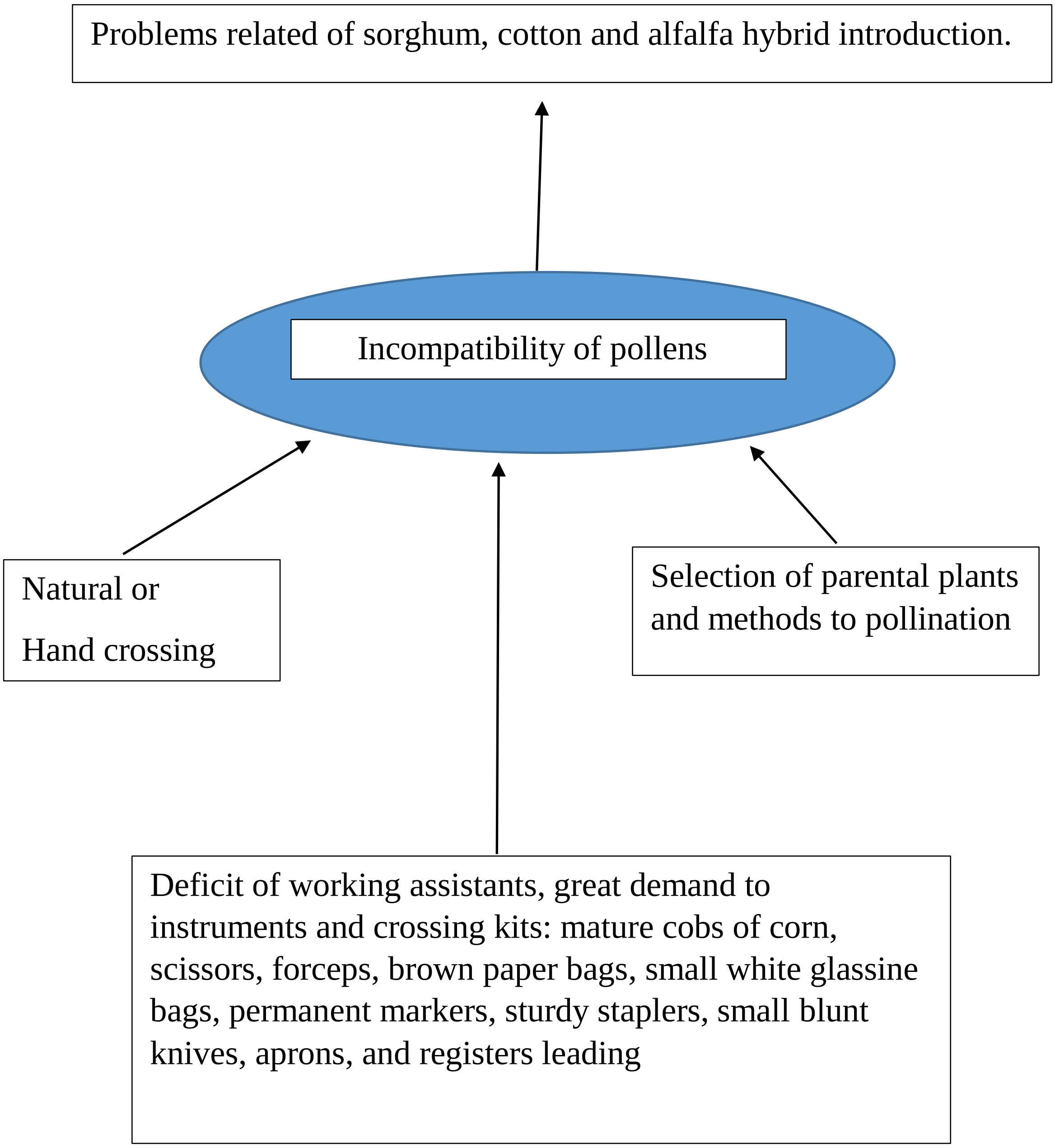
4.Does crossing affect the product quality of agricultural crops?

5.What are anthers or pollens of the plants?

6.Do agricultural crops have differences on the artificial crossing?

7.What advantages or disadvantages have natural and artificial crossings?

8.Improve your knowledge over the studied material on the base of pedagogical method "Problematic situation".



The 8th practical training.

The difficulties in hybridization and methods to overcome them.

Aim of the training. The students will acquaint with some difficulties of constrain fertilization in the process of plant hybridization and study the ways to overcome these difficulties.

Necessary teaching aids: lecture note-books, practical copy-books, pencils, rulers and erasers.

Hybridization (pollination) is the process of interbreeding between the individuals of one variety, different species (interspecific hybridization) or genetically divergent individuals of the same species (intraspecific hybridization). Development of plants let it be in the natural habitat or under controlling fields of breeders, accompanied by the exposing to cross pollinations. The most of cross pollinations occur in plants which have open flowers like flax (photo 14), sunflower, ambary,

Photo 14. **Flowers of one flax varieties.**

sorghum, maize, alfalfa and cotton plant.

The broad variation of offspring in the hybridization is essential for choosing the desirable genotypes. This variation can be occurred as a result of different species (interspecific hybridization), genetically divergent individuals of the same species (intraspecific hybridization) or remote species. Variation in regard of farm valuable traits and properties means a lot of new accessions. They make initial material extremely enriched for plant breeding. They have possibility to give guaranteed chance in separating resistant forms to diseases and pests, well adopted to adverse environmental conditions of hybrid population. But in this process, scientists often remark a lot of constraints resulting in not crossing or extreme difficulties of crossing between remote species and infertility, sterility of taken progenies. Beside this, the seeds of taken hybrids have low indexes of field germination. The limiting factors are:

1.Self-incompatibility.

-Pollen will not germinate on genetically similar individuals;

-Promotes outcrossing (figure 3).

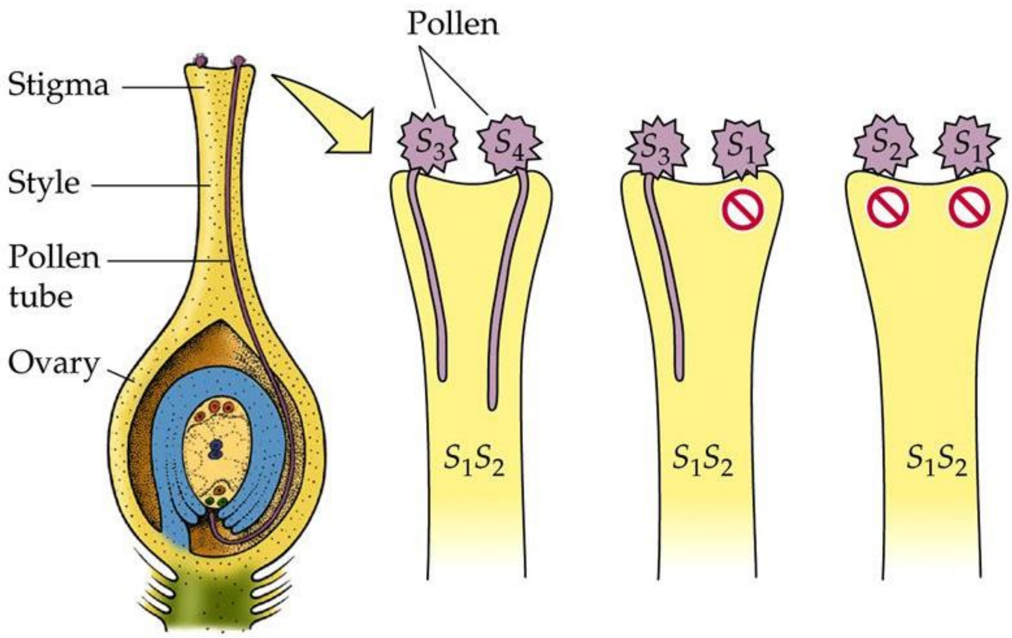


Figure 3. **Self –incompatibility occurring in the flowers of cotton plant.**

Biological and physiological unfitness of liquids around the pollen tubes is the major reason of incompatibility in the interspecies hybridization.

2.Hybridization of distantly related species usually problematic.

-a few or no seed produced;

- recovered hybrids are often sterile.

Here, can be observed, that pollens of genetically dissimilar accession will not grow normally on the stigma of other accession. Often, because of slow growing, the tubes of pollens are not able to rich the ovary to fertilize the egg cell. Some of them can grow until the egg cell and even fertilize it but the further development fails. This is one of the main reasons leading to above mentioned problems.

3.Hybridization between two species of the same genus usually takes place by sexual fusion. It is usually used to transfer desirable genes from wild species of plants to cultivated species. The progenies of such interspecific crosses may be:

-fully fertile;

-partially fertile or

-sterile.

Non-crossing of two different species is the result of unfitness of their gametes to each other on genotype, physiology and structure. In general, it is not easy to get offspring at these crossings.

Various factors cause the sterility of offspring in the intra-species and genus hybrids. The main of them are:

1.Breaching reason in the cell division at the process of sexual cells formation by non-similar nucleus and cytoplasm.

2.Influence of inhibitory genes on the development of male and female parts of flower.

3.Negative effect of chromosomal structure differences on the conjugation of chromosomes at the meiosis division. Sexual process is progressively destroyed when crossing has been done between accessions with different number of chromosomes. Because, half of chromosomes will not be able to find their pairs at the time of conjugation and they randomly distribute to girl cells at the end of meiosis division. This results in formation of different chromosome numbers in the gametes.

How to overcome the incompatibility?

Some methodologic ways to overcome the partial or fully sterility of offspring have been worked out by the native and foreign genetic scientists and breeders. They are:

1.Using of colchicine to form amphidiploidy (homological chromosomes) which restores the fertility.

2.The second way of overcoming the offspring sterility can be hybridization of protoplasts. Here, protoplast fusion technique helps greatly in the fusing of nuclei of 2 genetically separate species. And by using of this technique can be decided another problem, still more difficult transferring of foreign genes responsible for desirable traits and properties like resistance to environmental stresses.

3. The next way of overcoming sterility of progenies is connected with upbringing of parental accessions in a certain condition. This method was developed by the famous Russian scientist I.V.Muchirin. The meaning of this method consists in grafting the stalk (young wood) of sterile hybrid on the branch of parents. The hybrid becomes fertile under the effect of stock stalk (figure 4).

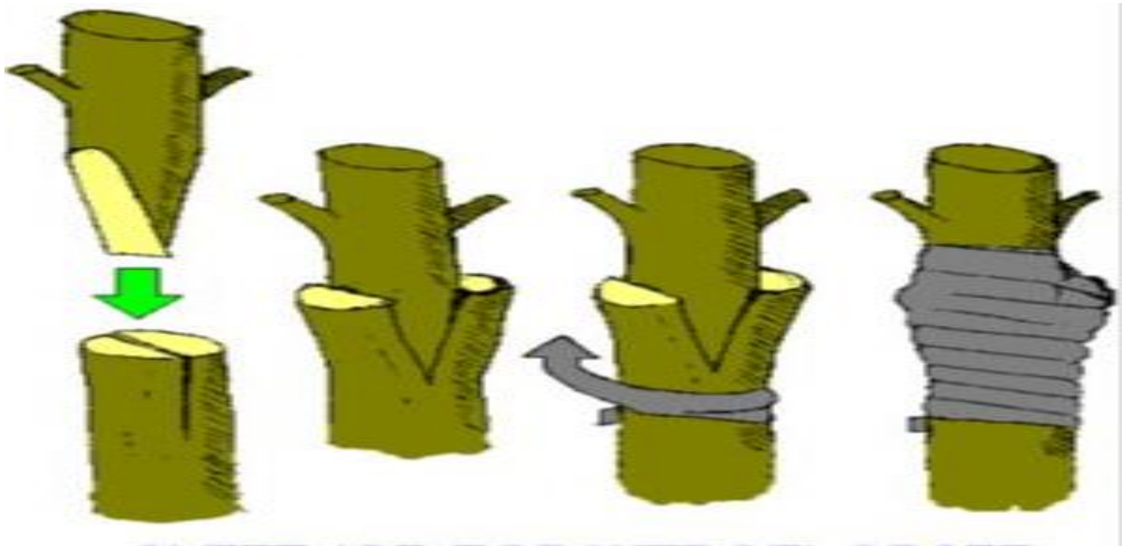


Figure 4. **Grafting view of hybrid stalk on the cleft of parent branch.**

4.Pollination of hybrid flower with the pollens taken from parents. Mostly, the pollens of hybrids of the first generation are inactive. Thus examples can be observed in the intra-species hybrids of cotton plant and tobacco. Method of mixed pollens has been elaborated to solve this problem successfully.

5.Backcrossing of parents can be another way in the overcoming of crossing difficulties. This is an alteration of combination order (maternal plant x paternal plant) in the hybridization, if the pollens, applied on the stigma of foreign flower, grow restricted. For example, the normal seeds are not produced in hybridization of rye and wheat by this order of combination. It should be changed if the wheat is taken as the maternal plant, the hybrid will have fertile seeds, let it be a few amount.

According to the foreign experiences there are such mechanisms as suggestion to promote cross pollination (from internet). They are:

1.Separate male and female plants.

2.Separate male and female flowers on one plant.

3.Anthers and stigmas developing at different times.

4.Structural adaptations to reduce self- pollination (position of anthers and stigma).

5.Incompatibile mechanisms to prevent fertilization (affects pollen tube formation).

The questions for improvement of acquired knowledge on producing of fertile offspring from closely related and remote species in hybridization:

1.What is the incompatibility between pollinations?

2.What factors are the main reasons in partial or fully sterility of hybrids?

3.How can be overcome the sterility of hybrids in intra-special hybridization?

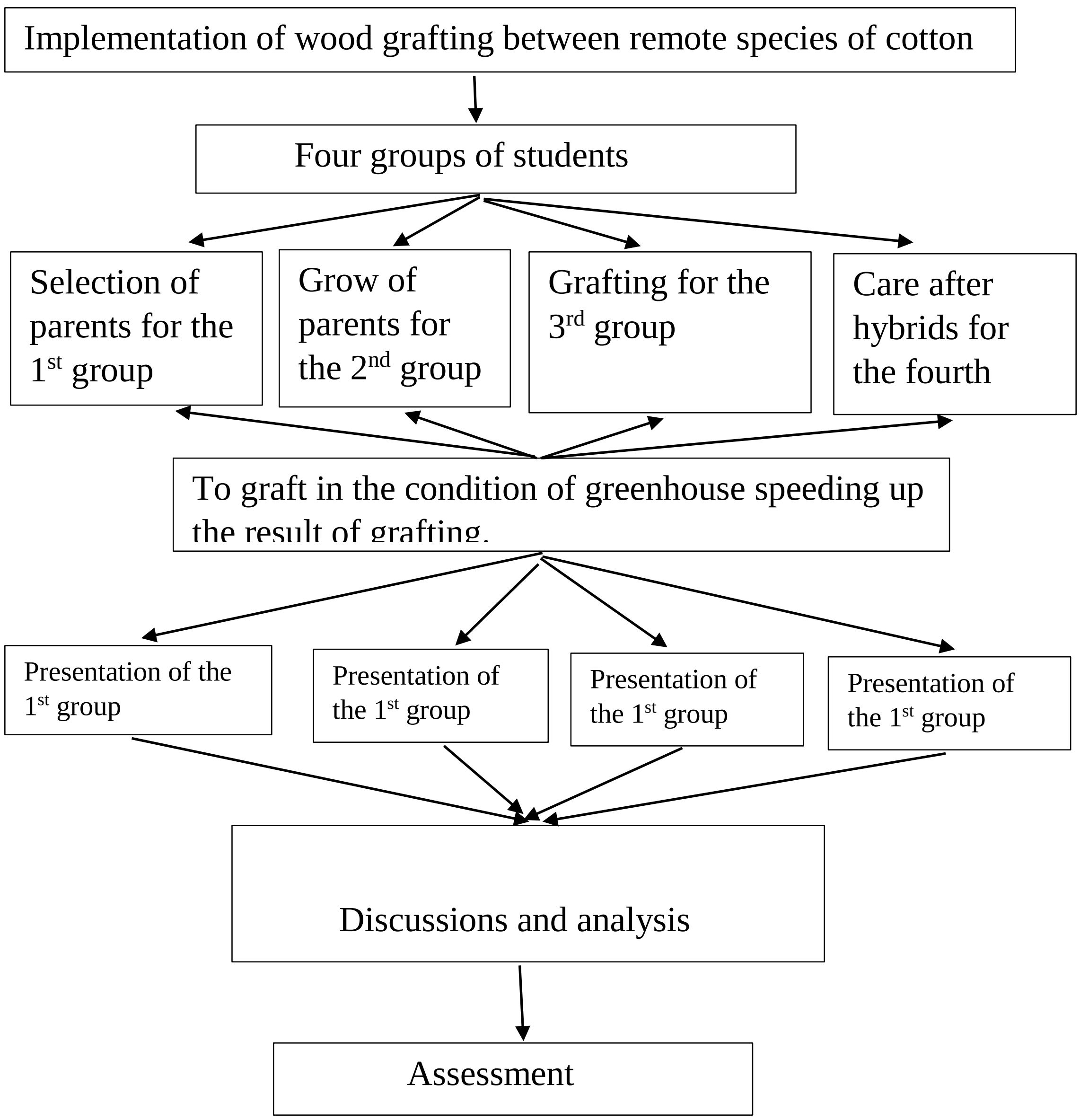
4.What is the merit of I.V.Muchirin in overcoming the sterility of closely related species hybrids?

5.Did you do any attempt to graft trees?

6.Could you get the best results in the consequences of grafting?

7.Is there any advantages of progenies taken in the result of grafting?

8.Carry out the training over the method “Working in the small groups”, pedagogical method to consolidate studied material.



The 9^{th} laboratory training.

Individual selection orders in agricultural crops.

The aim of the training. To study individual selection, its orders, importance in the plant breeding and kinds of individual selection is the aim of this lab training.

Necessary teaching aids: lecture note-books, lab copy-books, internet access and placates dedicated to individual selection schemes of different agricultural crops.

Two methods of selection (individual and massive) are employed in the applied plant breeding. Each of them is carried out in various appearances depending on the kinds of crops (cotton plant, wheat, corn, alfalfa), flowering biology (self-pollination and cross-pollination) of plants, objects of plant breeding (single or multiple) and also erudite skills of breeders.

The seeds of every plant are propagated and the grown progeny of plants will be evaluated during the next several generations. Particularly, individual selection can be a basic at these breeding processes. Owing to this, an opportunity to test the transferring possibility of genetic qualities of some individuals is created.

Creation of historically known variety Tashkent-1 may be shown as one of the remarkable examples relevant to the importance of multiple individual selection in the process of cotton breeding. This variety was evolved by the well-known cotton breeder S.M.Mirakhmedov (photo 15) and it gave the beginning of the fifth strain changing (since 1971) in the cotton growing. The variety had been developed in 1969 by the continuous individual selections of wilt resistant plants from (F3) backcross hybrid populations of S-4727 and wild G.hirsutum L. ssp.mexicanum var.nervosum (Watt) studied in the wilt infected backgrounds. Due to high wilt resistance, this variety at its time had occupied more than 1 million hectares throughout the cotton plantations of the former Soviet Union via replacing all grown wilt prone cotton varieties.

Population is artificially divided into family and lines at the course of individual selection.

Individual selection had become scientifically substantiated, main method of plant breeding, after the theory of V.Ioganson, on the idea about genotype and phenotype and either transferring of traits in populations and pure lines to progenies in the turn of XX century.

Primary selected seed stock plant is examined on genotype for several years. Genotypes of unfitted, randomly selected plants are rejected. Hundreds of progenies selected, planted and tested at different successive years of similar condition at the process conducted by the method of individual selection. This facilitates breeders to identify differences between hereditary (genotypic) and non-hereditary (phenotypic) variations and on the base of this an opportunity to pick out the best progenies and multiply their seeds are appeared. At this, the amount of primary selected seed stock plants has become 2-3 thousand depending on the amount of initial accessions, variable nature of population, work conditions and capability of breeder.

Single individual selection may be employed in the works conducting on self-pollination of plants. Natural populations, hybrid and mutant populations are taken as the initial material for implementation of selection.

Photo 15. P**lant breeder, laureate of State Prize S.M.Mirakhmedov marks out the best individual plants with desirable traits for selection, 1985.**

The progeny of one seed stock plant selected from natural population or varieties is called a **line.** The progeny of one elite plant selected from hybrid populations - **family** and progeny of selected plant from mutant populations - **mutant line.**

The order (sequence) of single individual selection conducted in the experimental plots of **self-pollination plants** constitutes the following breeding and seed production activities (chart 5):

-the first year, the best plants are selected out of initial population. Sum total of every plant on valuable farm-biologic traits is evaluated at the laboratory and some of them do not meet the requirement, they are rogued;

-seeds of all remained elite plants are sown one by one in the nursery of the next year. Here, poor families (lines) are rejected, the best families are remained for selection. Every line, planting in the breeding nursery, gets a certain numeral number. It passes through all successive stages (tests and multiplications) under this number. All these lines (families), until they get the end of the trial, are called numbers;

-the best numbers, selecting in the 3rd year from 1st year breeding nursery, are planted in the 2nd year breeding nursery, mostly best numbers are planted in the control nursery (CN). Here, the poor numbers are also rejected, the best ones are selected. The best ones in this sequences are passed further, through preliminary variety testing (PVT) field, from this to competition variety testing (CVT) field, variety testing in the different zones (VTZ) and then to state variety trial (SVT).

At the time of tests, the seeds of most performed numbers are either planted in the fields of preliminary multiplying (PM) fields and their seed production works are getting started.

Carrying out of individual selection in the **hybrid populations of self-crossing plants** takes place quite differently. The difference is associated with the emergence of segregation in the progenies of selected elite plant. That is why, correct decision of the question on defining the generation, since what to begin with in the individual selection is essential in the successful plant breeding.

Individual selection is more complicated and more labour-intensive in comparison with massive selection. The new variety, developing by plant breeding method of individual selection, is originated from one selected elite plant. It is obvious, that the period of time to be lasted during the breeding and seed multiplying process depends upon the amount of seeds produced by selected elite plant.

Individual selection in the cross-pollinated plants. Due to continuous process of cross-pollination and segregation occasions, it takes place in the cross-pollinating plants like cotton, maize, flax, sunflower, tobacco, some beans, buckwheat, safflower, ambary and alfalfa. It is impossibility to create new variety as a result of single individual selection. Consequently, a large number of individual selection is to be used in the breeding process of such crops. At this, individual selection is repeated until selected elite plant will be achieved as a desirable perfection. In some cases, this process turns in an eternal continuation.

In 2017, seeds of 16 cotton varieties have been commercially planted throughout the republic of Uzbekistan. They are: Namanghan -77, Sultan, Bukhara-102, An-Bayaut-2, Andijan- 35, Omad, S-4727, Andijan-36, Parloq-1, Khorezm-150, Beshqakhramon, Andijan-37, Porloq-2, Chimbay-5018, Namanghan-34 and C-8284. From them: Namanghan-77, **AN-Bayaut-2, Omad and** Khorezm-150, **were released by the method of individual selection.**

The variety Namanghan-77 has been developed by the breeders Vad.Avtonomov, M.Saidakhmedov, A.Shermatov and A.E.Egamberdiev. It was evolved by individual selection from natural hybrids of the variety S-6526 at the Kizilravot experimental plot of Uzbek Cotton Breeding and Seed

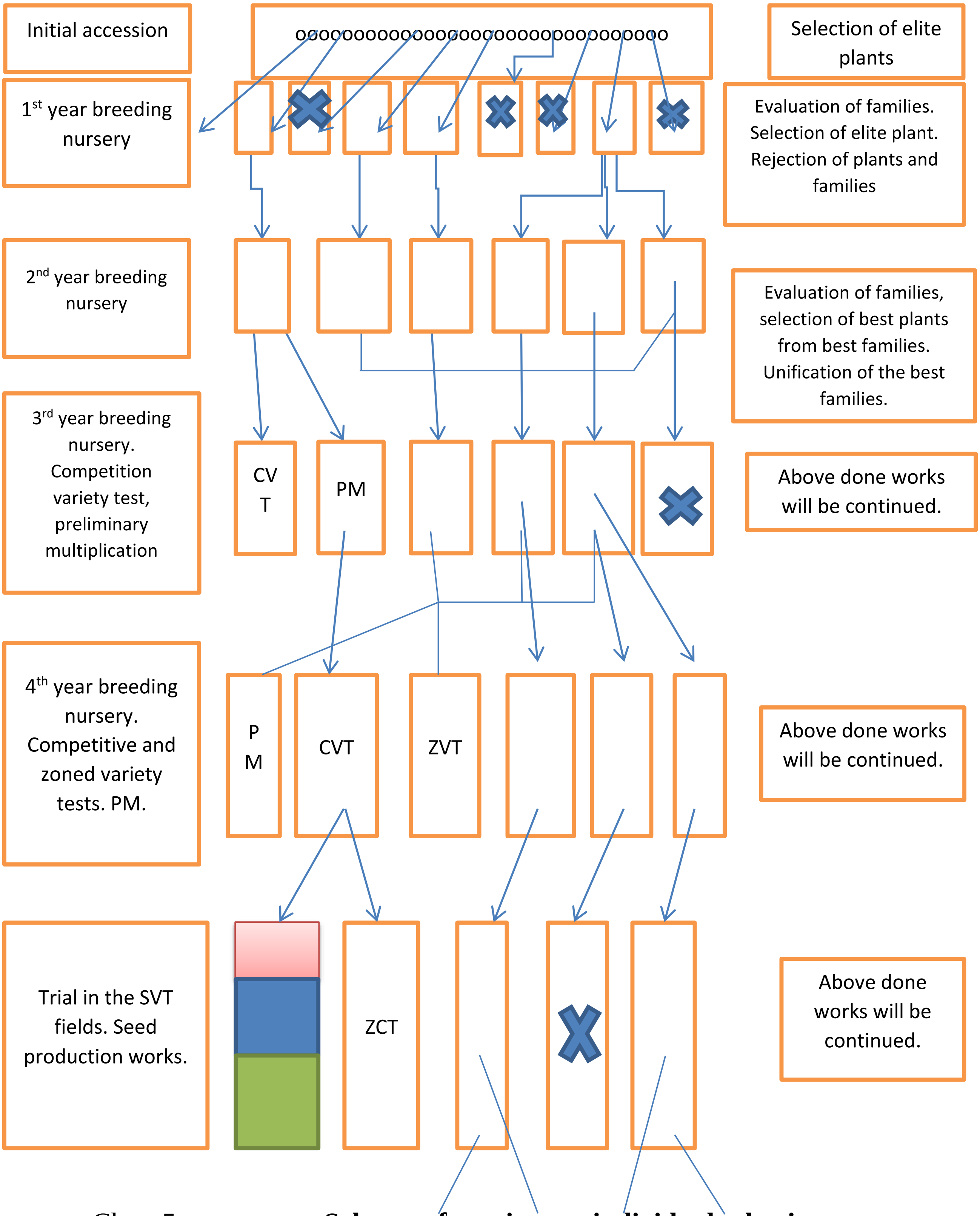


Chart 5. **Scheme of continuous individual selection**

Production Scientific Research Institute (CB&SPSRI). The variety was included into the state register since 1994. The precocity is equal to 120-124 days.

Questions and tasks to firm the mastered knowledge on using of individual selection:

1.Why there exist many kinds of individual selection?

2.What is the main importance of individual selection?

3.How individual selection can be used in the progenies of hybrids obtained from self-pollinating and cross-pollinating crops?

4.What varieties of cotton plant were developed by the help of individual selection?

5.What individual selection was exploited in the developing of varieties Sultan, Bukhara-102, An-Bayaut-2, Andijan- 35, Omad, S-4727, Andijan-36, Parloq-1, Khorezm-150, Beshqakhramon, Andijan-37, Porloq-2, Chimbay-5018, Namanghan-34 and C-8284, Namanghan-77, **AN-Bayaut-2, Omad and** Khorezm-150?

6.Find out the kinds of individual selection used in the plant breeding of grain crops and make a brief report.

7. Find out the kinds of individual selection used in the plant breeding of field crops and prepare a brief report.

8.Consolidate of acquired knowledge on the base of pedagogical method of opinion, reason, example and generalization (OREG):

1st task. Report your opinion about the conducting of phonological stage over the theme “Individual selection of elite plants” on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

2nd task. Report your opinion about the conducting of phonological stage over the theme “Repeated selection of elite plants” on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

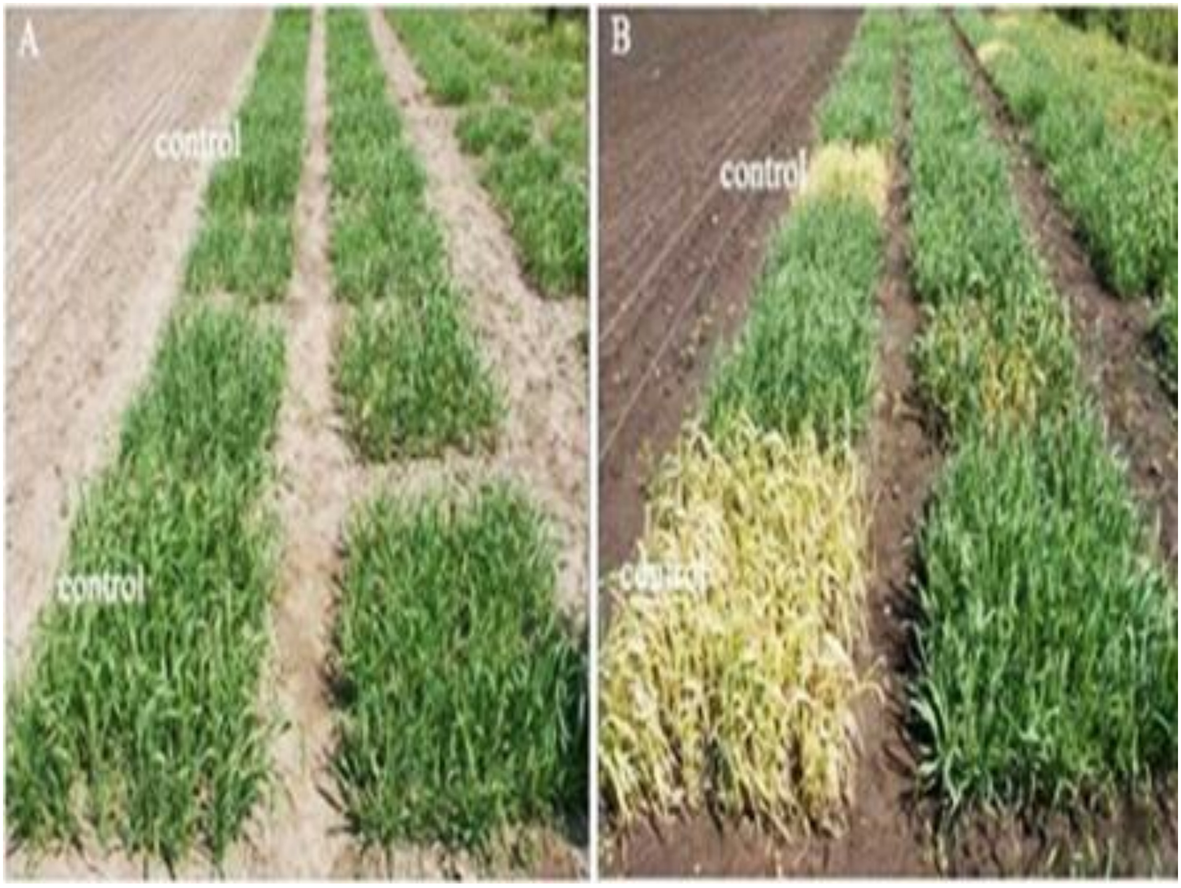
The10th practical training.

The methods of evaluation of plant breeding material.

The aim of the training. The main aim of the training is to study the approaches of evaluation of plant breeding material.

Necessary teaching subjects: lecture note-books, plant breeding schemes, copy-books,

All kinds (numbers, varieties, collection samples, semi-wild accessions, hybrids) of selected elite plants at the breeding process are called breeding material. Evaluation of breeding material means taking into account of farm –biologic traits and properties characterizing the farm importance of one of varieties or numbers. In general, breeding material is compared with widely planting – standard (control) variety of this crop or initial material. Parental pairs for hybridization is selected on the base of information taken from evaluation of breeding material and also on this base selected or rejected elite plants and hybrids (photos 16, 17). Productivity and quality of product are the main indexes for characterizing



Photos **16, 17. Assignment of control and experimental accessions in plant breeding plots.**

breeding materials. But, at first these indexes are very complicated, because they are characterized through summarizing some simple traits and properties and the second, under the influence of the growing condition they may be subjected to considerable alterations. Therefore, the breeder must intelligently evaluate the confusing reasons of alterations and differences arising in the desirable traits and properties of the breeding materials. This procedure on evaluation of breeding materials proceeds on every coming year in the initial accessions and breeding nurseries (chart 6). They are: productivity, resistance to cold, drought, diseases, smut, pests, fitness to care by mechanical machines and harvesting of crop, resistance to lodging and product quality.

Lab, field and green house methods are applied in evaluation of breeding materials during the breeding process. Using one of them depends on the kind of experiments and directions of research in which can be taken expected result, enough in estimating of the studied materials.
Productivity evaluation. The yield gained from one plant refers to its productivity and the yield brought together from a certain area is called the yield per unit of area. The yield of crops pronounces of plants' productivity and plant stand density. So, plant productivity is one of the two main indexes defining the variety's yield per unit of area (photo 18).

Photo 18. **Plants of rice and their panicles.**

Evaluation of breeding material on the productivity at the initial stages of breeding process can be possible only in the selected individual elite plants and in their progeny hybrid plants. Because, they are cultivated in the registered single lots of a plot. The ultimate productivity of every plant of cereal crops is determined by summing up their average number of grains per panicle and weight of 1000 grains.

Evaluation of resistance to cold. Resistance property of winter crops has a great farm importance because of partially or even, some of years fully loosing of plants taking place at the period of over wintering. Here, genetic non-resistance of growing varieties is the main reason of possible plants' lost. Various methods of evaluation are used in order to define the difference of cold resistance within different breeding numbers and varieties and then (by their help) select significantly resistant accessions.

The properties of plants can be evaluated by the direct or indirect methods.

Evaluation method of breeding material's resistance to cold in the conditions of field. There are several sub-methods: a) visually measuring evaluation. At this evaluation, the breeder passes across the field in spring and examines the plants and defines the thinning degree in the result of this extermination. Every lot or nursery is marked by five score sequences depending on their thinning degree. The highest score 5 is given to the lot where killed plants were not visually noted in it. The lot with a few killed plants is marked with 4 score. The half of plants were killed – 3 score and more than half and almost all correspondingly -2 and 1 scores. This evaluation is considered as relative one. Therefore, evaluation of nurseries must be done by one researcher. The other evaluation sub-methods are: b) accounting up the numbers of alive and killed plants in spring by the using of three 0,17 m^2 land samples per breeding material; c) taking 3-5 samples of land constant squares of 20-30 cm long, 12-15 cm width and 10-12 cm of depth. This is the most precise evaluation. Every sample must content at least 15 plants.

Indirect evaluation includes: sugar content and speed of ATF formation.

Drought resistance of plants has a complicated nature and involves in anatomic-morphologic properties of water steam evaporation speed forming plants, dehydrate of cytoplasms, concentration of salt compounds, physiologic tolerance of plants, growth and development of biologic properties.

Drought resistance of plants is presented in three appearances: soil drought, air drought and mixed.

Direct in the field, artificial condition and indirect evaluation methods are employed to evaluate plants' drought resistance.

Evaluation of disease resistance. Diseases of agricultural crops like rust of wheat and oats, wilt of cotton, smut of corn and sorghum (photo 19) are extremely destructive ones and cause a great damage to the productivity and product quality.

Developing of resistant varieties is a very complicated process, because of rapid increase of disease spreading agents and extended diversities of race structures. For example, rust disease has more than 350 and smut has 20 races. In spite of these they can change simultaneously their adaptability to new varieties due to mutations.

Resistance of plants associated with their morphologic-physiologic peculiarities. Apart from this, resistance of plants can be explained by the differences in developing stages of plants and pathogens. Biochemical properties of plants are not exclusion.

The special tests by manual infection (inoculation) of disease causing pathogens are employed to evaluate the resistance of breeding materials. For this purpose, there will be laid out intended nurseries.

Natural infection of plants may be attained by the using of the following methods:

1) To plant only one crop year by year in order to collect a lot of disease pathogens.
2) To change the appropriate date of planting and seed planting rate.

Photo 19. **Extended infection of sorghum with smut.**

3) To plant of testing material among strongly disease prone varieties.

The necroze spots on the leaves of cereal crops are distinct signs of rust infection. So, this phenomenon (photo 17) gives good opportunity to evaluate resistance of plants in the field conditions (by direct method). This will have done by recording the number of infected plants relatively to total number of plants.

Similarly, the tests will be conducted on the brown and yellow rust diseases. Here, the percentage of infected area of leaf can also be taken into account. The degree of infection is marked by 5 scores. If, there is not any spot signs it marks by “0” score. 1 score is given to the leaf possessing by weak spot. And so on marking continued up to 4 score with leaf, the most part of which is covered with rust spots.

Resistance to lodging. Resistance to lodging is tested and evaluated by the methods of field (direct) and in the lab conditions (indirect). In the field condition it uses 5 score evaluating system. The “5” score is given to the plot, where the plants do not show any appearance of lodged plants. Slightly lodged – “4” score, and so on “1” will be given to the part of plot, where the plants have massively lodged outlook.

Questions to review the studied material:

1.What is the breeding material?

2.Why the resistances of breeding accessions are evaluated?

3.What methods of evaluation are used in the breeding process?

4.Can you describe the consequences of growing disease and lodging prone varieties?

5.Does evaluation of breeding material affect the productivity of crops?

6.What is the advantages of lab evaluation of breeding materials?

7.What is the disadvantages of evaluation in the field condition?

8.Review over the traits and properties of cotton varieties: S-6524 and Bukhara-102 (on the base of pedagogical method of “Resume”):

Topic 1: Evaluation of breeding material in the special conditions	
Advantages	Disadvantages

Topic 2: Evaluation of breeding materials in the artificially subjected to the disease infecting pathogens	
Advantages	Disadvantages

Topic 3: Evaluation of breeding materials in the field conditions	
Advantages	Disadvantages

The 11th laboratory training.

Massive selection orders in the agricultural crops.

The aim of the training. Mastering of massive selection in the breeding process of agricultural crops by the students is the main aim of this training.

Necessary teaching aids. Lecture note-books, lab copy-books, placates with schemes of breeding process, pencils, rulers and erasers.

Massive selection is a simultaneous selection of the best (elite) plants from initial population which have traits totality similar to newly developing variety (photo 20).

Photo 20. **Breeder (third on the clockwise) and his inferior colleagues discuss massive selections techniques.**

Remarked plants' groups in the breeding nurseries for mass selection, repeatedly inspected and some of them returned, off-typical plants prior to harvest are eradicated and removed from the breeding plots. After that, selected plants in the nursery are harvested together according to the number of the nursery pointed out in the field register. At that time all selected accessions named after their numbers and their pods and seeds picked out mostly manually and placed in the family sacs with numbered tags similar to the numbers in the harvesting register. Then, they are subjected to drying in the area with sacs or free of sacs. Dried crop of seeds is exposed to cleaning and transferred to the lab analysis.

Grain performance (outlook variation), appearance (color uniformity) grain filling and health are evaluated visually and through weighing, measuring by special lab equipment and instruments.

Some massive selected numbers with off-type grains and defects on above mentioned traits are repeatedly rejected in the result of lab analysis. So, the remained numbers or selections are the progenies of the best massively selected elite plants.

Massive selection has changed modifications: one time (single) massive selection, multiple selection, negative selection, family massive selection and others.

The lab data of massive selected numbers are compared with the field phonologic records on plant architecture, vegetation period and fruit components for coming to scientific conclusion. On the base of conclusion, the seed material of the best numbers will be prepared to plant in the breeding nurseries of the next year.

If the planned aim involved in the improving desired trait of initial material is achieved by ones' massive selection, the selection work will not be done more. This kind of massive selection is called one-time massive selection. One-time massive selection may be effective in the breeding process of self-pollinating crops. In the out-crossing crops contrarily, **multi-time (multiple) massive selections** will give good results (chart 6).

Initial variety	❍□❍□❍□❍□ ❍□❍□❍ ❍□❍□❍□❍□❍□❍ ❍□❍□❍□❍□❍□❍ □❍	**1st selection.** Selection of elite plant from variety

Testing of the first selection with initial variety or standard	❍□❍□❍□❍□ ❍□❍□❍ ❍□❍□❍□❍□❍□❍ ❍□❍□❍□❍□❍□❍ □❍	**2nd selection.** Selection of plants from crop of the first selection
Initial.	Selection.	Standard variety.

PM*

Variety testing stations

Testing of the second selection at the breeding station	❍□❍□❍□❍□ ❍□❍□❍ ❍□❍□❍□❍□❍□❍ ❍□❍□❍□❍□❍□❍ □❍	**3rd selection** Selection of elite plants from the second crop
Initial.	Selection.	Standard variety.

PM*-preliminary multiplication

Chart 6. **Multiple massive selection works in the plant breeding process.**

Multi-time massive selection will be done continuously until the goals of plant breeding are fulfilled and the new variety has been developed. Thus, year by year the elite plants are massively selected from the breeding nurseries in which progenies of selected plants of the previous years were studied. It means that the best elite plants are together selected every year and their progenies are tested by comparing with initial material and commercially growing (standard) variety.

Massive selection, depending on its specification, is considered as the slightly easy, simple and raped method.

It is used not only nowadays, but since ancient times, when people's plant breeding had initially been started in different appearances and nationwide throughout the world.

A lot of varieties have been developed on the self-pollinating plants. More notable on the out- crossing plants are corn, cotton, sunflower, alfalfa and other plants via using one of massive selections.

Single massive selection is employed mostly in the self-pollinated crops and the multiple massive is mostly suitable to apply in the breeding of out-crossing plants. Frequently, the massive selection is also practiced to clean wild plants, local and foreign varieties from mixes, to improve quality of products and to increase productivity of plants.

The amount of selected massive selection makes of several hundred units annually.

Progenies, which do not manifest the expected farm traits at the time of inspections, are excluded from successive observations. If, it is a single massive selection method, the selection will not have repeated in the second and successive years. In case of multiple massive selection, it will have continued in the next years. In order to know the efficiency of selection, the material taken in the second year is compared with initial material and standard variety by planting them together.

The seeds of crops which have high index than standard variety are submitted to variety testing. The new varieties which passed through State variety trial are commercialized and included into State register by the decision of state commission. Since that time these new varieties' seed reproduction in the production scale is started.

Preliminary seed reproduction (multiplication) begins in the preliminary seed producing farms, locating near by the elite farms. The multiplication of new varieties seeds is implemented under the direct guidance of breeders by using seed production procedures similar to elite farms.

The out crossing plants have heterozygous state, that is why, their significant traits and properties peculiar to varieties may frequently exposed to alteration. Herein, if the massive selection is not conducted periodically, they will lose some valuable traits. For example, the amount of sugar in the kernels of corn hybrids decreases since the stopping of next selection. In order to prevent this incident, an eternally improving or multiple massive selection has to be continued in the coming years.

Negative selection is another kind of massive selection. At this selection, the plants which do not meet the posed requirements on the improving traits and properties are selected and discarded. Such kind of selection is also applied at the time of weeding on the uniformity of variety and species in the seed stock fields. This negative massive selection is widely used in the seed production farms to maintain morphologic, biologic and economical traits and properties of the varieties and hybrids.

Questions for consolidation of the acquired knowledge:

1.What is massive (group) selection in the plant breeding?

2.Are there any other kinds of massive selection?

3.Can you explain the designations of single and multiply massive selections?

4.When and where can be used mass –family selections?

5.When and where can be used mass –family selections?

6.What is the advantages of massive selection in the self-pollinating crops?

7.How can be listed the order of massive selection procedures?

8.Which crop varieties are developed via massive selection?

9.Firm of acquired knowledge on the base of pedagogical method (OREG):

1.Report your opinion about the massive selection over the theme “Order of massive selection in the development of sunflower varieties” on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

2.Report your opinion about the massive selection over the theme “Order of massive selection in the development of alfalfa varieties” on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

The 12th practical training.

The requirements to newly developed varieties of agricultural crops.

The aim of this training. The students study the varieties of agricultural crops and their different kinds. The importance and determination of the varieties. Requirements in regard of varieties posing by the farmers and agricultural industry of our republic.

The necessary teaching aids. Lecture note books, copy-books, register on newly introduced varieties for industrial production, literature about plant breeding of agricultural crops published by local and foreign breeders.

Plant breeding is completed by releasing of the new varieties. And the new varieties deserve to far more and enhance the quality of producing staples.

Moreover, they can fulfill the goal in achieving of valuable initial materials for successive breeding procedures.

The varieties are the outcome of plant breeding activities of scientists dedicated to the improving of agricultural crops at the scientific research institutes and their local branches (photo 21).

Photo 21. **Bird's eye view of one regional branch of the world known plant breeding and seed producing company.**

Variety of crops is developed by the working activities of man, otherwise it is created artificially. It is characterized as the means of production to increase the fertility of agricultural industry.

Variety refers to the totality of cultural plants developed through plant breeding way which have certain heredity morphology, biology and valuable farm traits and properties.

The following phenomenon must be highlighted when characterized the variety. The plants establishing the totality of plants has similar origin. They are reproduced progenies of one or a few of plans. Their similarity over farm-biologic properties and morphologic traits has been achieved through selection techniques. In general, the varieties are developed to grow in concrete climate and industrial condition. That is why, it is high productive in one soil-climatic condition and in other place it may has not any advantages. It must also be fully suitable to the degree of mechanization and farming culture achieved at the farm (photo 22).

Photo 22. **Field demonstration of newly developed (bean) peas varieties.**

The variety has to secure of getting stable bumper crop and quality staple in the corresponding climatic and industrial condition. Varieties, depending on their origin and evolved method are divided into local (indigenous) and bred varieties.

Local variety is called a variety which drive from very simple methods of artificial and natural selections under long period of growing of one or another crop in a certain place. A lot of valuable varieties of various crops are the varieties developed by the national plant breeding. The most of their plants are diverse over the farm-biologic characteristics and in this reason they will be an initial material for further plant breeding researches.

Bred variety is called a variety involved by the help of some scientific methods. The plants establishing the bred variety has been very good uniformed on the morphological traits and farm-biologic properties. Bred varieties, owing to evolved methods, divided into population, line, clone and hybrid varieties.

Population varieties are called varieties created through massive way of selection, out of out-crossing and self-crossing plants.

Independently, what kind of variety is grown in the regions of the republic, they must be suitable to the conditions of cultivation and taking care after. Except this, farmers choose the certain variety according to desirable traits and biological properties.

In general, varieties of agricultural crops must meet the major requirements to them. They are:

*The variety has to be able to produce the bumpy and stabile yield.

*It must have a high productive capability, and rapidly justifies extra expands invested by the farmers for fertilization and other agro practices.

*The varieties have to be resistant to the stresses of growing conditions.

*The varieties have to be tolerant to drought, cold, withstand the cold stresses at the overwintering period.

*They must be resistant to diseases and pests, preventing any damage to the productivity of crops.

*To have fitness to cultivation practices by the help of mechanisms.

*The varieties must be possible to give product of high quality.

*They have to secure high and best quality product in their condition of cultivation.

The main requirements presenting to traits and properties of the varieties are divided into some classes:

a) Property and traits of productivity: weight of grains per one ear of cereal crops, cob's weight and number of grains on the corn plant and weight of raw cotton per one ball and number of balls on one cotton plant.

b) Properties and traits of resistance to stresses of cultivation conditions. They include: genome potential of plants in the using of soil humidity through formation of strong root system, resistance to cold, biotic stress like the stem lodging.

c) The traits and properties of varieties resistance to diseases and pests are associated with their bio-chemic and physiologic properties of plants. For example, closed flowering of wheat decreases infection by smut, hardiness of seed peel of sunflower, protects from specific pests, gossypol content of cotton plant, prevents the attack of destruction pests and others.

Questions for consolidation of students' knowledge on the theme:

1.Where the new varieties of agricultural crops are developed?

2.What is the scientific definition of variety?

3.Does variety increase the efficiency of agriculture and how?

4.What kind of crop varieties are studied at this lesson?

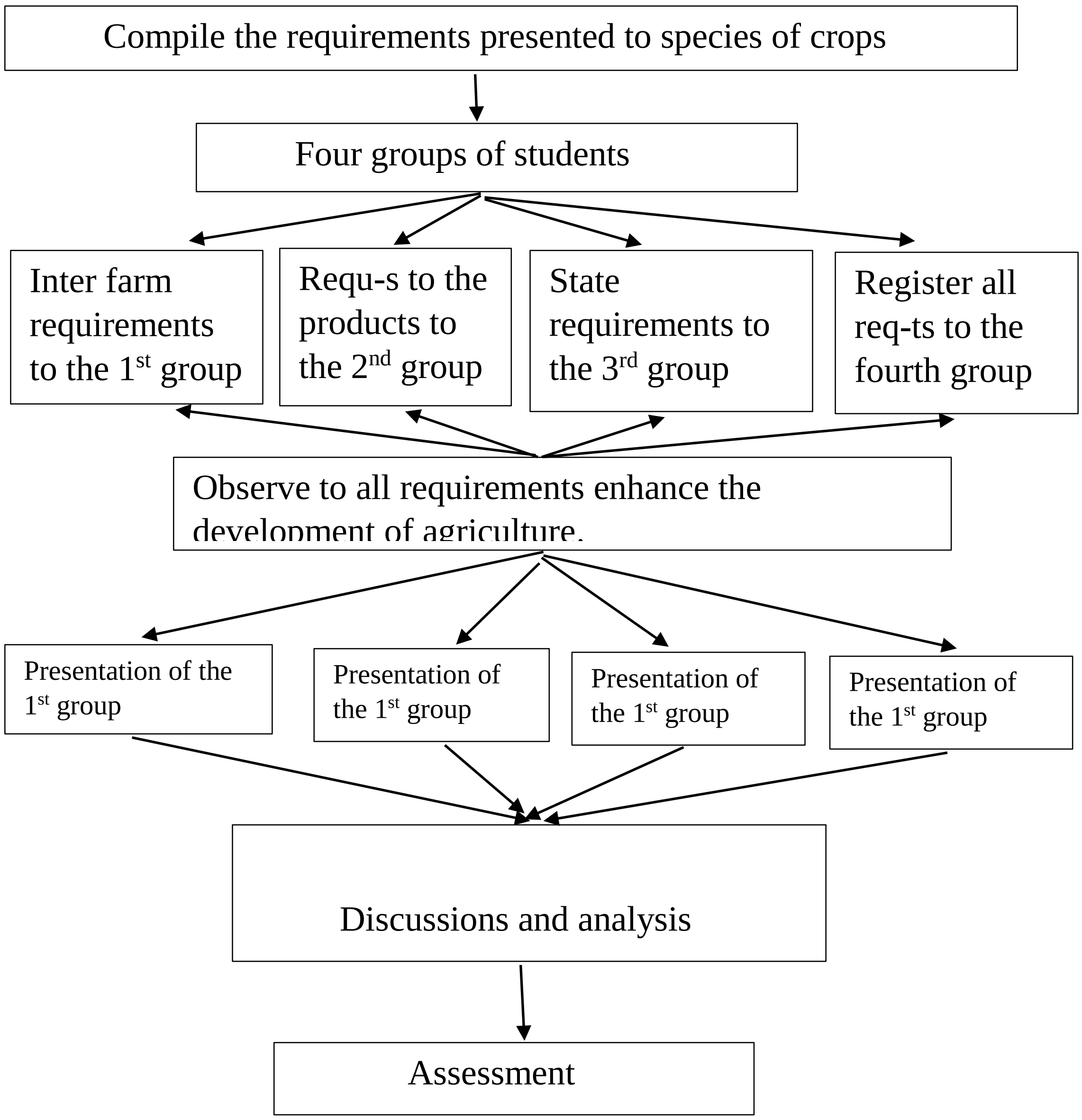
5.Can you list the major requirements posing to the new varieties?

6.Into what classes are divided the main requirements?

7.What kind of requirements are posed to the varieties of cotton?

8. What kind of requirements are presented to the varieties of cereals?

9. Repeat the training over the method "Working in the small groups", pedagogical method to consolidate studied material.



The 13th laboratory training.

Determination of the variety signs of agricultural crops.

The aim of the training. The students study variety signs of some agricultural crops by the instruction of the teacher. They take the herbariums of different plants available at the laboratory and master the basic rules of determination the variety signs of other agricultural crops. As the example, the students draw (at the page of their lab copy-books) one plant architecture, focusing on the variety signs on their own preference (Photo 23).

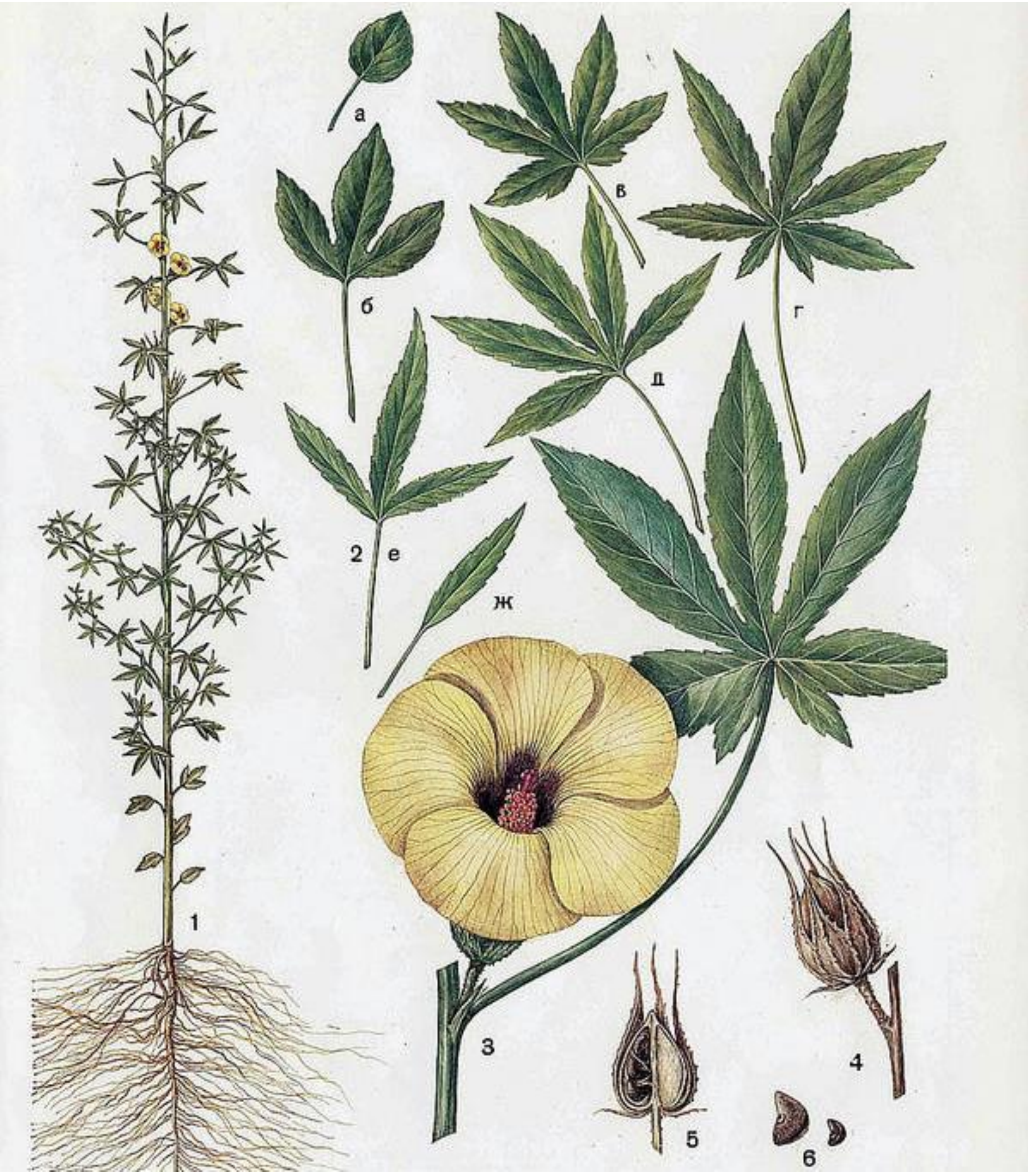


Photo 23. **Plant architecture and yield components of ambary.** Where: 1-flowering plant; 2 a, b, v, g, d, e, j – leaves according to their places on the stem: up

to top; 3 – part of stem with flower and leaf; 4 – matured boll, 5 – cross-section of ambary-boll; 6 – seed, enlarged on the left.

Necessary teaching aids. Literature on the varieties of agricultural crops, state register on the introduced varieties into production, placates of agricultural crops, lab copy books, pencils (and colored desirable), rulers and erasers.

All measurements at the scientific research institutes, directing to ensure healthy, uniform and productive elite seeds of crops, would give an anticipated result only by setting up a hard control above all seed stock industrial areas. Because only the seeds of high variety grade and seed quality can possible to give bumper crops. That is why, the important task, directing to maintain high variety grade and planting quality of seeds at the period of reproduction, has entrusted to the share of our country's seed production. But, there is no complete maintaining possibility to prevent reduction of their variety grade and planting qualities at the time of seed production, storage, transferring to other farms. Taking into account this, regular control has been set up above seed stock plantations and seed stocks with the purpose of constant improving of seed quality and their productivity in our country.

Every variety has its genetically distinct plant architecture and reproductive components which described by the author of variety. These distinguished peculiarities involve in morphological traits and biological properties of every variety of agricultural crops. Complex of these indexes and uniform inheritance from generation to generation exhibits the degree of variety grade. Maintaining the uniformity in the variety grade is the main core of the plant breeding process and seed production system.

Scientifically proved that maximal potential of productivity and a certain quality of product of grown varieties depend on the variety grade of these varieties.

Variety grade of ambary (photo 21) is defined through inspection of plant morphology (architecture) and reproductive components. They are:

*Main stem, length, thickness, hairiness of stem. There exists a straight correlation between length of stem and fiber output (photo 21). The high stems give much fiber than dwarf stems. And the vegetative period of varieties also frequently depends on the length of stem. So, varieties characterizing by long stem, are late ripening and on the contrary.

Thickness of the stems vary from variety to variety which consists of 1-2 cm up to 3 cm. The top part of stem makes 0,33 cm (photo 24). And the quality of obtained fiber differs according to the part of formation. The best fiber produces from the lower part of main stem.

Photo 24. **Fiber producing from the stems of ambary plant.**

*length of nodes varies correspondingly to the number of nodes which range from 40 to 80 even 90.

*Color of stem may be light green, green and yellow-green. These colors can be changed up to red until the stem gets matured. In this situation the defining color of variety accepts that color which recorded at the time of approbation.

*Hairiness of main stem is determined by the inspection of stem part on 35 cm height. Beside the hairiness there are thorns also. The thickness and sharpness of thorns straightly depends on the diversities of varieties.

*Level of branch setting. The branches on the main stem can get setting from 15^{th} up to 40 nodes at the lower part of stem. The amount of branches on the stem has positive relation with the thickness of plant stand per unit of area, even staying depressed. In regard of cultivating varieties this sign of ambary has genetic heredity and every variety has determined quantity in the recommended condition of growing. And availability of the branches on the stem of plant is undesirable trait from viewpoint of farming. The varieties without branches are able to stay without them, even in the situation of exceeded plant thinning.

*Color of branches. Branches of ambary varieties also have genetically hereditary nature. They may be met in green, dark green, yellow green and spotted with anthocyan and purpled (photo 25).

Photo 25. **The stems outlook of one of the ambary varieties.**

*Stipule of leaves. Stipules are prickly shaped (photo 22).

*****Leaves. In general, the leaves of ambary can be schematically represented as: one spiral of leaves is simple heart shaped; another one spiral is three lobe-like and the third is five lobed; two spirals – seven lobed, two spirals – five lobed and so on (photo 22). Above listed characteristics of leaves also have variety peculiarities and can be found in the descriptions of concrete varieties. The total number of leaves per plant can be ranged at the level of 40-50. The colors of them, depending on the varieties vary from green to purple.

*Flowers. Flowering begins after 75-85 days of germination. Petals of flower buds are yellow. At the time of opening they turn into tender creamy colors. And at the time of wilting they again turn into yellow.

Questions and tasks for consolidation of obtained knowledge:

1.On the example of studied ambary plant try to describe the variety signs of another plant variety presented in the herbariums of the class room or depository of the laboratory.

2.Draw variety signs of analyzed plants on the page of your lab copy-books.

3.Can you describe the variety traits of sunflower?

4.Can you describe the farm valuable signs of cotton?

5.What variety signs of alfalfa do you know?

6.Do variety signs of varieties affect the productivity?

7. To firm mastered knowledge on the base of pedagogical method of "Thick and thin".

Questions of "Thin"	Questions of "Thick"
All varieties of crops have to …….? According to what we can guess this is the best variety? Which varieties are bad for you? How would wild species affect to identity of varieties? Is there any variety in your region best to its variety purity?	How you can determine the variety signs? Does variety sign affect positively to form disease resistance? What is sign set of oat variety? Which signs of rye are important for getting the best black bread?

The 14th practical training**.**

The reasons of variety worsening.

The aim of the training. The aim of the training is to study the biotic and abiotic factors which cause worsening the variety uniformity and seed qualities of growing varieties. They master the knowledge about the elite plants' uniformity at the breeding stage and at the cycle of seed reproduction and prevent works focusing on the maintaining of the variety grades.

Necessary teaching aids: lecture note-books, copy-books on the practical trainings, seeds of different registered crop varieties, variety characteristics, herbarium plants of different varieties, instructions on the production of elite plants and next generations, seeds of cereal crops, cotton plant and beans.

Every variety of agricultural crops has to represent its unequal genetic characteristics such as distinctness, uniformity and stability (photo 26).

Photo 26. **The breeders inspect and remove off type plants from nurseries.**

According to the UPOV (The International Union for the Protection of New Varieties of Plants): "the variety must be distinct (D), that is, easily distinguishable by certain characteristics from any other known variety. The other two criteria, uniformity (U) and stability (S), mean that individual plants of the new variety must show no more variation in the relevant characteristics than one would naturally expect to see, and that future generations of the variety through various propagation means the necessity of continuation to show the relevant distinguishing characteristics [19].

In Uzbekistan, either exist some methodic instructions and standards regulating the variety uniformity and quality characteristics. Elite plants of the new variety and generations of reproduced seeds (reproductions as R_1, R_2 and R_3) have to be grown under the guidance of those instructions and meet the standard requirements on their characteristics.

In spite of scientifically well-founded breeding process and seed reproduction system functioning in our republic, varieties of agricultural crops subject to some extent of worsening. According to literature, the major reasons of worsening of variety grades of growing varieties are:

1.Mechanical worsening.

2.Cross-pollination.

3.Asorting (altering or segregation).

4.Infection and damage.

5.Mutation.

Incidental mixing of seeds of one variety with other varieties and even with the seeds of other species is called mechanical worsening. This kind of worsening can occur frequently in the time of harvesting, transportation, reprocessing, storage, stock seed treatment and even at the time of planting. For example, rye with winter wheat, durum wheat with bread wheat and barley with oat. Preventing measurements taking into practice at the above listed seed provision chain have a great importance in the maintaining of seed stock quality which secure the variety uniformity (or purity) kept at high level. Seeds of some crops do not differ from each other (photo 27). Therefore, a great attention is required at the time of harvesting,

Photo 27. **Seeds of some field crops.**

transporting and packaging before preparing to storage or treatment prior to planting. Careless operations result in their intermixing and lead to lowering seed stock quality. Occurrence of foreign seeds in the piles and sacks will be discovered at the time of lab analysis and these grains of a batch are to be sent to reprocessing. Availability of foreign grains in the grains of one, for example, even grains of soft wheat in the bulk of hard wheat significantly decreases the quality of produced flour.

More important of seeds' mixing is in the planting seed stocks because of a high seed multiplication coefficient of the plants. Otherwise, they have an enormously character of propagation throughout the variety population and come to irrevocable process of variety waste.

Cross-pollination may be happened between plant populations of varieties of one self-pollinating crop or crops like wheat and rye, oat and barley. Cross-pollinating has an extraordinary spoiling effect on purity of varieties of biologically cross- pollinating plants, growing in the neighborhood. Such crops are: **cotton,** maize, flax, sunflower, tobacco, beans, buckwheat, safflower, ambary and alfalfa. Setting up the space isolation between fields of varieties and inbred lines of crops in the seed stock producing farms is an essential element of elite seed production system of any country. The following norms of space isolation in regard of agricultural crops have been accepted:

Winter hard wheat from soft wheat – 200 m.

Triticale – 150 m.

Rye – 150 m.

Dwarf stem rye from taller stem rye – 1000 m.

Buckwheat, winter vetch, peavine – 200 m.

Beans (common bean, mung bean, peas, chick pea) – 500 m.

Produced seed-stock by non- observation of above presented isolation spaces is exposed to exclusion at the field approbation and won't use for planting.

Segregating process in the varieties, hybrids of agricultural crops is the genetic principle. Because, in the viewpoint of heredity, they are combinations of different genes from different parental plants, incorporated into one new plant genotype in the result of plant breeding. Plant breeding is conducted in the definite environmental condition. Reproduction of seeds at the time of seed multiplication is accompanied by the recombination of those genes controlling basic traits and properties of bred plants. The result of this recombination frequently cause appearing of undesirable plants in the elite plant population, which scientifically is refer to the segregation. Segregation of new plants with new complex of traits worsening the uniformity of any variety and decreasing their crop profitability. Therefore, the continuous selection of typical elite plants in the multiplication nurseries is a foreseen work in the seed production systems. Beside this, the optimal condition of growing like to the condition, when the variety was developed is recommended. Because, the segregation tends to increase in the non-typical growing conditions as well.

Here is a list of ten major diseases of cotton plant: 1. Angular leaf spot. 2. Vascular wilt disease. 3. Grey mildew. 4. Antracnose disease. 5. Root rot disease. 6. Boll rot disease. 7. Leaf spot. 8. Redding disease. 9. D. Injury. 10. Tobacco streak virus disease. Other crops also have their specific diseases nor less than cotton plant.

Most of their pathogens causing diseases on the plants of varieties have spreading swift as lightning. If spreading occurs with the seed material it becomes all national problem and all seed material have to be destroyed. Because, the number of infected plants in the variety population will increase year by year and all the seed material, apart from their variety uniformity are classified as the unfit to planting purposes. In the viewpoint of feeding people and agricultural animals the very high requirements of standards put on grains' infection by the disease causing pathogens. Consequently, the great attention at the system of seed production is being paid to the clearness of primary seed materials and some other methodically efficient procedures are being used to prevent the emerging of disease spreading sources. All efforts (in particular, disinfection of seeds, storage premises, transporting vehicles, covering materials, working instruments and others) of agricultural industry focused on the seed protection and production of elite plants perfectly free of disease pathogens.

Widely spread pests of cotton plant are Aphids, Beet armyworm, cotton bollworm and others. They are residents of cotton plantations, fed on the account of plant particles and can attack to other crop species coming in the rotation to cotton and contrarily.

Not only plants of varieties of agricultural crops but their grains and seeds are deteriorated by the pests of agricultural crops. They do damage and spoil the grains and lowered their planting and technical qualities. The pest life cycles have been adopted to the main crops. That means that cotton boll worm has synchronized its developing cycle with development stages of cotton plant. The major harmful generation of cotton boll worm suits with setting of buds and bolls of cotton plant. In particular, for this reason also the harmfulness of this pest progressing year by year.

There were worked out many methodic procedures to prevent the pests harm on plants and their grains. One of them includes planting of seeds prior to or late than dates of plantings in the previous farming years. This is one of the organic-manual way to prevent damaging of ears and bolls of plants by the pests and maintain the quality of grains and seeds.

Mutation or spontaneous alteration of major traits and properties of elite plants in the variety population can be emerged permanently. Such kinds of mutations occur rarely but early or lately they cause worsening of variety. Natural mutants multiplied as the random mixes within plants of variety. To find mutants and exclude them from variety population become significantly difficult because of occurrences of modification variability and natural hybridization. Practice of inappropriate agro-technician in the seed stock crops can be a reason of deterioration of produced seeds productive quality. According to report of famous wheat breeder P.P.Lukyanenko, there was not observed the deterioration of productivity quality of winter wheat variety Bezostaya-1 grown in high background condition up to the 6^{th} reproduction. Beside this, absence of systematic variety improving selections in the conditions of agricultural industry can be the reason in deterioration of variety seed qualities.

Tasks to consolidate knowledge on deterioration reasons of variety qualities:

1.Prepare examples of mechanical worsening of farm desirable traits of cotton plant varieties from recently published scientific articles.

2.Explain cross-pollination and its influences on variety grade of grown varieties of agricultural crops.

3.What's the segregation in the process of plant breeding and its dependence with the selection of elite plants?

4.Prepare the report about the protection procedures to prevent infection plants by the disease causing pathogens and damage of yield components by the destructive pests.

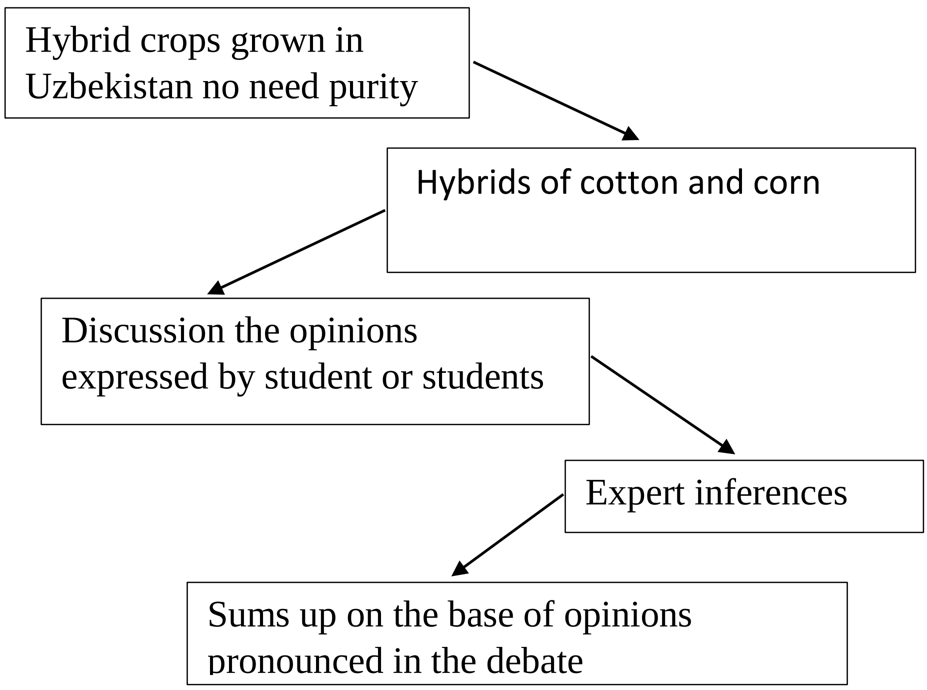
5.Compile the list of mutant factors and present some of the negative and positive mutation outcomes in the plant breeding.

6.What is the major reason to worsen the variety indexes?

7.How can breeder to minimize the reason of worsening the variety index?

8.Do the insects affect the worsening of the variety indexes of crops?

9.On the base of pedagogical method "Debate" organize question and answer exchange with your friends about studied material.



The 15th laboratory training.

Determination of gluten amount in the grains of wheat varieties.

The aim of the training. The students get acquaintance with the standard (GOST P 54478-2011) worked out to define gluten amount (photo 28) in the grains of wheat. They learn about definition of gluten, structure and its order of analysis. They master analysis of flour, experience of manual and mechanical washing of gluten under the control of assistant who taught technical safety rules (GOST 12.0.004).

Photo 28. **Wheat ears, grains and produced flour.**

Necessary laboratory devices and teaching kits. Lab mill (up to 0,9 mm), lab paste mixer (photo 29), gluten form giving set, IDK (+-0,5 error index and from 0 to 150,7 measuring indexes), measuring of deformation (photo 85), in the training of 32), scales (GOST 24 104 and +-0,01 g of preciseness) and other devices showed in the standard, lab copy-books, pencils, rulers, erasers, copy from state standard (GOST 27839-2013).

Gluten of wheat flour is referred to the chemical compound in the structure of flour including into a group of proteins, non-dissolving in the water, it is a family of proteins (mainly it consists of glutenin and gliadin proteins, and there are 15 irreplaceable amino-acids in its texture, essential for the man health) possible to form a sticky network that has a glue-like consistency when flour is mixed with water.

Amount of gluten (amount of raw gluten) **in the flour** – weight in percentage of washed out, raw gluten in ratio of weighed flour mass.

Photo 29. **Mechanical flour mixer**

Crumbling gluten— stiff gluten, strongly crumbles, porous, unconnected, splitting itself, impossible to define its quality in the device of IDK.

Non-washing gluten – it is very weakening and it is impossible to make sticky mass from it and to define its quality in the device of IDK.

The regime of washing of crumbling dough – regime of washing out of gluten when impossible to form the sticky dough even after twice and many times mixing.

Dried gluten – gluten taken from raw gluten by separating unconnected water through artificially drying.

The amount of dried gluten – weight of dried (dry) gluten in percentage ratio of weight of flour sample taken to analyze.

Macaroni flour – flours of soft and hard wheat designated to produce macaroni products.

Order of work. Inspect of tape water availability in the lab conditions prior to analysis.

Taking of flour sample, checking the working regimes of mechanical devices before washing of flour and adjust according to the wheat variety from which the sample taken. Samples incorporated and separate lab sample of 60 grams.

Weight 50 gram of grain from selected wheat and grind in the lab mill. Then sift it with the help of sieve (№ 43). Output from sieve has to be not less than 60%. Separate 25 gram of flour from properly mixed lab sample with the cup (№ 2). (The amount of washed gluten should be at least 4 grams. In the other case sample flour is multiplied as shown in the table 4).

Under mixing of dough and its settling, water with18-20°C of temperature is required for gluten washing.

Mixing of dough (table 4) is fulfilled in the dough-mixer device with dosator (photo 29)

Table 4. **Water amount for dough mixing from wheat flour**

Weight of flour sample for analyze, gr.	Water volume, см^3
25.0	14.0
30.0	17.0
35.0	20.0

Full taking out of dough from dough mixer is done after the work completion (±2% with water dosator and19±1second mixing). Resting dough on the surface of dish also gathered and combined in main mass. In the cases of inadequate mixing the repeated mixing is also admitted.

The ready dough in shape of cylinder is covered by the cup №2 for 20 minutes to settle.

After that dough is washed out of gluten by the tape water, holding it in the sieve №25. Dough is planed permanently by hand in water to prevent its splitting away at the time of washing. Dough parts which have split away will bring together from sieve and add in dough.

Washing is continued until the starch is fully washed away. The completion of the washing is examined by putting one gluten drop into glass through pressing. If the droplet forms a stable unsettled chalk color liquid in the glass, it shows that the washing has ended.

The washed gluten is pressed in the hand and the excess water is separated and wiped with towel. It is dried for 3-5 minutes. The gluten turns into sticky-glue state in the hand.

Dried gluten is weighed and then is washed again for 2 minutes and pressed. After that is weighed up to 0.01 preciseness. The washing has been completed if the differences between weighs are not more than 0.10 grams.

Defining the amount of pressed gluten. Total weight of gluten is calculated as a result of main washed out gluten weight. At this, the pressed raw dough weight is weighed up to 0,01 g preciseness. Weighing is fulfilled by one person in two replicates and on one scale in a short time.

Treatment of analysis.

Amount of raw gluten in the flour powder: X, % for raw gluten is calculated up to the first 10 preciseness by the following formula:

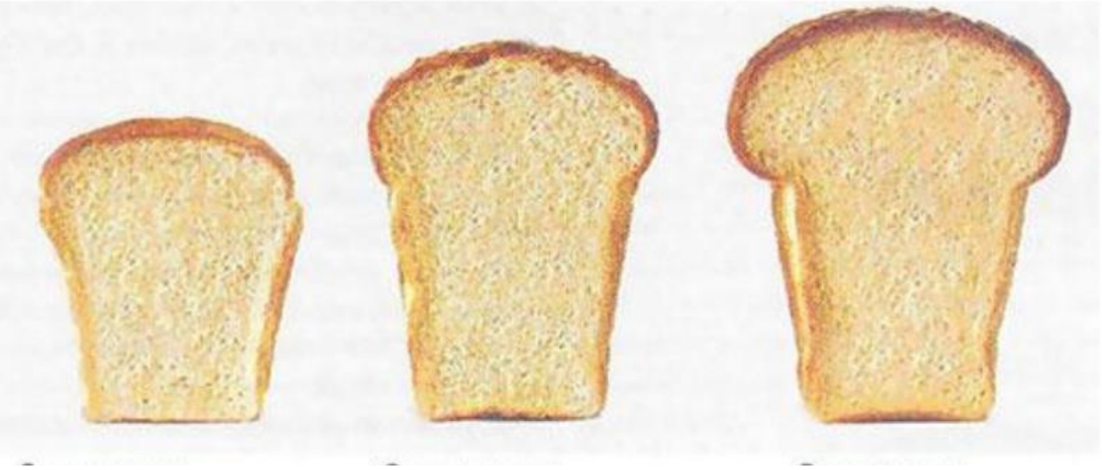
$$X = \frac{M_1}{M} \times 100$$

Here, M_1 – is gluten weight, g.

M – weight of flour powder, g.

100 – coefficient of repeated calculation, %.

According to the taken result, the amount of raw gluten in the flour powder shows the texture and quality of bread baked from this flour as the examples presented below (photo 30).



Gluten content -20%. Gluten content -30%. Gluten content -40%.

Photo 30. **Depandance of the baked bread quality on the gluten amount.**

Questions and tasks on the theme:

1.How can be explained gluten in the flour powder of wheat?

2.Can you describe the crumbling gluten, unwashed gluten and washing regime of non-crumbling flour?

3.What dried gluten, amount of dried gluten and macaroni flour definitions consist of?

4.Describe lab analysis order to define gluten amount?

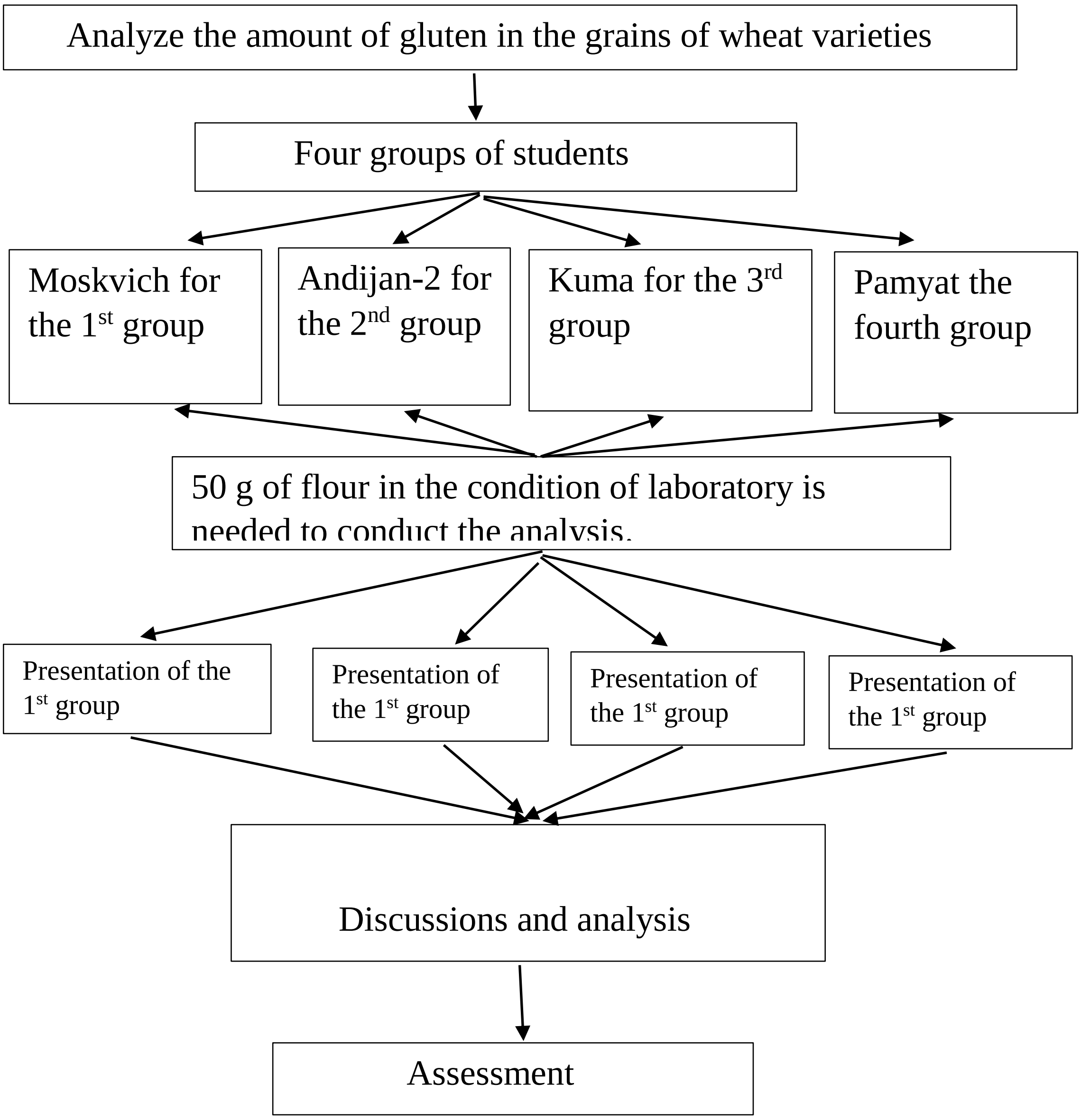
5.How the result of analysis is calculated?

6.How is the amount of gluten in the flour of wheat defined?

7.What is the gluten of wheat flour?

8.How would amount of gluten affect the quality of bread?

9.Organize the training over the method “Working in the small groups”, pedagogical method to consolidate studied material.



The 16th practical training.

Heterosis and its kinds.

The aim of the training. The aim of this training is to get acquaintance with the idea of heterosis, its kinds and to use heterosis in the plant breeding practices.

Necessary teaching aids. Literature or internet access to the world information about heterosis in the plants of agricultural crops, placates depicting plant heterosises on the agricultural crops, copy-books for practical trainings, rulers, pencils, erasers.

Heterosis refers to the phenomenon in which hybrid offspring exhibit characteristics that lie outside the range of the parents (Shull, 1908).

Heterosis, also called hybrid vigour, the increase in such characteristics as size of fruits, growth rate of plants, fertility of pollen grains, and profitable crop of hybrid plants over those of their parent plants (photo 31). Plant and animal breeders exploit **heterosis** by mating two different pure-bred lines that have certain

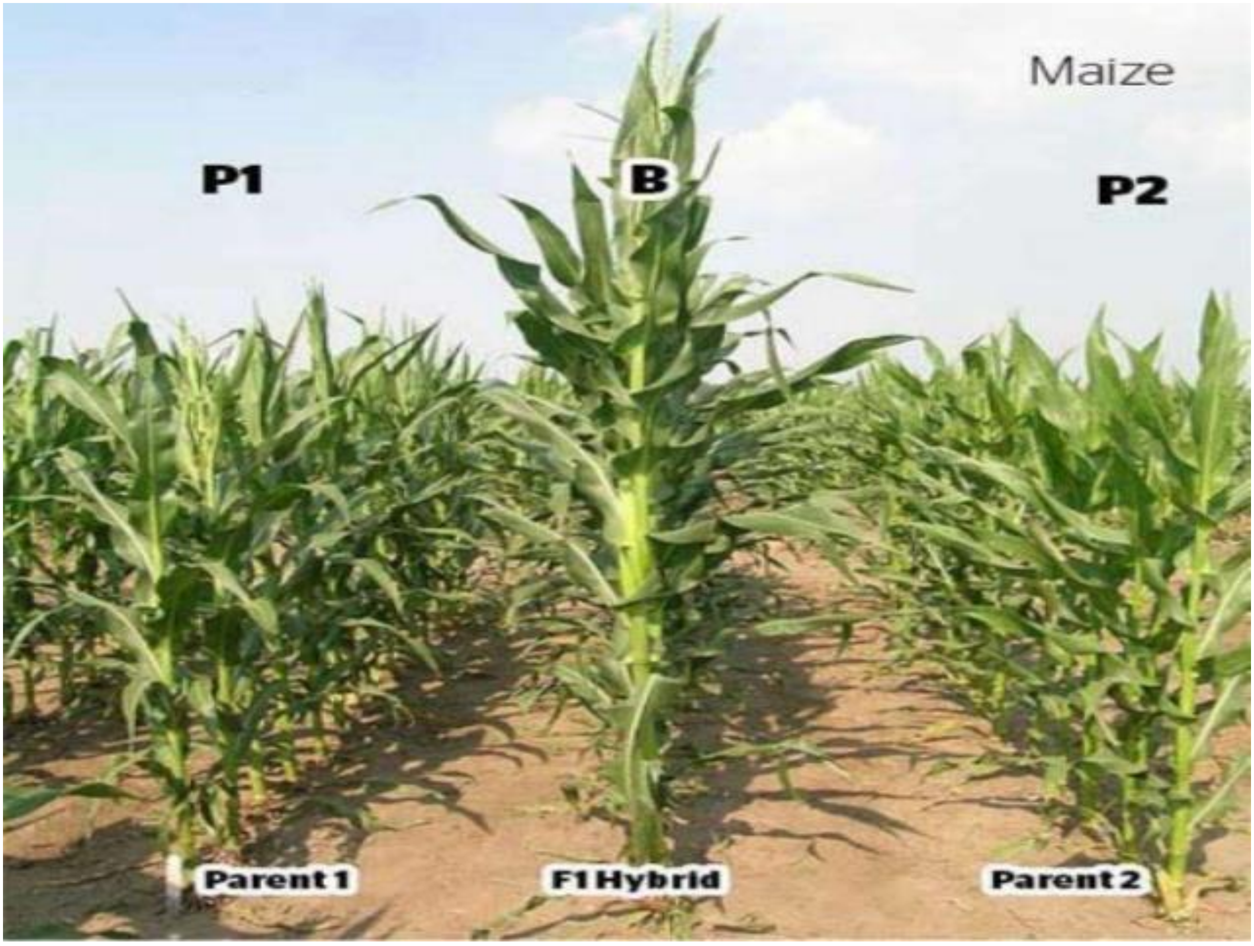


Photo 31. **Simple morphologic view of heterosis between two parental plants.**

desirable traits.

The vigor (survival and high yield) of hybrids than their parents for the first time was discovered in 1760 by I.G.Kelreyter, honored member of the Petersburg's Science Academy. He watched the vigor (survival, vigorous development and high yield) within the hybrids of tobacco diversities and had an initiative to its use in the practice of plant breeding. Later he has identified that only the first generation is possible to use in the production.

After that, Ch. Darvin investigated it more in detail and showed the bases of heterosis in his book "The influence of self and out pollination on the plant world" published in 1876. In his book Ch. Darvin linked up the cause of heterosis with genotype differences in the gametes of parents.

American scientist D. Bill (1878) under the effect of Ch. Darvin's ideas intercrossed varies varieties of corn at Michigan agricultural college. Crossings have resulted in taking hybrid offsprings which yielded for 10-15 percent more products than their parental forms (photo 32).

Photo 32. **Simple reproductive view of heterosis between those parents.**

In 1914, V.Shell introduced the term "heterosis" into science to show the vigor of heterosis hybrids. And the Sweden genetic A. Gustavson divided the heterosis, occurring in the plants, into three main kinds:

1.Reproductive heterosis – it refers to the arising of reproductive organs, a lot of fruits and seeds.

2.Somatic heterosis – vigorous development of plants' vegetative organs.

3.Adaptive (adaptation) heterosis – strengthening of plant surviving.

Hybrid seeds of corn, sorghum, sunflower, cotton plant, rice and other crops are produced in the most of world countries and are grown in the vast agricultural fields (photo 33). In some crops, the first generation of hybrids give 25-40 % and even to 50% more yield of high quality than previous parental plants. In this case, the genetic reproductive heterosis in the hybrids is identified by the statistical formula (hp = (F_1 – MP), suggested by G.M. Beil and Atkins (1965).

Here: hp – index of dominancy;

F_1 – F_1 - arithmetic mean of trait of hybrid combination;

P - arithmetic mean of trait of the best parent;

MP – arithmetic mean of both parents.

Evaluation of dominancy of F_1 hybrids is carried out in the following order:

Index of hp is equal to 0 – no dominancy;

Index of hp is equal to 1 and less – partial dominancy;

Index of hp is equal to 1 – full dominancy;

Index of hp is more than 1 - heterosis.

Crossing of organisms is carried out by the order of out - breeding and inbreeding.

Out-breeding refers to crossing of remote organisms or plants.

On the contrarily, crossing of organisms closely related to each other (relatives) is called **inbreeding.** Inbreeding belongs to the animals and the plants.

Several times, year by year, compulsorily crossing with each other in the progenies of outcrossing plants is called **inzucht.**

Photo 33. **Hybrid cotton plantation in rain fed areas**

Reproductive heterosis is characterized by the growing of productivity in agricultural crops:

- **Increase in size and genetic vigor:** Hybrids are generally more vigorous i.e.: larger, healthier and faster growing than the parents e.g., head size in cabbage, cob size in maize, fruit size in tomato etc.
- **Increase in yield:** Yield may be measured in terms of grain, fruit, seed, leaf, tuber or the whole plant. Hybrids usually have increased yield.
- **Better quality:** Hybrids show improved quality e.g., hybrids in onion show better keeping quality.

Somatic heterosis. Here there are two possible causes of heterosis:

- **Dominance hypothesis:**

This theory was proposed by Davenport (1910), Bruce (1910), Keable and Pellew (1910). This theory is based on the assumption that hybrid vigor results in bringing together female dominant genes. According to this theory, genes that are favorable for vigor and growth are dominant, and genes that are harmful to the individual are recessive. The dominant genes contributed by one parent may complement to the dominant genes contributed by the other parent, so that F will have more favorable combination of dominant genes, than both parents e.g., Dominant genes ABCD are favorable for good yield. Inbred A has the genotype AA BB cc dd (AB dominant) and inbred B has the genotype aa bb CC DD (CD dominant).

It is described that the genotype of F hybrid contains dominant genes at all the loci represented here (ABCD) and exhibits more vigor than both of the parent inbred lines.

Over dominance hypothesis:

This hypothesis was given independently by Shull (1903) and East (1908). According to the supposition, hybrid vigor on the basis of heteozygosity is superior to homozygosity. According to this hypothesis there are contrasting alleles for example a_1 and a_2, for a single locus. Each allele produces favorable yet different effects in the plant. In a heterozygous plant (a_1, a_2) a combination of the effects is produced.

Adaptive heterosis of hybrids is expressed by more adaptability to environmental changes due to their heterozygosity which may be summarized in the following results:

1.Increased Yield:

Increase in yield which may be measured in terms of grain, fruit, seed, leaf, tuber or the whole plant is one of the most important manifestations of heterosis.

2.Increase in Size and General Vigour:

Heterosis results in more vigorous growth which ultimately leads to healthier and faster growing plants with increase in size than their parents.

3.Better Quality:

In many cases heterosis yields better quality which may be accompanied by higher yield.

4.More Disease Resistant:

Heterosis sometimes results into development of more disease resistant character in the hybrids.

5.Increased Reproductive Ability:

Hybrids exhibit heterosis by expressing high fertility rate or reproductive ability, which is ultimately expressed in yield character.

6.Increase in Growth Rate:

In many cases the hybrids show faster growth rate than their parents, but that does not always produce larger plant size than the parents.

7.Early Flowering and Maturity:

In many cases the hybrids may show earliness in growing and maturity than their parents, for some crops these are the desirable characters for crop improvement. All these manifestations of heterosis can be traced at all levels of hybrid plant organization.

The questions for consolidation of the acquired knowledge on heterosis principles:

1.What is heterosis?

2.Who were the scientists discovered the phenomenon of plant heterosis, which later was introduced as the scientific term into science?

3.Into what kinds has been divided heterosis by Sweden genetic A.Gustavson and what are their differences between each other?

4.What are the meaning of dominance and over dominance?

5.How can we identify the genetic nature of heterosis in hybrids of crops?

6.What scientists have introduced the term heterosis into the science?

The 17th laboratory training.

The rules of average sampling.

The purpose of the lab training. The students are acquainted with such conceptions as seed planting quality, conditioned seeds, seed batches, control units, average sample and the order of average seed sampling of the crops.

The necessary articles employing at the time of studying the average seed sampling in the lab are: lab copy-books, manual on practical lessons on the subject of "Selection and seed production of field crops.", extracts out of the state standards: on the orders of storing and average seed sampling of farm crops (12036-85), table of the sizes of control units for sampling of grain crops, models of the gauges, technical scales, paper and fabric seed packages, seed lab dishes, rulers, erasers, pencils.

Planting quality of seeds – this is totality of seeds properties, characterizing their fitness degree to plant.

Purity, germination, germination energy, growing vigor, vitality, moisture, weight of 1000 seeds, infection by diseases and pests are involved in the main planting quality of seeds. Every planting quality fixes by the GOST. The seeds meeting the requirements of the GOST on the planting quality are called **conditioned** and according them planting can be done; **unconditioned seeds** are not permitted to the planting.

The seed batch – it is a definite amount of uniform seeds (of one crop, variety, reproduction, category, variety purity, year of crop, similar origin, numbered and conformed by corresponding documents).

The control unites– one average sample of particular amount or its parts is taken to determine the quality of seeds at separate batch.

An average sample is analyzed in the lab to inspect the correspondence of seed quality to the requirements of standard documents, which selected from seed batch.

Methods of sampling have been approved by the GOST (Standard on the sampling of farm crops 12036-85). According to this standard, **samples are taken out** of different sacks (packages) of batch if the seeds are stored in the sacks (table 5)

Table 5. **The number of sacks, picked out to select samples of farm crops (beside corn in the cobs, included up to 10 kg).**

Number of sacks in the batch (control unite) in units	Number of sacks, picked out to take sample
Up to 5	All sacks
6-30	Every third, at least 5
31-400	Every fifth, at least 10
401 and more	Every seventh, at least 80

Samples of corn seeds in the cobs are taken to the analysis from every sacks of batch with up to 10 sacks; from every fifth sack of batch with 11 up to 100 sacks, but at least from 15; from every tenth sack more than 100 sacks, but at least from 15.

Selection of control sample is done from every sack with one sample (table 5), changing the sides of sacks by the help of special gauges (photos 34, 35).

Photos 34, 35. **Special gauges to take control samples from seed sacks.**

After taking off the needed sample the wholes on the sacks have made by the gauges will be closed according to the corresponding recommendations.

Taking off samples from heaps (photo 36) of grains is done from different

Photo 36. **Wheat grain heaps and a special gauge to take sample.**

places of the batch on the scheme of chart 8 and 9 from five places of heap, if the weight of batch is equal to 25 tons or less, and from eleven places, if the weight of batch is more than 25 tons. Three control seed samples are taken from every pointed out places (chats 7 and 8) of heap: from top lay – in the 10-20 cm depth, from surface, from middle and below parts – on the floor.

If the weight of batch is more than set up by the standard the batch is divided into two conditioned control units and from every part control samples are selected.

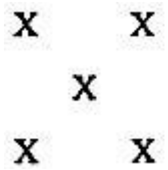


Chart 7

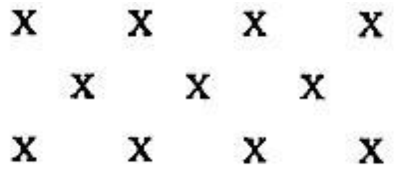


Chart 8

The control samples from the corn seeds, in cobs of heap, storing in the bins, are selected by hand from five places in three lays (top, middle and lower parts). On five cobs without selection are taken from each place – all together 75 cobs.

The control samples from seeds of corn, storing in the clamp under open air, are taken from five places (chart 9). The cobs are taken in the center of clamp from three lays at different depths, on the sides of clamp – from one lay on four opposite sides (totally 7 control samples). 10 cobs are being taken from each place without selection (totally 70 cobs).

Control cobs from seeds loaded in auto-cars are taken out of every car from five places (in the center and on the edges of the cars) in two lays. 2 cobs from each place without choosing, all together 20 cobs from one auto-car.

Control samples of two cobs from the corn seeds, packaged in the sacks, are taken from each sack and at the availability up to 10 sacks in the batch on one cob from each sack. The cobs are threshed and an average sample is picked out.

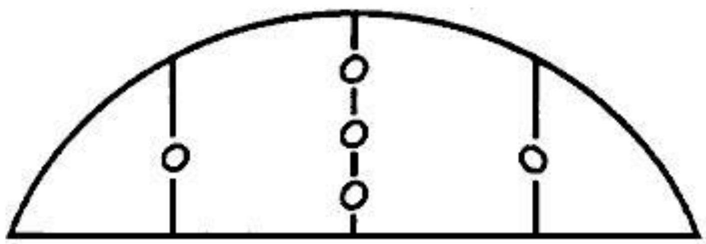


Chart 9. **Places of corn seed clamp from where the control samples will be taken away.**

Compositing of united samples. The control samples taken from batches (control units) are combined into one united sample after setting up their typicality. If the weight of united sample is not enough, supplementary control samples will be taken from different parts of batch.

Picking out the average samples. The three average samples are picked out from united sample:

the first for defining the purity, germination, vitality, typicality and weight of 1000 seeds;

the second for defining the moisture and barn (or granary) pests' settlement;

the third for defining infection of seeds with diseases in the humid chamber and in the nutritious mediums.

The average sample is picked out from united sample by the method of "Quartovaniya" (chart 10). For this procedure, the seeds of united sample are poured on the table, thoroughly mixed with two rulers and makes quadrat shape with the depth up to 1,5 cm for small seeds and up to 5,0 cm for enlarged seeds. After that the quadrat is divided into four triangles. Two of triangles on the opposite sides are combined together for compositing the first sample. And the two left triangles are also combined together for picking out the second and the third samples as above.

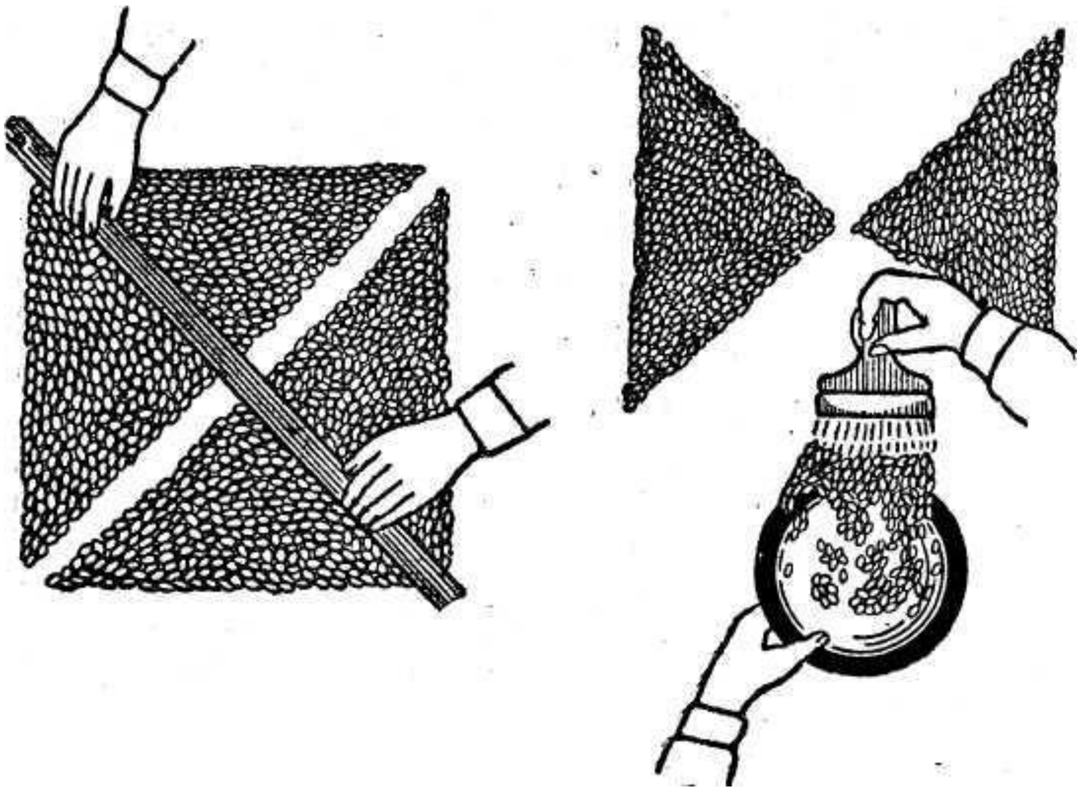


Chart 10. **The method of "Quartovaniya"**

The seeds for compositing of the first sample are divided again into four triangles and removed out of two opposite seed triangles. Such division is continued until the necessary quantity of seeds (table 6) are taken. For this purpose, the second and the third samples are also picked out by the same way from the left seeds, after the first division of united sample is made.

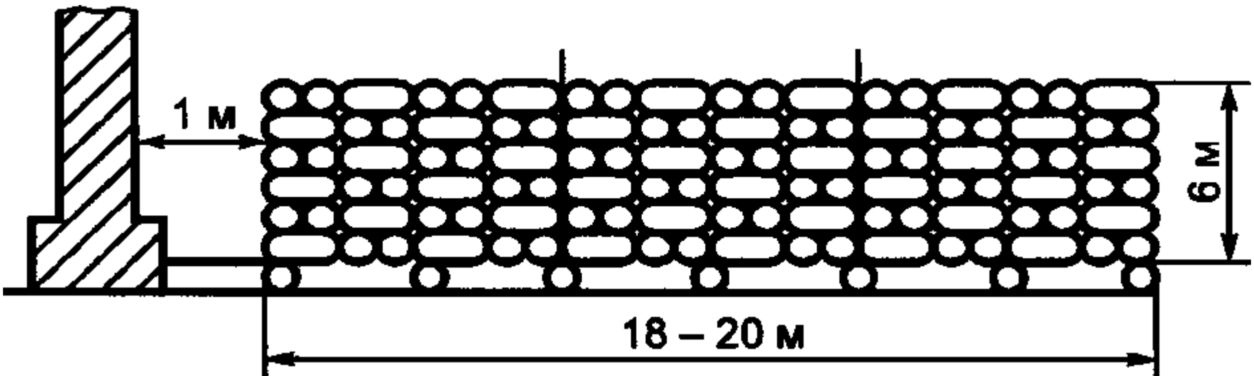
Table 6. **The size of control unites and average samples of grain crops**

Name of crop	The size of batches (control units), from which one sample is taken, ton.	Weight of average sample, g.
Corn	40.0	1000
Wheat	60.0	1000
Barley	60.0	1000
Oat	60.0	1000
Rye	60.0.	1000
Triticale	60.0	1000
Rice	60.0	1000
Sorghum	10.0	250

The method of point sampling from cotton seed. The point samples are taken evenly from well which are dig out of wall of well burred along the depth per piled control unit of seed.

The next point sampling is done from the 20 cm out of wall surface. If the seeds have natural free flowing, the sampling is done by the means of gauges (chart 11).

Scheme of dividing the batches to control units



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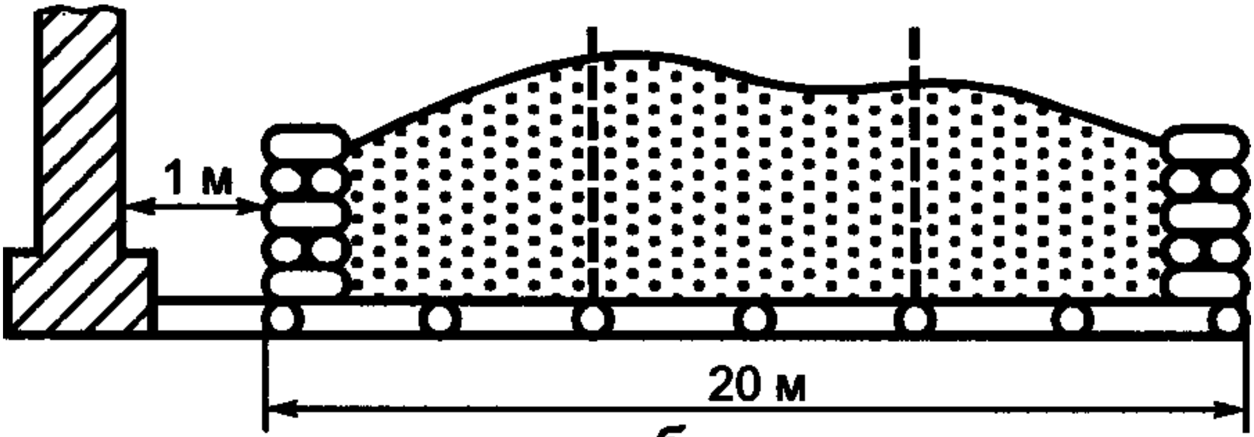

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Chart 11. **a — seeds in the sacks; b — seeds in the pile.**

The point sampling from seeds, packed in sacks, is implemented: from every sack when available up to 10 sacks; from every fifth when available 11-100 sacks in batch and from every tenth of sacks when available more than 100 sacks in the batch.

The total weight of point samples is calculated in such accounts that the weight, composed from united point samples, would not be less than 5 kg.

For the cotton seed, taking united sample depends on the seed piles, treated with chemicals or non-treated seeds, as shown below (table 7).

Table 7. **The size of control unites to take an average sample from cotton seed pile.**

Reproduction	Weight of control unit (ton)	
	Treated with chemical	Non-treated
Elite	5	10
F_1	10	20
F_2	20	40
F_3	50	100

This united sample of raw cotton or cotton seed is granted by the certificate, presented below. **Certification №___**

on cotton planting seed (which is valid for two months) _____________« », 20_____.

Given (to) ______________________,

On seed stock batch № ___ with mass ____ ton,

taken from cleaning of seed stock batch of raw cotton batch № ___,

Provisioned in ________________ in 20 ____,

intended to dispatch to ________________________

(and pointed out all lab analyze results below)

The questions and tasks to consolidate the gained knowledge:

1.What are the seed batch and control unit?

2.What significance have seed batch and control unite in the selection of the average sample?

3.Why the sizes of control units are changed in the reproductions?

4.Does seed certification affect to the marketability of seeds?

5.How is the quality of stored seeds judged?

6.Describe the rules and the order of an average sampling.

7.Practice taking of an average sample from cotton seed piles at your practical education visits to cotton seed storage warehouses.

The 18th practical training.

Cytoplasmic male sterility.

The aim of the training. The students will get acquaintance with the principles of cytoplasmic male sterility, occurring in the farm crops and improve their knowledge on the exploiting of cytoplasmic male sterility to get high productive hybrid lines of farm crops.

The necessary articles to conduct training: placates, depicting pictures about cytoplasmic sterility, lecture note-books, copy-book of practical training, rulers, pencils, erasers.

According to the internet information: cytoplasmic male sterility, as the name indicates, is under extra nuclear genetic control (under control of the mitochondrial or plastid genomes). It shows non-Mendelian inheritance , with male sterility inherited maternally. In general, there are two types of cytoplasm: F (normal) and aberrant S (sterile) cytoplasm. These types exhibit reciprocal differences (chart 12).

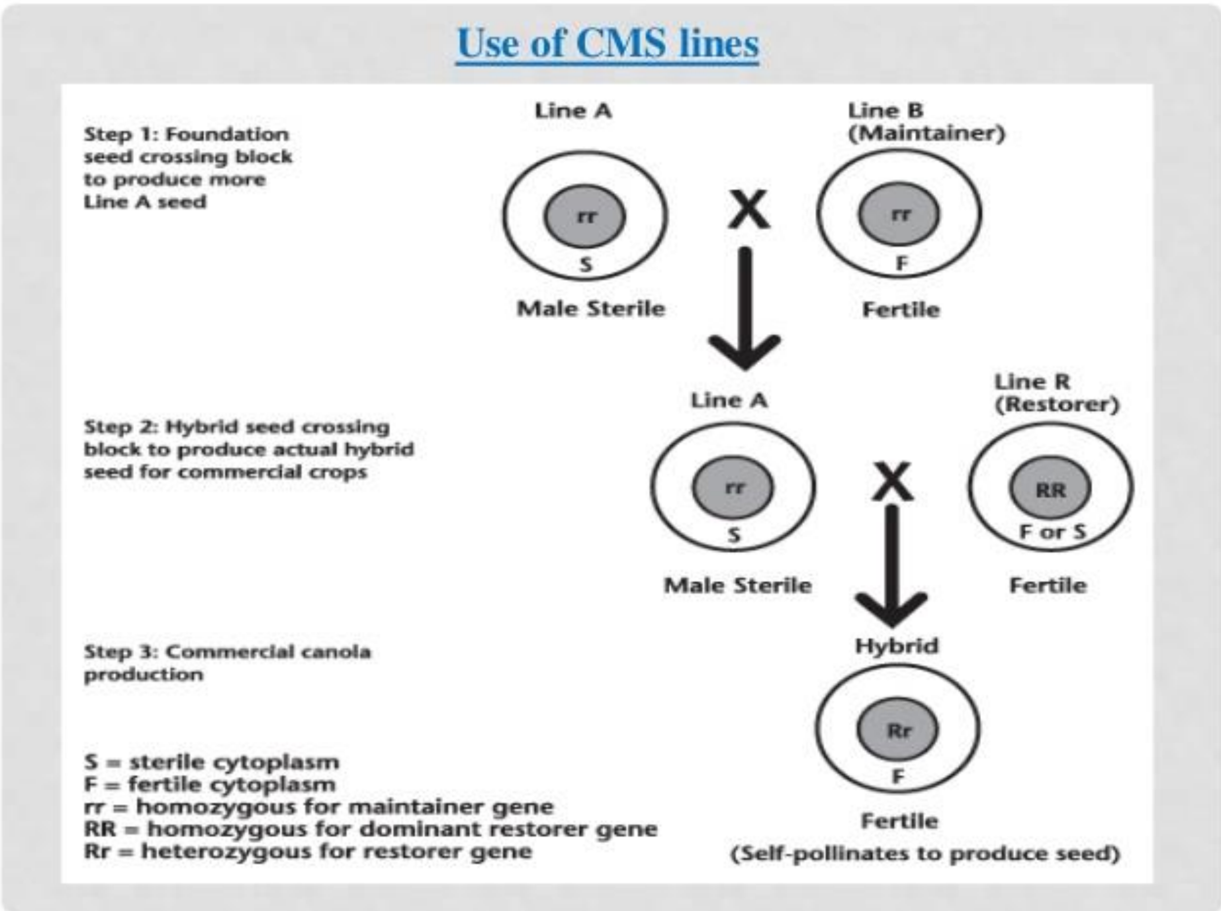


Chart 12. **Cytoplasmic-genetic male sterility**

While CMS is controlled by an extra nuclear genome, nuclear genes may have the capability to restore fertility. When nuclear restoration of fertility genes ("Rf") is available for a CMS system in any crop, it is cytoplasmic–genetic male sterility; the sterility is manifested by the influence of both nuclear (with Mendelian inheritance) and cytoplasmic (maternally inherited) genes. There are also restorers of fertility (*Rf*) genes that are distinct from genetic male sterility genes. The *Rf* genes have no expression of their own unless the sterile cytoplasm is present. *Rf* genes are required to restore fertility in S cytoplasm that causes sterility. Thus plants with F cytoplasm are fertile and S cytoplasm with genotype *Rf*- leads to fertile while S cytoplasm with *rfrf* produces only male sterile. Another feature of these systems is that *Rf* mutations (*i.e.*, mutations to *rf* or no fertility restoration) are frequent, so that F cytoplasm with *Rfrf* is best for stable fertility.

Cytoplasmic–genetic male sterility systems are widely exploited in corn, sorghum rice, sunflower (photo 37) and flax plants for hybrid breeding due to the convenience of controlling sterility expression by manipulating the gene–cytoplasm combinations in any selected genotype. Incorporation of these systems in these crops for male sterility evades the need for emasculation in cross-pollinated of parental genotypes, thus encouraging cross breeding of these plants to produce only hybrid seeds under the supervision of breeders.

Photo 37. **Inspection of hybrids developed by the method of cytoplasmic-male sterility.**

In rice hybrid breeding on the base of cytoplasmic – male sterility.

Hybrid rice seed production requires a plant of initial rice material from which no viable male gametes are introduced. This selective exclusion of viable male gametes of chosen rice plant can be accomplished via different paths, rice hybrid seed producing. One rice breeding path, emasculation is done manually to prevent an initial rice plant from producing pollen, so this initial rice plant can serve only as a maternal parent. Another simple way to establish a female rice line for developing hybrid variety is to identify or create a rice line that is unable to produce viable pollens. Since a male-sterile rice line cannot self-pollinate, seed formation is dependent upon pollen from another rice male line. Cytoplasmic male sterility is also can be used in rice hybrid development. In this case, male sterility of initial rice plant is maternally transmitted and all progeny will be male sterile. These CMS lines of rice plant must be maintained by repeated crossing to a sister rice line (known as the maintainer of rice line) that is genetically identical, except that, it possesses by normal cytoplasm and, therefore, by male-fertile rice. In cytoplasmic–genetic male sterility restoration of rice fertility is done by using restorer rice lines, carrying nuclear genes. The male-sterile of rice line is maintained by crossing with a maintainer rice line carrying the same nuclear genome but with normal fertile cytoplasm (figure 7).

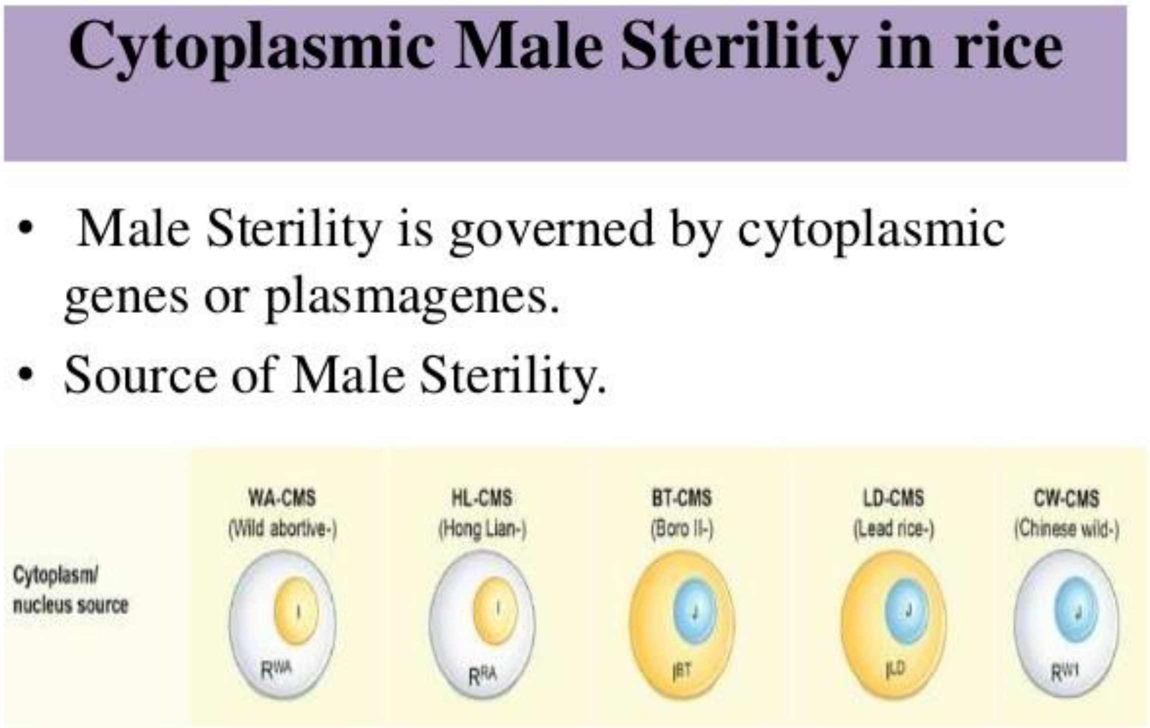


Figure 7. **A schematic presentation of five well-studied rice CMS types.** Abbreviations for cytoplasm source are: R^{wa} for wild-abortive Oruza fufpogon, R^{ra} for red-awned O.rufpogon, and R^{w1} for Chines wild rice (O.rufpogon) accession $W1^{BT}$ and 1^{LD} for indica Boro-II type and lead rice, respectively. Nucleus sources are either indica or japonica.

In cotton (Gossypium hirsutum) two cytoplasmic male sterility systems, known as D_{22} and D_8 CMS systems, have been developed (Sterwart, 1992) by transferring cytoplasms from wild species (G.anamalum 2n=26 x G.thurberi 2n=26) into cultivated cotton (G.hirsutum) through three fold hybridization. Semi-sterile plants were picked out within hybrids of crossings. And they exposed to self-pollination in two generations by Mississippi breeders. So, two types of plants: with cytoplasm of G. anamalum and cytoplasm of G.hirsutum.

Plants with G. anamalum have full CMS and recessive gene ms of sterility in homozygous state.

In the recent years by the scientists of many countries have been found that various chemicals such as gametosids can be used to get CMS of cotton plant. For example, pulverization of RW-450 solution at the rate of 0,5-1% on cotton buds promotes to get high sterility of cotton flowers (photo 33).

In India, by the means of alternation planting of two cotton varieties, in which one of the varieties was treated with “Mendok solution” at the experiment station of Povilpatty, had been taken 62% of cotton hybrids in the free of pollination and 72% in the artificially pollination.

However, a part of mentioned achievements, the molecular mechanism, leading to fertility restoration in cotton, is not fully scientifically discovered.

The questions and tasks to firm taken knowledge about CMS of plants:

1.What is CMS of plants and its importance in the plant breeding?

2.Can you present a report about using of CMS in corn hybrid breeding?

3.Down load some new reports from internet sources about the hybrids of flax and sorghum have been developed on the base of CMS.

4.Why fertility restoration by dominant genes is essential for hybrid seed production based on CMS to obtain high yield of hybrid seeds on a commercial scale?

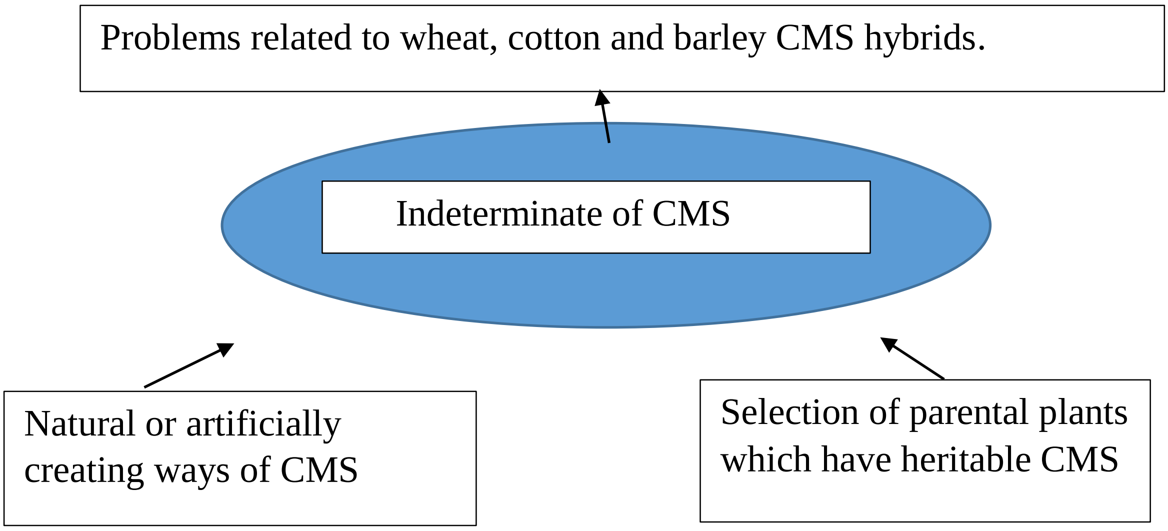
5.How CMS of crops will effect on agriculture?

6.Why is conducted the determination of CMS in the crops?

7.In what countries is used the CMS of cotton widely?

8.How can be developed rice hybrids on the base of CMS?

9. Improve your knowledge of the studied material on the base of pedagogical method “Problematic situation”.



The 19th laboratory training.

Determination of sprouting vigor of seeds and germination ability.

The aim of the laboratory training. To get acquaintance with the conceptions of seeds' sprouting vigor, laboratory germination of the farm crops (except cotton plant seeds) and the lab method to define them by the means of filter papers under the guidance of relevant standard (GOST 12038-84) is the aim of this training.

Necessary lab kits to conduct lab analyzes: Seeds of different farm crops, Petry dishes, filter paper (photo 38), lab paper scissors, seed counter and layer (photo 96 in the book of "Selection and seed breeding of grain and grain-bean crops", 2019), thermostat, in the photo 11 of above mentioned book), tweezers, microscope, magnifying glasses, manual and text books, special tables, pencils, rulers, erasers.

Photo 38. **Filter paper rolls to prepare filter lengths for Petry dishes.**

Sprouting vigor (or energy) – this is an index of rushed seed sprouting. The seeds which have higher sprouting vigor, generally are resistant to adverse conditions; seedlings drive form such seeds grow rapidly, develop and less infected by the diseases. This index has a direct correlation with laboratory germination.

Laboratory germination – this is percentage of normally germinated seeds in the probe, taken for analyze. Germination is the one of the most important indexes of seed stock material, which has a great industrial significance. Fitness of seeds to planting and rate of planting are defined by this index. The seeds with high germination at the appropriate cultivation give rapid, rushed and healthy seedlings. The seeds, which have germination, does not meet requirement of standard, will not admit to planting.

Description of the lab method to define sprouting vigor and germination of seeds. The growing of seeds is implemented in the optimal conditions of laboratory set by the GOST 12038-84 (table 8).

Table 8. **Seed growing conditions.**

Crops	Conditions of growing			Terms of definition, days.	
	Box	Temperature, °C.	Light	Sprouting vigor	Germination
Soft wheat	НП, МБ, Р, МБ*	20	Darkness	3	7
Hard wheat	НП, МБ, Р, МБ*	20	Darkness	4	8
Barley	ВП, НП, Р, МБ	20	Т	3	7
Ray	НП, МБ, П, МБ*	20	Т	3	7
Oat	ВП, НП, Р, МБ	20	Т	4	7
Rice	МБ, НП	20-30	Т	4	7
Millet	Р, МБ	20-30	Т	4	7
Corn	НП, Р	25, 20-30	Т	4	7
Sorghum	НП, Р, МБ	25, 20-30	Т	4	8
Buckwheat	Р, МБ	25, 20-30	Т	4	7
Peas	НП, ВП	20	Т	4	8
Chick pear	НП, ВП	20	Т	3	7
Soya	НП, Р	25, 20-30	Т	3	7

Bean forage	НП	20	Т	4	10
Sunflower	Р, НП	25, 20-30	Т	3	5
Flax	НБ	20	Т	3	7
Common alfalfa	НБ, МБ	20	Т	4	7
Sudan herb	НП, НБ	20-30	Т	3	8
Rape	НБ	20, 20-30	Т	3	7

Conventional signs: НБ - on the filter paper; МБ – in the lays of filter paper; МБ* - in the lays of filter paper and permanent water supply; Р – rolls of filter paper; Г – in crumpet filter paper; НП – on the sand, С – light; Т – darkness.

The seeds of analyzing crop (common alfalfa) are used to define the germination, picked out at the identification of seeds' purity. Four probes with 100 seeds (for enlarged seeds like corn and chick pea) and 50 seeds (like alfalfa and flax) each one are counted out by hand, without choosing or by the help of seed counter-layer.

The filter paper is used as a spread under seeds when seeds grow (photo 26). The filter paper must be clean, not painted with poisonous substances. It is used in the shape of a mug (in the Petry dish).

Prior to the growing, the filter paper is soaked without surplus of water. Surplus of water must be taken away.

Fifty seeds are laid on the soaked paper, placed in the Petry dish. This work is repeated three times in totally to be four replicates. They should be covered with lids (a little bigger Petry dishes). The order numbers of probes are written on the lids and except these, the dates of accounting the sprouting vigor and germination. It is necessary to observe the temperature of the thermostat at the period of growing and at the time when the fresh air comes in by periodically opening of the thermostat door.

Record of germinated seeds at the defining of germination is conducted in the terms, set by the technical conditions to every crop (table 7). Germinated seeds are fixed in two terms: at the first - the sprouting vigor is defined, at the second – germination.

At the accounting of germination, the following seeds are calculated separately:

-normally grown;

-soaked;

-hardy;

-rotted;

-abnormally grown seeds.

But it should be taken into mind, that for the most of farm crops, the percentage of germination is defined only on the normally germinated seeds.

The results of calculation at the defining of germination and sprouting vigor of seeds are recorded into the working form (laboratory table or appendix 3).

Arithmetic mean of germination percentage and admissible differences of four probes with consideration of admissible differences on the standard is presented below (table 9).

Table 9. **Arithmetic mean of germination percentage and admissible differences.**

Arithmetic mean of germination, %.	Admissible differences, %.	Arithmetic mean of germination, %.	Admissible differences, %.
99	2	88-91	6
97-98	3	83-87	7
95-96	4	75-82	8
92-94	5		

If at one probe, the difference is more than admissible, the percent of sprouting vigor and germination is defined on another three probes. In the case when the difference more than admissible has been discovered in two probes, sprouting vigor and germination are identified on the base of data taken after repeated growing.

Order of laboratory works:

-determine the view of box and prepare it to seed laying for growing;

-count out 4 probes on 50 seeds of alfalfa each one;

-prepare the thermostat, Petry dishes, water of room temperature and others;

-lay seeds of the probes on the moistened filter paper in the Petry dish and put on them label with written the number of probe and date of sprouting vigor and germination accounts;

-place them on the shelves of the thermostat;

-do daily controls on fixing the temperature and coming in the fresh air into the thermostat;

-calculate sprouting vigor and germination of seeds and record numerical data in the working form (table 10).

Table 9. **Defining of sprouting vigor and germination of alfalfa seeds.**

Starting ______________________ Completing __________________

Thermostat № _________________ Temperature __________________

On the light ___________________

In the darkness _________________ Box ____________________

Germination per a day	Date	Probes				An average percent
		1	2	3	4	
Sum-total						
Totally of hard seeds						
Remained units						
Including soaked						
Hard seeds						
Rotted seeds						

At the calculation of sprouting vigor						
At the calculation of germination of abnormally germinated seeds						
Totally						
Sprouting vigor, %						
Germination, %						
Germination with addition of admissible percent of hard seeds, %						

"__________________" "_____" 202__ .

Questions and tasks to firm the knowledge:

1.What does it mean sprouting vigor and germination of seeds?

2.What kind of lab kits is needed to do lab analyze to define the indexes of sprouting vigor and germination of seeds?

3.Discribe the lab method to be used in the defining of the indexes of sprouting vigor and germination of seeds?

4.List the work orders has been done in the method of defining sprouting vigor and germination of seeds?

5.How would high sprouting vigor of seeds effect on the productivity?

6.Why the field germination is studied?

7.What is the admissible percent of hard seeds?

8. Consolidate the mastered knowledge on the bases of pedagogical method named "Thick and thin" questions.

"Thin" questions	"Thick" questions
Where is the seed sprouting vigor analyzed? What kind of equipment is used to determine the germination in the lab?	How is lab work conducted? Does field germination effect on the productivity of crops? What is the difference between sprouting vigor and field germination of seeds?

The 20th practical training.

Using of inducing mutation.

The aim of this training. To acquaint the students with the arising of inducing mutation, its importance in the plant breeding and the kinds of mutants inducing artificial mutations in the plant materials is the aim of this training.

Teaching articles, necessary to conduct the training: lecture materials on topic of mutation, placates dedicated to the living organisms, subjected to mutation, internet source, picture and characteristics of plant varieties (Octiyabr-60) developed through plant breeding method of induced mutation.

General and simple explanation about the mutation and its importance in the plant breeding reader can see in the program of FAO and IAEA, in particular, dedicated to the nuclear techniques in agriculture. According to this comment: since life first emerged on earth the diversity of living organisms has continuously evolved into a variety of species reaching the complexity that we see today (figure 8).

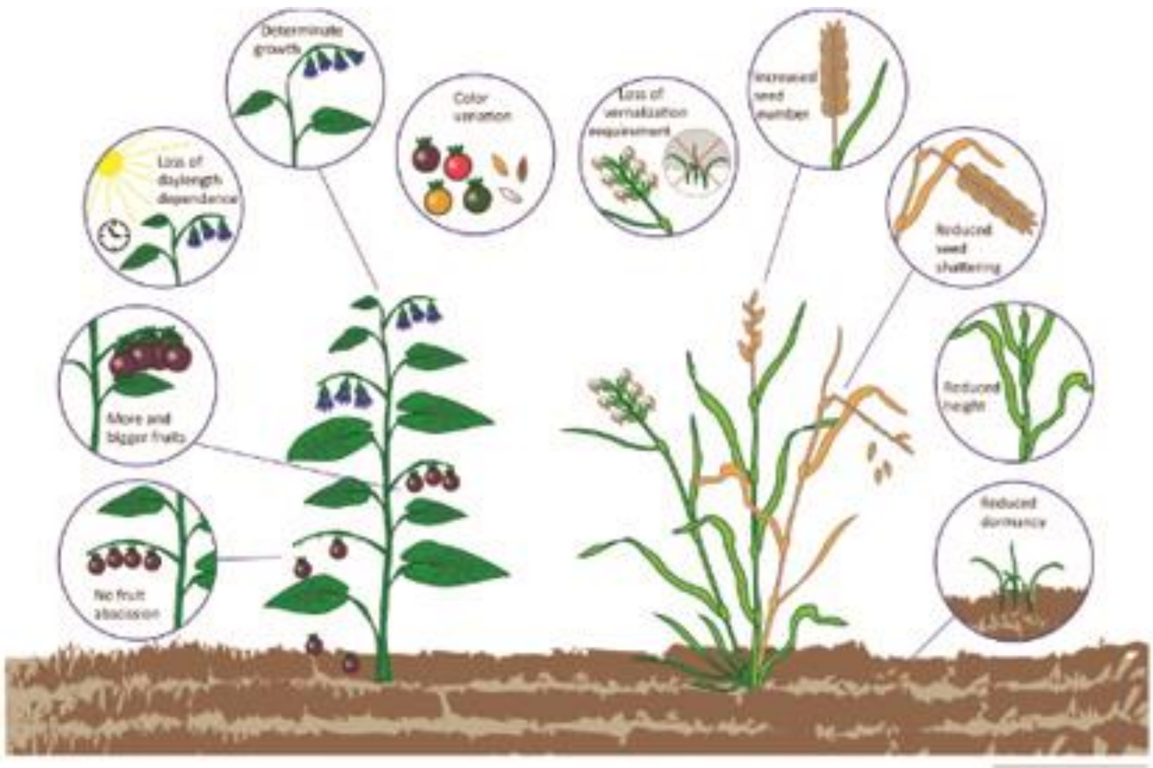


Figure 8. **Formation of plant species diversity in the world.**

What drives this massive variation? Exposure to ionizing radiation, which emanates naturally from the cosmos, from the sun, even from the earth itself, causing living organisms to mutate. Most of these mutations will not survive. But, in rare cases beneficial mutations create novel varieties, enabling them to survive and thrive in a wide range of environments. Over the millennia, farmers have taken advantage of these naturally occurring mutations by selecting and propagating the most promising ones.

Today, we don't have to wait for nature. Today, we no longer have to wait for nature.

In the 1920s, when researchers discovered that artificially ionizing radiation was capable of inducing beneficial mutations, crop breeders were able to increase the frequency of spontaneous mutations. The age of crop mutation breeding was born.

To induce desirable crop mutations, the seeds or other parts of initial plants are exposed to ionizing radiation (photos 39, 40). Then the seeds are grown for two, to

Photos 39 and 40. **Special equipment to induce seed mutation.**

four generations. The plants of treated seeds are inspected until the new, but desirable mutant characteristic can be identified. Once identified desirable plant from the mutated plants, more generations are grown to develop uniform breeding lines. Then the advanced mutant lines are tested in the field conditions. If it is necessary to enrich the achieved complexity of traits with traits of other variety, the crossings with them are implemented to incorporate and retain their agronomic traits. The progenies of hybrids are selected deliberately and then new progeny lines are compared in field trials with existing parental varieties. After formation of uniform desirable population of new varieties, their seeds propagated and officially licensed and released to the farmers.

Mutation breeding has generated thousands of novel crop varieties in hundreds of crop species and millions of dollars in additional revenue, delivering higher yields, increased nutritional value, resistance to the effects of climate change and tolerance to diseases.

Mutation breeding is a fundamental and higher successful tool in the global efforts of agriculture to feed an ever increasing and nutritiously demanding population.

Physical and chemical mutagens are the basic sources in the technique of inducing mutation. Most often X and gamma rays, UV radiation, fast and slow neutron, alpha ray and beta ray are explored in the mutation plant breeding. Radioactive isotopes of P-32 and P-35 also have mutagen effect, but they are inconvenient for the insecure storage and application. Radioactive cobalt (Co-60) and Cesium (Cs-137) placed in the cobalt bomb are usual sources of gamma rays in the laboratories (photos 39 and 40).

Except the physical radioactive substances, there are some chemical mutagens, which are able to cause induced mutations of plants, they are Ethyleneimine (EI), Nitrogen mustard, Diethylnitrosamine (DMN) and others.

Genetic nature of mutation is proved by the random, spontaneous changing (breaks, damages) of chromosomal DNA of plant genome then resulting in producing of new trait variations (figure 8). The plants with new traits or properties in the result of mutagen treatment are called mutagenic plants or mutagenic seeds.

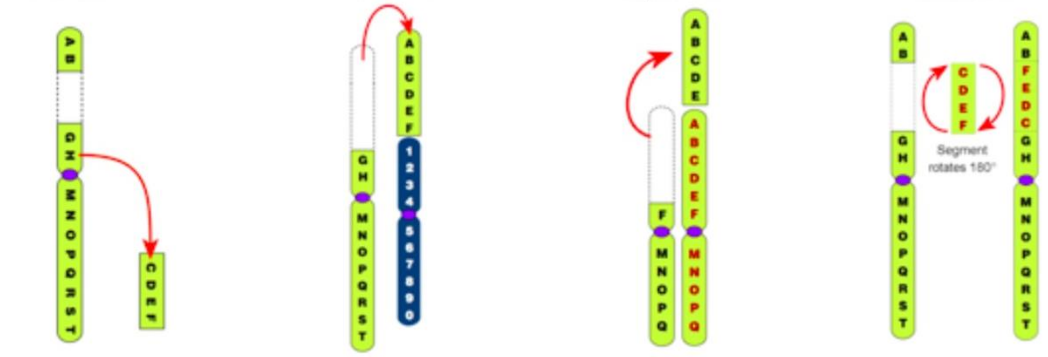


Figure 9. **Varieties of mutagenic changes of Double-strand in plant DNA.**

Above mentioned scientific principles and practical opportunities of mutation have been successfully transformed to develop productive cotton varieties such as AN-402, Samarkand-3, Karshy-7 and Octiyabr-60. The last one was the most important variety in the history of cotton growing and one of the major varieties in the sixth strain changing which had began since 1982.

Creation of the variety Octiyabr-60 by the breeder A.E. Egamberdiev (photo 41) is the best desciption of inducing mutation in the cotton plant breeding. The varieties Tashkent 1 and S-4727 have been involved in the chamical mutagen exposures at plant breeding process. Laboratory and field germinations of seeds of the variety Tashkent 1 were stimulated by 5-20% in the result of exposure with chamical mutagens of NMM, NEM, DMS and EI. Stimulation on the surviving has been remarked only at the exposure of NEM with duration of 12 days (up to 106,0% in comparison with control). Germination of seeds and suviving of seedlings of the variety S-4727 were decreased in most of variants, respectively by 0,4-14,8% and 08-20,8%.

All mutagens and some variants of EI activated the terms of flowering and especially, the maturity of plants of the variety Tashkent 1 by 6-12 days and on the variety of S-4727 by 5 days and height of plants respectively for 1,5-11 and 08-22 cms.

The mutagens stimulated the development of some qualtitative traits (in particular, number of bolls). So, the number of bolls on control plants of the variety Tashkent made 28,3 units, in the experimental plants -29,1 up to 40,1; on plants of the variety S-4727 respectively: 20,8 and 21,1 up to 24,4. This effect depends on the duration of mutant exposure and pronounced stronger at the activities of NMM and NEM.

Variation on the traits of bolls weight, height of setting the first fruiting wood, number of monopodiy and simpodiy in the M_1 were not observed or they were inconsiderable. The more length of fiber was remarked on the variety Tashkent 1 at the exposure of EI and NEM (39 mm against to 35,3 in the control). The forms with fiber length of 37,2 mm were found in the variety S-4727 after experiments with DMS and HEM (in the control -35,3 mm).

Photo 41. **A.E.Egamberdiev (second by the right side)– genetic and breeder, prized by the medal of N.I.Vavilov, the head of cotton mutation laboratory at the Institute of Experimental Biology of Plants, Academy of Sciences of the Republic of Uzbekistan with his scientific colleagues, 1985.**

Genotype with light-green color of plant phenotype was separated out of progenies, taken from crossings of mutagen M-281 with the variety Tashkent 1. Planting of this genotype of its F_3 gave a family. Plant breeding in this family in the wilt disease background infected by the fungy of verticilium has promoted to creat line L-5529, which gave initiation to the variety Octiyabr 60. This was one of the best results of using mutation in the history of cotton plant breeding and it was a bright example of taking this method more widely by many breeders. This method has become an irreplaceable stage of cotton plant breeding in the creation of valuable initial material to the development of up to date cotton varieties. Not only seeds but lately have been worked out more complicated modifications of this method, in which different organs of plants (bud, flower, overy and bolls) could be successfully exposured at different doses of mutagen factors. Obtained mutagenic lines purposefully are being hybridized with commercialed cotton varieties.

Due to the chievements in exploiting induced mutation in the breeding of cotton plant, N.N.Nazirov and others have released the mutagenic variety AN-402. It was evoved from seeds of wild Mexicov cotton, treated by the radio-active phosphorus. Since the 1979 it grown in the fields of the republic.

Samarkand-3 variety was developed by O.J.Jalilov in the result of taking radio-mutagen variety AN-401 and its hybridization with variety 108-F, this variety was introduced into production in 1981.

Karshi-7 variety of fine staple cotton also was developed by the breeder A.Tiyaminov in the consequence of mutagen participation. Here, the mutagenic line ML-100 had been crossed with the variety 7588-I, and then multiple selection of desirable plants was applied in the diffent agro-ecologic zones throughout the southern regions of the republic.

The questions and tasks to consolidate acquired knowledge:

1.Why exists so many plant species in the world?

2.What are four types of mutation?

3.What causes mutation?

4.Does mutation play a beneficial effect on the development of agriculture and how, if it does happen?

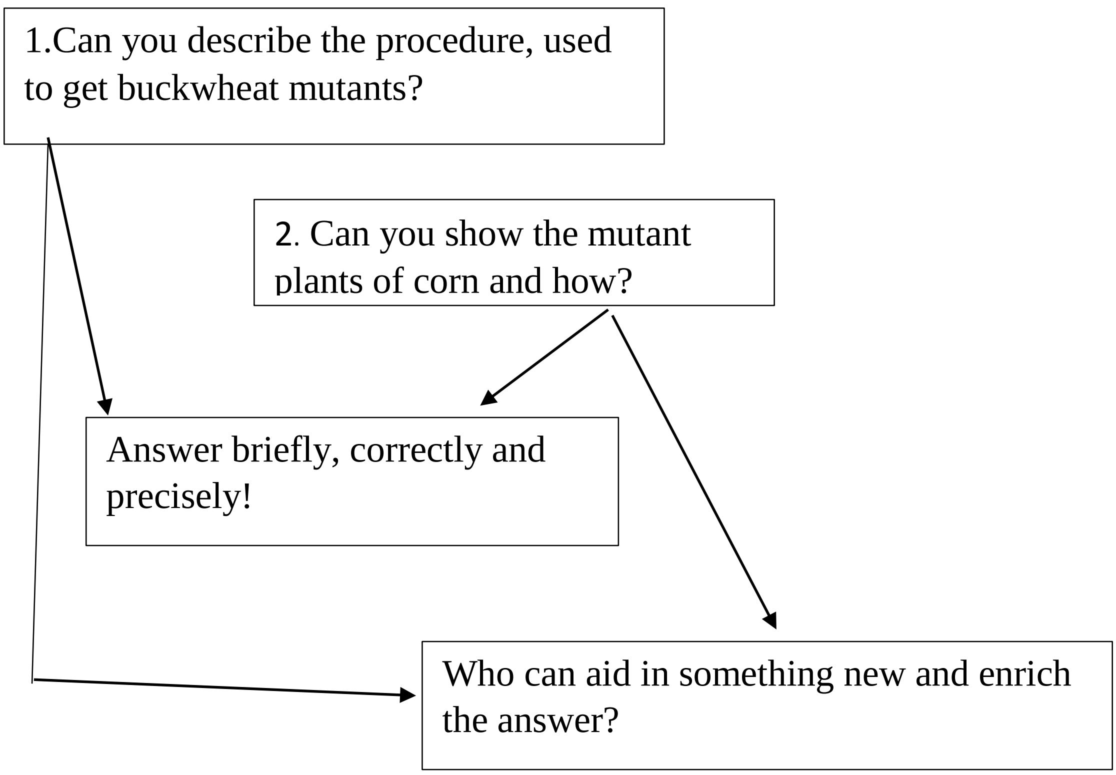
5.Do you know cotton varieties which have been developed by mutation?

6.Why the method of mutation is good for you?

7.Find out mutation plant breeding on the grain and bean crops and achievements in the development of mutagenic grain or bean varieties.

8.Prepare the sort reports about induced mutation in the researches of foreign scientists.

9. Train your knowledge development via answering to the questions according to the method of “Blitz question”



The 21st laboratory training.

Conducting techniques of approbation in the seed-stock area.

The aim of the training. Getting acquaintance with idea of approbation, kinds of seed-stock fields to be approbated, approbation techniques in the example of sunflower approbation, analyze of fruit basket and kernel and summarize the outcomes of approbation is the main aim of this lab training.

Necessary lab and teaching subjects to conduct the training: instructions to conduct approbation in the fields of sunflower, herbariums of different dried plant bundles, collected from plantations of oil flax, placards, depicting morphological structure of these plants, blank forms of approbation statements to be filled at the end of approbation (appendix 2), manual on the practical and lab trainings of field crops, lab copy-books, pencils, rulers and erasers.

Approbation, according to the law of the republic of Uzbekistan “About seed production” refers to the research, carrying out in the field, to identify general state of seed-stock, designated to the planting and the degree of genetic (variety) purity, resistance to diseases and pests (photo 42).

Photo 42. **Sunflower plantation is ready to approbation.**

The fields of seed-stock to be conducted approbation are: variety plantations of plant breeding stations, elite-seed production farms and district seed production farms, plantations of seed-stock plots, plantations of perspective and deficit varieties.

Field approbations of the plants are carried out by the agronomists of seed-producing farms. Some of the foremost specialists, passed through the approbation training courses can be attracted to help their agronomists.

At the beginning of his approbation the agronomist must to check the existence of confirmative documents, such as approbation statement, variety certificate, identity to the seeds, certificate to the seeds, that the planting has been done with the seeds of selection varieties, self-pollinated strains or hybrids to conduct field approbation.

Sampling (photo 43) is conducted by the agronomist passing through diagonal of the plantation and taking point samples out of equal distances. Simultaneously, with the inspection of plants and taking of samples, approbatory-agronomist identifies the general uniformity and variety grade of plantation and either the

Photo 43. **Sunflower baskets (florescence) at the time of maturity.**

infection of field by the pests and diseases. Variety grade (or variety purity) is defined in percent ratio of amount of typical plants of studied variety to the amount of all observed plants. Plantations, according to the variety purity, are separated to three categories: I – if the variety purity is higher than 98%; II – if the variety purity makes 95-97% and III- when the variety purity is equal to 90-94%.

Approbation of the plantation of sunflower is implemented at the time of maturing the most parts of baskets (florescence).

Samples are selected and taking out at 100 points, from every 10 plants in each point. One normally developed kernel is taking out from every basket and 500 kernels out of them are analyzed (the rest of them are kept in the farm for the case of checking).

The typicality of variety is identified on the size, shape and color of kernels. All typical kernels are also analyzed to define their shell characteristics.

The aim and the organizational measurements on the approbation of oil flax are not differentiate from approbation of sunflower. Approbation of the field of oil flax is conducted at the time of early, yellow maturity (photo 44). Sampling is also done passing through the diagonal of the field and with taking, without selection, 15 plants each from 20 points of the field. Collected plants is bounded into the individual bundle and labelled with recording the date of approbation, name of the farm and variety.

Photo 44. **Formation of an approbation bundle.**

Analysis of plants in a bundle on their morphological features facilitates to identify the category of variety purity as the example of sunflower. Agronomist-approbatory can also define the mixes of off type plants, representing other varieties or hybrids.

Furthermore, seeds of plants also can help in determining the variety degree of the studying oil flax variety.

Sharp, color and weight of 1000 seeds defer considerably between grown varieties (photo 45).

Photo 45. **Seeds of different varieties of oil flax.**

According to the weight of 1000 seeds, oil flax varieties can have enlarged (9-13 gr) and middle seeded (6-8 gr).

Since the end of the sample analyses the agronomist-approbatory gives to the farm approbation statement. This statement is formed in three copies (appendixes 3). One of them is remained in the farm, the second is delivered to the district department of agriculture and the third submitted to the seed provisional point prior to the acceptance of variety seeds to the sale or storage.

The result of approbation can be undesirable or all indexes of seed-stock plants don't meet the requirements of standards (or unfitted for planting purposes).

The following documents are filled in on the bases of the approbation results of sunflower and oil flax plantations:

to reproducing plantations, seed crop which is intended to use for sale, - approbation statement on the form of 195;

to plantations, have been recognized as unfitted for planting purposes – culling statement on the form of 200.

Questions and tasks for students to consolidate studied material on the approbation of farm crops:

1. What is the approbation and how it has been defined in the state law "About seed production" of the republic of Uzbekistan?

2. How can be identified the categories of plants on the variety purity?

3. Does shape or color of sunflower kernel effect on the result of approbation?

4. What sampling techniques are used in the approbation of sunflower and oil flax fields?

5. Can you distinguish the differences of the forms 195 and 200?

6. Practice approbation technique in the plantation of sunflower at the time of your case study as self-work and prepare report of the base of filled in approbation statements 195 and 200.

7. Practice approbation technique in the plantation of oil flax at the time of your case study as self-study work and prepare report on the base of filled in approbation statements 195 and 200.

8. **Review over the approbation bundles: barley variety and oat variety (on the base of pedagogical method of "Resume"):**

Topic: Conducting of approbation on the hey bundles of barley herbarium variety	
Advantages	**Disadvantages**

Topic: Conducting of approbation on the base of hey bundles of oat herbarium	
Advantages	**Disadvantages**

The 22nd practical training.

Usage of polyploidy and haploid.

The aim of the training is to study polyploidy and haploid in the farm crops. Their origin and importance in the plant breeding of agricultural crops.

Necessary teaching subjects to teach students on the nature of polyploidy and haploid: polyploidy crops' herbariums, placates, illustrating plant polyploidy and haploid, video presentations about the research of polyploidy plants and origin of haploid plants, lecture materials on this theme, pencils, erases and practical copy-books.

Polyploidy is the state of a cell or organism having more than two paired (homologous) sets of chromosomes. Most species which cells have nuclei (eukaryotes) are diploid, meaning that they have two sets of chromosomes—one set inherited from each parent. However, some organisms are polyploidy, and polyploidy is especially common in plants.

In other words, polyploidy is the condition in which diploid cell or organism acquires one or more additional sets of chromosomes or the polyploidy cell or organism has three or more times the haploid number (figure 10).

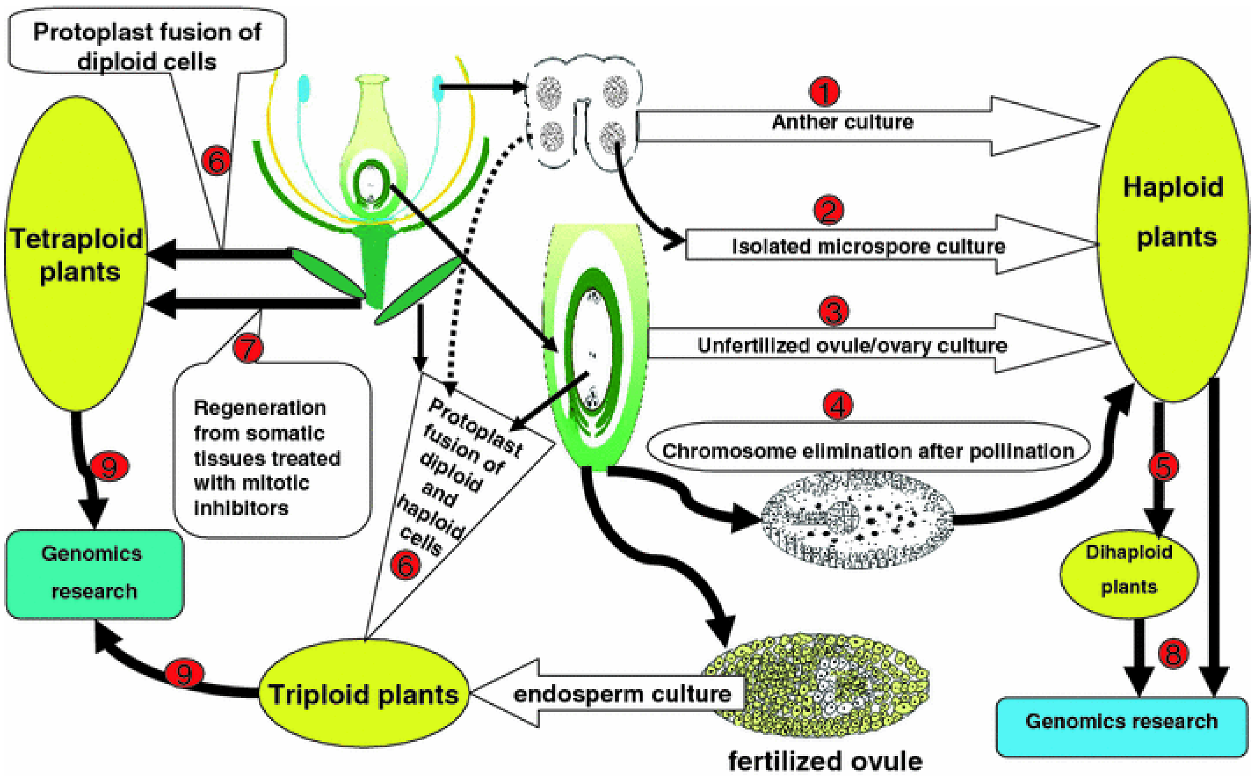


Figure 10. **Formation of polyploidy and haploid cells in the farm crops.**

Polyploidy may occur due to abnormal cell division, either during mitosis, or commonly during metaphase I in meiosis. In addition, it can be induced in plants and cell cultures by some chemicals: the best known is colchicine, which can result in chromosome doubling, though its use may have other less obvious consequences as well.

Whole genome duplication, or Polyploidization, is a major mechanism in plant evolution. Numerous studies have tried to evaluate the proportion of polyploidy in angiosperms, varying widely between 30% and 80% [11]. It is now acknowledged that probably all angiosperm lineages experienced one or several rounds of polyploidization in their history (table 11).

Using aspects of **polyploidy** in the plant breeding of farm crops gives plant breeders more options for developing novel plants and improving existing cultivated varieties.

Table 11. **A list of major farm crops and their ploidy.**

Common name	Ploidy	Name	Propagation
Maize	2x=20	Diploid	Outcrossing
Wheat	6x=42	Hexaploid (bread wheat)	Outcrossing
Rice	2x=24	Diploid	Selfing
Soybeans	2x=40	Diploid	Selfing
Barley	2x=14	Diploid	Selfing
G.hirsutum cotton	2x=52	Tetraploid	Outcrossing
G.herbaceum cotton	2x=26	Diploid	Outcrossing
Sorghum			
Wheat		Tetraploid (durum wheat)	
Triticale			
Sunflower			
Rye			
Millet			

Polyploidization is a basic feature of plant evolution. Nearly all of the main food, cotton, wheat (appendix 4) and oil crops and others (table 10) are polyploidy. When ploidy levels increase, yield doubles; this phenomenon suggested a new strategy of rice breeding that utilizes wide crosses and polyploidization dual advantages to breed super rice (photo 46). As low seed set rates in polyploid rice usually makes it difficult to breed, the selection of Ph-liked gene lines was emphasized. After progenies of indica-japonica were identified and selected, two polyploid lines, PMeS-1 and PMeS-2 with Polyploid Meiosis Stability (PMeS) genes were bred [DeTian Cai, et all. 2007]. The procedure included seven steps: selecting parents, crossing or multiple crossing, back-crossing, doubling chromosomes, identifying the polyploid, and choosing plants with high seed set rates that can breed themselves into stable lines. The characteristics of PMeS were determined by observing meiotic behaviors and by cross-identification of seed sets. PMeS-1 and PMeS-2, (japonica rice) have several characteristics differ from other polyploid rice lines, including a higher rate of seed set (more than 65%, increasing to more than 70% in their F1 offspring); and stable meiotic behaviors (pairing with bivalents and quarivalents nearly without over-quarivalent in prophase, nearly without lagging chromosomes in metaphase

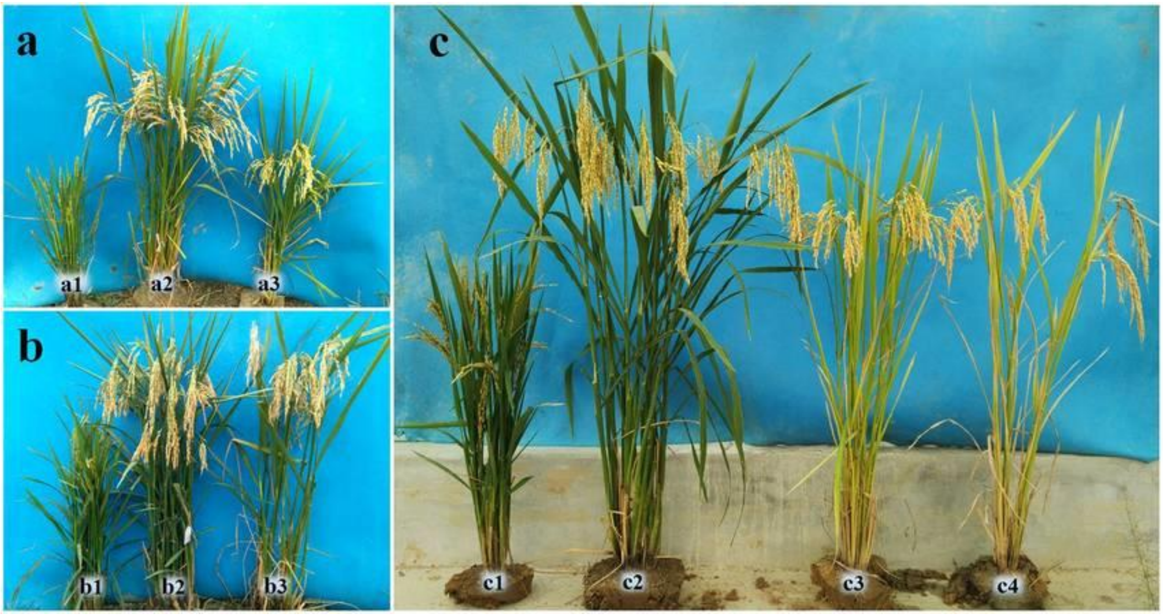


Photo 46 (bunch of photos). **Rice polyploidies in one of the researches.**

and without micronuclei in anaphase and telophase). The latter was obviously differ from control polyploid line Dure-4X, which displayed abnormal meiotic behaviors including a higher rate of multivalents, univalents and trivalents in prophase, lagging chromosomes in metaphase and micronuclei in anaphase and telophase. There were also three differences between PMeS lines and normal diploid lines of the breeding method: chromosomes doubling, polyploidism identifying and higher seed set testing. The selection of PMeS lines is the first step in polyploid rice breeding; their use will advance the progress of polyploid rice breeding, which in turn will offer a new way in breeding super rice.

There exist two different concepts for the definition of the type of polyploidy. On the one hand is the classic cytogenetic definition where the presence of only bivalent-forming chromosomes during meiosis characterizes allopolyploids while multivalent formation of homologous chromosomes indicates autopolyploidy [6]. The second definition is based on a taxonomic concept, where polyploids formed through hybridization of different species (allopolyploids) in contrast with hybrids formed through genome duplication or crossing of different genotypes (figure 11) from within a species (autopolyploids). Taxonomic allopolyploids are often termed segmental allopolyploids in the cytogenetic reference frame, indicating the presence of only locally differentiated chromosomes.

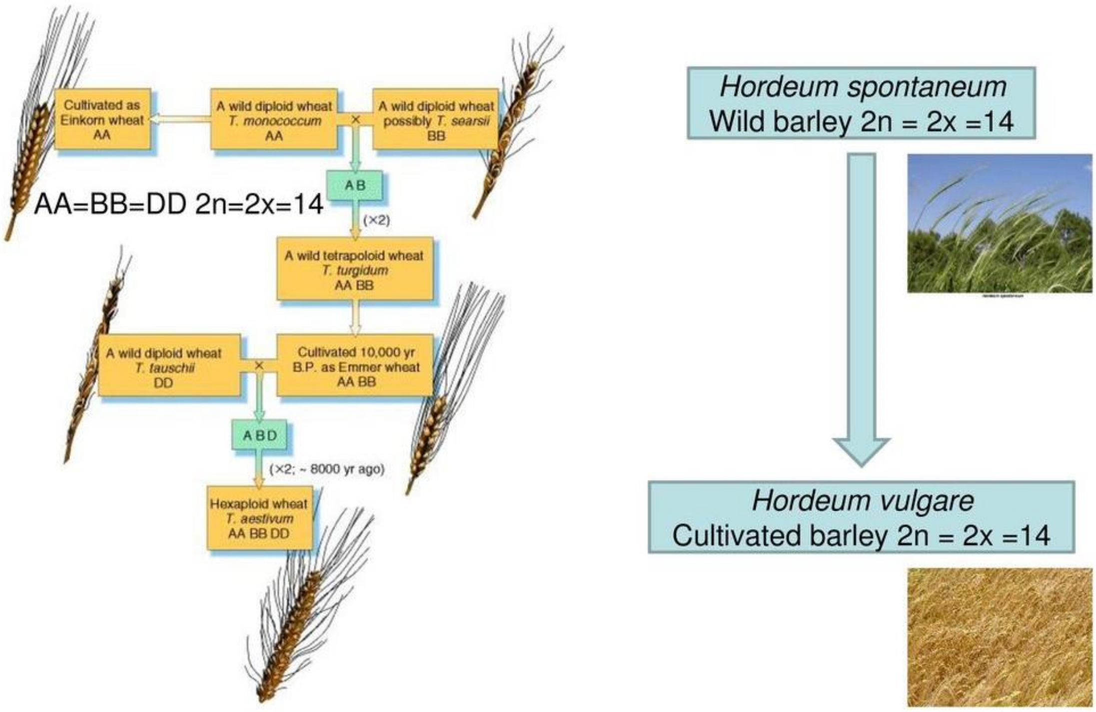


Figure 11. **The evolution of bread wheat and barley: a history of hybridization and domestication.**

Evolution of hard wheat (Triticum durum) also as soft or common wheat (Triticum aestivum) species (above presented figure) had took its start through the historical process of polyploidy, an increase in the number of sets of chromosomes beyond the normal two sets. (a) The ancestral einkorn wheat (Triticum boeoticum) has two sets of chromosomes and produces small seeds. (b) Durum wheat, which is used to make pasta, was bred to have four sets of chromosomes and produces medium-sized seeds. (c) Common wheat, which is used mostly for bread, was bred to have six sets of chromosomes and produces the largest seeds (appendix 5).

Haploid describes a cell that contains a single set of chromosomes. The term haploid can also refer to the number of chromosomes in egg or sperm cells, which are also called gametes. In maize, gametes are haploid cells that contain 10 chromosomes (table 10), each of which is one of a chromosome pair that exists in diploid cells.

Haploid plants originate from gametes (or gamete-like cells) that do not go through fertilization, but can still generate a viable individual. Therefore, haploids contain only the chromosome set found after meiosis in male (sperm cells) or female (egg cells) gametes, Britt, A.B., and Kuppu, S. (2016). This chromosome set 'n' corresponds to only half of the chromosome set found in the fertilization product (zygote) and other somatic cells. Depending on whether the single set of chromosomes comes from the maternal or paternal side, the plant is referred to as maternal haploid and paternal haploid, respectively.

In a DH plant, the chromosome set of a haploid plant has been doubled spontaneously or artificially. Chromosome doubling is necessary since haploid plants are generally frail, organ size reduced and are not fertile. The most commonly used chemical agent to render haploid plantlets diploid is colchicine, which blocks cell division without blocking chromosome duplication. This treatment acts like a 'copy–paste' of the haploid genome into a diploid genome. Consequently, in DH plants all loci are homozygous. Chromosome doubling creates 'pure' homozygotes or fully inbred lines (Figure 12).

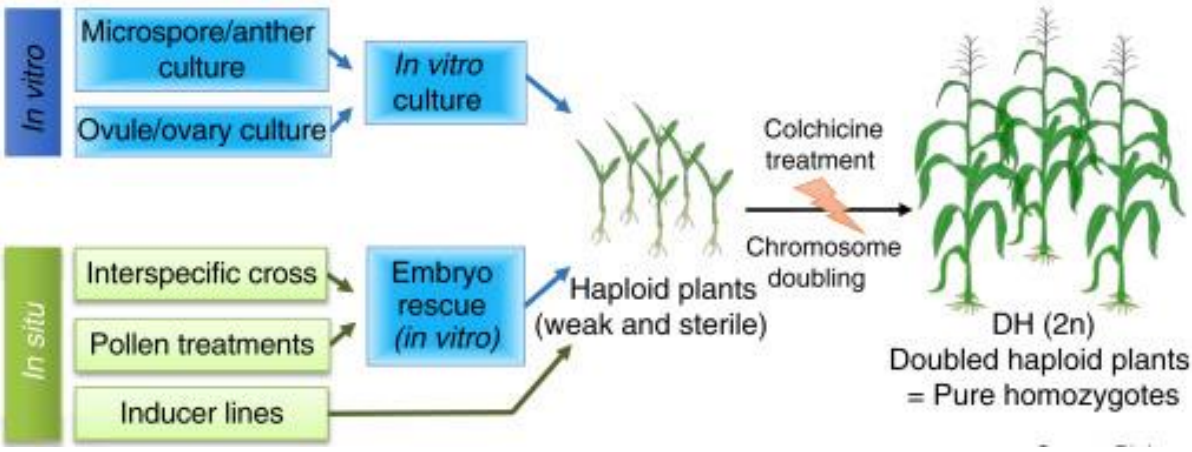


Figure 12. **Overview of doubled haploid technology**

First different methods are used to create haploid plants. Then chromosome doubling on haploid plantlets results in perfect homozygous plants named doubled haploid (DH) plants.

Doubled haploid technology comprises both the production of haploid plants and the chromosome doubling process (Figure 1). It has become an important tool in plant breeding, since it shortens the time needed to create pure homozygous lines, which can either be released directly to farmers as cultivars or used as genitors (inbred lines) for the production of hybrid seeds. The primary advantage of DH plants is to possess a phenotypic stability due to the fact that all alleles are in a homozygous state. In short, DH technology increases the efficiency of plant breeding.

The numerous methods to obtain haploid plants can be classified into two categories (Figure 12). Firstly, in vitro methods are based on the culture of haploid cells and their differentiation into haploid embryos and ultimately haploid plants.

Both male (microspores or pollen) and female haploid cells (megaspores or ovules) are used, depending on the responsiveness of the cells in a given species. Secondly, in situ methods make use of particular pollination techniques using irradiated pollen, inter-specific crosses or so-called ‘inducer lines’.

Haploid inducer lines are routinely used in plant breeding for maize only, and thus represent an exception. Maize haploid inducer lines all derive from a particular genotype discovered in the 1950s that possesses the ability to induce the development of haploid embryos on a maize line a matter of interest upon pollination with the inducer pollen. The pollen from the inducer line triggers the development of the egg cell into an embryo containing only a haploid maternal genome. This process is called in vivo gynogenesis (Figure 13). Recently, haploid inducer lines have also been created in Arabidopsis thaliana, Brassica juncea and maize by the use of engineered centromeric histone in 3 (CENH3) variants. However, this haploid induction method has not been reported in plant breeding programs so far.

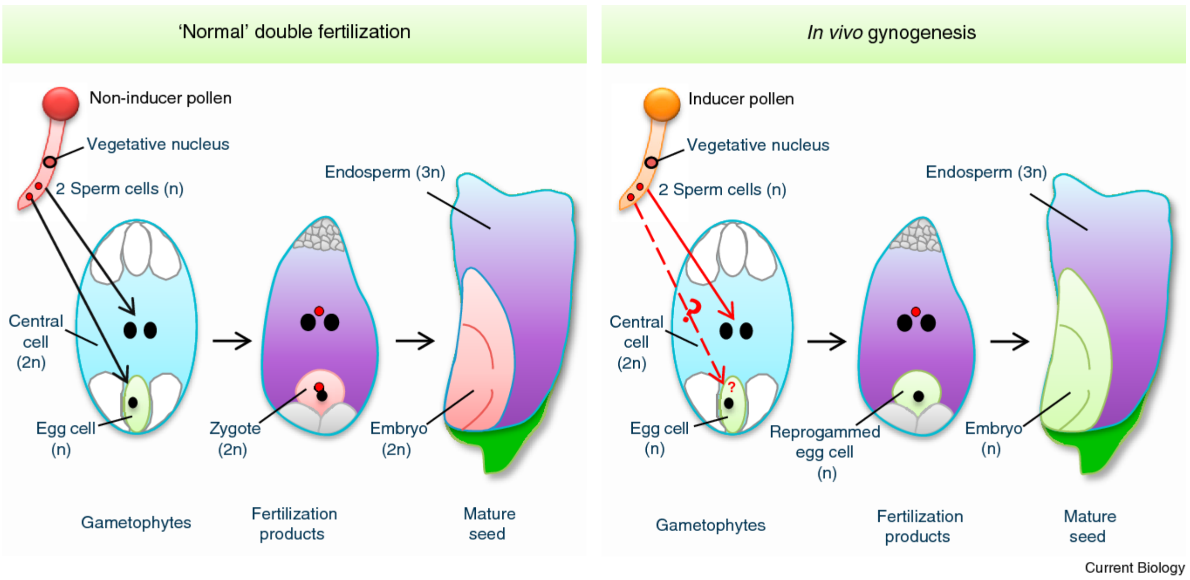


Figure 13. **Comparison of double fertilization and in vivo gynogenesis in maize.**

In flowering plants, sexual reproduction is characterized by a unique biological process named double fertilization, which consists of two separate fusion events between male and female gametes (left). This double fertilization leads to a diploid embryo and triploid endosperm that represent the two major seed components. In case of fertilization with pollen from a maize ‘inducer’ line (right), double fertilization is impaired, resulting in seeds containing a haploid embryo with only the maternal genome.

All flowering plants are characterized by a particular way of sexual reproduction called double fertilization. It consists of two parallel fusion events between male and female gametes (Figure 13). The haploid egg cell is fertilized by one haploid male gamete and becomes the diploid embryo. At the same time, the diploid nucleus of the central cell is fertilized by the second haploid male gamete of the same pollen tube to form a seed nutritive tissue, the triploid endosperm (Figure 2). Pollination by a maize inducer line results in an atypical fertilization event in which only the central cell is fertilized normally by a male gamete, and the egg cell develops into a haploid embryo lacking the paternal genome (Figure 13). Note that after pollination by a maize inducer line, only about 10% of the developing seeds contain a haploid embryo, the remaining 90% are normal diploid embryos.

Questions and tasks to consolidate acquired knowledge on polyploidy and haploid:

1.What is polyploidy?

2.Find out ploidies of sorghum, wheat (Tetraploid - durum wheat), triticale, sunflower, rye and millet and fill in table 10.

3.What is an example of polyploidy?

4.What is polyploidy breeding?

5.What is a haploid plant?

6.Why is doubled haploid technology impactful for agriculture?

7.What is a haploid inducer line?

8.What kind of different methods to produce haploid plants do you know?

9.How does in situ haploid induction work in maize?

10.Find out positive effects of haploid cell on plant breeding and prepare a brief scientific report about them.

11. Consolidate acquired knowledge on the base of pedagogical method (OREG):

Report your opinion about the kinds of polyploidy and haploid on the theme "Usage of polyploidy and haploid in agricultural crops" on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

The 23rd laboratory training.

Control of seed storage and variety purity.

The aim of the training. Getting acquaintance with cotton plant seed storage and control variety purity of seeds by the students is the major aim of this training.

Necessary teaching aids to conduct the training: some standards designated for storage of the cotton seeds, lecture note-book, cotton seeds (naked and with fiber), placates depicting warehouses for storage of cotton seeds and bags to store seeds, pencils, erasers.

According to the internet sources, cotton seed (photo 47) is characterized as seed approximately 3/8-inch-long and 3/16 inch wide. It is covered by a soft fibrous white substance. Sometimes the seed will appear blackish and fiber less (no cotton adhering to the seed).

Photo 47. **Cotton seeds and their various outlooks.**

Ginning machine is used to separate the cotton fibers from the seed. Cotton gin had been invented by Eli Whithey in 1793.

In the Past the separation of cotton fibers from the seeds is done by hand (manually). It was very hard and time consuming work. Invention of cotton gin has considerably reduced the time and extraordinarily enhanced efficiency of cottonseed ginning.

There are two types of ginning machines for our cotton ginning plants.

1.Saw gin machine (for middle fiber cotton varieties, G.hirsutum L.).
2.Roller ginning machine (for fine staple cotton varieties, G.barbadense L.).

Cottonseeds are surrounded by fibers which grow from the surface of the seed. This lint is removed in one of the ginneries and used to make cotton thread and fabric.

The seeds are about 15% of the value of the crop which totally makes: 70% of raw cotton weight and are pressed to make oil and used as animal feed. About 5% of the seeds are used for sowing the next crop.

Storage of cotton seeds is implemented by the guidance of the GOST 5947-68 (reissued, June 2010). According to this GOST cottonseeds are packaged in fabric or paper bags (photos 48, 49) or in piles (unloaded) insuring perfectly safe (at 10^{o} C; 14% of humidity) and ensuring from mixing with industrial varieties.

Photos 48, 49. **Storage of cotton seeds in paper bags and unloaded.**

Seeds accepted to the storage should have certificate about the seed quality presented below:

Certification
№___
on cotton planting seed (which is valid for two months)
___________« », 20_____.
Name of the cotton variety
_____________________________________,
Given (to) ______________________,
On seed stock batch № ___ with weight ____ ton,
taken from cleaning of seed stock batch of raw cotton
batch № ___,
Provisioned in ________________ in 20 ____,
intended to dispatch to _________________________,
Industrial grade of the seeds
______________________________,
Moisture (to absolute dried and real weight)
_____________,
Purity (impurity or spoilage)
________________________________,
Full hairiness of the seeds
_________________________,
Multiple delinting ________________________,

The seed batch – it is a defined amount of uniform seeds (of one crop, variety, reproduction, category, variety purity, year of crop, similar origin, numbered and conformed by corresponding documents).

After two months of storage, the cotton seeds will be analyzed again to define their quality safe.

GOST 21820.0-76 spreads to seed stock raw cotton and cotton seed intended to plant and identifies the methods to select samples for determination (control) of planting seed qualities. Depending on their batch weight the sampling is carried out from batches or their parts. The weight of control unit, identified for seed stock raw cotton and cotton seed is presented in the table 12.

Control unit – one average sample of particular amount or its parts is taken to determine the quality of seeds at separate batch.

Table 12. **Weight of control unit for seed stock raw cotton and cotton seeds.**

Reproductions	Weight of control units (ton)		
	Seed stock raw cotton batches	Seeds at the ginning and storage times	
		Non-disinfected	Disinfected
Elite	15	5	10
F_1	30	10	20
F_2	60	20	40
F_3 and successive reproductions	150	50	100

Storage of cotton seeds in the farms prior to sowing. The planting seeds are delivered to farmers from state provisional points in correspondence with variety allocation plan, on the conformed norm of sowing, identified plan of area and modes of planting.

At the time of releasing, provisional point gives a certificate to the recipient in which pointing out the characteristics of planting and variety quality of seeds and their origin (elite farm).

The planting seeds are transported in the fabric or paper bags, every batch, distinguishing from each other by quality and variety indexes, in individual transport. Until sowing the seeds are conserved in the dried, good aired premises which previously cleaned properly and disinfected.

Boards and reed stacks are laid under seed bags to prevent moisture penetration to them from floor. The width of every stacks must be equal to the length of two bags, and the distance between neighboring stacks – at least 1m, that lets free air flow and makes it possible to the controlling persons to check the state of seeds. In the sun lighted days, all windows and doors are opened to air the premises.

The naked seeds are required great attention because of their high environmental moisture absorbing characteristic and raped spoilage. The state of seeds is subjected to systematic observation at the time of storage. In case of moisture penetration, soaked seeds must be immediately dried by spreading them out on the dried area by the depth of 10 cm and regularly mixing necessary.

Control of seeds at the time of storage is more important, especially for those intended for seed purposes. First attention in the maintaining the good quality of stored seeds must be paid to the moisture of seeds, that is the seeds are properly dried and cleaned. Because, poor quality seed loses its viability even when stored under ideal storage conditions. Furthermore, high moisture heating (chart 13), which encourages the growth of seed, burns fungi and increases insect activity. Hence, grain must be stored dry at 14% content (MC). As a rule of thumb, for seed MC between 5% and 14%, each 1% reduction in MC approximately doubles seed storage life.

A special control should be observed above the functioning order of storage facilities. A good storage facility maintains good quality seeds with high viability and vigor. Sample seeds for moisture content are taken every month to monitor seed condition in storage. Sanitation and cleanliness in the storeroom must be maintained. Keep the storage room free from insects and spilling seeds on the floor.

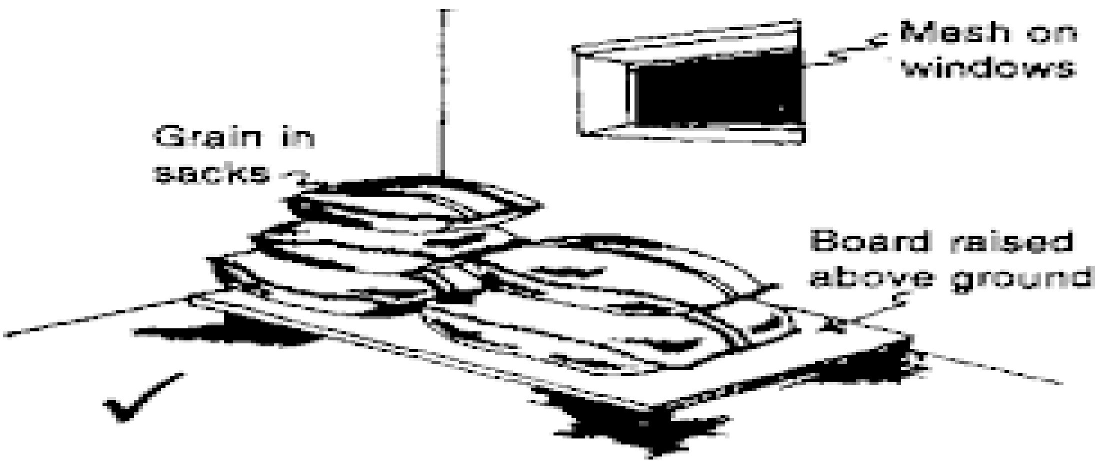
Store old and new seed stocks separately. As much as possible, do not mix the new stocks with old ones to prevent pest infestation. Maintain the ideal temperature and relative humidity inside the storeroom.

According to advanced seed storage technologies, the following factors of environment have to be under control:

1.Increase in temperature and humidity can cause seed deterioration and promote proliferation of seed borne pathogens and stored grain insect pests.

2.As a rule of thumb, each 5C decrease in storage temperature between 0C and 50C approximately doubles seed storage life. When storing seeds under ambient condition, the storage room should be provided with adequate ventilation.

3.Use Paleta (pallets) or tarimas to keep the piles at a distance from the floor to avoid moisture condensation. Pile the bags following the Japanese Piling System, where the bags are piled leaving the center space vacant to facilitate better aeration. This also allows access for re-sampling and quality inspection.



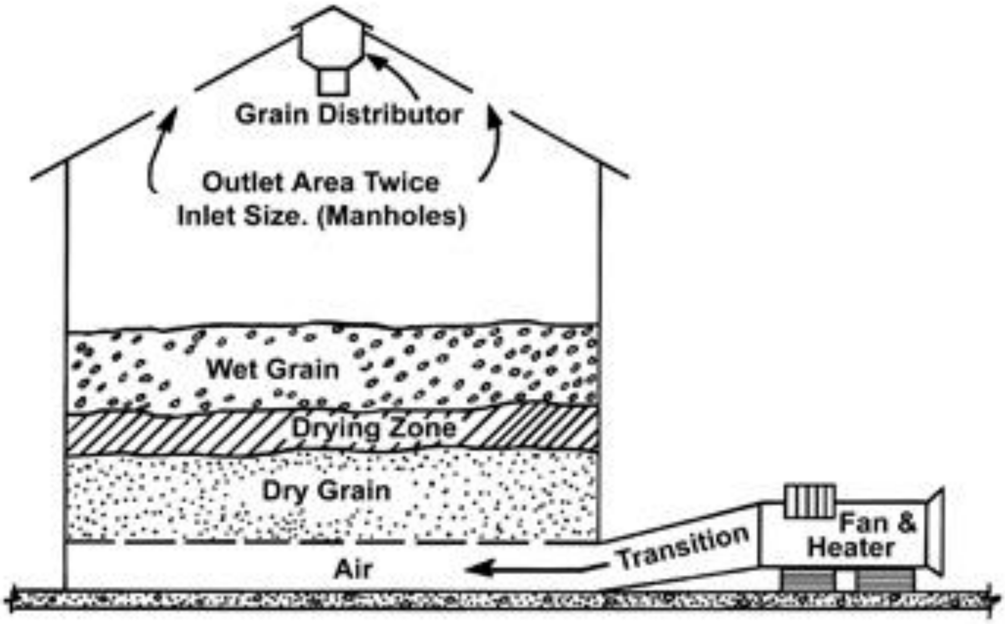


Chart 13. **Seeds stored in bags (above) and in the pile (below).**

Defining of purity (or impurity) of seeds is carried out in two ways:

a) Definition of contents of mineral and organic impurities;

b) Definition of contents of empty, beaten, burnt and moved seeds.

Weighed portion (навеска) of seeds in 500 g is sifted through sieve with the outlet of 3x3 mm above the oil paper.

Picked out sweepings and dust are combined in the dish, and seeds bear on the clean sheet of paper and by the pincers selected remained mineral and organic impurities from them; then all mineral and organic impurities are weighed. At this, smallest down (пух) picked out from the sifting of seeds adds to the weight of seeds.

Contents of mineral and organic impurities in the percentage (K_o) is defined on the following formula:

$$K_0 = \frac{m_0 \cdot 100}{500},$$

Where: m_o –weight of mineral and organic impurities in g;

500 – initial weight portion in g.

After defining contents of mineral and organic impurities from sieved weight portion, two portions on 100 units of seeds each one are sieved without selection, each portion weighed and analyzed individually.

At the beginning picked out beaten and damaged seeds, which have less half of nucleus, safe nucleus seeds and their parts. Then unbroken seeds cut in half (across) and are overlooked. The seeds are selected to one out of five groups depending on the studied analyses:

The first – the color of seeds nucleus is specific for this variety (table 13);

The second – touched seeds, color of nucleus is dark, then foreseen for this variety;

The third – hollow seeds;

The fourth – burnt seeds with black color of nucleus;

Table 13. **Requirements to color of seed nucleus of cotton seeds.**

Grade of cotton seed	Corresponding grades of raw cotton	Color of cross-section of the nucleus
I	I	Light-creamy with greenish and other spots depending on the cotton varieties
II	II	Creamy with spots depending on the cotton varieties
III	III	From grey-creamy up to yellowish with spots
IV	IV	From yellow up to light-brown

The fifth – beaten and damaged seeds, which have less of half of nucleus, safe nucleus and their parts.

The seeds of the second group weight with the seeds of the fifth group, which together consist of oil mixes. (Beaten and damaged which have less half of nucleus, safe nucleus of seeds and their parts involve in oil mixes).

Contents of oil mixes (b) in percentage are calculated on the formula:

$$b = \frac{m_м \cdot (100 - K_0)}{M_c},$$

Where: m_o – weight of oil mixes in g,

M_c – initial weight of 100 unit of seeds in g,

Ko – percentage content of mineral and organic mixes.

The seeds of third group are weighed together with seeds of forth group.

Taken weight (K_c) in percentage is calculated on the formula:

$$K_c = \frac{m_c \cdot (100 - K_0)}{M_c},$$

Where: m_c – total weight of hollow (third group) and burnt (fourth group) seeds in g,

M_c – weight of 100 unit seeds in g,

K_o – percentage content of mineral and organic mixes.

Mean arithmetic index on two weight portion is accepted for general content of oil mixes or hollow and burnt seeds if difference between two definitions will be not more then:

for I grade 0,5%,

for II-III grades 1,0%,

for IV grade 2,0%.

At the case of exceeding of this difference the repeated analysis is conducted. If difference does not exceed established norm of admits, the result of repeated definition is accepted as the completion result.

Otherwise, mean arithmetic index of oil mixes or hollow and burnt seeds on four weight portions is accepted for a completion result.

Percentage content of impurities (a) is defined on the formula:

$$a = K_o + K_c ,$$

where: K_o – percent content of mineral and organic mixes,

K_c – percent content of hollow and burnt seeds.

Content of total impurity (C) in percentage is defined on the formula:

$$C = a + \frac{b}{2} ,$$

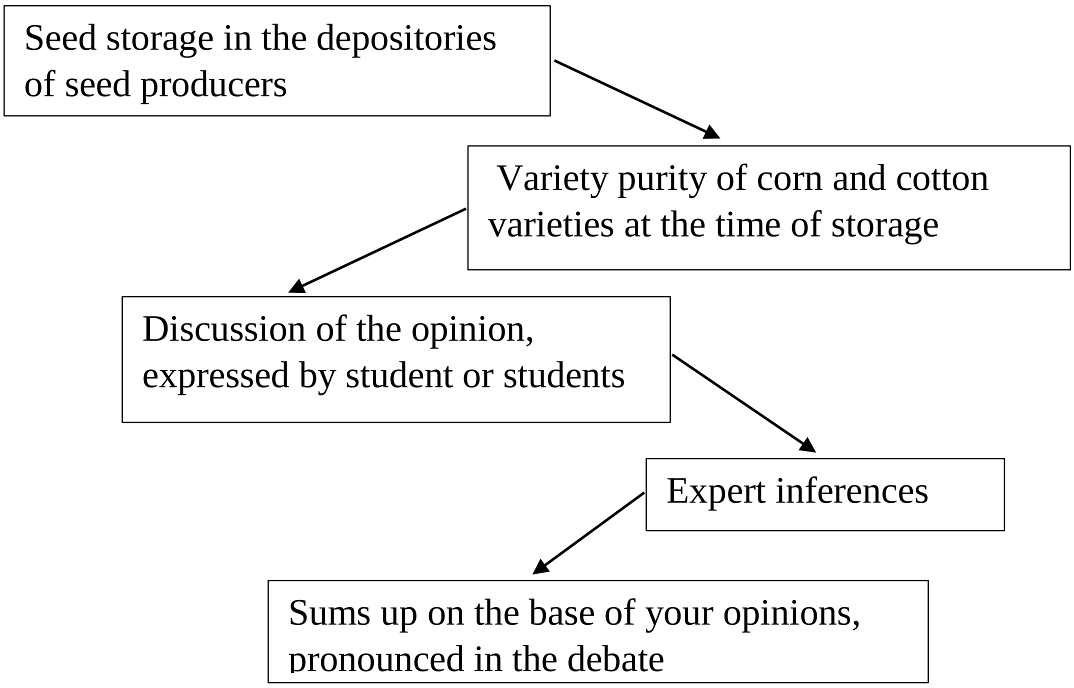
Where: a – percent content of impurities,

b – percent content of oil mixes.

Final result of impurity is rounded off up to 0,1%.

The questions and tasks to firm acquired knowledge on control of seed storage and variety purity (or impurity):

1.What is the ginning of cotton seed?
2.What standard has been worked out to control cotton seed storage?
3.Can you explain the meanings of seed batch and control unit?
4.Do you remember what kinds of gauges are exploited?
5.Does the color of seed nucleus have relation with the purity of seeds?
6.Review the methodical order of sampling from stored cotton seed.
7.Review the ways of defining cotton seeds purity (or impurity) by using cotton seeds available in the laboratory.
8. On the base of pedagogical method “Debate” organize question and answer, share your friends with studied material.



The 24th practical training.

The work carrying out in variety trial plots.

The aim of the training. The aim of this training is to get acquaintance with variety trial plots. Organizing of variety trial plots, allocation of varieties in blocks, testing them and phonological observations in the replications and doing summarize on new varieties' dignity are involved in the complex of scientifically research works implementing in these plots.

Necessary teaching aids: Internet sources, text books about plant breeding of farming crops, manual on conducting of crops variety trial, placates depicting the scheme of variety trial plots, blank forms of phonological observations, latest state register on newly commercialized varieties of agricultural crops, pencils, rulers and erasers.

Variety trial plots (broadened; competitive and state) have different structural schemes, depending on the crop species (photos 50, 51), cultivation and objectives.

Photos 50, 51. **Outlook of plot to test flax and alfalfa varieties.**

Plots of broadened (or control nursery) variety trial.

Cotton plant breeding establishments are built in these plots. The best varieties of department are tested in the broadened variety trial plot. Plot is selected according to even and on the possibility identical in regard of soil. Agro-practices should be typical to its district. Simultaneous conducting of agro-measurements in all parts of a trial plot is an extremely important condition for the preciseness of the experiment.

The nursery is laid out in six replications. The replications may be allocated in one or in several belts. Combination of testing varieties and standard is called block. The rupture of blocks is not allowed at any disposition of replications that is transferring of variety from one block to other.

At the disposition of blocks in the neighboring replications it is necessary to strive that one name blocks would be stay maximal far from each other. Below is presented the scheme chess like allocation of blocks at the disposition in three belts (chart 14)

Guarding area		
Standard	Standard	Standard
III	IV	I
Standard	Standard	Standard
I	V	II
Standard	Standard	Standard
II	VI	III
Standard	Standard	Standard
VI	I	IV
Standard	Standard	Standard
IV	II	V
Standard	Standard	Standard
V	III	VI
Standard	Standard	Standard
III	IV	I
Standard	Standard	Standard
I	V	II
Standard	Standard	Standard
II	VI	III
Standard	Standard	Standard
VI	I	IV
Standard	Standard	Standard
IV	II	V
Standard	Standard	Standard
V	III	VI
Standard	Standard	Standard

Guarding area

Chart 14. Scheme of blocks' allocation at the disposition in three belts.

In every replication, the variety occupies a lot, presenting row with 100 holes or two rows with 50 holes each one.

The scheme of plants allocation is similar to the industrial condition.

The varieties (photos 52, 53) included into broadened, or competitive variety trial, incorporated in groups over the precocity, sometimes taking into account and other traits as type of plant architecture (canopy).

Incorporation in groups haunts the purpose of creation a specific agro-practice condition of cultivation for every group.

The beginning and 50% of germination, blooming and maturity are taking into consideration in the nursery of broadened variety trial.

Purity of variety is defined along the lines and varieties in the period of flowering. 100 boll probe species are taken from every variety in all replications. Yield of the first harvest, until the frost of opened bolls and total yield (taking into account immature bolls) are also taking into consideration.

Probe species are analyzed in the laboratory, where weight of raw cotton out of one boll, fiber output and its length are defined. Technological quality of fiber is either defined. The mean indexes are defined out of data of six replications and the main summary of broadened variety trial is composed (form 19, take a look at

Photos 52, 53. **Nursery of broadened variety trial of Scientific Research Institute of Cotton Breeding, Seed Production and Agro-technologies, 2017.**

The appendix 6).

Competitive variety trial.

The best varieties of the Institute or station and either the best varieties of other stations, successfully passed through broadened station variety trials in the course of two years. Competitive variety trial is laid in six replications. Every variety occupies the lot consisting of five rows with 100 – holes in them, at the scheme 60x60x2-3 it makes 180 m^2. In the plot of competitive variety trial takes into consideration:

-the beginning and 50% of germination, blooming and maturity;

-state of plants in the plot on June 1, July 1 and August 1.

Height of plants, number of leaves and the level of the 1st fruit wood setting are defined on the 1st of June;

Height of plants, number of fruiting woods on the 1st July;

Height of plants, number of fruiting woods and number of fruiting organs (buds, flowers, bolls) on the 1st August.

-percentage of variety purity in the period of blooming;

-percentage of infection by wilt and bacterial blight;

-plant stand density after sprouting and at the beginning of ripening;

-25 boll probes are taken to determine technological quality of fiber;

-200 boll probe species are taken from all plants to define boll size, length and output of fiber, absolute weight of 1000 seeds;

-crop of raw cotton from the 1st harvests, until frost of opened bolls and total;

Rate of the variety maturity in the broadened and competitive variety trials is identified on the decade harvests. Taken data is compared with the half sum of neighboring standards.

Statistical treatment of data is done on the method of pair standards.

State variety trial plot.

The new varieties releasing in the plant breeding institutes primarily studied in the broadened and competitive variety trials and on the base of that makes conclusion about the value of new variety in comparison with commercialized variety. Final assessment about the perspective of new varieties and the identification of regions to cultivation are granted on the base of the conducted tests at the state variety trial in the courses of three years. This testing procedures similar to foreign advanced testing works (photos 54, 55).

State commission at the ministry of agriculture is implemented state variety testing. It is completely independent out of plant breeding establishments releasing new varieties. It disposes networks of state variety testing plots, which located in various zones throughout the republic. The soil of the plots has to be typical to their zones, identical to fertility of soil. Agro-practical backgrounds should be similar to the leading farms of the regions.

Photos 54, 55. **Demonstration of cotton variety potential in the USA.**

Agro-technical features of new varieties: response to watering regime, plant stand density, chopping and others are taking into consideration at the testing process. All these data have to be recommended by the authors of the varieties at the time of submission of varieties to the state variety testing.

According to the plant architecture (canopy) of new varieties, they are grouped, in order to select variety to the cultivation practices. Locally commercialized variety is included into every group (appendix 6) as the standard variety. If, there are more than 10 varieties in the test, the standard includes twice into every replication.

Yield of raw cotton and fiber from September harvest, until frost of opened bolls and total yield with yield of immature bolls; precocity from the days from planting to harvest and rate of boll ripening; fiber output, weight of 1000 seeds, resistance to diseases and pests, weight of bolls, resistance to lodging and shedding of raw cotton, beginning from bolls, defects of seed and fiber in the bolls.

Fiber of new varieties is analyzed on their technological qualities: micronire, length, strength, uniformity and others.

The new varieties are tested for fitness to mechanized harvest (photo 54).

The state variety trial conducts two types of variety testing: competitive – in the small lots and industrial – in the enlarged lots.

The following research works are fulfilled in the small lots:

-to lay out four (even: six, eight) replicated rows on the account of 100 m^2 area totally;

-to place one or two replications (rarely three) depending on the convenience;

Two or three varieties are tested in the enlarged lots and make the lists of works:

-laying out an experiment in two replications. Area of a lot under observation and recording of every variety must be no less than 1,5-2,0 hectares. Both replications are placed in one belt. Agro-practices are done according to the recommendations, handed by the breeder.

Questions and tasks to consolidate acquired knowledge on works to be fulfilled in the plots of variety trials:

1.What is a variety trial plot?

2.Can you list the works which must be done in the trial plot?

3.How many varieties are tested in the trial plot?

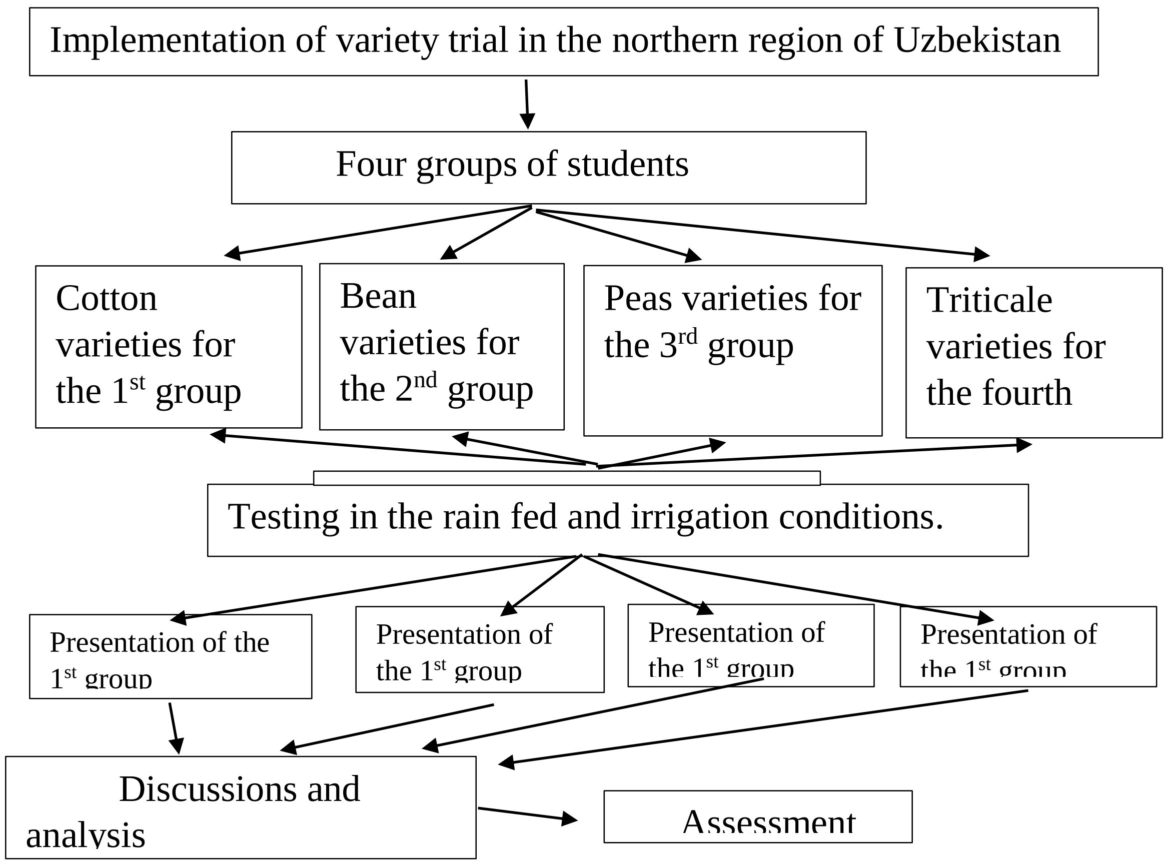
4.Which signs of varieties are the major indexes in the testing?

5.By means of internet sources find out flax and alfalfa trial methods.

6.Make a scientific report on the list of works to be fulfilled in the testing plots of flax.

7.Make a scientific report on the list of works to be fulfilled in the testing plots of alfalfa.

8. Carry out the training by the method “Working in the small groups”, pedagogical method to consolidate studied material.



The 25th laboratory training**.**

Discarding on lab analysis and available methods in selection of elite materials.

Aim of the training. The aim of this training is to get acquaintance with field observations and lab analysis of selected plant data on newly developed soya variety “Sochilmas”. Rejection orders of off type plants and selection of elite seed plants in plant breeding process.

Necessary teaching subjects: Placate, depicting the scheme of individual selection of bean bearing crops, plant herbarium of soya variety “Sochilmas”, seeds of this variety, lecture note-books, pencils, rulers and erasers.

Soya (Lat. Glycine max) is a herb grass, annual, self-pollinating plant, number of chromosomes – 20 ($2_n = 40$).

Domesticated soya has spread across all of the continents of the world and sown more than in 60 countries. This crop is predominantly spread between grain-bean and oil crops (photo 56). It is a raw source for wide range of food consuming products and rich of protein (32-48% and even up to 50%). It can replace meat, egg and milk products in the ration of men. It has an irreplaceable amino acid of lisin,

Расм 56. **One of the plots planted by soya species.**

(2-2.7%) in its structure.

Broadened scientific-researches on soya varieties are also being conducted by plant breeders of agricultural crops in our republic.

Below listed objects and directions in the creation of soya varieties have been remarked before plant breeders, according to the demands of national economy in the products of soya crop and response of soya plant to soil-climatic conditions of our republic: high productivity, precocity, non-bursting of beans, resistance to lodging, diseases and pests, development of varieties with much oil and proteins content in seeds.

The development of variety with non-bursting bean is the most complicated task among above listed objects (photos 57, 58). Because, bursting of soya beans


Photos 57 and 58. **Bean bursting on soya plant.**

and scattering of grains had been associated with this crop's natural selections in its evolutional development and genetically fixed. Researches showed that at the time of harvest, losing of crop in the result of bean bursting reaches up to 8% at 9% of beans' humidity (Laura Lindsey, 2017).

A great outcome in the decision of this problem, occurring in the varieties of soya crop, has been achieved by a group of scientists, headed by professor M.F.Abzalov (photo 59), at the Institute of Genetics and Plant Biology of Science Academy of the republic of Uzbekistan.

In general, individual selection method of plant breeding is employed in the researches of soya, by taking into account that it is a self-pollinating plant. Above mentioned scientists studied plant characteristics and properties in the populations of the world and local collection species in the field and laboratory conditions to find a non-bursting bean source.

Annually, 100-gram seed stocks of species are planted in the collection nurseries with 4 m length each on the planting schemes of 60 or 45x10-15x2. In this scheme of seed planting, the seeds of initial seed amount are enough for sowing of 10 collection nurseries.

Расм 59. **Professor of biological science M.F.Abzalov and junior scientific staff N.R.Baratova are remarked elite plants for individual selection, 2015.**

Individual selection out of species' plants has been implemented in the coincides of the world's commonly using method (chart 13).

Below listed phonologic observations were conducted in the first year family study nursery:

-germination;

-height of plants;

-length of internodes;

-number of internodes of the main stem;

-number of beans;

Number of seeds in the bean;

-rate of bean bursting;

-hairiness rate of stem and leaves;

-damage and infection of plants;

Data, combined in the result of phonologic observations, have been reprocessed through statistical, hybridologic and lab analysis. Texture of pulled out plants has studied, the beans have been thrashed, yield has weighed, the seeds have been studied and the weight of 1000 seeds has also been defined. The plants which hadn’t met the requirements to selecting elite plants were rejected.

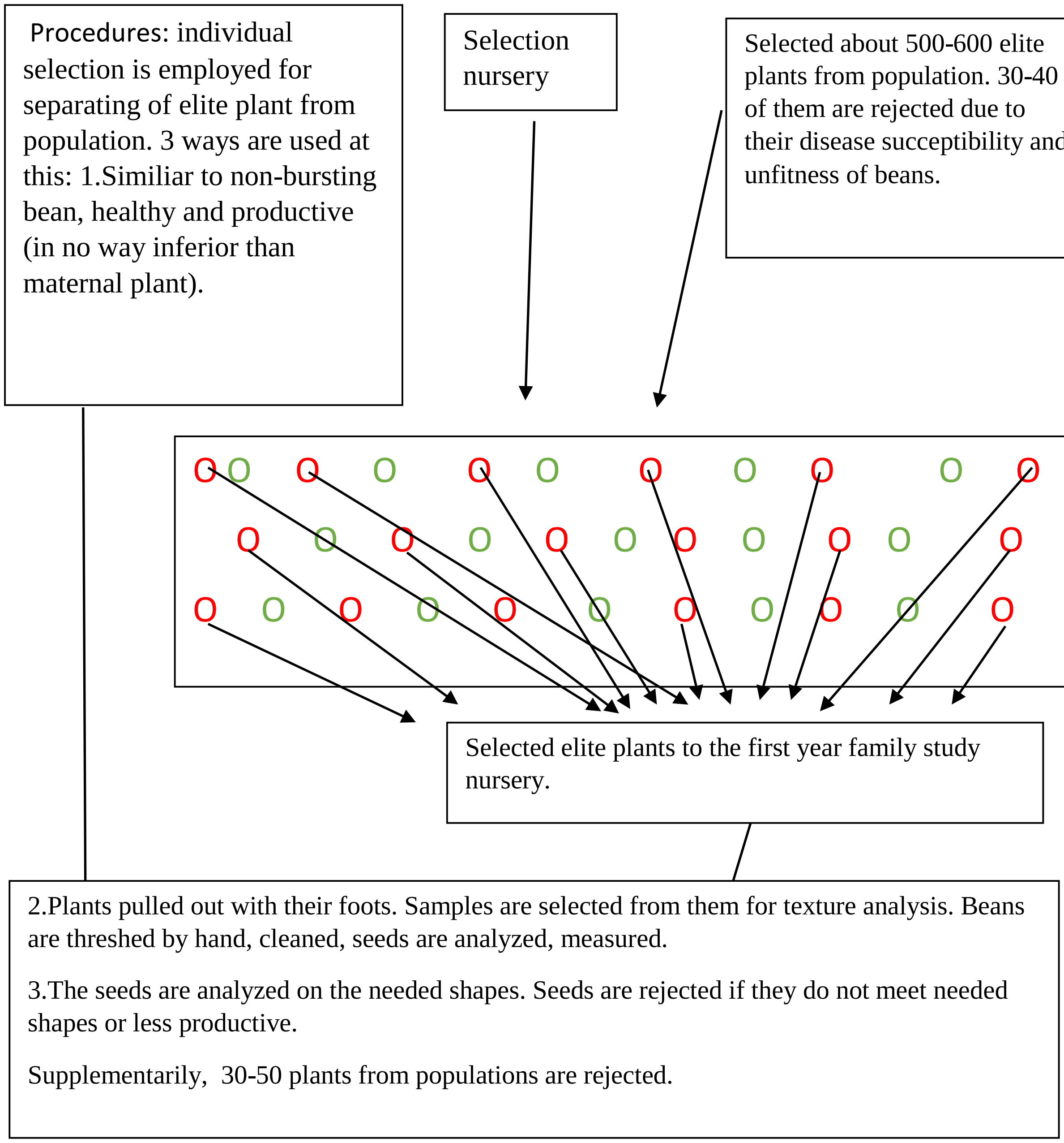


Chart 13. **The scheme of individual selection of soya elite plants for the first year family study**.

In the result, the variety of “Sochilmas” (it means non-scattering) with non-bursting bean, productive, resistant to diseases and pests, possessing by high content of oil and protein has been developed from elite plant progenies (photo 60).

The variety was developed in 2015 by M.F.Abzalov, N.R.Baratova and E.Kh.Saribaev. It was registered in the state register in 2016 and granted the patent №NAP 001171.

Farming traits: Growing vegetation -90-95 days; height of plant-60-85 cm; number of internodes -18-20 units; number of beans per plant -90-130 units; number of beans per 1 internode -5-6 units; number of grains per bean -2-3 (4) units; weight of 1000 seeds -130-140 g; protein content -40%; oil content-22-23% and productivity -2.5-3.0 tons (see appendix 7).

Photo 60. **Appearance of the variety "Sochilmas".**

Morphological characteristics: Plant has dark green color; hairiness of stem is medium; leaf has lancet shape; three lobbed; flower is white; grains are yellow; leaves turn into yellow at the end of vegetation, which is the mark of maturity.

Specific peculiarity of the variety: owing to its precocity, it can be sown in the fields after winter wheat; the productivity has reached up to 3.0-3.5 tons in the first sown and 2.5-3.0 tons in the second sown at the State testing in 2010.

The questions and tasks for consolidation of the acquired knowledge:

1.What are the main directions of soya variety plant breeding?

2.On the base of what indexes can be discarded the breeding material?

3.How the elite plant selection effects on the agriculture?

4.How can you make the variety better?

5.Which kind of soya variety is the best one for you?

6.Get acquaintance with information on the laboratory analysis, rejection and selection method of elite plant in the development of chick pea varieties by using internet sources.

7.Define the availability of new, non - bursting varieties of mungbean, get a brief acquaintance with laboratory analysis, rejections and elite plant selection methods and compose a short report on them.

8.Why the quality lab analyze is conducted?

The 26th laboratory training.

Determination the quality of corn grains.

The aim of this training is to learn methods of determination the qualities of corn grains, and calculation of the statistical indexes.

Necessary laboratory subjects: Copy of standard (GOST 13634-90), technical-lab scales, sieves № 08; № 1,0 with hole diameters of 2,5 mm, analyze board, lab knife for cutting, lab corn thresher (photo 61), grain drier (СЭШ-3М), lab beakers, cooler, pincers, magnifying glass with enlarging for 4-5 times, average probe (10 cobs), cups for scales.

Photo 61. **Functional state of laboratory corn grain thresher.**

Commonly accepted order on the laboratory determination of corn grain quality is:

1.Determination of typical composition.

2.Determination of cob’s pest infection.

3.Determination of grain output.

4.Determination of grain moisture.

5.Determination of grain dockage.

Depending on the color and shapes (table 14) of corn grains divided into different types.

1.Determination of typical composition of corn in cobs is being conducted on the united probes, taking out 10 or 100 cobs. From them picked out cobs of different types, counting cobs of each type is done solely and their percentage content calculated.

Table 14. **Typicality of corn grains on the growing varieties.**

Number and name of types	Color and shape of grain (photos 62, 63)	Content of grains or cobs of other types, in %, no more.
I-dent corn, yellow.	Yellow, orange, yellow with white top. Predominantly prolonged with cut sides and pressed at the top of grains.	15,0 and white no more than 5,0.
II-dent corn, white.	White, colorless, pale-rosy. Predominantly prolonged-with cut side and pressed at the top of grain.	15,0, and yellow, no more than 2,0.
III-flint corn, yellow.	Yellow, orange with white top. Top of grain is white. The top of grain is circle without pressed in. Glittering grain.	15,0, and white no more than 5,0.
IV-flint corn, white.	White, colorless, pale-pink. The top of grain is circle without pressed in. Shinning grain.	15,0 and yellow, no more than 2,0.
V-semi dent corn, yellow	Yellow, orange. Shape changing from dent to flint with weakly pressed at the top of grain or without pressed in.	25,0 and white no more than 5,0.
VI-semi dent corn, white.	White, colorless, pale-rosy. The shape is changing from dent to flint with weak pressed at the of top or without.	25,0 and yellow, no more than 2,0.
VII-popcorn, white.	White, prolonged with beaky shape or circle top. Smooth grain.	15,0 and yellow, no more than 2,0.
VIII-popcorn, yellow.	Yellow. Prolonged with beaky shape or circle top. Smooth grain.	15,0 and white, no more than 5,0.

Photos 62, 63. **Shapes and colors of grown corn grains.**

Determination of typical composition of the grains is conducted after crushing (shucking) out of average probe (photo 48) in weighed portion of 50 grams.

Foreign substances of corn are separated from main type of corn grain at the analysis of the weighed portion. Taken faction is weighed and the result is pronounced in percentage to weighed portion.

Registration of the results:

Type ……………………….. , cobs ……. %.

Type ……………………….. , cobs ……. %.

Type ……………………….. , cobs ……. %.

Type ……………………….. , cobs ……. %.

Type of corn ………………………………… .

The results on the defining of typical composition of corn are registered in the documents about the quality of grain with the precision up to 1%.

Impurities of cobs of other types in the same color is admissible in the corn of each type, no more than 10% in the accounting (table 13).

2.Determination of cob’s pest infection. This index is defined by taking of probe (10 cobs) and all cobs are thoroughly inspected by the help of magnifying glass on the availability of pests.

To discover infection of corn cobs with mites (photo 64), 10 corn cobs, pair by pair

Photo 64. **Mites can damage not only green plant but maize cobs also.**

are knocked each other above the black glass to defining infection of corn cobs by the maize mites. Then, surface of the glass is overlooked by the help of magnifying glass to detect mites.

In the detection of insects and mites, their amount is identified. The amount and species of pests are remarked and registered in the documents.

Registration of the results:

1.Species of pest ……. , number ….. .

2.Species of pest ……. , number ….. .

3.Species of pest ……. , number ….. .

4.Species of pest ……. , number ….. .

3.Determination of grain output from cobs. The average probe in the amount of 10 cobs is weighed and crushed. Taken grain after crushing is weighed. Mixed grains (with smallest ones) of 100 grams are picked out and the parts of corn cob, mixed at the time of crushing, are separated out of weighed portion. Cleaned grains are weighed.

Output of grain is defined on the following formula:

$$X = \frac{m_1 - m_2}{m},$$

Where: m_1 – weight of grain, taken after crushing of average probe, g.

m_2 – weight of pure grain in 100 grams of weighed portion, g.

m – weight of corn coms of average probe prior to crushing, g.

Registration of the results.

Weight of average probe prior to crushing ……. g.

Weight of grain after crushing of average probe ……. g.

Weight of pure grain in 100 g of weighet portion ……. g.

Output of grain …… in %.

Output of corn cobs ………%.

Internet source on the calculation of grain output from corn cobs:

Weight of average probe is 2800 g. 2200 g of grain with smallest parts of corn cobs has been taken at the time of grain crushing. 99 g has been left in 100 g of weighed portion after cleaning out of smallest parts.

Calculation:

Output of grain out of corn cobs consists of:

$$B_3 = \frac{2200 \cdot 99}{2800} = 77,7 = 77\%;$$

$$B_{cp} = 100 - 77 = 23\%.$$

4.Determination of maize moisture of in the corn cobs. Three corn cobs picked out of united probs. Moisture of grain and corn core are determined solely. Corn cobs are crushed by hand or by corn thresher and picked out of weighed portion in 50 g. from taken grain, which is grinded up to certain size. Then, picked out two weighed portions in 5g. each. They are dried with main method or preliminary drying, if the moisture is more than 18%.

For determination of corn core moisture, a parts of 2 cm from every core ends are cut and through away. Then 3 cm each one, from end and from center parts of corn core are cut and the moisture is determined by only main method in two 5-gram weighed portions.

The moisture in the corn cobs is meant a fraction: moisture of grain – in numerator, and moisture of corn core – in denominator.

Moisture is calculated to all batches of maize in corn cobs, taking into account weight correlation of grain and corn core.

Internet example for calculation of general moisture of maize in corn cobs: moisture of grain – 20%, moisture of corn core – 24%, content of grain in corn cobs – 78%, corn core – 22%.

General moisture of maize batch in corn cobs will be equal to (table 14):

$$\frac{20 \cdot 78}{100} + \frac{24 \cdot 22}{100} = 22{,}8\%.$$

The results of the calculation are written in the table 15.

Table 15. **Registration of results on determination of maize in corn cobs.**

Name of product	Weight of empty cup	Weight of cup with weight portion		Dried, g.	Moisture in g.		State of grain on the moisture.
		Prior to drying.	After drying		Replicate	Average	
Grain of maize							
Grain of maize							
Corn core							
Corn core							

The questions and tasks to firm the acquired knowledge at this training:

1.What term is given to the process of removing grains from corn cob?

2.How many kernels on a corn cob?

3.What are corn cobs used for?

4.How do you remove corn kernels from corn cobs?

5.Anyone can recommend an efficient method for shucking of corn grains?

6.How can we differentiate corn types?

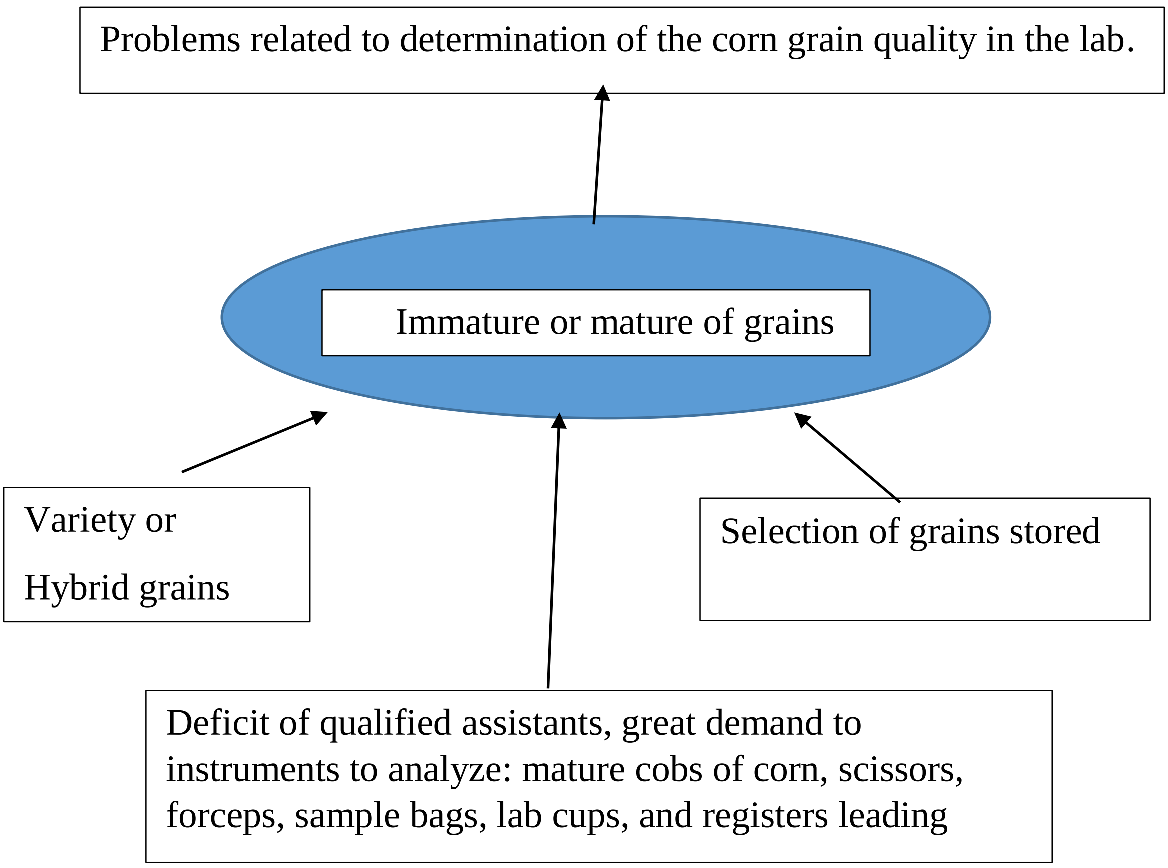
7.What do the mites cause in corn?

8.How to analyze typical composition, cob's pest infection, grain output of maize and grain moisture?

9.Fill in the blank columns of table 14 with results of your calculations.

10.Determine the grain dockage of maize by the guide of standard (GOST 13634-90).

11. Improve your knowledge over the studied material on the base of pedagogical method "Problematic situation".



The 27th practical training.

The requirements presenting to seeds and their classification.

The aim of the training. To study the main requirements of farmers and industry posing to the qualities of farming crops' seeds (in the example of cotton plant, grain and grain-bean) is the major aim of this training.

Necessary teaching subjects: Literature, dedicated to the planting seed production, samples of different seeds of crops from different reproductions, types of cotton plant seeds (photo 65), certificate form, copy - books, pencils, erasers, rulers.

Fuzzy seed (raw product) Delinted seed Graded seed Treated seed

Photo 65. **Cotton seeds.**

The requirements to the seed stocks are identified by the state standard (GOST Uz.SS. 663:2006). The seed stock, meeting the requirements of the standard, is called conditioned seed and has a certificate of correspondence (appendix 8).

The main indexes of seed stock in the state standard are: germination, fiber residues on the seeds, mechanical damage of seeds, moisture and admissible norms on the grade.

Germination is the number of seeds normally sprouted in a certain lab condition and pronouncing in the percentage. The seeds depending on the sprouting are divided into three classes: 1 – 95%; 2 – 90% and 3 – 85%.

The seeds with germination at least 85% are used for planting. Simultaneous and even sprouting of seedlings in a certain area of seed bed depend on hair residues beside of the usual seed fibers. Because, the exceeded hairiness of seed stock, then remarked in the standard (photo 64), causes the sticking of seeds to each other in the process of mechanical planting which results in the lowering of sowing quality. The indexes of cotton seed residues, indicated in the standard, prevent from lowering the sowing quality and enhance the mechanical efficiency of cotton seed planting. According to the standard, the seeds of G.hirsutum varieties must have hair residue no more than 0,8% and varieties of G.barbadense – 0,4%. Mechanical damage at the processes of ginning and delinting shouldn't be more than 5%. Because of increased seed damages the sown seeds become more vulnerable to the soil pathogen microorganisms and the most of sown seeds decay before sprouting. The moisture of cotton seed stock until sowing has the great importance and 9% of its optimal standard index must be kept by all cotton seed producers at their provisional processes. The grade (variety purity) of seed stock is defined by the numbers of seeds possessing genetic traits and properties identical to the certain variety. Seed grade (variety purity or category) is remarked in the percentage (table 16).

Table 16. **Seed qualities of cotton plant**

Seed category	Variety purity %, not less	Germination %, not least	Moisture %, not more	Dockage (mass portion of mineral and organic sweepings)			Downy for delinted seed %, not more	Mechanical demage %, not more			Residual faberness %, not more		
				For fuzzy	For seed least downy	For delinted		For fuzzy	For seed least downy	For delinted	For fuzzy	For seed least downy	For delinted
OS	100	95	9.0	0.5	0.5	0.2	0.5	5.0	8.0	6.0	0.9	2.5	0.4
ES	99	90	9.0	0.6	-‘-	0.3	0.4	6.0	-‘-	7.0	0.8	-‘-	0.4
R-1 R-2	98	90	9.0	0.7	-‘-	0.3	0.4	7.0	-‘-	8.0	0.8	-‘-	0.4
R-3	96	87	10.0	0.7	-‘-	0.3	0.4	7.0	-‘-	8.0	0.8	-‘-	0.4

Data, taken from a recent industrial experiment (Ashurov M. and others., 2018), are the bright example of the importance of provisioned cotton seed quality in the efficiency of cotton growing (photos 66, 67). Variation of seedlings' numbers in this experiment was statistically considerable in every probe of 1 m seed bed.

We can easily count upon the numbers of each seed bed from these photos. They are: 11 in the first seed bed and 3 in the second seed bed. The same state of difference on the numbers of seedlings per 11,1 m long of probe (in 10 point probes singled out through diagonal of 24 ha plantation) was underlined in the field observations (table 17). Importance of these data in regard of farming point view becomes more understandable after converting them into hectares of cotton plantation or seed expend per hectare.

Photos 66, 67. **The numbers of cotton seedling per 1 m of seed beds.**

Grain and grain-bean crops also have special standards for identification their seeds and sowing qualities (photo 68).

According to the standard (GOST 10467-76) which is so far under function for grain crops, wheat seeds, designated to sowing, have to meet certain requirements:

Table 17. **Numbers of healthy seedlings in the probe seed beds, 2018.**

Probes of seed bed	Numbers of seedlings prior to thinning, 1.05.	Numbers of seedlings after thinning, 20.05.	Numbers of removed seedlings at the time of thinning.	Number of removed seedlings in regard of grown seedlings, in %.
1.	221	100	121	54,8
2.	207	57	150	72,5
3.	232	106	126	54,3
4.	143	60	83	58,0
5.	194	142	52	26,8
6.	125	37	88	70,4
7.	103	65	38	36,9
8.	185	71	114	61,6
9.	198	94	104	52,5
10.	163	92	71	43,6
Totally:	1771	824	947	-
Mean:	177,1	82,4	94,7	53,1

Variety purity of seed producing plantation should be no less than (in %):

99,7 – nursery of reproduction, super elite and elite of soft wheat;

99,9 – nursery of reproduction and super elite of hard wheat;

99,8 – elite.

Photo 68. **Outlook of grain and grain-bean crops.**

Depending upon the variety purity, plantations of the first and successive reproductions are divided into categories: I, II, III, which must be correspond to the norms of (no less than): I – 99,5; II – 98,0 and III – 95%.

Seeds of wheat are divided into three classes according to the sowing qualities (table 18).

Table 18. **Variety purity and sowing qualities of grain crops.**

Crops	Categories (variety purity)			Classes		
	I	II	III	1	2	3
Wheat						
Purity of seeds, at least.				99,0	98,0	97,0
Contents of soft wheat, no more than.				0,5	2,0	4,0
Content of other plants, unit per 1 kg.				10	40	200
Germination, % at least.				95	92	90
Moisture, no more than 14%.				14	14	14
Maize						

Rice						
Rye						
Oat						
Sorghum						
Triticale						
Chick pea						
	99,5	98,0	95,0			
Purity of seeds, at least.				99,0	97,0	
Contents of others, units per 1 kg.				5	30	
Germination, in %.				95	90	
Moisture, % at least.				14	14	
Sunflower						
Millet						
Soya						

Questions and tasks to consolidate the acquired knowledge:

1.What indexes of seeds compose their quality?

2.Do standard and certificate of cotton seed have any effect to the efficiency of cotton growing?

3.Do you know other natural or external conditions, which effect on the germination of seeds and obtaining the healthy seedlings of agricultural crops?

4.Why treatment of seeds is done by chemical substance?

5.What categories and classes are characteristic of the seeds of sunflower?

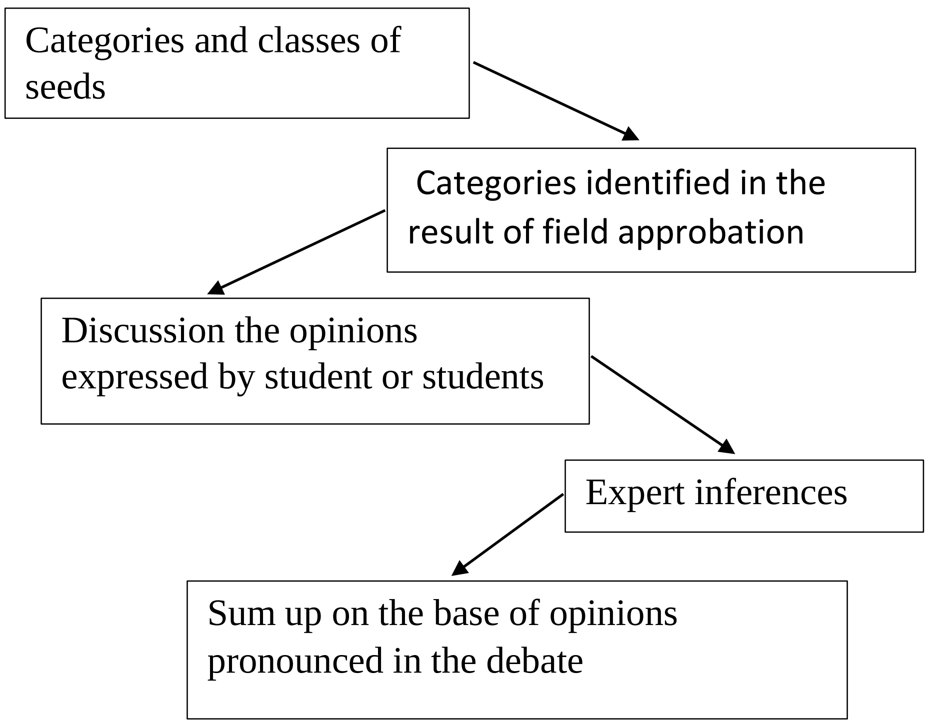
6. What categories and classes are characteristic of the seeds of millet?

7. What categories and classes are characteristic of the seeds of soya?

8.Calculate the expend of cotton seed per hectare and for 24 hectare of experiment plantation (use data of table 16) on average and the total seeds have been lost in the result of seed quality, in particular.

9.Use the internet information and continue filling in the table 17 with the variety purities and seed qualities of crops: maize, rice, rye, oat, sorghum, triticale, sunflower, millet, soya and other crops which are grown by our farmers throughout the republic.

10. On the base of pedagogical method "Debate" organize questions and answers exchange with your friends about studied material.



The 28 th practical training.

Preliminary reproduction of seeds of commercialized varieties.

The aim of this training is to study preliminary seed production of seeds of commercialized cotton plant, wheat, barley (photo 69) and sunflower varieties and hybrids.

Necessary teaching aids: placated dedicated to the seed production systems and schemes of farming crops, internet sources, lecture note – books and literature, copy – books on practical trainings.

Seeds of newly developing varieties and hybrids are reproduced (multiplication) in the preliminary seed producing farms since their state testing had

Photo 69. **Plants of barley in preliminary seed reproduction farm.**

begun. This activity was introduced into seed production system with the aim of obtaining enough quality seed stocks of promising variety or hybrid to spread in possibly short time in enlarged areas of regions. Generally, new varieties and hybrids are studied in several climatic and soil condition trials to evaluate their adaptability and productive potential. Undoubtedly, the breeders are not capable to provide with seeds districts in which their variety or hybrids will be regionized. Consequently, preliminary seed reproduction in the seed production system promotes with wide scale of commercializing new varieties and hybrids in short period of time with maintaining of genetic and farm dignities of the new material.

The method of preliminary seed reproduction on the seeds of new cotton varieties is similar to elite seed reproduction (look through 14th training of the teaching manual “Selection and seed production of cotton plant”).

Preliminary seed producing farms are foreseen to dispose in neighborhood to elite farms and of course, the farming conditions will not distinguish to each other.

Accelerated reproducing ways of new wheat varieties with high seed multiplication coefficients in the world’s seed production practices have been elaborated by academician Lukyanenko, Russian famous plant breeder, in the 1950s of the last century. So, wheat variety “Bezostaya 1” had been grown in the area of more than 500 thousand hectares in two years after its introduction into production. Since that time, breeding center of Krasnodar SRIA rapidly reproduce the required amount of variety seeds of new wheat and barley varieties. Here, the seeds of new variety are reproduced in the seed plots of 10-20 farms in the year of their transferring to state variety trials. In the second year, the number of seed reproducing farms increased up to 40-50, depending upon the positive results. By this way, the enough amount of seed stock is created at the time of introduction of the new variety into production and due to it the term of introduction is reduced up to 5-7 years. So, the seeds of the new variety are sown in the farms after better predecessor crops, in clean fallow and alfalfa with the planting norm of 100-120 kg\ha. Crop of 4.0 tons and more is obtained from such plantations. 140-160 kg\ha of seeds are planted instead of 240-260 kg in the common industrial plantations. In such kind of wide row sowings with 60-70 cm apart or ribbon sowing of 45 cm apart 25 kg\ha of seed is sown. In spite of this lower sowing rate, the taken crop gets up to 6.0 ton\ha. Consequently, the reproduction coefficient reaches to 200 and more.

Above mentioned method was improved and employed to create a contemporary system of accelerated seed reproduction and introduction of the new, high productive varieties into industry. This system includes the following basic measurements:

1.Organization of massive production of seeds of the new variety in the main seed producing farms in the probability of its regionizing.

2.Reproduction of the new variety in the fields of plant breeding centers, in the main seed producing farms for several years before its regionizing; until state and even competitive variety trials.

3.Applying of special ways which ensure great seed reproduction coefficients: optimal agro-background, broadened row sowings, decreased rate of seed sowing, conducting of negative selection, species and variety weeding, thoroughly cleaning and grading of seeds to get the norm, meeting requirements of standard to elite seeds.

In these works, plant breeding establishments use all seed stocks of original seeds, including produced from competitive, ecological and state variety trials.

Development of plant breeding and seed production of maize has been marked as one of the priorities in the development strategy of agricultural complex of the republic.

Sunflower hybrid (photo 70) is the important means of production, targeted to provide further increasing of yields of agricultural products and enhancing their quality. Creation of high productive hybrids and varieties, maintaining their farm-biological properties, increasing reproduction coefficient and accelerated introduction of the best hybrid seeds into industry consist of basic works of all seed production teams.

The most valuable hybrids promoting increase of yield, enhancing the quality of products and decreasing its production cost affect favorable influence on the economy of farms in different privatization forms.

Support of valuable farm qualities and biological properties of hybrids is achieved by the growing of plants in a high agro-technical background, by systematic conducting of species and variety weeding, removing plants infected with diseases and agricultural pests, by exception of possibility of mechanical and biological impurity with other varieties and plants of this variety with negative traits.

Moreover, the norms of distant isolation (take a look at the practical training 14) between cross-pollinating crops are to be observed at the dispositioning of seed plantations, seed producing and industrial plantations (lit.: pikabu.ru<story……).

Photo 70. **Plants of sunflower in a hybrid plantation.**

Selection of typical parents in the nursery of reproduction (multiplication) is carried out by the breeder or his /her assistant, who knows very well about parental plants (photos 71, 72). In this work, some dozens of typical plants for

Photos 71, 72. **Single isolations on paternal plants and pair isolations - on maternal plants.**

paternal plant and some dozens of pairs for maternal plants are being selected. The isolation fabric puts on selected plants to prevent pollination by the foreign pollens. The label is hanged on the stem under isolation. All information about plants: name of strains, date of isolation, date of pollination is marked on isolations and labels. Information is duplicated.

At this, the label with the note about sterility (without pollens) and fertility (with pollens) analogy is hanged on every maternal plants.

Pollination is done by hand as soon as flowering of plants has begun. The pleasant moment at the time of pollination is that hands are washed with alcohol after every plant to prevent of bearing pollens by hand. But, this pleasant cannot compensate the heat, stuffy air and the volume of the works.

After maturing, all isolations are cut and brought to the laboratory. If it is needed the baskets are dried. Then, every basket is thrashed by hand in individual packet. At this, all information of isolation and label is transferred on the packet. In this process, plants infected with diseases, insufficiently pollinated, atypical plants and plants with hurt isolations consisting of 20-25 percentage are rejected.

The second year in the preliminary seed reproduction of sunflower hybrid includes: inspection on the progenies. Packets selected in the previous year are sown in the individual rows as the paternal plants and pair rows for maternal plants. Planting is done in such account that every row has at least 100 plants at the time of flowering (photo 73).

A progeny of every plant is evaluated individually on many traits: uniformity, variety purity, sterility of maternal strain and others. Rejection of selected plants in this stage of reproduction makes 90%. Isolations covered on the selected three-five plants in the maximal quantity.

Photo 73. **Nursery of reproduction in the second year, “selected” rows of maternal plants. All uncovered with isolations are rejected ones.**

It may be occurring that progenies of all plants selected in the previous year have to reject and again it is necessary to repeat selection of passed year. So far, God renders his mercy, but such kind of possibility must be having in mind.

The seed production of paternal plants is conducted solely, with such difference that the isolations on the plants are singled stand. Again a hand harvesting, again a hand thrashing and so on, only the packets now are grouped in the number of one plant.

The lab evaluations of progenies involve in the third stage of preliminary seed reproduction. At this, the using of green house complex has facilitated the considerable decreasing the time of seed reproduction. Analysis on the purity and uniformity and also for traits like: resistance to diseases, herbicides and etc., of paternal plants are individual to every strain (photos 74 and 75).

Rejection in this stage of seed reproduction may be accounted from 30 to 60%. After all rejections, progenies of several plants are selected. They go on through the next stage of evaluations and rejections.

The fourth stage of a hybrid sunflower seed reproduction consists of reproduction in grouped isolations. Here, the progenies of selected plants are sown in 6-8 rows with the length of 10 to 50 meters each. Maternal plants are sown in alternating rows, with sterile and fertile plants (photos 76, 77).

Photos 74, 75). **Seedlings of selected plants can easily be subjected to different analyzes in the condition of green house (on the left – resistance to herbicides; on the right – seedlings prone to diseases and resistance to them).**

The cruel rejection on the uniformity is executed in the growing period, because this is a key stage in the seed production of sunflower. A little mistake in this season means all: “good bye, genetic purity of seed material”.

Rapidly mounting metal framework is constructed on every nursery, not long before flowering and covered with mosquito net. This is done to prevent penetration of insects in with off pollens (photo 78). After that, only lab assistant has permission to enter. Individual overall is put on every isolation in order

Photos 76 and 77. **Seed reproduction nursery and basket without ray florets and phylary.**

to prevent bringing of pollens in. The baskets are cut out of ray florets and phylary for making easier hand pollination (photo 76).

Only lab assistant has permission to come in the protected area. This area under mosquito net with isolations in it is protected. With beginning of flowering the assistant begins to pollinate the plants every day. And pollinated plants remain under the mosquito net until harvest time.

Photo 78. **The hybrid plants are kept under the mosquito net until harvest (photo was taken through the net).**

Again harvesting by hand (individually harvested and thrashed in the rows of maternal fertile plants and sterile rows also individually). Infected by disease baskets are rejected, left baskets are thrashed by the plant breeding thrasher.

The fifth stage of hybrid seed reproduction is implemented in open area. The area of 2-3 hectares is selected for this intention and no any field of sunflower is presented around of 3 km.

Seeds of paternal plants are sown by solid rows and sowing of maternal seeds are hardier: 6-8 rows devoted to the planting of sterile analog strains and then is left vacant row, then 4-6 rows for fertile analog, then again vacant row and so until the border of the field.

All works involved in selection and rejections except lab analysis as the same as above listed seed reproduction stages.

Questions and tasks for firming of obtained knowledge on preliminary seed reproduction works of farming crops:

1.What aim has been foreseen in the organizing of seed reproduction farms in the system of seed production?

2.Can you explain the natural and genetic meanings of fertile and sterile pollens of flowers?

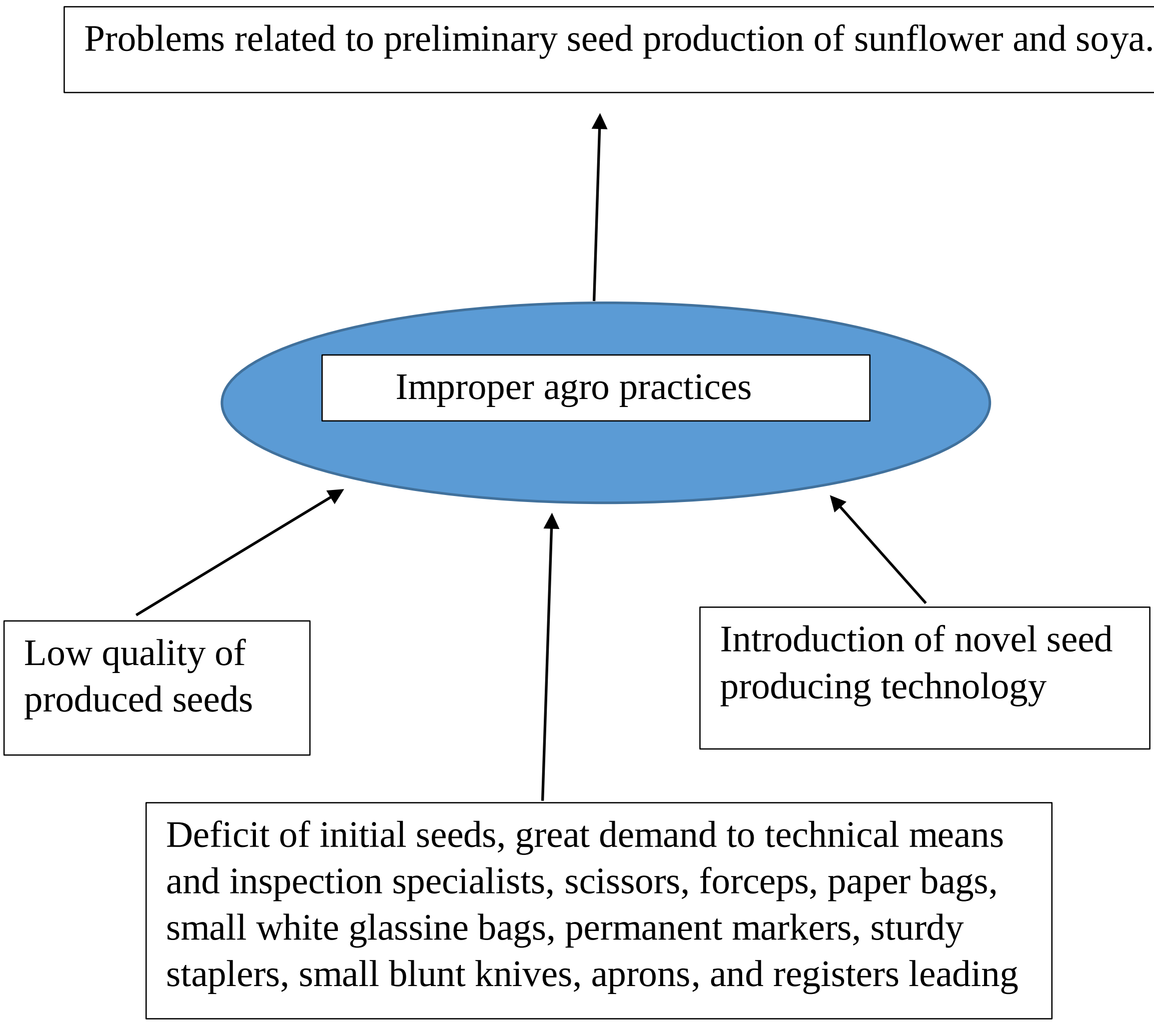
3.Does the sterility of pollens take any affect in the establishing of proper plant seeds and plant progenies?

4.How the method of preliminary seed reproduction of new wheat varieties is characterized?

5.Look through the 14th training of the teaching manual “Selection and seed production of cotton plant” and retell the preliminary cotton seed reproduction.

6.Using of internet cite “pikabu.ru<story<semenovodstvo _podsolnechnika_kak _proizvodya” prepare a full report about methods of hybrid sunflower seed reproduction in the open area at the SRIs of Russia.

7. Improve your knowledge on studied material on the base of pedagogical method “Problematic situation”.



The 29th practical training.

The main agro-technic and seed production measurements in elite seed producing farms.

The aim of the training. The main aim of this training is to get acquaintance with agro-technic and seed producing measurements to be fulfilled in the elite seed producing farms on the example of cotton plant (photo 79).

Necessary training subjects: lecture note-books, list of elite seed producing farms specializing on cotton plant, instruction for producing of elite, R_1, R_2 and R_3 seed stocks, tables on seed stock scheme charts, pencils, rulers, erasers and copy books for practical training.

Photo 79. **Cotton plantation of functioning elite seed producing farm.**

Network of elite cotton seed production is approved by the republican government. Every elite farm produces seeds of only one zoned variety of cotton.

The main goals of the elite farms consist of cultivation of the best plants in the optimal growing condition and separating the seeds of raw cotton by the means of individual selection.

The below presented tasks are implemented in elite seed stock production farms:

-maintaining all beneficial biologic and farm qualities of the variety;

-purification of seed stocks from diseases and pests;

-retaining a high grade clearness of the variety by the way of selection and prevention of seed stocks from mechanical contamination and others;

An elite seed producing scheme should be organized in the direction which could ensure selection of the best plants and increasing of their yields.

Below presented methods are implemented for elite seed stock production:

1.Without inter variety crossing (chart 10):

a) the 1st year seed stock nursery
b) the 2nd year seed stock nursery

c) seed stock reproduction nursery

2.By the way of inter variety crossing

Elite seed production without using inter variety crossing is based on continuous individual selection of best typical plants, by inspecting of their 2-3 progenies.

In the 1st year seed stock nursery

The best progenies taken by the individual selection without inter variety crossing are selected and propagated.

In general, the seeds of 1000 – 1200 individual selected plants from the best families in its preliminary seed production farm are sown in the 1st year seed stock nursery. The seeds of every individual selection are planted by hands or specialized row drills in 40 – 50 nests, 20-30 cm apart of solely rows.

Area of nursery depending upon the total area of elite plantation makes from 0,5 to 1,0 hectare. One plant per nest is left after thinning. Inspection of plants in the field likely to preliminary propagation of elite seeds is the most effort consuming and responsible work. The field of the 1st seed stock nursery is inspected twice: the first – at the massive cotton flowering (in July) and the second – at the starting of boll cracking (August – September).

Atypical families on the morphological traits, abnormal developed, blight and wilt infected plants are rejected. These families are marked in the field register and tagged with mark of rejection or removed from the field.

The plants subjected to more thoroughly examining at the second inspection. Because, at this time the quality of raw cotton and its fiber can be approximate evaluated by visual method. Additionally, some of less productive, late ripening and infected by strong diseases, insect damaged families also rejected at the second inspection.

Raw cotton yield of the 1st year seed stock nursery is harvested once, when 6-7 opened bolls appear on the plant, in the following order:

1) harvesting of cotton from sample plants;
2) harvesting of cotton from rejected families and plants;
3) harvesting of cotton from selected families.

Raw cotton yield harvested from 100 bolls of non-rejected families constitute the *samples.*

In order to calculate correctly harvested bolls, they will be picked in specially prepared cellular sacks. Every sample will put in a single sack. Number of family is written on the sack and the tag with this number is put in it also. The samples are sent to the lab for checking boll size, fiber output and fiber length.

The yield of selected undefected families is solely put together in previously prepared and numbered sacks. The sacks will also be provided by numbered tags attached to them.

Raw cotton picked out of plants of every family prior to the ginning is weighed solely and calculated the yield per a plant and per plants of a row. So, the weight of yield harvested from all plants and of samples are added to the weight of every families' yield.

Families are selected to plant in the 2^{nd} year seed nursery on the base of information of the field inspection, lab analysis and assessment which had been given to the family in the previous year.

The 2^{nd} year seed stock nursery.

The seeds of the best families produced in the 1^{st} year seed stock are planted to the 2^{nd} year seed stock nursery with area of 2,5 - 4,0 hectares. The numbers of selected families should not be less than 400. Depending on the variety of every family and soil fertility, planting is done in several rows with 100 seed nests and nests should be 20 – 30 cm apart. Seed stock is planted manually or by seed drill. One plant per nest will be left after thinning.

Field inspection in the 2^{nd} year seed nursery is done at the same way as in the 1^{st} year seed nursery. Rejecting families are defined on the base of field inspection results and marks given previous year and the best plants will be separated by individual selection to increase seeds number and get prepare seeds for planting in seed stock propagation nursery of the 1^{st} year. Samples of 100 bolls are harvested from the 2^{nd} year seed stock nursery to evaluate economic quality of raw cotton and fiber. Size, fiber output, fiber length and maturity of raw cotton ball are fully analyzed. Raw cotton crop harvest in the 2^{nd} year seed stock is done in the similar order as it was done in the 1^{st} year seed stock nursery. Here, individual selections are conducted in the best families for preparing the seeds to plant in the 1^{st} seed stock nursery in the next year. The total yield harvested from these families is used to plant in the seed stock propagation nursery.

Seed stock propagation nursery

The seeds of non-rejected families of the 2nd seed stock nursery are propagated in this nursery. No less than 250 families are planted in the area of 30 – 35 hectares. Seed drill is used to plant the seeds. Depending on the row length and seed amount of family, the seed drill makes one single or several rows for every family. One plant will be left per seed nest at the time of thinning.

Inspection of field during seed stock propagation is done once before bolls begin to open. The best families are selected at the inspection and atypical, late ripening, low productive and strongly infected by the diseases families are rejected.

Seed stock raw cotton is harvested twice: the first time – availability of opened bolls on fourth and fifth woods; the second time – available of opened bolls on the seventh and eighth woods.

Crop of rejected families and some other plants are harvested first and immediately transferred to the provisional point. The crop of not rejected families gathered together in one place, placed into new sacks, attached numbered tags on them and the similar tags with records about origin, cultivar, elite, time of harvest are put in them and then they delivered to provisional point as the elite cultivar.

Elite seeds have to be 100 % pure, fully meet the standard of requirements, not less than 2nd class of germination and the fiber of high technologic property relevant to certain cultivar.

Questions for consolidation of studied knowledge:

1.What is the main goal of the elite seed producing farms?

2.What kind of procedural tasks are implemented in the elite seed producing farms?

3.What methods of seed production are used in the seed producing scheme?

4.Can you describe difference and importance of terms: individual selection and rejection?

5.Do individual selection and rejection of pants or families effect on the quality of elite seed stock provision?

6.Where are the elite seed production provisional points placed?

7.Do elite seed production measurements worked out for all crops?

8.How can imagine elite seed production situation in the abroad?

9.Which kind of selection is used in the elite seed production farms?

The 30th practical training.

The important factors of enhancing seed quality.

The aim of the training. To study the internal and external factors effecting on seed quality of different agricultural crops, standard requirements imposed to their quality and man origin factors of enhancing seed quality are the main aims of this training.

Necessary teaching subjects: lecture note – books, tables with standard requirements, pencils, erasers, practical copy – books.

According to assessment of the FAO: “Seed is the repository of the genetic potential of crop species and their varieties resulting from the continuous improvement and selection over time. The potential benefits of seed to crop productivity and food security can be enormous” (photo 80).

Photo 80. **Corn’s cob and its seeds**

The potential benefits of seed are the result of continuous improvement and selection of variety over time. But, in the conditions of agricultural industry every variety gradually, year by year, loses previous potential performance (biologic properties), trueness to variety, germination and vigor, free from disease infection and insect damage and appearance, increase inert matter, foreign crops, weed seeds in a certain seed lot.

Scientifically substantiated causes of seed quality worsening and seed contamination are:
1. Mechanical contamination with foreign plants (varieties or other plant diversities) and cross pollination (biological contamination);
2. Splitting on traits (alteration);
3. Increasing of plants infection by the diseases and damage by the insects;
4. Mutation occurrence.

There are different causes of mechanical contamination can occur, some of them are: mixing with other seeds at the process of cleaning and treatment, spoiling at the time of storage, transportation and sowing. Many instructions and rules have been elaborated by seed science researchers to avoid or prevent mechanical contamination of seed stocks at every above mentioned situations. Mechanical contamination rate varies significantly depending on crop's flowering biology (self-pollination or cross-pollination).

Every variety characterizes by its homozygous state on the economic traits and biological properties. In the industrial condition, arise individuals unlike constituents and are crossed together, the resulting hybrids with divergent characteristics. These new plants present heterozygous heredity. Number of heterozygous plants increases accordingly to the seed multiplying coefficient of every crop.

Above mentioned factor has been foreseen at the elite seed production system functioning in our country (remember previous training). Namely, continuous individual selection with the checking of successive progenies is the major positive factor to return variety trueness and sustainable productivity.

Our agricultural crops grow under a considerable pressure of biotic stresses as disease pathogens and pests (photo 81). They lower the quality of products

Photo 81. **Some factors affecting on the cotton plant.**

taken from agricultural crops. Apart from decreasing their productivity they lead to inefficiency of crop cultivation. In general, farmers observe disease and pest controlling and yield comparable crop which does not meet nations demand.

Traditional basics of organic disease and pest management:

-maintain healthy soil;

-maintain healthy crop;

-use of natural pesticides and insecticides;

-monitor the crop regularly;

-promote natural predators and

-use suitable varieties.

Creating genetically resistant cultivars to diseases and pest and cultivation them in optimal growing conditions are the scientific solution of this problem. That is why, innovational approaches in the plant breeding facilitate choosing efficient resistant germplasm on the base of plant origin centers (proposed by N.I.Vavilov) and purposeful transferring of valuable trait genes to new varieties genome (guided by principles of G.Mendel).

All morphologic characteristics and farm-valuable properties of varieties of agricultural crops can be subjected to natural mutations. Outcome of mutation gives different new, unexpected plants with divergent characteristics. Of course, new plant forms perform not only negative but either positive characteristics. They say, that such mutations occur seldom but they, more probably, promote destroying of varieties dignity, purity and productivity. This has progressing character ending with association of modification variability and producing difficulties in variety clearing works at seed stock farms. New mutant plants may be fixed by seed producers during several years. These plants sustainably maintain their traits ignoring annual alteration of growing conditions. Because, mutation causes genetic alteration of plant traits. So, seed breeder can reject plants as the mutants on the base of long-term experiences.

Creation of optimal growing condition and regular inspection over seed stock plants are the major man created factors to enhance the seed quality which could meet the standard requirements (table 19).

Table 19. Standard requirements imposed to seed quality of soft and hard wheat species

Crop species	Classes	Purity, %.	Mixing of other plant seeds, units per 1 kg.		Germination, %.
			Totally	Plants without weeds	
Soft wheat	1	99	10	5	95
	2	98	40	20	92
	3	97	200	70	90
Hard wheat	1	99	10	5	90
	2	98	40	20	87

The seeds with lower seed quality indexes than above pointed out indexes are considered unfit to plant and will not permitted to plant by farmers. Controlling factor in securing the seed quality at the governmental scale is divided into two activities: inter farm control and government control.

International seed quality system presented by FAO in 1993 and revised in 2006 has also been successfully experienced in worldwide scale. This seed quality system aimed at assisting farmers, seed producing specialists as well as staffs of extension services in distribution of qualitative seeds. The following activities involved in this seed system:

-seed rules and regulatory framework;

-seed quality;

-seed production and delivery;

-seed security and rehabilitation.

Questions for consolidation of acquired knowledge:

1.What is a quality of seed?

2.How do we enhance the quality of a planting seed?

3.What does mean potential benefits of seed quality?

4.Does a state seed standard have any impact in the development of agriculture?

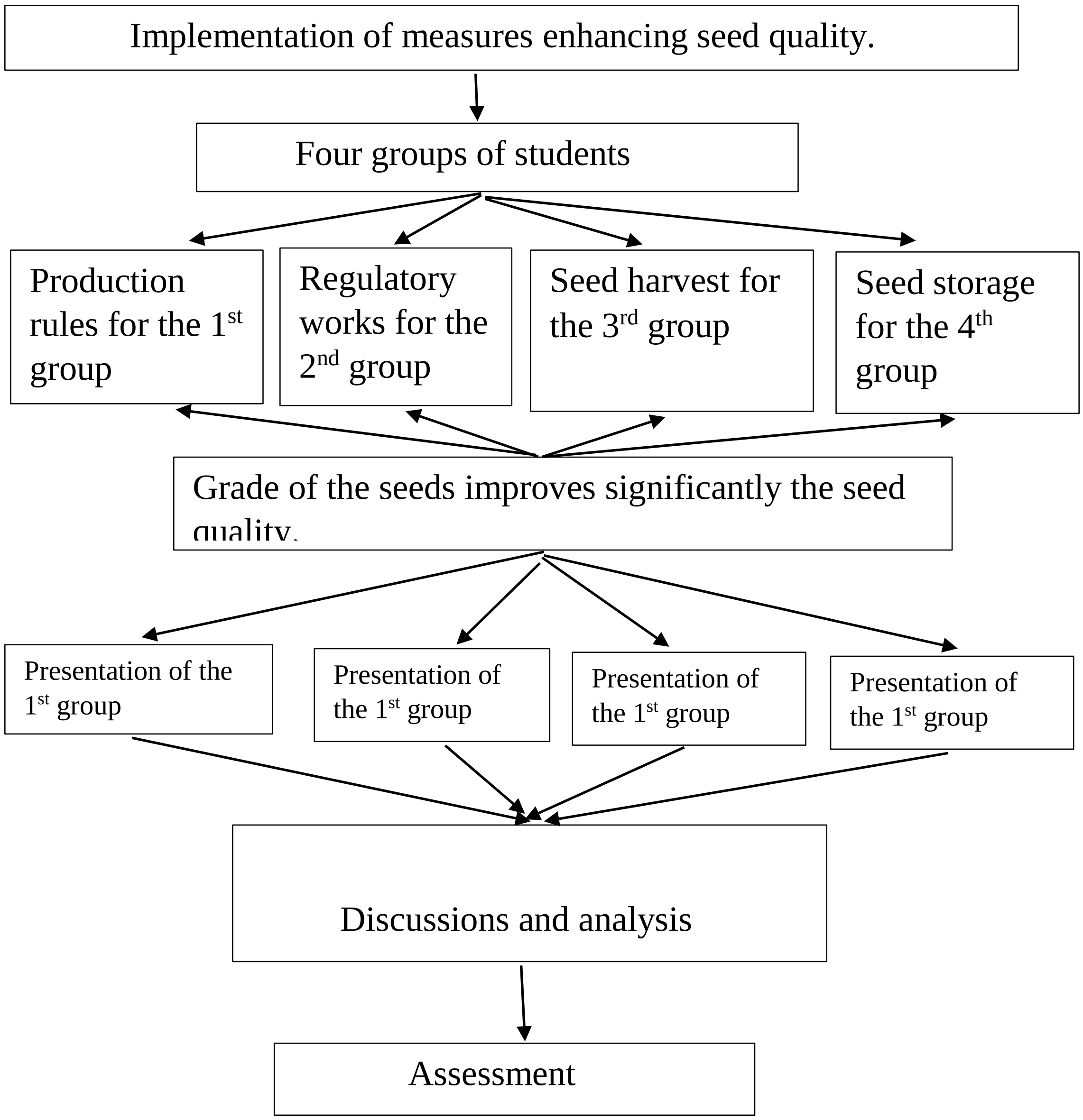
5.Do you know differences between national and international seed systems?

6.Does disorder of irrigation affect the quality of producing seeds?

7.Does disorder in feeding of elite plants affect the quality of elite seeds?

8.What international seed testing organizations do you know?

9. Carry out the training over the method “Working in the small groups”, pedagogical method to consolidate studied material.



The 31st practical training.

The technology of high qualitative seed production.

The aim of the training. To track the successive procedures of seed production technology by the students and use similar order in mapping out the personal seed producing projects which consists of their course works at the end of this subject are the main aims of the training.

Necessary aids for students: internet access technique, text books on seed production, standards on the seed quality, practical copy books, pencils, erasers, rulers and seeds of different crops.

The word **technology in agriculture** means a wide range of knowledge and tools focused on solving various tasks of agriculture. Scientists have created and use new smart technologies in growing of agricultural crops, extending farmers and plant breeders' ability, either making seed production system the most crucial part in the agricultural development (photo 82).

Photo 82. **Active sections of technology.**

Below listed procedures are essential in seed production technology of agricultural crops (chart 14):

-selection of appropriate field;

-sowing seeds of high quality;

-maintain of recommended isolation distance;

-establishment of appropriate male and female ratio (in such crops as maize, rice, sorghum);

-following recommended agronomy;

-roughing off types until flowering;

-field inspection;

-harvesting, threshing, storage and transport with care.

High quality seed is raised and harvested from appropriated field. Selection of appropriate field for certain crop cultivation and its seed production depends upon the results of field monitoring. Field monitoring is the basic section of the technological chain and seed production system. Field monitoring builds up actual indexes of soil water capacity, soil fertility, soil erosion of fields of the region and delivers to certification departments. Because, every agricultural crop has specific response to growing condition for performance its genetic potential. Selection of appropriate field for a certain crop is vital which guarantees the highest yield potential with seed of fine quality. It is widely known that good quality seed can increase yields by 15 - 20% and provides elite seed stock reproduction for subsequent planting.

Every agro-technic practices (plant stand thinning, soil hoeing, weeding, fertilizing, ridging, spreading and watering) at plant developing stages should be done according to the results of field inspection (or crop analysis) and diagnosis of insects and pests. Setting of isolation distances for corn 500 to 1000 m, triticale -150 m; rye – 200 m, sorghum – 300 m. can be adjustable prior to the flowering stage of plants by removing plants grown inside the boarders of these isolation distances.

Roughing off type plants until the flowering stage is also a basic part of the high quality seed production scheme of grain crops.

Harvesting of crops requires a special approach in regard to every crop. That is why preparing to harvest, for example of wheat, significantly varying from other crops. The 1st stage of this work is consists of defining grain moisture level. It will determine when wheat is ready to harvest. Today, this work can be fulfilled any time by the help of GIS (Geographic Information System). This technique has become as the basic tool in seed production technologies of the world seed companies like Monsanto and Bayer (photos 83, 84). They are able in short time to predict the field state. The favorable time for beginning wheat harvest is that when the maturing grains contain moisture within 14 to 20%. Wheat grain harvest requires to begin and complete the harvesting and delivering to depositors’ procedures in a short

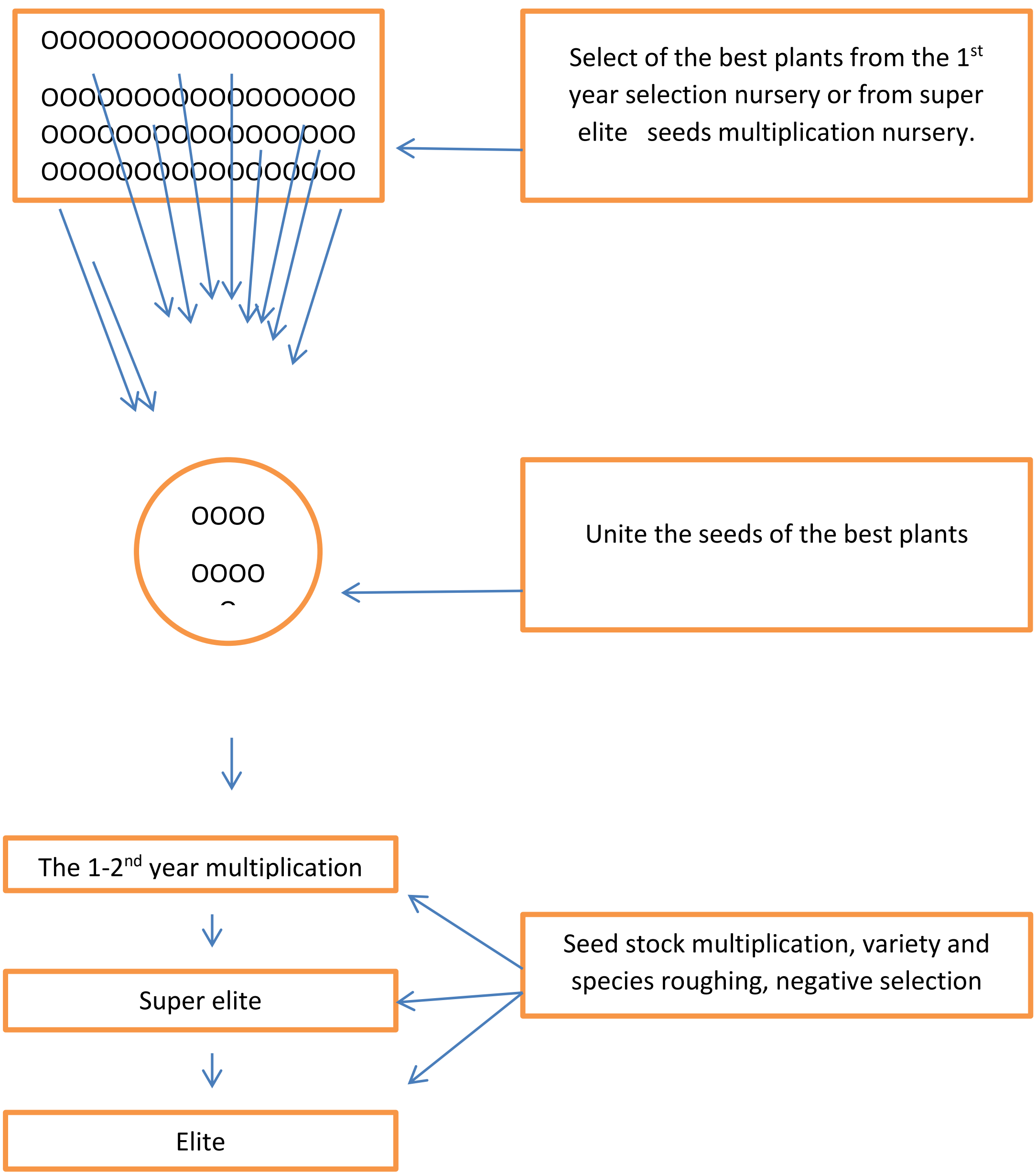


Chart 14. **Scheme of grain crop elite seeds production by means of massive selection.**

time. Because, if wheat is left out in the field too long, hot winds or rain can destroy the crop and the seed quality may decrease.

Beside, wheat harvesting in seed producing farms requires the use of combines. This situation requires setting up adjusted team operation of several combines and grain transporting trucks.

In the industry modern and traditional methods of wheat harvest can be met and their technology slightly differentiated from each other depending on the amount of grain production. On-farm storage of grain after harvest is common for small seed

Photos 83, 84. **Operation of GIS tools in agriculture.**

producing famers, while direct transporting to government or private elevators are annual obligations for enlarged grain producing farmsteads. If small farms will produce grains, they will need to have oxen-trodden mud-packed threshing squares or mechanical threshers.

In all above mentioned technologies grain must be harvested in a timely manner. It secures from shattering, pre-harvest sprouting, damage, weather effect. It is important to minimize pre-harvest grain losses, quality worsening and maintained enough moisture for storage. If the farmer produces grain of corn or bean crops it has to use cracking and breaking machines. During these operations, a great attention should by payed on retaining the marketability of the cleared grain. In general, part of grain either will be used for seeding purposes. So, harvesting, threshing and transportation require adequate control of the farmer in cooperation with seed extension service's staff. This means that during the reprocessing the quality of seed grain has been maintained.

According to the information of scientists: "Occurrence of microflora fungi and inoculum on grain is cosmopolitan, and thus prevention or avoidance of some losses are difficult to achieve. The use of fungicides that are non-toxic to the grain or to humans has not yet become common practice and drying, both prior to and during storage, remains the only practical method of control. Microflora damage grain by: (i) damp grain heating, which causes caking and fermentation or rotting; (ii) reducing food value as a result of degradation of starch and protein, mycotoxin production and production of a musty, unappetizing smell; and (iii) jeopardizing its ability to germinate through injury to the germ".

Insects and mite pests also attack to grain at the time of storage, deteriorating the general quality of grain piles including the seed quality in them. Quality deterioration associated with germ damage which results in a reduction in seed germination.

Occurrence of pests in stored grain is related to high grain moisture content.

Specialist responsible to storage of grain should know optimal conditions for pests. Temperature around 30^0C, with the relative humidity of 40 to 80 percent are the optimal conditions for the most of pest species. So, storage conditions for grains must kept below the humidity of 40 and temperature also below of 30^0C. Thus, under normal storage moisture and temperature conditions recommended by the standards, harm due to pest damages is minimized. At these parameters of condition all pests inhibit their life activities and reproduction.

Widely recommended that grain deterioration in storage can be minimized or prevented by keeping the grain dry (less than 12.5 % grain moisture), cool (less than 10^0C) and free from insects. This is the major factor to retain best grain and seed quality in the seed production technology of agriculture.

The questions for consolidating studied material:

1.Can you describe the meaning of the word technology?

2.What is the structure of seed production technology?

3.How can help GIS applications to the functioning of seed production technology?

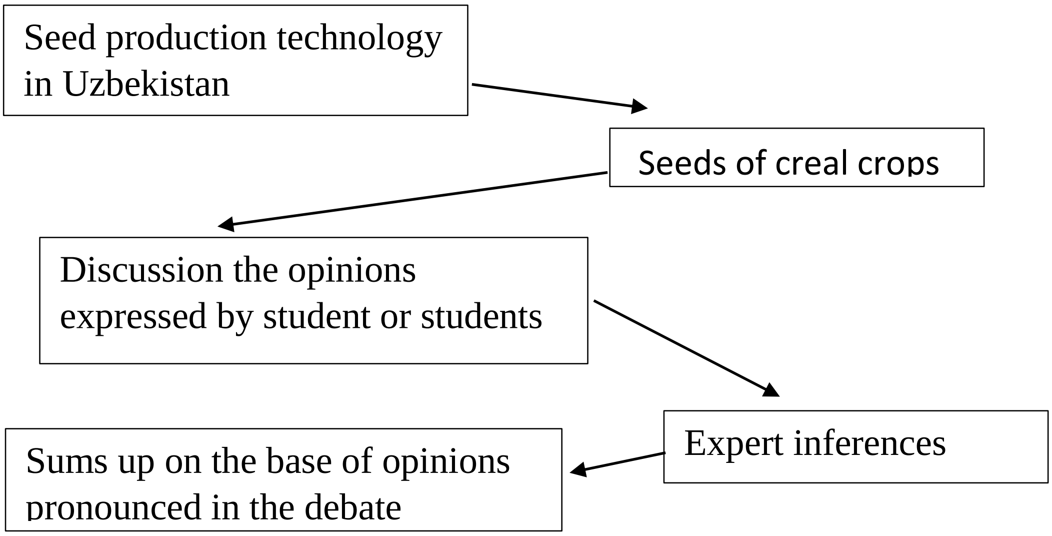
4.What procedures has seed production in the scheme of elite seed producing system?

5.Is there any factor to eliminate the development of pests during the seed storage?

6.Does temperature level affect the function of seed production?

7.What affect has the level of moisture on the quality of seeds?

8. On the base of pedagogical method “Debate” organize question and answer exchange with your friends about studied material.



The 32nd laboratory training.

Determination of raw gluten quality of flour in the IDK device.

The aim of the training. The students get acquaintance with state standard worked out to determine the gluten quality in the flour powder. They study raw gluten quality and the order of its analyze. So, they master the analyzing process by watching the work, done by the assistant, who mastered methods of analysis and passed through technical insecurity (GOST 12.0.004).

Necessary laboratory kits and teaching subjects. Lab mill (up to 0.9 mm indexes), lab dough mixer (+- 2% with water dosator and for 19+-second), device IDK to give form to gluten (+-0.5 of error index and in range of 0 to 150.7 measuring index), measuring device of deformation (photo 85), scales (GOST 24 104 and in error of +-0.01 g.) and other instruments shown in the standard.

Photo 85. **Set of IDK device.**

Laboratory copy - book, pencils, rulers, erasers, notes from state standard (GOST 27839-2013).

Gluten exists in two states: raw – in sticky liquid and dry – in powder state.

The quality of gluten – a family, characterizing reolopic properties (extension, deformation and elasticity), which will be shown in groups of gluten boll pressed into 4-gram mass at the indexes of IDK device.

Sample of 4 grams is separated from it fully washed, pressed and weighed gluten to define its quality. If there is more weight of raw gluten, than intended, two samples of 4 grams each will be taken. These samples are turned into bolls by the machine, designed to make circle bolls.

By hand (manually) gluten is turned into boll to wash it by the help of hands. In this case, the surface of gluten mass is polished 3-4 times by the fingers until it gets polished surface.

The ready boll is placed into the dish with water of 0.25 дм^3 to settle (photo 86). If there is not possibility to keep it in the water of 18 – 20^{o}C, the boll is placed in the

Photo 86. **Lab dish and gluten boll in it.**

other dish with water of 4.0 дм^3 to keep the temperature. Time to keep boll in the water consists of 15 minutes. By mechanic method it makes 10 minutes.

Since the time has finished, the boll will be taken from water and put on the table of IDK device for measuring. The data of gluten deformation and elasticity will be illustrated on the screen of IDK device.

Writing down the data of device is fulfilled in the 0.1 preciseness of IDK indexes.

According to indexes of table 20, the data of IDK on the quality of measured gluten are written in one of the certain group.

If gluten, after washing, has become dismissing, does not sticky and is not circle, it is called solving and won't measured by IDK device.

Measuring of gluten is carried out in two replications by one device and by one person.

Table 20. **Classification of gluten quality taken from the wheat flour.**

Group of quality	Characteristics of gluten	Quality of gluten, in the indexes of IDK.			
		Bread baking flour and common consumption*		Macaroni flour	
		Extra grades, high and first grades.	The second grade	Soft wheat**	Hard wheat***
				Extra grades, high and first grade	High, first and second grades
Crumbling		Undefined			
III	insufficiently strong	No more 32	No more than 37	-	-
II	Sufficiently hard	33-52	38-52	-	-
I	Good	53-77		48-77	48-82
II	Sufficiently soft	78-102		78-102	83-107
III	Insufficiently soft	103 and more		103 and more	108 and more
Unwashed		Undefined			
*Characteristics of flour – at the rate of state documents which accepted this standard.					
**Fitted of flour characteristics to GOST – 31491.					
***Characteristics of flour – GOST 31463.					

Getting of dried gluten. For the control above the raw gluten washing out (mainly in weak and crumbling gluten), determination of dried gluten in ratio of moisture is also recommended.

Determining is carried out in the lab drying oven. Drying lasts for 4 minutes. Temperature is 160°C.

Dried gluten taken out of stove and dried in the air for 1 minute. Weighed and again is put into the stove, taken out and weighed. If there is some difference, the procedure is repeated until the difference has come to end. Dried gluten is weighed to the precision of 0.01 gram.

Treatment of analyzed results.

The amount of dried gluten in the flour – X, %, is calculated by the following formula for dried gluten in the second 10 precisions:

$$X = \frac{M_1}{M} \times 100$$

Here: M_1 – weight of dried gluten, g.

M – weight of flour powder, g.

100 – coefficient of continues colculation, %.

The questions and task for consolidation of obtained knowledge:

1.What kinds of gluten are exist?

2.What is the quality of gluten?

3.What is the order of gluten quality analyze?

4.What is the structure of quality classification of gluten taken from the flour of wheat?

5.Why taking of dried gluten is recommended?

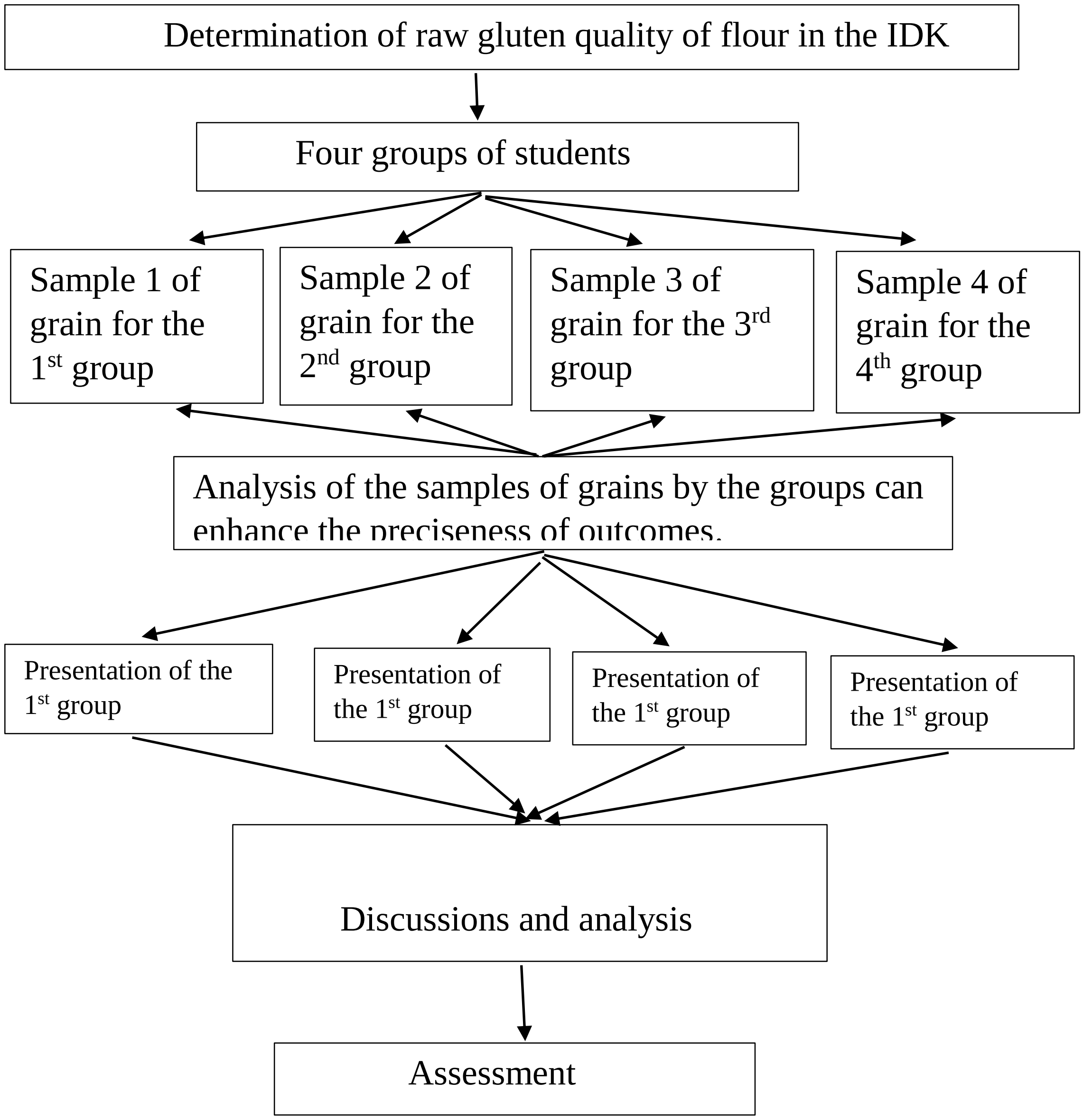
Table 21. **Quality indexes of wheat varieties grown in the Khoresm region.**

№	**Varieties**	**Grain**	**Flour**	**Gluten**		
				%	**IDK**	
1	Moskvich	50г	25г	30	93	II sufficiently weak
2	Andijan-2	50г	25г	33	91	II sufficiently weak
3	Kuma	50г	25г	28	45	I good
4	Dokha	50г	25г	30	93	II sufficiently weak
5	Esaul	50г	25г	28	39	II sufficiently hard
6	Polovchanka	50г	25г	35	26,4	II sufficiently hard
7	Pamyat	50г	25г	20	67	I good
8	Buzgala	50г	25г	35	33,6	II sufficiently hard
9	Tanya	50г	25г	24	74	I good
10	Nota	50г	25г	25	12	II sufficiently weak
11	Kroshka	50г	25г	25	35,2	Sufficiently hard
12	Krasnodar-99	50г	25г	35	62	I good
13	Valentin (triticale)	50г	25г	30	45,9	I good

6.How the result of analysis is calculated?

7.Define again the amount and quality of gluten from the grains of wheat varieties (presented in the table 21), available in the lab depository on the bases of methods of the 15th and today’s trainings.

8. Organize the training over the method "Working in the small groups", pedagogical method to consolidate studied material.



The 33rd laboratory training.

Determination of oil content in the seeds of sunflower and soya.

The aim of the training. The students get acquentance with the definition of oil content summerily accounted by the standard (GOST 10857-64) on determination of oil content in oil crop seeds. They master the working process of soxhlet extraction set (chart 12) used for determination of seeds' oil content and learning the order of extraction method with this apparatus to define the oil content in the seeds of sunflower and soya varieties.

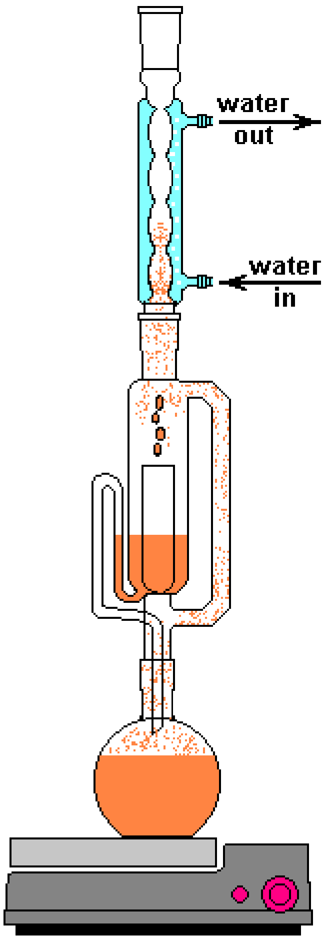


Chart 12. **A set of soxhlet extraction.**

Necessary lab aids. Soxhlet extraction set, drying oven, lab mill, analytical scales, porcelain cups, distillation flask (with 50- 100 см^3), glass funnels, 10 cm glass sticks, pincers, garbage cups, sand clocks (timers), ethyle ester or brome naphthaline, chlore - naphthaline, water absorbing cotton wool or filter paper, average seed samples of sunflower and soya varieties, lab copy books, pencils, rulers and erasers.

According to the standard, an immature fat and fat like substances existing in the seeds which are extracted together from studied seeds in the ester solvent is introduced as **the oil content** of seeds.

Oil content in the seeds of sunflower, soya (photo 87 and 88) and other small seed bearing crops is determined through extraction of immature fat from seeds by the help of soxhlet apparatus and solvent chemicals on **the method of extraction.**

Photos 87, 88. **The seeds taken for laboratory analysis.**

Extraction process by using of soxhlet apparatus. Soxhlet apparatus set consists of four parts: refrigerator (or condenser), extractor, retort (or siphon) and heat source.

Extractor of soxhlet apparatus is set on the retort which has a circle tray. Refrigerator is set up in its top part. A paper chuck with sample in it is put in the extractor. When the solvent in the retort has heated its steams are separated and have started to rise up through the tube. They surround and wash the sample and saturated with dissolved fats. The steams, saturating with fats, rise up to the part of refrigerator and condense into fat drops. These drops fall down to capsule holding sample and fill up, then started to flow back in the retort through its riffle. Solvent from extracted substance fallen into retort has evaporated again. The oil in its texture remains in the retort. The process of steams rising up and washing off the sample, condensation and returning of combined fats into retort through riffle of capsule will continue.

The process is continued until all fats in the sample have fallen in the solvent of retort. The period of the process depending on the seed species, oil content, rate of seeds' grinding and weight of sample has lasted for several hours and up to few days.

The process of extraction is continuous, the solvent permanently rises up through tube and washes off the definite part of sample's fat, condenses and returns into retort. The optimal rates of solvent boiling temperature and flow of cold water are adjusted by taking into account the cycle of filling up the riffle of capsule with extracted substance and its returning to the retort which makes 10 – 15 minutes.

This process continues until the studying sample has entirely becomes fatless. The following acts are conducted to define the end of extraction:

-to watch complete becoming colorless of liquid in the extractor;

-to watch no spot remain on the glass of watch after evaporation of a drop;

-to compare the light broking indexes between clean solvent and extract.

After that the apparatus is disunited in its parts. The extract, remaining in the capsule, is poured into retort. The retort with oil is subjected to evaporation on the electric heater or it is better to separate the solvent by the means of rotational evaporator. Then the retort with oil is dried in the drying oven until its constant weight and it is weighed. The weight portion of obtained fat is determined by the help of definite weight of clean retort, sample and extracted oil by the method of calculation.

The remained fatless sample is used for the next analysis (to define the cellulose and other indexes).

Order of the laboratory works:

1.The students are divided into groups (5 people each) under the guidance of experienced assistant. The groups choose one of the seeds of sunflower or soya to determine its oil content.

2.Fifty grams of seeds will be taken from chosen sunflower and soya varieties through diagonal seed dividing method of “Quartovaniya” (the 17^{th} training). The seeds using for determination of seeds’ impurities are screened on the sieve (photos 88 and 89). Organic and non-organic substances, separating from seeds, are remained on the sieve and their weight is defined in percentage of taken sample. This data is needed for determination of pure seeds oil content.

3.Every group puts its seeds in the porcelain cups and dried at the temperature of 100 - 105°C in the lab oven. At this, the seeds of sunflower are dried for 1 hour and seeds of soya for 2 hours. If the seeds of sunflower have 15% moisture, it will be dried for 1 hour.

4.The seeds are grinded. The seeds of sunflower are milled in the mechanic mill until their nucleus have turn into flour. And the seeds of soya are milled until their particles could go through the sieve with holes of 0,25 mm.

5.The grinned seeds are mixed properly. Weighed portions of 8 – 10 grams each are singled out on the analytical scales from mixed mass for extraction chuck. The chuck (or cartridge-case) is made from porous paper, cardboard, rarely from metal nets. Its volume must let itself to get freely in the extractor, steam and liquid will be freely able to go around chuck and wash it away. Cotton wool should be placed under the chuck. Top of the chuck also should be covered with another cotton wool and it is placed in the extractor.

6.Dried for 1 hour at the temperature of 100 – 105 °C and weighed retort is united to the extractor. Ester is poured through the extractor, then refrigerator mounts to the top of extractor and the process of extraction is started.

7.Extraction of sunflower seeds is implemented for 22-24 hours, and soya seeds for 18-20 hours.

8.It is necessary to define the end of fat in the sample, in order to know that the extraction is over. For this, the extractor is disconnected from retort and one drop of solvent from extractor is dropped on the watch's glass. It must remain no spot after evaporation of ester.

9.After finishing of extraction, the ester drives away from solvent. The remained oil is dried until its constant weight at the temperature of 100-105°C in the drying oven. The first weight measuring is done in 1-1,5 hour and the second in 30 minutes. The drying is stopped when the increasing of weight is watched in both scales and the low weight is accepted for the calculation.

10.The moisture of weighted portion of the dried and grinned seeds is determined by drying method. Drying is carried out after one hour at the temperature of 100-105°C, replication is done after 30 minutes.

11.The following formula is used to determine the fat content of dried seeds in percentage (X):

$$X = \frac{(m - m_1) \cdot 100}{m_2}$$

- Here:
- m - weight of retort and oil, g;
- m_1 – weight of empty retort, g;
- m_2- weight of dried seed weight portion, g.

Then, the following formula is used for calculation of taken result of dried substance and in percentage (X1):

$$X = \frac{X \cdot 100}{100 - W}$$

- Here:
- Weight of dried and grinned seeds is also determined by oil content: w – in % (photos 89 and 90).

Photos 89, 90. **Oils, extracted from sunflower and soya plants.**

An arithmetic mean of two replicated calculations is accepted as the result. The difference between two calculations should not be more than 0,5% for the seeds of sunflower and 0,3% for the seeds of soya.

Questions and tasks for consolidation of trained materials:

1.What does the definition of oil content of plant seeds consist of?

2.How is the soxhlet apparatus built up?

3.Are there other methods, except extraction one, to determine the oil content of seeds?

4.Can you review the working orders (or work flew) of soxhlet apparatus?

5.How do you determine the oil content of a seed?

6.How do you find the mass percent of oil from different oil seeds?

7.Which of cooking oil (sunflower or cotton seed) is good for health?

8.Describe the process of the extraction method to determine the oil content of sunflower and soya seeds in the lab conditions.

9.Prepare the report, using internet sites about the methods of determination the oil contents of other oil bearing crops' seeds and narrate about them to the students.

10. Consolidate the acquired knowledge on the base of pedagogical method (OREG):

Report your opinion about the oil content in the seeds of sunflower and soya on the theme "Determination of oil content in the seeds of sunflower and soya" on the base of OREG method.

O- ____

R- ____

E- ____

G- ____

The 34th laboratory and field trainings.

Development of seeds and their field germination.

The aim of the training. The major aim of this training is to analyze the definition of seeds, their development, field germination, find out the special features and to study their texture differences and responses to germinate in the field condition.

Necessary laboratory aids: Previously prepared seeds' average probes, singled out of different varieties of cotton plant, grain and field crops, lab scales, lab seed counters, seed retorts, water heaters, lab scalpels, different dishes, cups and pincers, lab copy - books, pencils, rulers and erasers.

What is seed? According to the internet sources: A seed is an embryo and food source covered by a protective coat (Figure 14, 6th step).

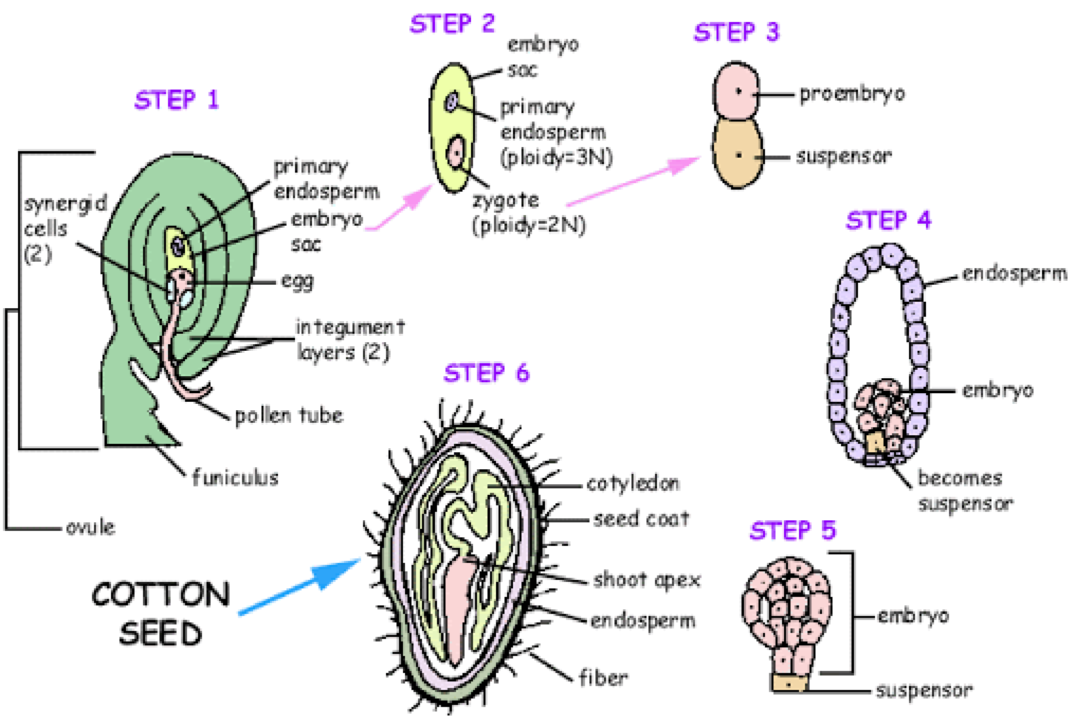


Figure 14. **Steps of seed development of cotton plant.**

How does a seed develop? In general, three stages involve in seed development (figure 14):

1.Double fertilization (fig. 14, 1 and the 2nd steps).

2.Development of embryo and endosperm.

3.Cell expansion and maturation

Seeds protect the zygote from drying out, help disperse them due to their coat diversities and have eatable attractiveness. When the seeds land on a proper soil condition grow a new plant (fig. 15).

Germination of seeds in the field. When seed is planted, it first grow roots. Once these roots take hold, a small plant will begin to emerge and eventually break through the soil. When this happens, we say that the seed has sprouted. The scientific name for this process is germination. Figuratively, this process can be divided into the following stages of germination:

1.Seed.

2.Root comes out.

3.Seed coat falls off.

4.Shoot comes out.

5.Seedling.

6.Baby plant.

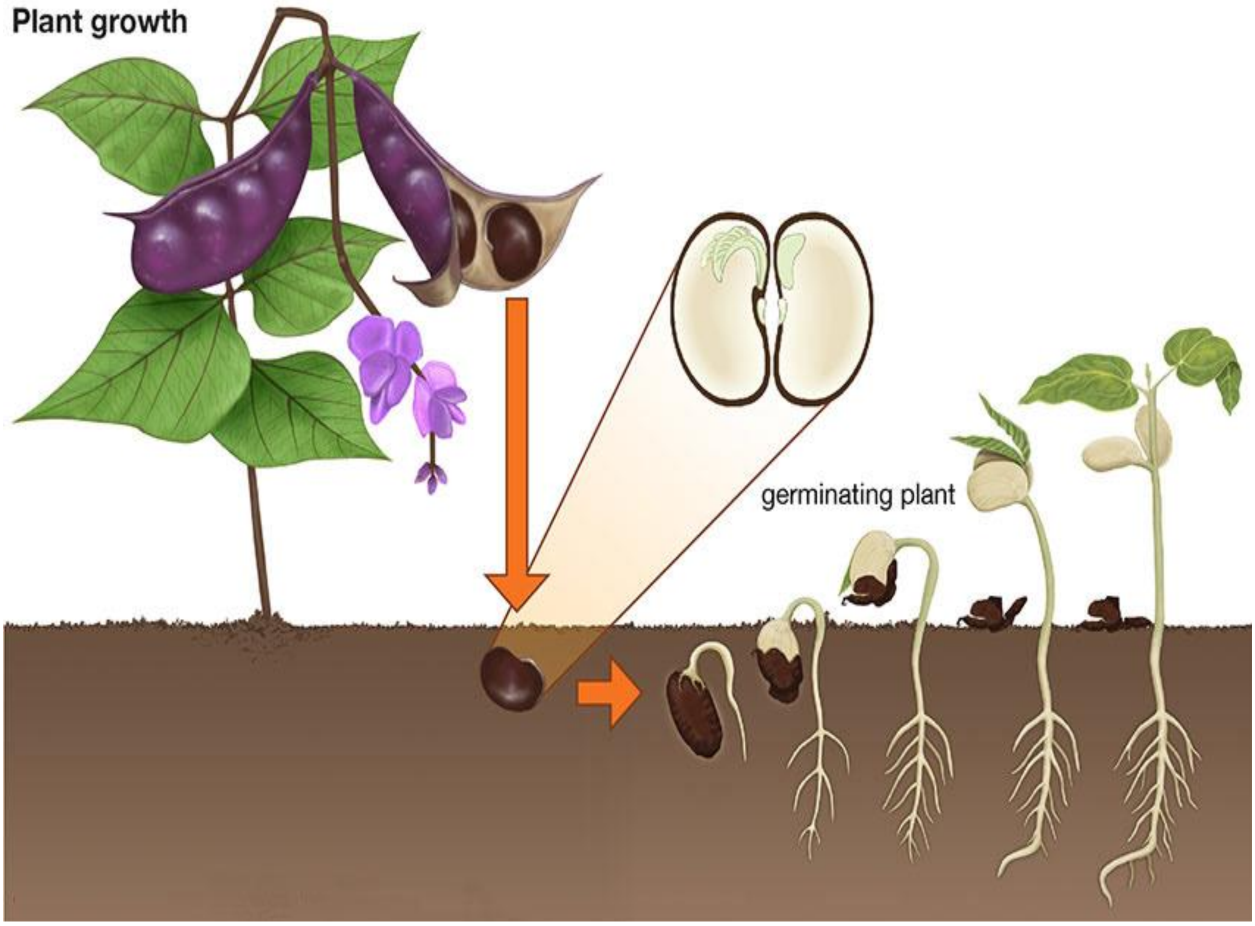


Figure 15. **This is how a new plant is born in the field.**

Texture of seeds of different agricultural crops is characterized specifically and is considerably distinguished from each other on their morphology, biological features and biochemical contents (figure 16 and appendixes 9-13).

Field germination of seed is an important process by which the seed actually starts to grow. Starting of germination primarily depends on a soil conditions of the certain field. The seed response to the special conditions to sprout, they are:

*warmth

*oxygen

*water

*without all above mentioned three conditions (water, oxygen and warmth) the seed will not grow.

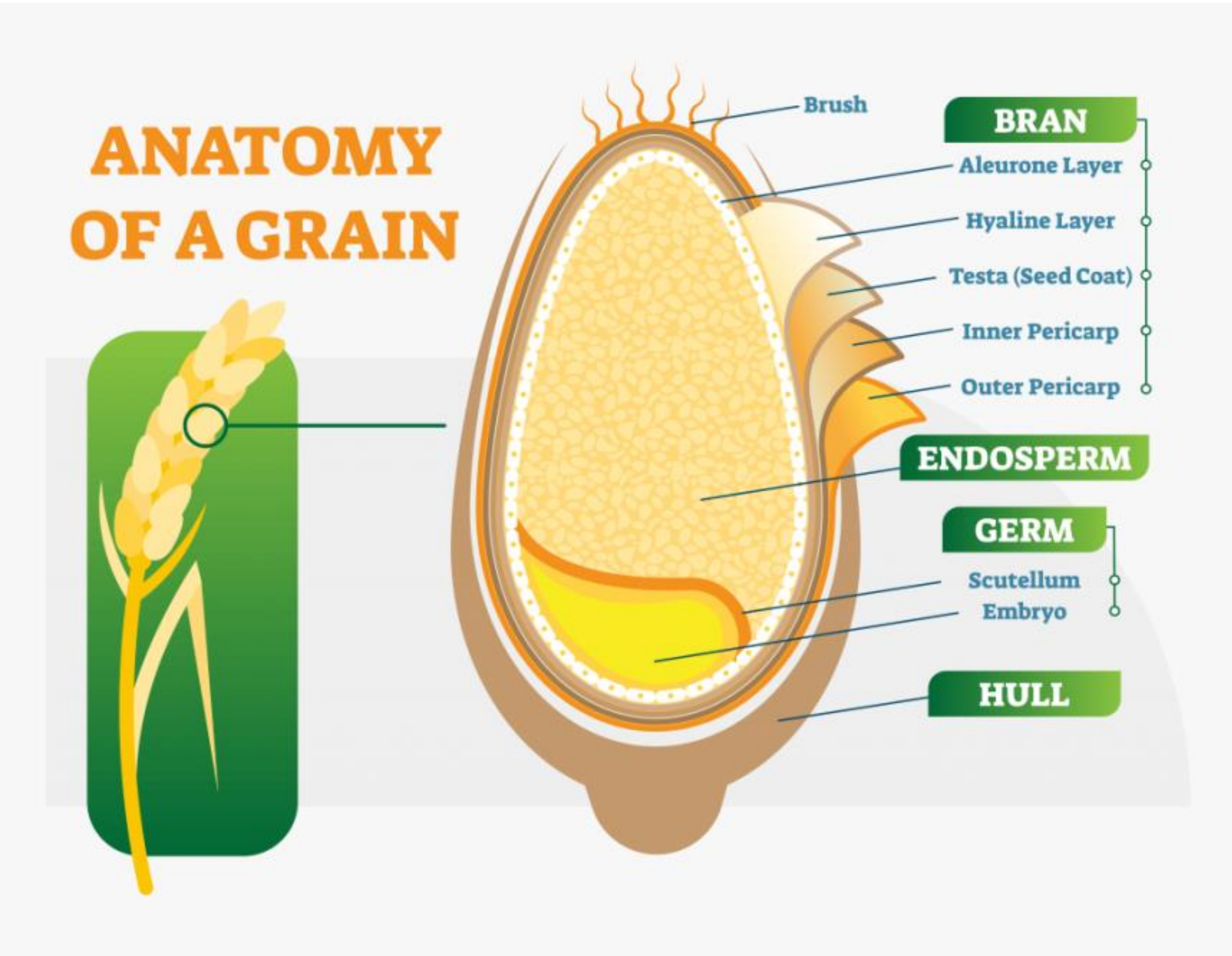


Figure 16. **Cross view of cereal seed.**

Soil temperature. Planting of seeds to the soil is done at the definite temperature (warmth). Response of seeds of different crops to the soil temperature is not similar because of their genetic features and anatomy of seeds. As suggest the results of foreign and local experiments, warmth effects on cellular metabolic and growth rates. As above mentioned, that seeds from different species and even seeds from the same plant germinate over a wide range of temperature. Seeds often have a temperature range within which they will germinate, and they will not germinate above or below this range. Many seeds (cotton seeds for example) germinate at temperature slightly above 60-75 F (16-24 C), while others germinate just above freezing degree (barley and rye) and others germinate only in response to alternations in temperature between warm and cool. Some seeds (chick pea) germinate when the soil is cool 28-40 F (-2 - 4 C), and some (beans) when the soil is warm 76-90 F (24-32 C). Some seeds require exposure to cold temperature (vernalization) to break dormancy. Some seeds in a dormant state will not germinate even if conditions are favorable. Seeds that are dependent from temperature to end dormancy have a type of physiological dormancy. For example, seeds, requiring the cold of winter, are inhibited from germinating until they take in water in the fall and experience cooler temperatures. Cold stratification is a process that induces the dormancy breaking prior to light emission that promotes germination.

Oxygen is required by the germinating seed for metabolism. Oxygen is used in aerobic respiration, it is the main source of the seedling's energy until it grows leaves. Oxygen is an atmospheric gas that is found in soil pore spaces; if a seed is buried too deeply within the soil or the soil is waterlogged, the seed can be oxygen starved. Some seeds have impermeable seed coats that prevent oxygen from entering the seed, causing a type of physical dormancy which is broken when the seed coat is worn away enough to allow gas exchange and water uptake from the environment.

The importance of water. According to the world literature, mature seed is often extremely dry (about 14%) and needs to take in significant amounts of water, relative to the dry weight of the seed, before cellular metabolism and growth can resume. Most seeds need enough water to moisten the seeds but not enough to soak them. The uptake of water by seeds is called **imbibition,** which leads to the swelling and the breaking of the seeds coat (bran in the fig 16). When seeds are formed, most plants store a food reserve in the seed, such as starch, proteins, or oils. This food reserve provides nourishment to the growing embryo. When the seed imbibes water, hydrolytic enzymes are activated which break down these stored food resources into metabolically useful chemicals. After the seedling emerges from the seed coat and starts growing roots and leaves (appendixes 14-18), the seedling's food reserves are typically exhausted; at this point photosynthesis provides (appendix 19) the energy needed for continuous growth and now the seedling requires a continuous supply of water, nutrients, and light.

At the sowing time everyone can mark the field with the type of plant, date of sowing, the days to germination. Some seeds take two weeks (table 22) or more to sprout. Poor germination can be caused by over wetness or cold soil, which causes rot of a seed.

Data of table 22 show that the cotton seed drills lay seeds in the soil in a different number per every stripe meter. There were studied 10 samples of one-meter length each. Laid seeds' number consists of 7 to 24 units. Seeding was conducted with dry, delinted and disinfected seeds on April 4.

Recording of seedlings has been conducted since April 10 to April 22, each recording was conducted in every 3 days. There can be seen that emerging number of sprouted seedlings has increased gradually, day by day for 18 days.

The numbers of seedlings out of sown seeds differ from 53,8 to 100,0%. On May 6, grown and saved seedlings were accounted and on average made 75,3%. So, 24,7% of sown seed have been lost after seeding them in the condition of soil. The reason of losing is based on various factors. They can be seed quality, temperature, oxygen deficit, over moisture and others.

Table 22. **The number of sown seeds per 1 stripe meter of seed drill and the field germination of cotton plant seeds (M.Ashurov and others., 2019).**

Samples	Number of sown seeds, unit.	Sowing date.	Emerging and losing of seedlings							
			10.04.	13.04.	16.04.	19.04.	22.04.	Number of seedlings out of sown, in %	06.05.	Number of seedlings out of sown, in %.
1	24	04.04	4	6	10	14	19	79,2	16*	66,7
2	27	-\-	6	10	16	22	27	100	23	85,2
3	7	-\-	-	2	3	5	6	85,7	5	71,4
4	17	-\-	1	3	8	12	15	88,2	11	65,0
5	17	-\-	-	2	7	11	15	88,2	13	76,5
6	9	-\-	-	1	3	7	9	100	8	88,9
7	16	-\-	2	5	9	13	16	100	15	93,8
8	14	-\-	-	3	6	8	10	71,4	10	71,4
9	13	-\-	-	1	4	5	7	53,8	7	53,8
10	23	-\-	3	6	10	15	18	78,3	19	82,6
Mean	16,7						14,2	75,7	12,7	75,3

Number of healthy seedlings out of sown seeds, in %.	85,0		76,0	

*-re-established data.

If you take an attentive and comparative look at two numbers: number of sown seeds and emerging number of seedlings on April 22. You can see another, a key difference on the increasing number. A part from the seeds that sown belongs to the same seed batch, field also the same (the number of seeds per meter does not matter) but there is something that may depends on the seeds features.

Diversity in the living organisms is also peculiar to the seeds of plants, which has been historically proved by many famous biologic scientists. There is a good example of diversity of sunflower seeds (chart 13) remarkably reflecting in the seed germination (Melnikov A.V., 1998).

Here, the diversity of the seeds is interpreted by view point of relation between planting quality and size of seeds. It was proved that planting quality of seeds directly depends on the weight of 1000 seeds.

Furthermore, you can see both possible way of seed germination studies: lab and field. Studied seeds of sunflower showed increasing seed germination of 90 to 92 in the lab and 76 to 79 in the field conditions. But here, the main key is that the two first indexes (90 and 76) were the result of the seeds which have weight of 43 g per 1000 seeds. And the second, higher indexes were the result of seeds with the weight of more than 46 g.

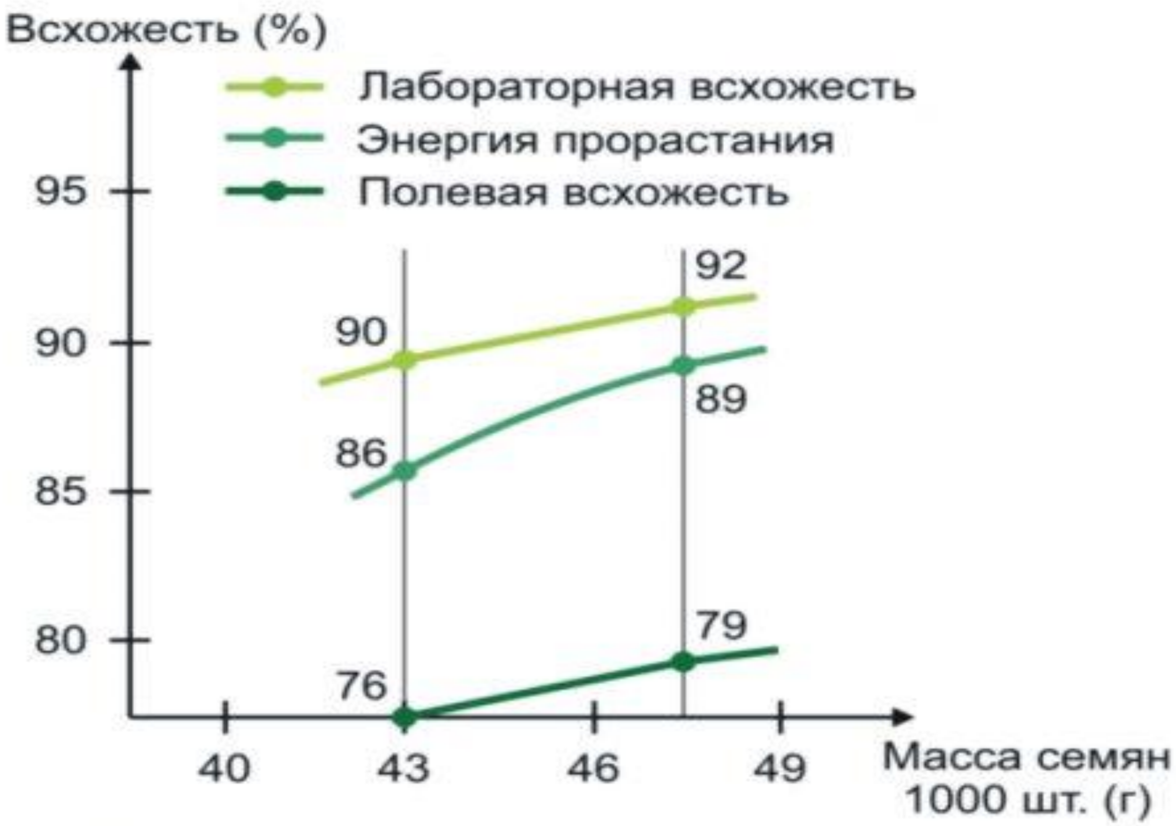


Chart 13. **Relation of germination and seed size of sunflower.**

So, the planting quality is the key indexes in the taking of rapid, healthy and even stand seedlings of any agricultural crops. Planting quality characterized by many component indexes of the seeds: purity, moisture, damage, size, growing energy and germination. All these indexes are very important in taking of adequate seedling stand in a very short time with minimum seed losing.

In the production, the great attention of seed producers and farmers is focused on **the planting fitness** of seeds, which means the relation between seed purity and germination in %:

$$\frac{a \times b}{100},$$

where, a- seed purity, %;

b- seed germination, %.

If the purity of the studied seed batch consists of 98 % and the germination – 92%. The planting fitness of this seed batch will be equal to:

98 x 92 : 100 = 91,6%.

Questions and tasks for firming of acquired knowledge:

1.How do seeds sprout?

2.How long does it take for a seed to sprout?

3.Why is photosynthesis an important plant process?

4.What stages has germination of seeds?

5.Can you describe the character of seed responses to the field condition?

6. What essential parts of farm seeds do you know?

7.What is the seed quality of crops?

8.Does seed quality change the seed sprouting results?

9.Make drawings of anatomic texture of seeds in your lab copy - books on the base of appendixes 10-13.

10.Work out a new study on the seed sprouting of winter cereal crops.

11.Present a report about biochemical value of other studied crops in this manual similar to wheat seed in the appendix 9.

The 35th practical training.

Study of biotechnology in the plant breeding.

The aim of the training. Getting acquaintance with basic, goals, methods and achievements of biotechnology in agriculture subject is a major aim of this training.

The needed teaching aids. Internet source, lecture note books, pictures devoted to the kinds, methods and outcomes of biotechnology, herbariums of agricultural plants and their seeds, copy books for practical trainings, pencils, rulers and erasers.

Biotechnology – it is a technology, biological systems, alive organisms or their parts are employed in it to develop or create new benefit products. The term of biotechnology refers to more wide complexes of modification processes of biologic organisms to ensure human demands, commencing modification of traits and properties of plants, animals and microorganisms (photo 91).

Creating of high-productive varieties of domesticated (using of cell culture and tissues). | Regulation of reproduction of agricultural animals | Cloning of animals

Фото 91. **Research aspects of biotechnology in agriculture.**

The term of biotechnology in the sphere of agricultural sciences is used by the world circle of scientists as lab methods at their experiments of gene enginery and cell culture grown in the nutritional petri dish medium. The merit of biotechnology in the development of agriculture has a progressing manner and characterized by the accelerating of breeding process. Selection is conducted in the condition of lab, with the certain chromosomes of somatic cells of donor organisms. The genes of donor chromosomes, which responsible to expression of desirable traits and properties are marked (coded). Marked genes of both cells are gathered in one recipient cell by inserting or replacing at the level of DNA recombination depending on the selection object. This experimental cell with reconstructed gene sequence chromosome is exposed to cell division for regeneration of new purposefully transformed plant. At this no need to experimentation for traditional multi-years field breeding process.

Biotechnology is based on the genetics, molecular biology, bio-chemistry, embryology and cell biology, and also on the applied disciplines – chemistry and information technologies and robot technique.

Kinds of biotechnology: Bio-enginery, bio-medicine, bio-pharmacology, bio-information, artificial selection and cloning.

Gene engineering, cell engineering and cloning are the basic methods of biotechnology.

Gene engineering — total combination of modes, methods and technologies getting of RNA and DNA, separating of genes out of organisms, implementation of manipulations with genes, inserting them into other organisms, which can inform plants about benefit properties. This process is implemented by the help of corresponding enzymes, splitting molecules of DNA strictly in definite sectors, and ligase, stitching fragments in united re-combined molecule DNA and also agrobacterium plasmid (Ti-tumor inducing) (figure 17). The latter represents itself a

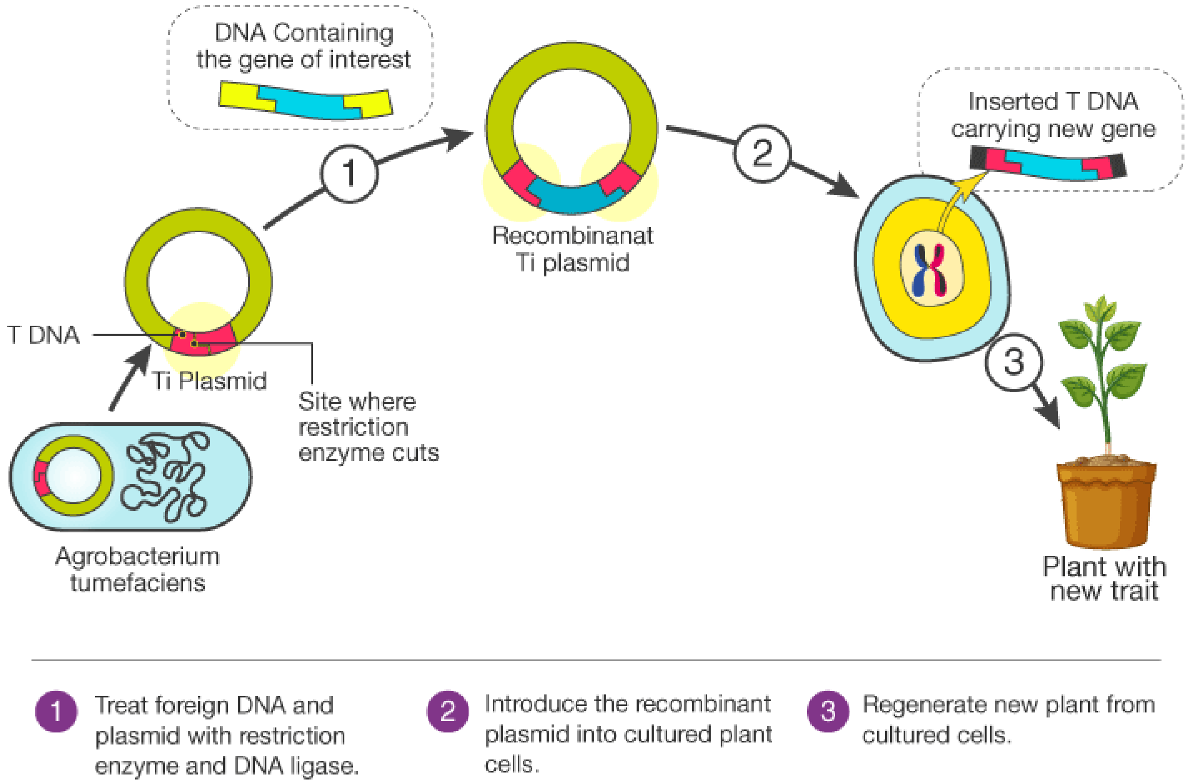


Figure 17. **Scheme of getting transgenic plant.**

mini-circled DNA which is natural vector system and used to transfer genes into plants. "Cutting" of genes is conducted with the help of special "genetic scissor" enzyme, then the gene "is stitched" in the vector - plasmid, by the help of that the gene is inserted into bacteria. "Stitching" is implemented by the help of other group of enzymes – ligase. By the way, the vector must contain all necessary: promoter, terminator, gene operator and gene regulator, to manage the work of this gene. Besides that, vector must contain marker genes, which hands over the new properties to the recipient cell, permitting to differentiate this cell from initial cells.

Artificial synthesis of insulin (appendix 20) at the beginning of 1960s has been acknowledges worldwide as the century achievement of the gene enginery. In the result of that, one of the human problems associated with insulin deficit, which owns polyhedral influence on the metabolism, practically in all tissues of the organism, has been decided forever.

The potential of the biotechnology in agriculture unbounded by the utilization of genetic methods on the base of DNA recombination, cells and cloning technologies to create and use of genetically transformed biologic objects (appendix 21). The development of biotechnology has made production possible to substantially intensify, enhance the using efficiency of plant resources, to solve ecological issues, to create new plant forms and realization own potentiality in the industrial processes.

Cotton bollworms had caused a considerable loss to agriculture at the beginning of 1990s, that's why governments of various countries have decided to streamline the researches, which would be promote to create GM-cotton, resistant to pest. In the result of that, appeared the cotton varieties, plants of which have bacterial toxin. This toxin with gene, taken from *Bacillus thuringiensis*, is destructive to caterpillars of worm, but harmless in regards of other insects. This measure has not only helped to protect cotton from loss, but has decreased pollution of environment from insecticides, which had been applied before against to this pest.

The method of transferring desirable gene from foreign organism to grown cotton varieties can be described in this order (figure 18): Bacteria Bacillus

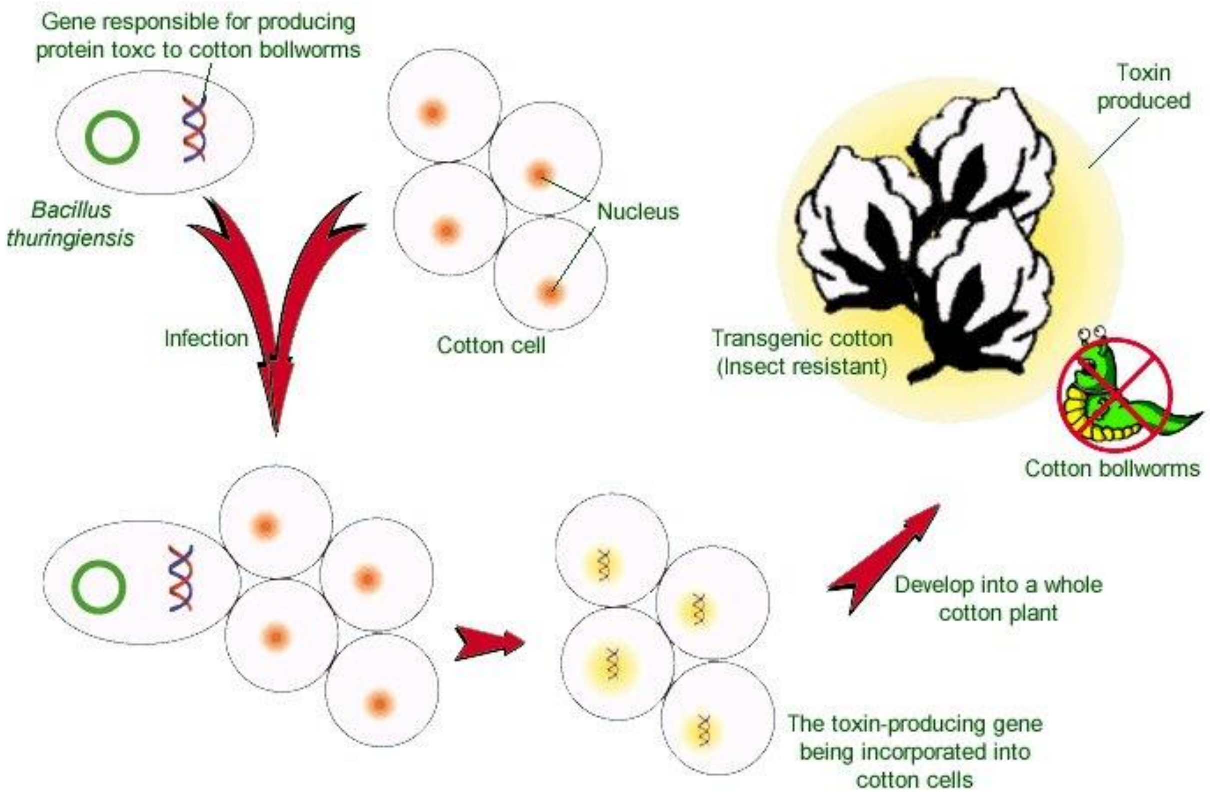


Figure 18. **Development of insect resistant transgenic cotton.**

Thringiensis produces endotoxin, destroys gut of target insects and it will be absolutely harmless to mammalians. The gene, expressing this toxin, is extracted from bacteria and is inserted into plasmid of soil bacteria Agrobacterium tumefaciens. Then, a piece of plant tissue of cultural cotton variety, grown in the nutritious medium, is infected by this bacteria (photo 91) bearing genes responsible to produce 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. Genetic description on the using method to obtain the transgenic cotton is given in the appendix 22.

Nowadays, transgenic cottons present themselves as Genetically Modified Organisms (GMO Cottons). Plantations planted with GMO cottons have attained their top indexes - 98% of total plantations in the USA. Then follows India, China, Brasilia and Pakistan. Their share on the GM-cotton area doesn't decrease than 90% of all fields, intended for planting of agricultural crops.

Cell engineering – growing of cell culture of plants, animals and bacteria in the special feeding condition (in vitro) to conduct a various kind of researches (combination, extracting or transplantation). Plant breeding process of varieties development in agricultural crops has speed up thanks to these genes based on innovative practices. Now, the time, needed in traditional plant breeding to create the new variety, has decreased from 11 to 3-4 years (appendix 23). It has also the opportunity to solve the barer of inter species incompatibility in the obtaining of hybrids via crossings in the cereal crops. This method, based on the cell protoplast infusion, has made it possible to get different hybrids of various potato, tobacco species and others.

Changing of ecology in the world scale related to regional activities of producers, where grows the demand of plant resistance to physical factors. Plant breeding researches in the direction of cold resistance, drought resistance and tolerance of new varieties of agricultural crops to salinity on the base of cell engineering method are successfully being conducted by the genetic scientists and plant breeders (table 23).

Table 23. **Salt tolerant cell lines and plants – regenerators, taken at in vitro plant breeding (by V.S.Shevelukha, 2008).**

Initial material to plant breeding (Chromosome set).	Concentration NaCl, (M).	The result of cell plant breeding.
Medicado sativa (2n)	0,17	Callus
Medicado sativa (2n=2x2n)	0,08-0,17	Plants
Citrus sinensis (2n)	0,08-0,17	Callus
Nicotiana tabacum (2n)	0,17	Suspension, plants
Datura innoxia (2n)	0.17-0,34	Callus, plants
Pennisetum americanum (2n)	0,19	Embryo suspension
Ipomea batatas (2n)	0,17	Suspension
Crepis capillaris (2n)	0,12	Suspension

Oriza sativa (2n)	0,17	Embryo callus, plants

Uzbek genetic scientists of Center of Genomics and Bioinformatics, Academy of Science of Uzbekistan in collaboration with scientists of USA[lit] have used the fiber quality QTL-associated with PHYA1 gene fragment to create a specific RNAi (interference) construct to explore the biological role of PHYA1 and (indirectly) other photochromic genes in cotton tissue culture.

In particular, the RNAi construct was somatically transformed into the highly embryogenic but non-commercial Coker-312 variety, which is considered as the genetic standard for cotton regeneration work. This research has led to successful obtaining of transgenic cotton embryos bearing the cotton PHYA1, RNAi construct in the history of agricultural biotechnology of Uzbekistan.

When compared with control plants, heritable improvement of vigorous root and shoot development, early-flowering, early-maturity, productivity traits (appendix 1) and major fibre quality traits (appendix 2), through several generations of two independently derived RNAi cotton transformants were observed.

It was demonstrated that the RNAi-associated traits were transferable from somatically regenerated RNAi Coker-312 lines to other locally commercial Upland cultivars via conventional sexual hybridization.

So, through manipulation of PHYA1 gene expression by using RNAi, above mentioned scientists have achieved simultaneous improvement of several important traits, such as fibre length and early maturity, without negative affect on the other key parameters such as yield—a goal that has largely eluded conventional breeding. For instance, introgression of superior fibre quality traits from Pima cotton (G. barbadense) into Upland (G. hirsutum) cultivars, using interspecies genetic hybridization, is challenging, owing to segregation distortion and linkage drag, that often results in introgressed progenies, that are late maturing or have poor agronomic quality. Application of RNAi has allowed them to effective solution of these fundamental problems, and rapid improvement of maturity, flowering, yield and major fibre quality traits, thus transforming commercial Upland varieties into more long-stapled, productive and early-maturing cultivars.

Moreover, “Gene knock out technology” has also been worked out to the deepening this study of photochrome (photoreceptor gene family) functions.

Multiyear studies of Uzbek scientists in the aspects of biotechnology have resulted in developing of cotton cultivars (photo 92) like Parloq-1 (Coker-312 x AN-Boyout-2), Parloq-2 (Coker-312 x S-6524), Parloq-3 (Coker-312 x Tashkent-6) and Parloq-4 (Coker-312 x Namanghan-77).

Photo 92. **The plant architecture of PHY1 gene-derived, novel RNAi cotton cultivar "Parloq-1"**

Cloning (in biology) – appearing of several genetically identic organisms (photo 91) through natural or somatic (including of vegetative) reproduction or parthenogenesis. The term "cloning" of the similar meaning is used often in regard of multicellular organisms. Process of obtaining several identical copies of hereditary molecules is either specified with cloning (molecular cloning).

Questions and tasks to consolidate attained knowledge:

1.What is biotechnology and its methods of study?

2.What is the differences between methods of agricultural biotechnology?

3.How the advantages of biotechnological methods in the plant breeding of plant varieties can be explained?

4.Using of internet source, prepare short report about one of the kinds of biotechnology: (bio - engineer, bio-medicine, bio-pharmacology, bio-information, bionics, artificial selection and cloning) and outcomes of chosen one.

5.What does the term of "cloning of organisms" mean?

6.How would the gene engineering effect on the future of agriculture?

7.Which of cotton varieties were developed through the method of gene modification?

8.Can you describe the process of gene transferring?

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.	Ўсимликларнинг генетик (нав) жихатидан қанчалик тоза эканлилигини, касалликларга, заракунадаларга чидамлилиги ва экишга мўлжаланган уруғликнинг умумий холатини аниқлаш мақсадида далада ўтказиладиган тадқиқот.	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.	Навнинг бошқа нав ёки экин билан табиий чангланиши ва кичик мутациялар натижасида кечадиган ифлосланиш.	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.	Илмий-тадқиқот муассасаларида селекциянинг илмий усуллари асосида яратилган нав.	Сорт, созданный в научно - исследовательских учреждениях на основе научных методов селекции.

CMS –	Cytoplasmic male sterility (infertility), that is pollen grains inability to impregnation.	Цитоплазматик эркак стериллиги (пуштсизлиги), яъни чанг доначаларнинг наслсиз (пуч) бепушт бўлиши.	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.	Кондицияли уруғлик ҳосилининг экилган уруғлик миқдорига нисбати.	Соотношение урожая кондиционных семян к количеству посеянных семян.
Dominancy –	The privilege of one over other on allele traits in the heterosis organism.	Гетрозигота оргнизимда аллель белгилардан бирининг иккинчисидан устун туриши.	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.	Навга хос энг яхши ўсимликларнинг танлаб, кўпайтириб олинган уруғлиги бўлиб, навнинг барча ирсий белги ва хусусиятларини кейинги бўғинларша ўтказади.	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.	Она сифатида олинган ўсимликнинг гулидаги чангдонларни териб олиш (юлиб ташлаш).	Удаление пыльников из цветков материнских растений.
Family –	Progeny of one cross pollinating plant, taken via propagating.	Четдан чангланувчи битта ўсимликни кўпайтириб олинган авлод.	Потомство одного перекрестно опыляемого растения, полученного путем размножения.
Heredity –	Transferring of trait and properties of the organism from generation to generation.	Организмдаги белги ва хусусиятларнинг наслдан наслга ўтиши.	Передача признаков и свойств организма от потомства к потомству.
Heterosis –	Becoming vigorious, viability and productivity of the first hybrid generation (F_1) comparing with parental organisms.	Биринчи бўғин (F_1) дурагайининг ота ва она организмларга нисбатан кучли, ҳаётчан ва маҳсулдор бўлиши.	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	Ирсий белги ва хусусиятлари билан фарқ қиладиган икки ва ундан ортиқ организмларни	Поколение, полученное путем скрещивания двух и более организмов, отличающихся по

	crossing of two and more organisms.	чатиштириб олинган янги бўғин.	наследственным признакам и характеристикам.
Hybrid population –	Totality of organisms differing from each other on hereditary sign, taken in the result of crossing.	Чатиштириш натижасида олинган ирсий жихатдан бир – биридан фарқланувчи организмлар тўплами.	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.	Турлари ёки туркумлари бошқа бошқа бўлган ўсимликларни дурагайлаш.	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	Нав, уруғлик ва ҳосил сифатлари бўйича давлат стандарти ва техник талабларга жавоб берадиган уруғлик материаллар махсус ихтисослашган хўжаликларда ишлаб чиқаришни ихтисослаштириш, концентрациялаш, барча	Специализация, концентрация производства семенных материалов в особо специализированных хозяйствах, отвечающих техническим и государственным стандартам по сортовым, посевным и урожайным качествам, а

	and automation, using the least labour expenditure.	технологик жараёнларни механизациялаштириш ҳамда автоматлаштириш асосида энг кам меҳнатни сарфлаб уруғчиликни ташкил этиш.	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 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 %.	Табиий офатлар вақтида фойдаланиш учун тўғридан-тўғри хўжаликларда ёки давлат жамғармаларида яратиладиган уруғ заҳираси (запаси). Унинг миқдори уруғлик тизимининг турли звеноларида ҳар хил бўлиб, масалан, бирламчи уруғлик звеноларида эхтиёт фонди уруғликка бўлган эхтиёжга нисбатан 100 % миқдорда, суперэлита учун 50 %, элита ва 1 репродукция учун 25-30 % миқдорда жамғарилади.	Запас посевных семян, созданный из непосредственно хозяйственных или государственных закромов, для их использования во время природных катастроф. Его объём различается в 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.	Фотосинтетик қобиляти юқори бўлиб, ташқи мухит омилларидан (тупроқ, сув, ўғит ва ёриғликдан) унумли фойдалана оладиган, ҳамда юқори агротехник шароитида ётиб қолишга, касаллик, зараркунанда ва бошқа ноқулай таъсирларга чидаб, мўл ҳосил ва сифатли маҳсулот берадиган нав.	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 урожая и качественную продукцию.
Introduction –	Bringing of the species and varieties of plants from other territories.	Ўсимликларнинг тур ва навларини бошқа жойлардан келтириш.	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, purification, transportation processes.	Ҳосилни йиғиш, янгилаш, тозалаш ташиш каби жараёнларда уруғликнинг бошқа нав ёки экин уруғига аралашиб кетиши (ифлосланиши).	Загрязнение посевных семян семенами других сортов или культур во время сбора урожая, обновление, очищение и транспортировки.
Modification variability –	Not hereditary (phenotype) variability.	Ирсий бўлмаган (фенотипик) ўзгарувчанлик.	Ненаследственная (фенотипическая) изменчивость.

Mutational variability –	It arises by the external influences and does not transmit from generation to the generation.	У ташқи шароит таъсирида юзага келиб, бўғиндан–бўғинга берилмайди.	Она возникает под влиянием внешней условии, но не передается по наследству.
Mutation –	A sudden (by spasmodic way) hereditary altering of traits and properties in the organism.	Организмдаги белги ва хусусиятларнинг тасодифий (сакраш йўли билан) ирсий ўзгариши.	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.	Организм генотипи билан ташқи шаротининг ўзаро таъсири натижасида оганизимда шаклланадиган ташқи ва ички белгилар (хусусиятлар) йиғиндиси.	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.	Муайян ареалда (территорияда) тарқалган, бир турга мансуб бўлган, ўзаро эркин чатишадиган, лекин бир-биридан ирсий жиҳатдан фарқ қиладиган ўсимликлар тўплами.	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 increasing the haploid chromosome sum of organism.	Организм гаплоид хромосомалар йиғиндисининг каррали ортиши билан боғлиқ бўлган ирсий ўзгарувчанлик.	Наследственная изменчивость, связанная с кратным увеличением 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.	Нусха кўчириш деган маънони билдириб, элита уруғликларни кўпайтириб олинган урууғлик, яъни элита уруғлик экилиб 1-репродукция уруғлик, ундан эса 2-репродукция, ундан 3 ва сўнгги репродукция уруғликлар олинади.	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.	Уруғни етиштириш, сақлаш ва амборлардан чиқариш вақтларида уруғликнинг экинбоплик хусусиятларини текширишга қаратилган тадбирлар тизими.	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.	Қишлоқ хўжалик ишлаб чиқаришнинг махсус тармоғи бўлиб, унинг асосий мақсади деҳқон, фермер ва жамоа хўжаликларини районлаштирилган, Давлат реестрига киритилиб экилаётган навларнинг уруғини нав тозалиги, биологик ва хўжалик хусусиятларини сақлаб оммавий равишда кўпайтириш.	Являясь специальной отраслью производства сельского хозяйства, её основной цель 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.	Муайян тартибда танлаш ва кўпайтириш билан навни янгилаб туришга (уруғликни қайта етиштириб туришга) қаратилган ўзаро боғланган питомниклар ва уруғлик экинзорларнинг мажмуи.	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.	Давлат планига мувофиқ барча экин майдонларини бир ёки бир қанча экинларнинг аъло сифатли уруғликлари билан таъминлаб турадиган бир-бири билан ўзарор боғланган ишлаб чиқариш тармоқларининг мажмуи.	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.	Ўзидан чангланувчи битта ўсимликнинг авлоди.	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.	Бирор экиннинг ишлаб чиқаришда экиб келинаётган эски навини серҳосил ва маҳсулотнинг сифати яхширoқ бўлган янги нав билан алмаштириш.	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,	Маҳсулдорлиги, нав ва экинбоплик хусусиятлари энг юқори бўлган уруғлик. У элита уруғлари етиштириш жараёнида ташкил этиладиган	Посевные семена с наивысшими продуктивными, сортными и посевными свойствами. Она получается путем размножения семей,

	established at the process of elite seed production.	оилаларни кўпайтириш питомнигидан олинади.	созданных в процессе 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.	Деҳқончилик соҳасида янги навлар (дурагайлар) яратиш ва экилиб келинаётган навларни яхшилаш усуллари тўғрисидаги фан.	Наука о методике улучшения высеваемых сортов и создания новых сортов (гибридов) в отрасли земледелия.
Triticale –	56 and 42 chromosomal wheat - rye amphidiploids.	56 ва 42 хромосомали буғдой-жавдар амфидиплоидлари.	Амфидиплоиды пшеницы и ржи, состоящие из 56 и 42 хромосомов.
Variation –	Quality and quantity altering of traits.	Белгининг сифат ва миқдор жиҳатидан ўзгариши.	Качественные или количественные изменения признаков.
Variability –	Difference of organism progeny from own ancestors on some of characteristics and properties.	Организм авлодининг ўз аждодларидан қандайдир белги ёки хусусиятлар билан фарқ қилиши.	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.	Селекция усуллари билан яратилган, аниқ ирсий морфологик, биологик хўжалик, белги ва хусусиятларга эга бўлган ўсимликлар гуруҳи.	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, realizing with the help of approbation.	Дала апробацияси ёрдамида амалга ошириладиган барча экин майдонларини давлат стандарти талаблари асосида юқори сифатли уруғлик билан тўла таъминлашга қаратилган тадбилар тизими.	Система мероприятий, направленных на полное обеспечение всех посевных площадей культурами с высококачественными семенами, на основе государственных стандартов, 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.	Бир нав ишлаб чиқаришда экилиб, унинг ҳосили, уруғликни экиш сифатлари ва биологик хусусиятлари пасайганидан сўнг шу навнинг уруғлик сифати юқори бўлган уруғ билан алмаштириб экиш.	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.	Янги нав яратиш жараёнида шу навни дастлабки (кичик), конкурс (катта), экологик ишлаб чиқариш, динамик ва давлат навсинашлардан ўтказиш.	Проведение предварительных (станционный), конкурсных (расширенный), производственно-экологических, динамических и государственных сортоиспытаний в процессе создания нового сорта.

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Appendixes:

Appendix 1.

Form № 19. **Main summary of broadened and competitive variety trial of cotton**

№ on the order	Variety	Plant stand, thousands\ha	Date of beginning flowering	Date	Days from planting __ % to mature		Raw cotton crop														Fiber output, %		Fiber crop						Size of bolls, g.		Fiber quality					Fiber index	Absolute weight of 1000 seeds, g.	III rate of wilt
							On 1.10		On 15.10			Until frost			From opened bolls			Total					Until frost		From opened bolls		Total				Length of fiber, mm.		Strength of fiber, g\tex	Micronaire	Uniformity.			
				Maturity, %	Absolute	Difference from standard	Ton \ha	In % than standard	Ton \ha	In % than standard	In % than total harvest	Ton \ha	In % than standard	In % than total harvest	Ton \ha	In % than standard	In % than total harvest	Ton \ha	In % than standard		Absolute	Difference from standard	Ton\ha	In % than standard	Ton\ha	In % than standard	Ton \ha	In % than standard	Absolute	Difference from standard	Absolute	Difference from standard						

Appendix 2.

Form № 195

Agricultural enterprise ______________________ Proved by the Ministry of Water Resources and Agriculture

____

region, land, republic

Statement has been done______________________________________

position, sign

Seed plantation _____________________________________ reproduction

by the sign

plantation has been recognized _____________________________________

position, sign

APPROBATION STATEMENT № ______

____ ______________________y. by me (us) practician (s) ____________

____ full

names, position

At the attending of farm representatives as ___________________________

____

name and position

Approbation of plantations has been conducted on ______________________

crop

In the farm ____

district ____

According to the data of approbation are set up

1.Name of the variety (hybrid, strain) ________________________________

selection number

____ _

if it has conformed variety

Botanical diversity ____

2. Total plantation area of crop under approbation in the farm ____ ha, including

seed plantation ____ ha, out of variety seeds planted and subjected to approbation ___ ha.

3.Location of seed approbation plantation:

field №___, team № ____, plot №_____.

4.What seeds were planted ____ own or imported

____

if the seeds imported, point out the exporter organization

5.Name, number and date of seed document to the planted seeds ____________

____

6.If the planting was made by the seeds of own seed crop, point out when and from whom they have been received for planting _____________________________

____

7.In what year the seeds of elite released from selection-experiment establishment

____

8.Variety quality of planted seeds: reproduction (generation) _________,

category _________, variety purity (uniformity) _____%.

9.Do other varieties or populations exist in neighboring farm boarding with crop plantation under approbation: name and area, occupied or in ____ y. ________

____

10.Space isolation from other varieties (for cross pollinator crops) ____________

____ and makes up _________ m.

observed, unobserved

11.Predecessors of plantation (crops, varieties and area under them) ______

____

Reverse side of approbation statement on the form of № 195 is available on the table materials of the lab and is filled together with all students of the group.

Appendix 3.

Form № 200

Physical (juridical) person ____
(region, land, republic)

Executor of the statement ____
(position, signature)

seed plantation, other plantations (unnecessary delete)

STATEMENT № ____

culling of plantation out of the fitted ones for use to seed purposes ____________

20 ___ y. under my (our) practician (s) ___________________________________

____

(full names and positions)

with attendance of farm representatives ______________________________
(full name and position)

crop plantations ____
Varieties, hybrid, strain ____
belong to the farm ____
district ____
recognized unfit for seed purposes and culled.

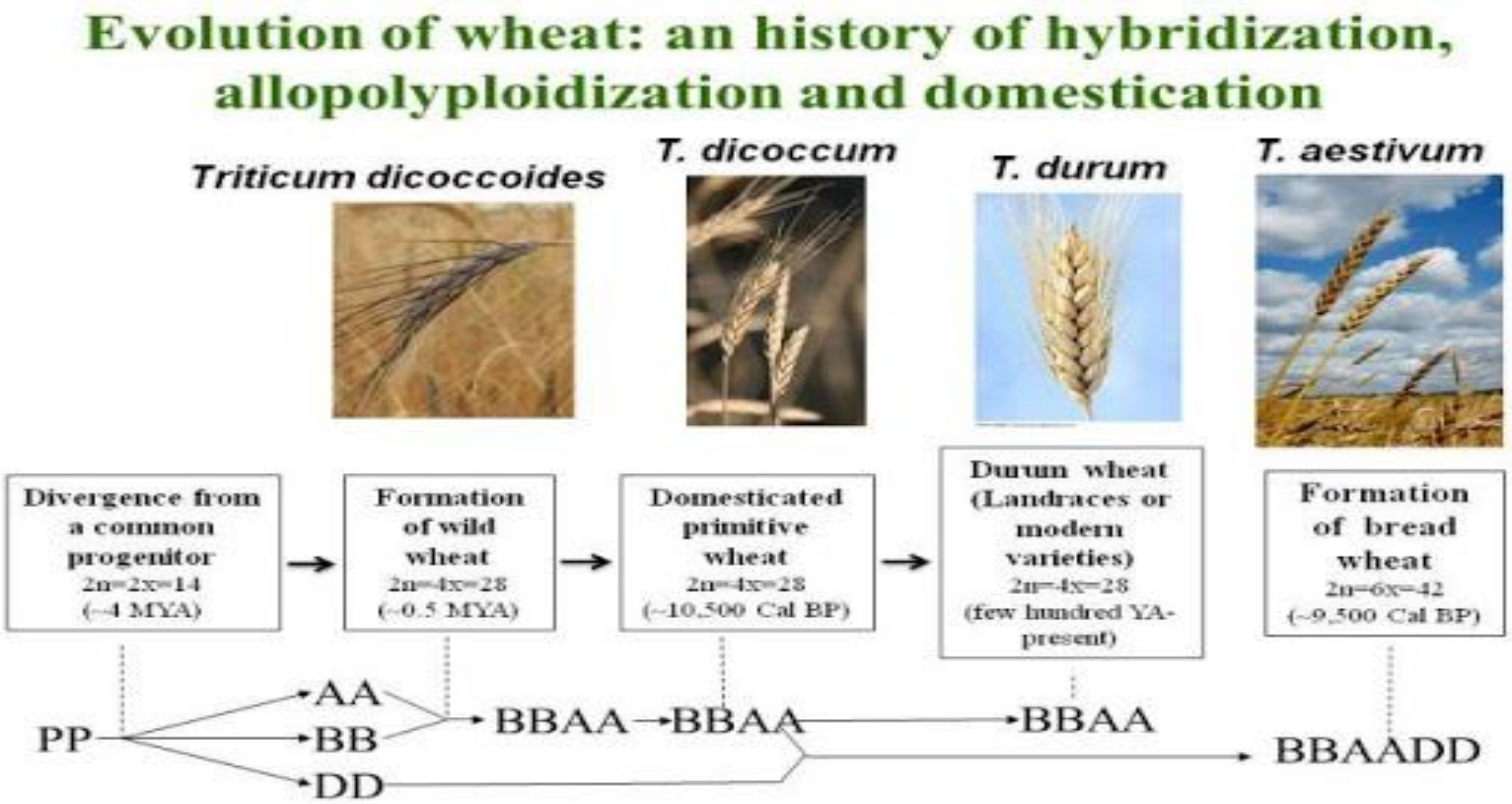
1.Culled plantation is located in the field № ____ the area of ____ ha.

2.Result of analysis:

a) approbation bundle (plants)

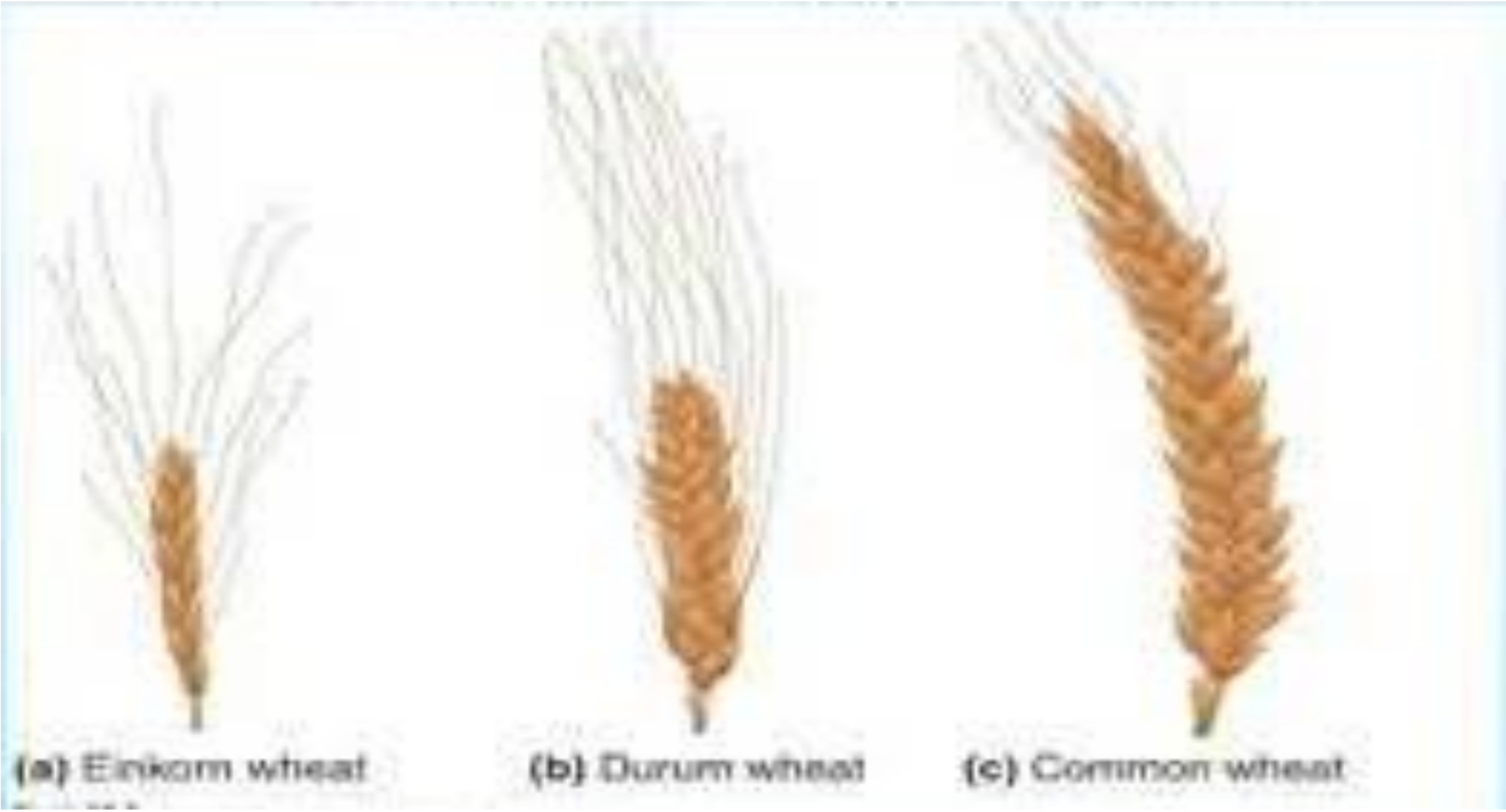
№ of bundle	Developed stock of the main variety		Compositions of variety impurities						Number of undevelop-ed stocks of approbated crop
	unit	%	Name and amount					Totally	
1									
2									
3									
4									
5									

Appendix 4.


Evolution of wheat: an history of hybridization, allopolyploidization and domestication
Triticum dicoccoides
T. dicoccum
T. durum
T. aestivum
Divergence from a common progenitor 2n=2x=14 (~4 MYA)
Formation of wild wheat 2n=4x=28 (~0.5 MYA)
Domesticated primitive wheat 2n=4x=28 (~10,500 Cal BP)
Durum wheat (Landraces or modern varieties) 2n=4x=28 (few hundred YA-present)
Formation of bread wheat 2n=6x=42 (~9,500 Cal BP)
PP
AA
BB
DD
BBAA
BBAA
BBAA
BBAADD

Appendix 5.

Sympatric Speciation. Usually happens through poliplody



Appendix 6.

Standard method of assigning 5 treatments to plots in 4 replicates of a field experiment.

I						II						III						IV						
1	2	3	1	4	5	1	2	3	1	4	5	1	2	3	1	4	5	1	2	3	1	4	5	1
st			st			st			st			st			st			st			st			St

Appendix 7.

“Sochilmas” Uzbek variety of soya

Appendix 8.

НАЦИОНАЛЬНАЯ СИСТЕМА СЕРТИФИКАЦИИ РЕСПУБЛИКИ УЗБЕКИСТАН

(Наименование органа по сертификации, адрес, № в Гос. реестре)

№ 1559164

СЕРТИФИКАТ СООТВЕТСТВИЯ

Зарегистрирован в Государственном реестре

"____" ________________ 20___ г.

№ ________________

Действителен до "____" ____________ 20___ г.

Код ОКП ____________ (справочный)

Код ТН ВЭД ____________ (справочный)

(предприятие, фирма, страна изготовитель)

Настоящий сертификат удостоверяет, что идентифицированная должным образом продукция:

(наименование, тип, вид, марка)

(количество или серийное производство)

соответствует требованиям нормативной документации ____________

Схема сертификации: ____________

Заявитель (изготовитель, продавец) ____________ (нужное подчеркнуть)

(адрес)

Сертификат выдан на основании:

а) документов ____________

б) испытания образцов ____________

в) акта проверки производства ____________

Инспекционный контроль осуществляет ____________

с периодичностью: ____________

Особые отметки: ____________

Знак соответствия проставляется: ____________

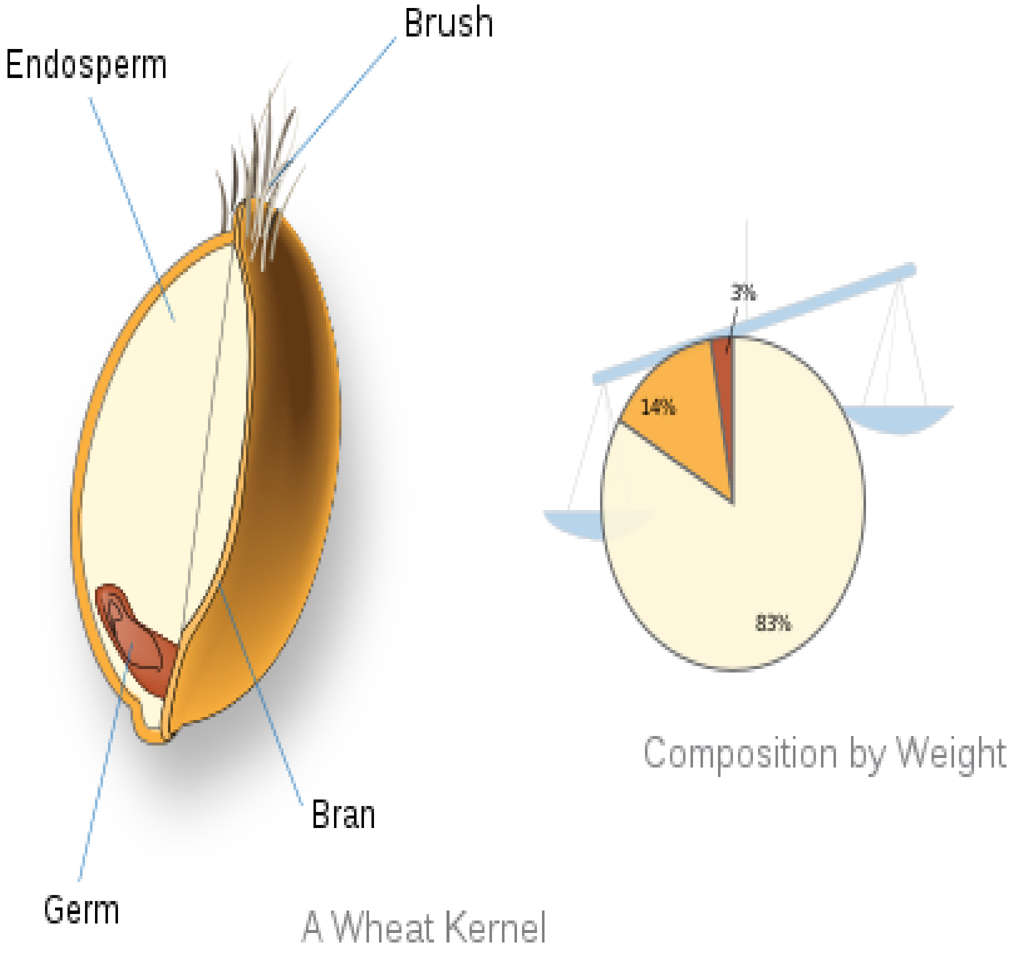
Примечание: Копия сертификата соответствия действительна только после заверения печатью органом по сертификации или держателем Подлинника.

Руководитель органа по сертификации М.П. ________ (подпись) ________ (Ф.И.О.)

Эксперт М.П. ________ (подпись) ________ (Ф.И.О.)

State certificate of correspondance

Appendix 9.

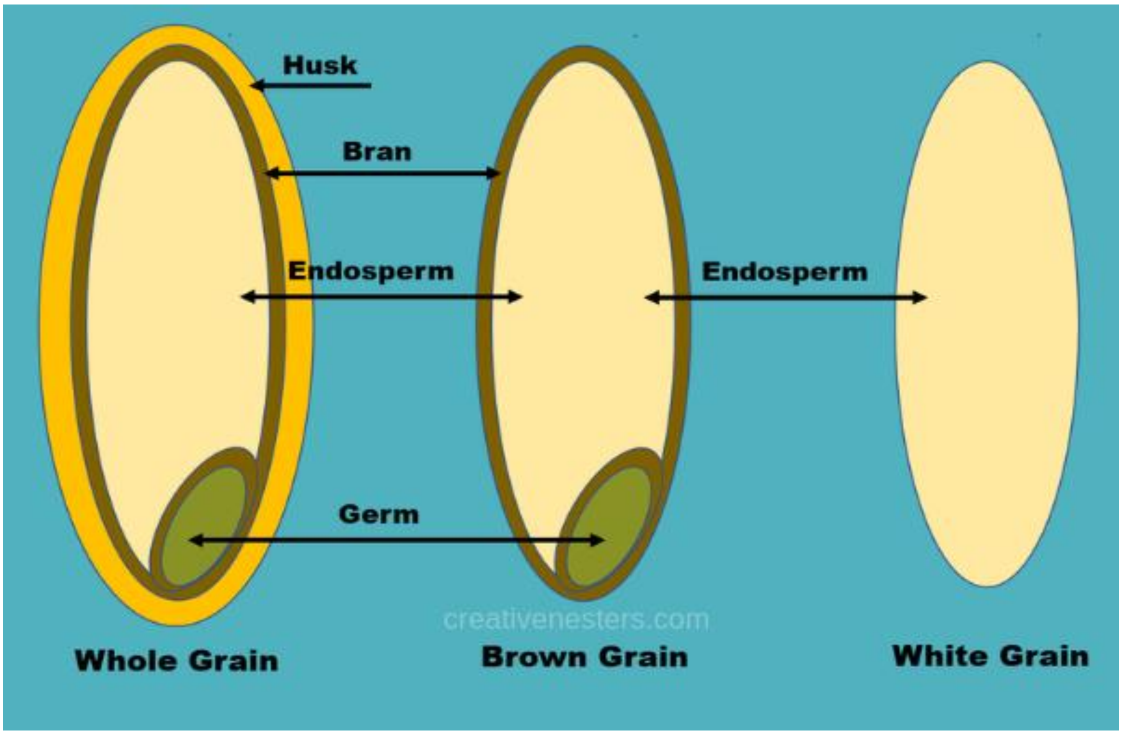


	Carb./g	Protein/g	Fat/g	Fiber/g	Iron (% daily req.)	Others
Bran	63	16	3	43	59	vitamin Bs
Endosperm	79	7	0	4	7	
Germ	52	23	10	14	35	vitamin Bs omega-3/6 lipids

Nutritional Value (per 100g)

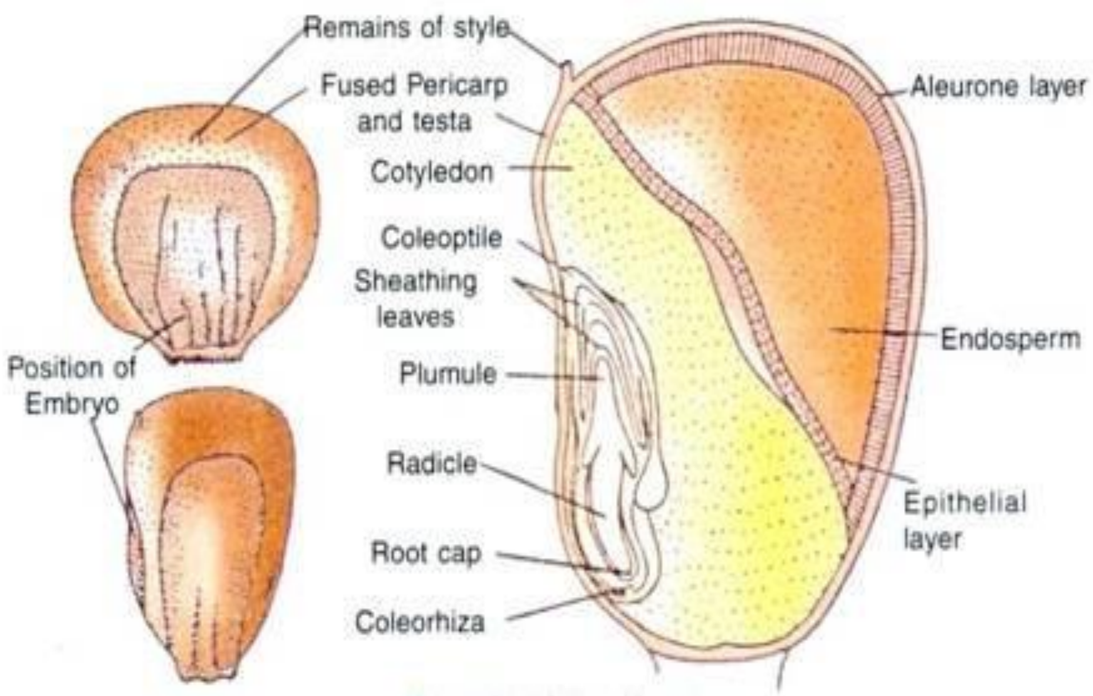
Anatomy and biochemical ingredients of wheat seeds

Appendix 10.



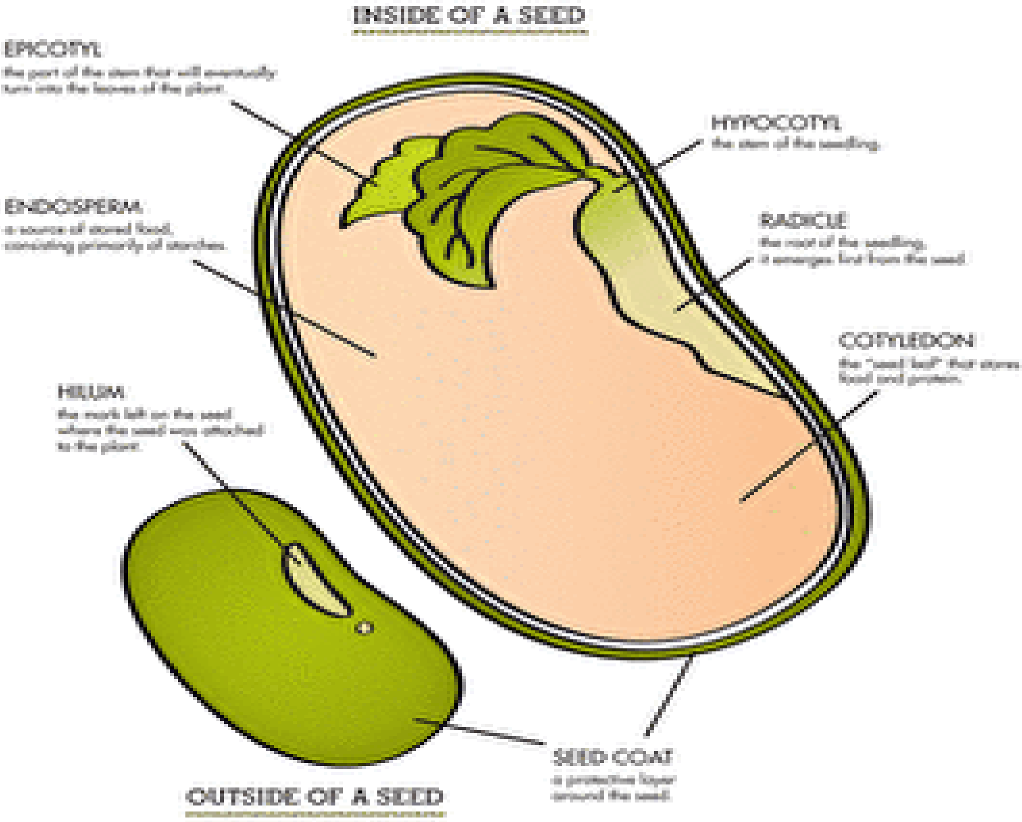
Anatomy of rice

Appendix 11.



Anatomy of maize

Appendix 12.

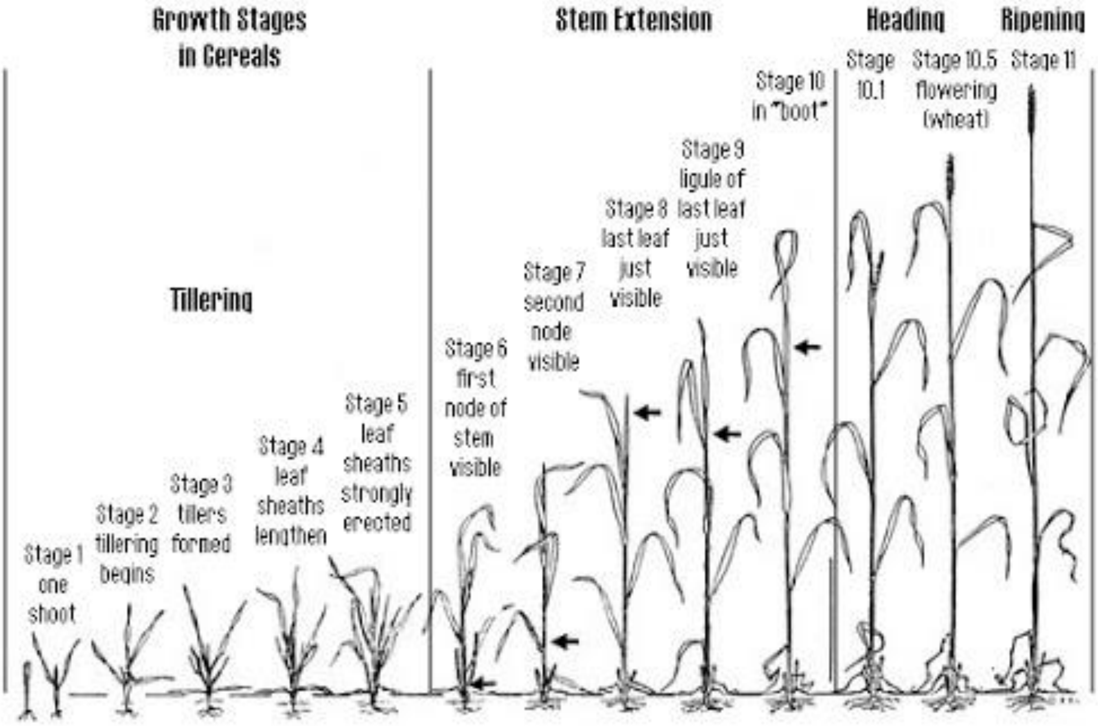


Anatomy of a bean seed

Appendix 13.

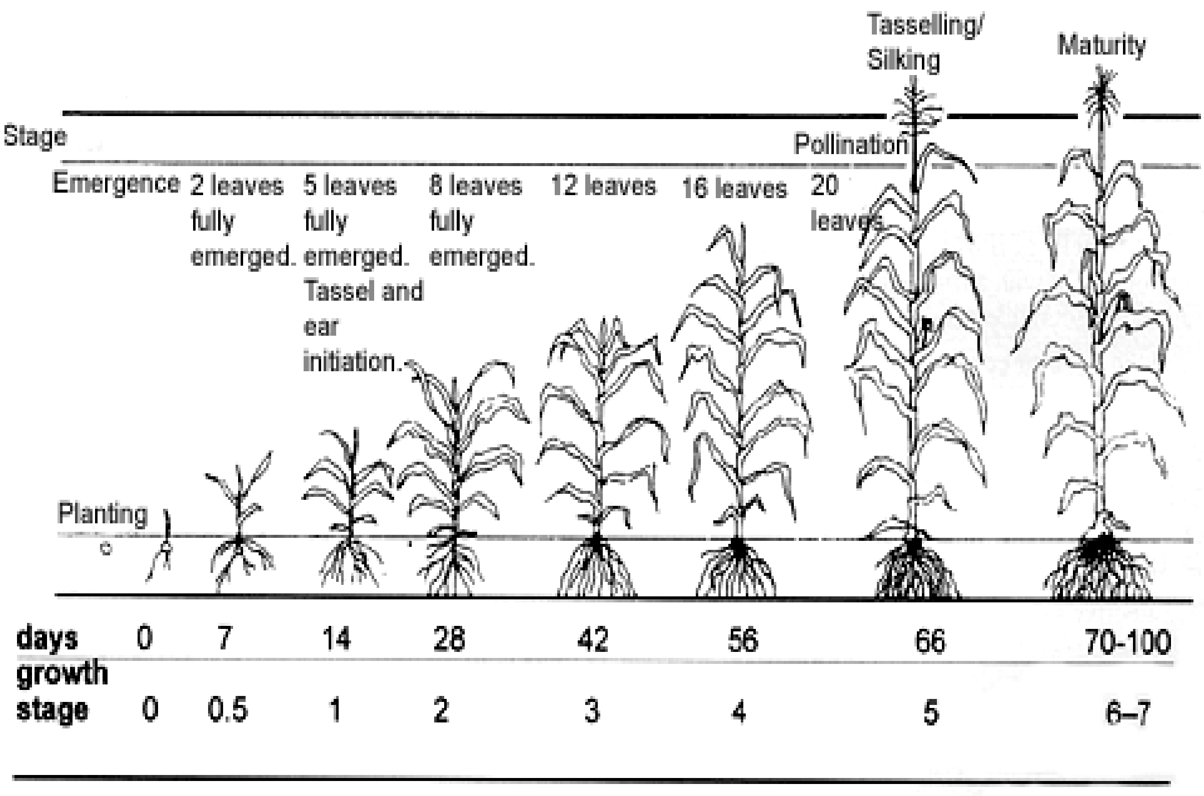
Anatomy of a sunflower seed

Appendix 14.



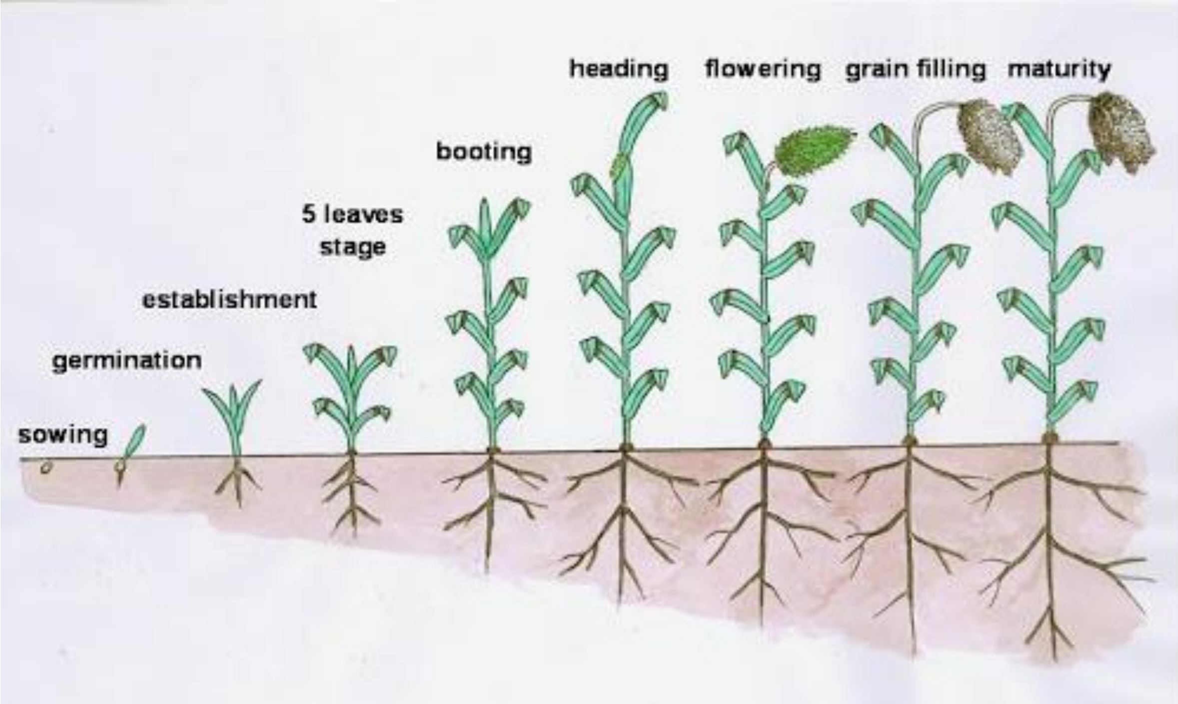
Growth stages in cereals

Appendix 15.



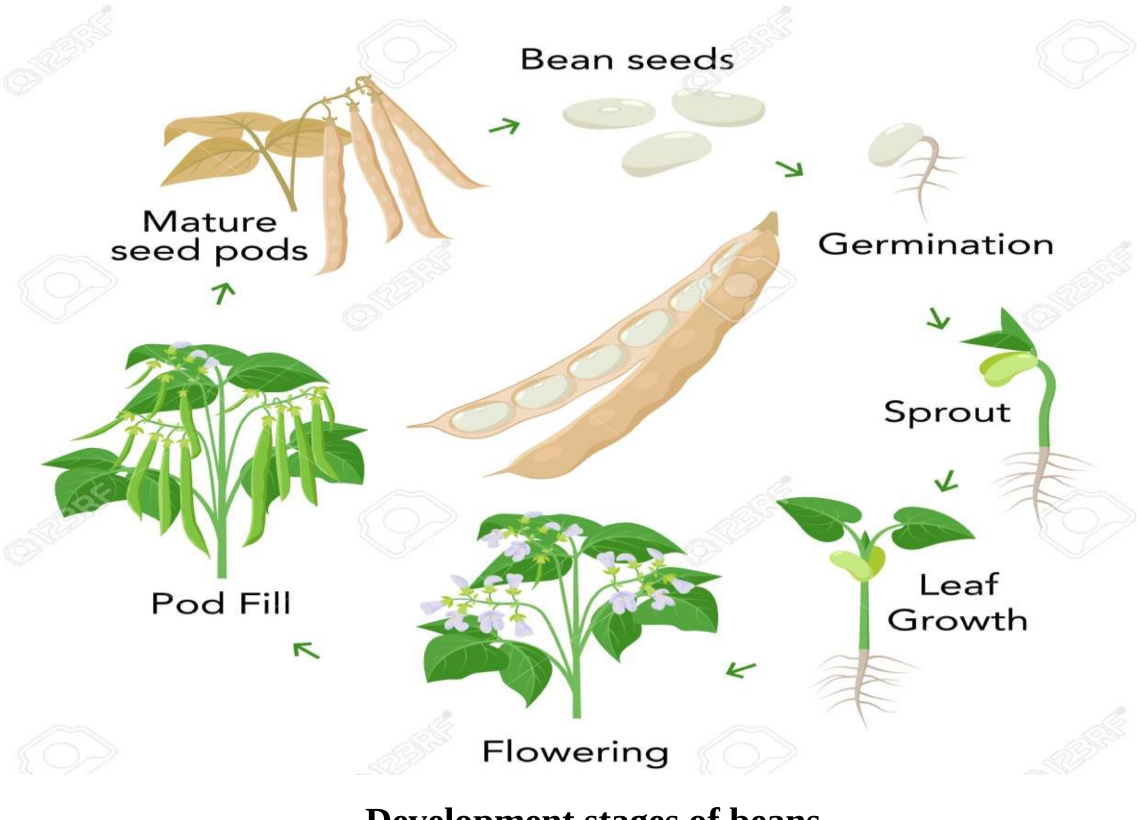
Growth stages of corn

Appendix 16.



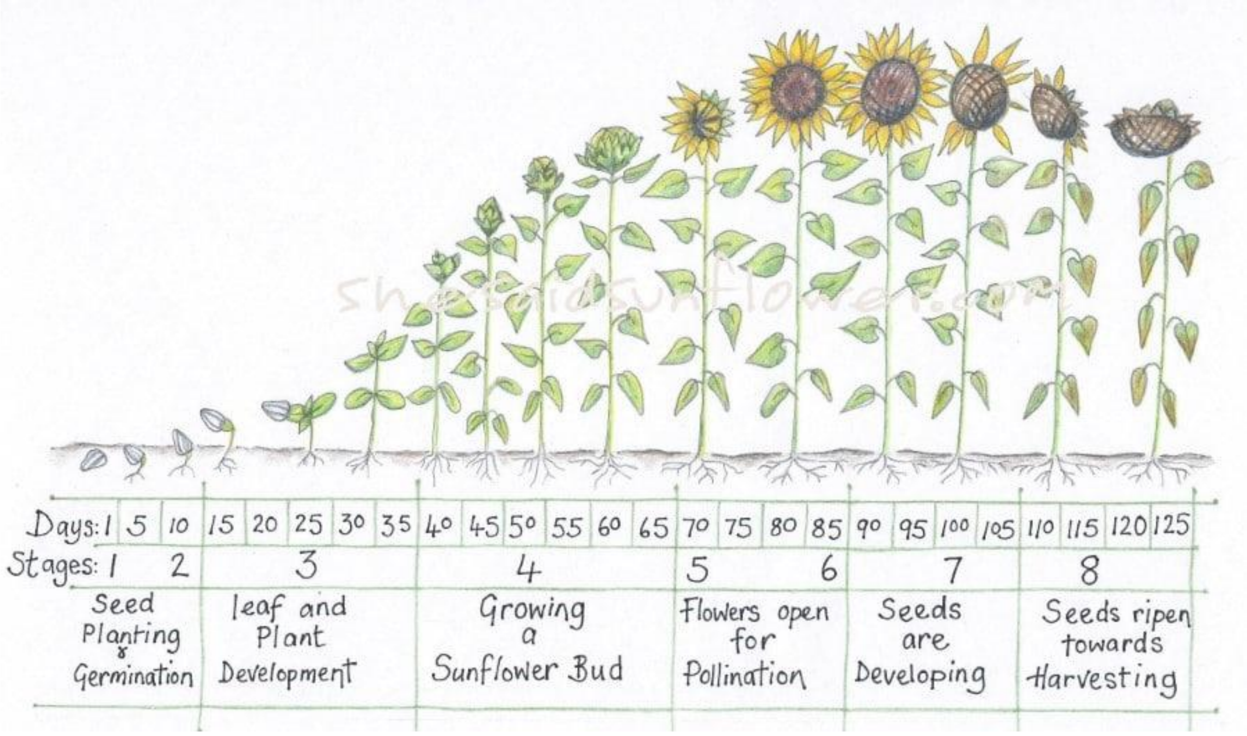
Sorghum development stages

Appendix 17.



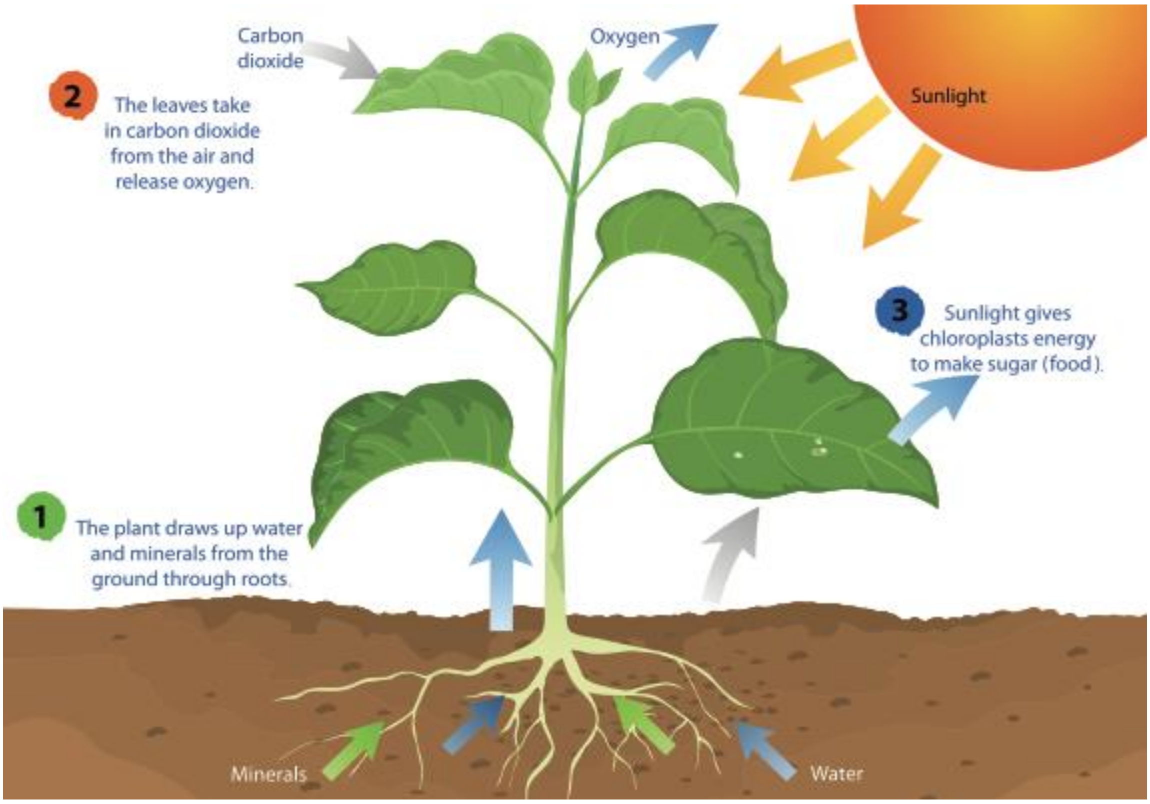
Development stages of beans

Appendix 18.

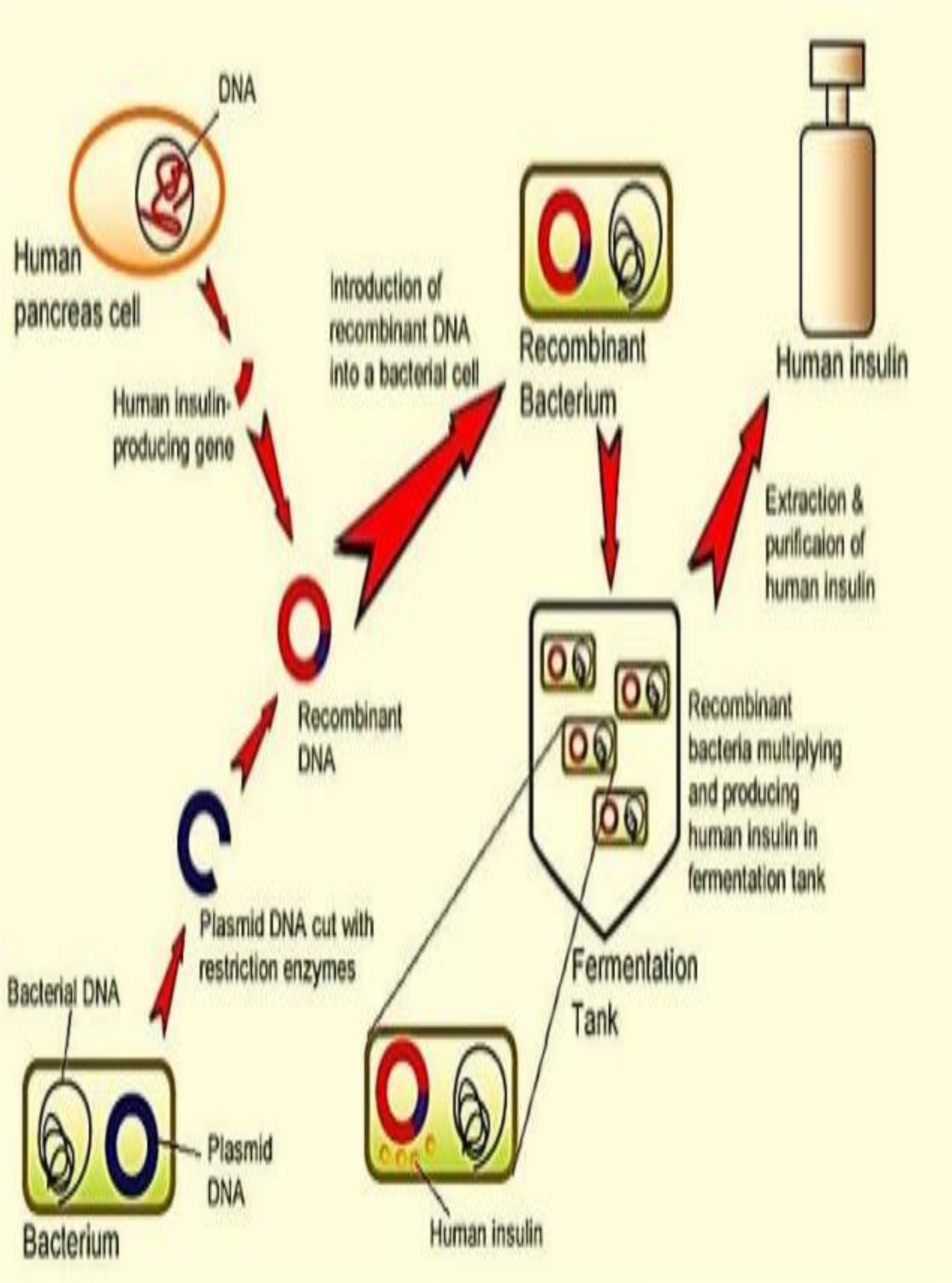


Development stages of sunflower

Appendix 19.

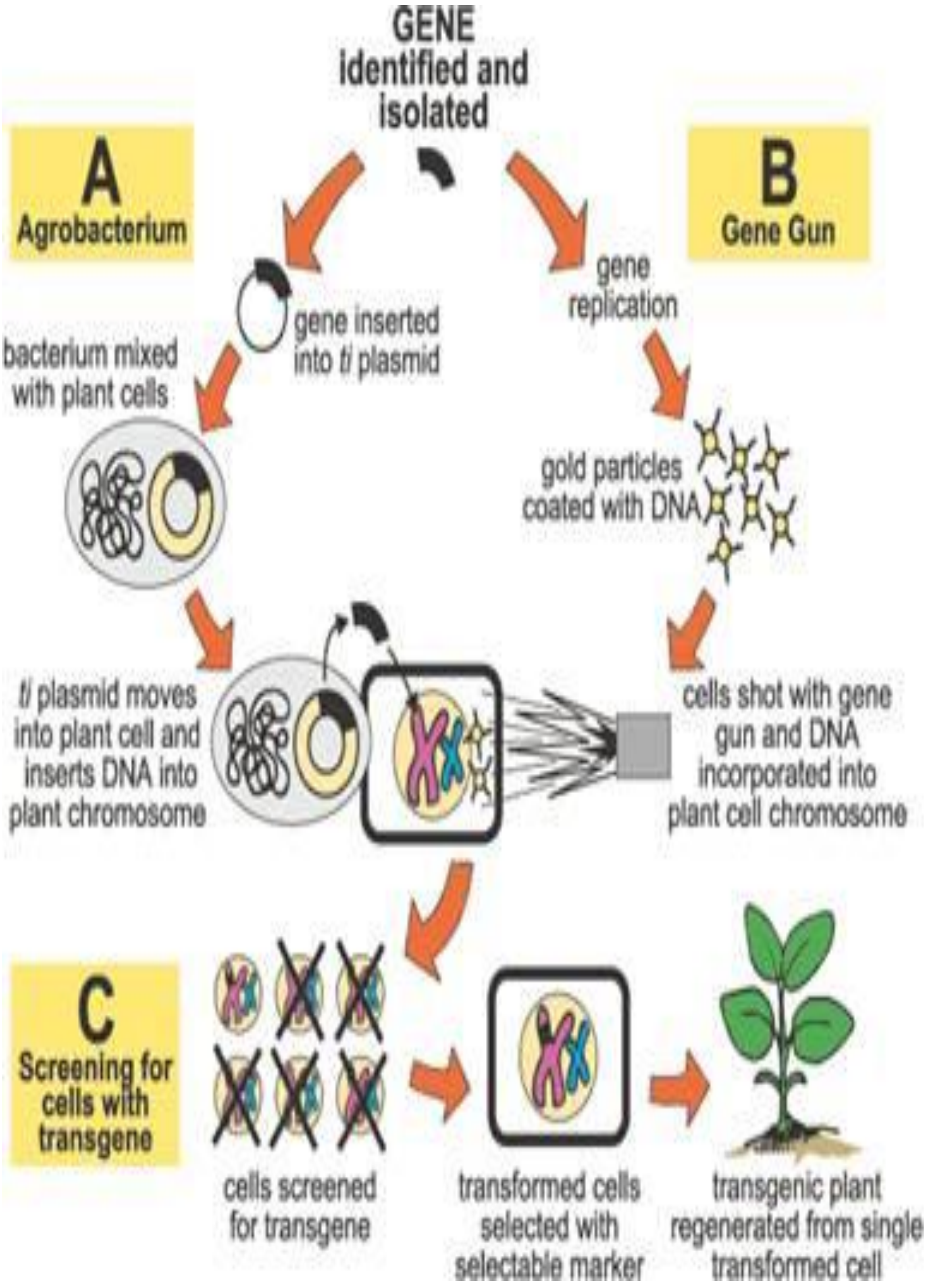


Plant photosynthesis



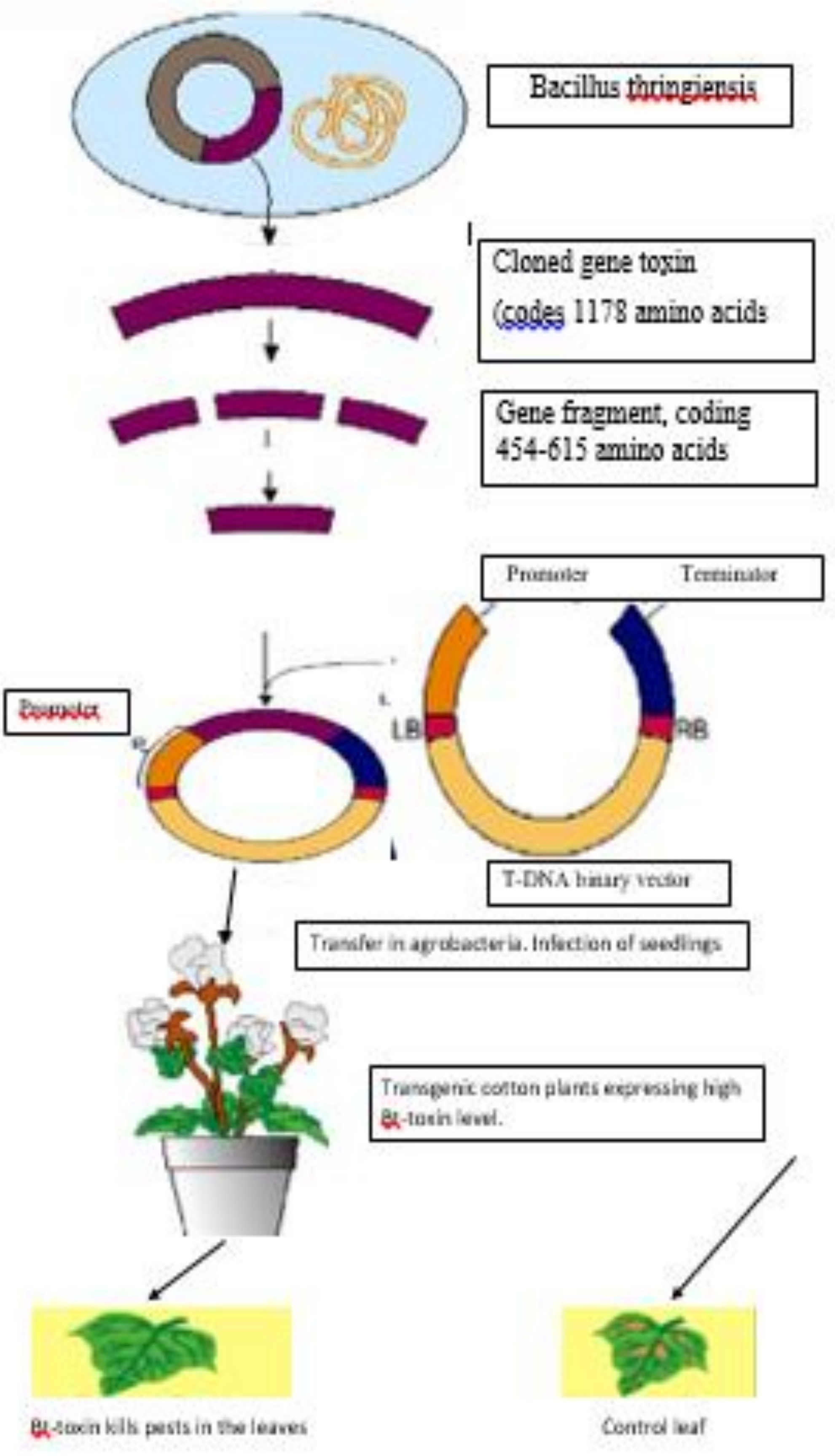
Method of taking gene – engineer drive insulin

Appendix 21.

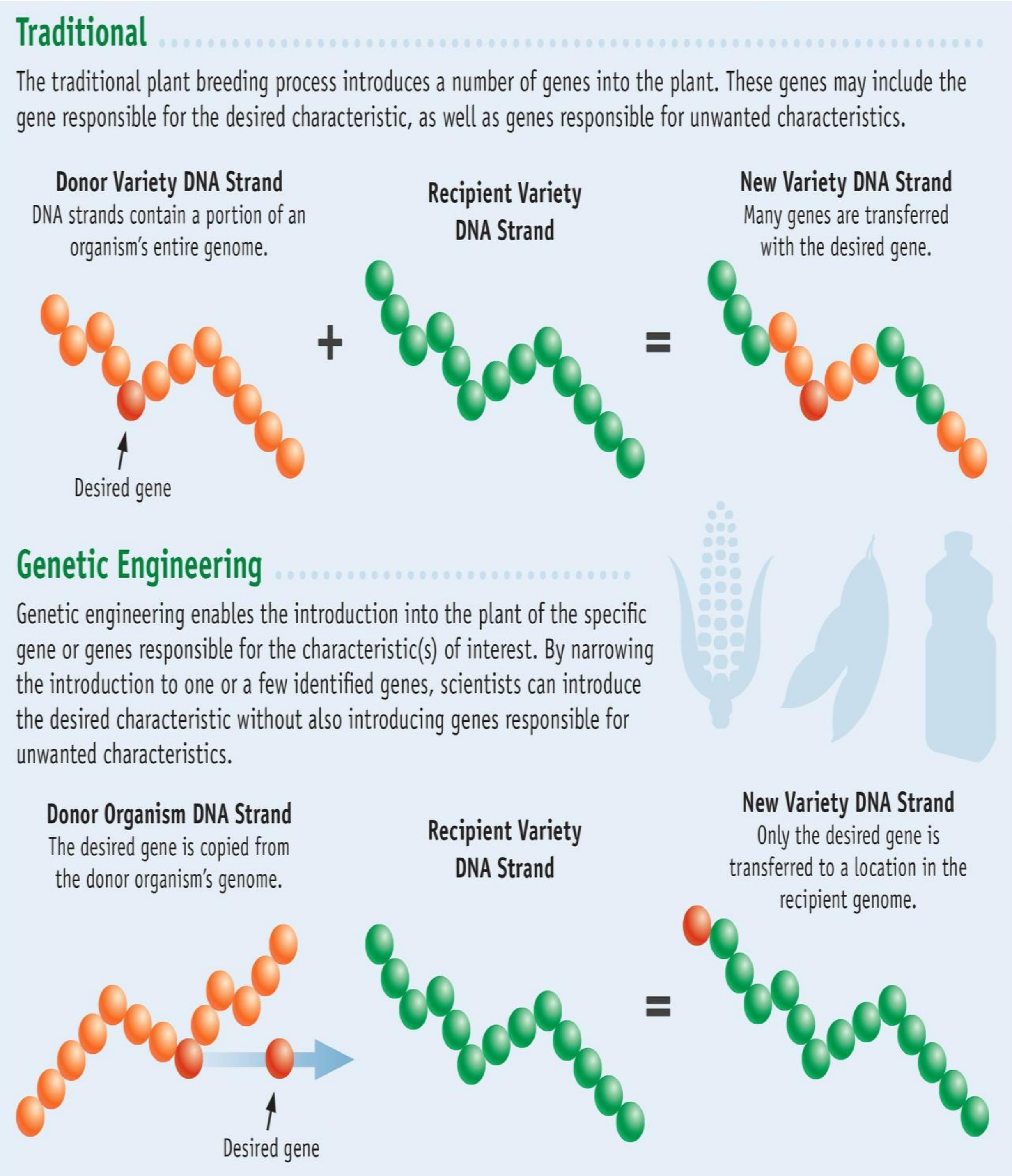


Methods of gene transfer

Appendix 22.



Genetic description of the method of genetic modification.



Traditional and genetic engineer methods of plant breeding.