SUNFLOWER PRODUCTION AND BREEDING IN THE USSR

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Sunflower is a staple oil-bearing crop in the USSR. 5.0 mln hectars are sown to sunflowers, whereas only 1.5 mln hectars carry other oil crops - flax, mustard, castorbean, soybean and rape. The Soviet Union holds first place in the world both in sunflower acreage and sunflower production. Two thirds of the world's sunflower production are centered here.

Annually our state oil extraction plants* produce over 2 mln tons of vegetable oils from oilseed and fibre crops (cotton, fibre flax and hemp, etc.) of which sunflower oil amounts to 1 mln 600 thousand tons. Sunflower is the major source of edible oil in our country, and only part of it is utilized for industrial purposes: for soap and drying oil production, etc.

Sunflower oil is widely consumed by the population of the country as salad oil and as kitchen oil for frying flour, vegetable and fish products. A large quantity of this oil is used for shortenings, by the fish and vegetable canning industries, and for confectionery purposes.

Due to its pleasant flavour and high quality sunflower oil enjoys great popularity throughout the country. It should be noted that the overwhelming majority of our customers prefer sunflower oil to peanut and olive oils, the price being equal.

Sunflower oil contains such physiologically valuable components as linoleic acid, vitamins and phosphatides. They account for the high quality of this edible oil.

Sunflower as feeding stuff is also of great value for animal husbandry. Sunflower cake containing 40% protein is a valuable feed for cattle because of its high content of such physiologically important and essential amino acids as lysine, tryptophane, leucine, and arginine, and others.

We produce annually 1 mln 700 thousand tons of cake, as a by-product of sunflower seed processing. It contains as much protein as we can get from 1 mln 130 thousand hectars sown to soybean when the latter yields 15 centners of seeds per hectar.

Threshed sunflower heads are a valuable source of feeding stuffs for sheep, cattle and poultry. Sunflower heads finely ground, added to the ration, increased weight gains of calves.

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* Sunflower seeds are processed not only by state oil plants, but also by those of collective farms.

Sunflower husk is a raw material for preparing ethyl alcohol, furfural, and yeast; threshed heads are employed for producing pectin not inferior in quality to that of apple pulp.

Being a remarkable honey plant sunflower is significant for beekeeping too.

The sunflower-growing districts of the Soviet Union cover a large area from the Carpathians to Lake Baikal, including zones of different soil-climate conditions. The largest and most important concentration of sunflower acreage is in the steppe regions of the Ukraine, in Northern Caucasus, Moldavia, the Central black soil regions, and the Volga area. Sunflower is cultivated on a large scale in Kazakhstan and Siberia as well, though its productivity decreases due to less favourable conditions as compared to major sunflower-growing districts.

The main sunflower seed-producing areas are shown in Table 1.

Table 1 Seeded acreages and sunflower yield in the USSR

Cultivation districts	Seeded area in 1000 ha. Year				Yield in 100kg/ha. Year			
	1913	1940	1960	1964	1913	1940	1960	1964
Total in the USSR including	982	3542	4190	4606	?	7.4	9.4	13.1
Northern Caucasus	351	792	1018	1079	?	9.9	10.0	12.9
The Volga area	197	786	695	783	?	3.3	6.1	10.8
Central black soil region	290	478	388	447	?	7.4	9.3	13.6
Moldavia	10	178	230	224	?	9.1	14.6	15.0
The Ukraine	76	719	1505	1754	?	13.2	11.0	15.2

Table 1 shows acreage expansion and sunflower yield increase. In 1964 the total yield reached 6 mln tons. It should be noted that the table represents mean yield data for vast areas with very large acreages. Of this crop, some regions of the Ukraine, Moldavia and Kuban provide higher sunflower yield, e.g. in Maryinsky region, Donetsky district, the Ukraine, sunflower from the area of 8300 hectars yields about 21.7 centners per hectar (1)*. For the last 5 years sunflower yield has averaged 25.5 centners per hectar from the area of 1000 hectars on the collective-farm "Kuban", Krasnodar district.

* Figures appearing in parentheses refer to comments from the floor made during presentation of this paper. They are recorded at the end of the paper.

Sunflower productivity in our country has been increased due to extensive utilization by collective - and state-farms of the research results of agricultural research institutes.

The principle research work on sunflower both in quantity and effectiveness is conducted by the All-Union Research Institute of Oil Crops. This Institute in Krasnodar has subsidiary experimental stations located in different zones of sunflower cultivation.

Well-known breeders, Academician V. S. Pustovoit and Academician L. A. Zhdanov are conducting research work at the Institute of Oil Crops. The investigations carried out there include not only research on breeding, but also on seed growing (2). (We mean by seed growing all phases of seed production, from breeders' stocks through foundation, elite, etc., to seed for use by state and collective farms); cultural practices; farm mechanization; and plant protection; as well as work on biochemistry; oil crops physiology; microbiology and agricultural chemistry; seed physiology and quality; cytology; farm economics; and so forth. It is too lengthy to speak on all these research problems, as I have to confine myself to report of breeding and seed growing. However, I consider it necessary to give you a brief description of research results in cultural practices and farm mechanization since they affect sunflower production as well as breeding program results.

Long-term experimental work in many zones of our country has resulted in resolution of many problems.

It was found that in areas of low precipitation sunflowers should not be sown for at least three years after such crops as sugar beet or alfalfa, which seriously deplete soil moisture. (3) Failing this rule of rotation sunflower will yield a lower crop.

Deep fall ploughing (27-30 cm) is of undoubted advantage. On sunflower fields grown over with weeds, such as Canada thistle, Cirsium arvense, and cornbind (4), Convolvulus arvense, the deep tillage should be preceded by two shallow ploughings as an effective weed control treatment in combination with 2,4-D application.

Sunflower is recommended to be planted in well-warmed soil after eliminating early weed seedlings by presowing cultivation. This determines the date of seeding.

As a result of many years of field trials conducted by many experimental stations it was found necessary to relate the stand (number) of sunflowers per hectar to soil-climate conditions. Furthermore, the optimum quantity of plants per hectar for the main zones of sunflower cultivation was determined. It was found that variations of spacings between hills and rows with constant number of sunflowers per hectar did not affect sunflower yield. That is why planting in check rows, 70 by 70 cms apart (5) has become common in all the sunflower-growing areas. The number of plants per hectar will depend on the number of plants per hill. In the regions of sufficient moisture, on fertile soils, the seed yields are highest when the number of plants comes up to 50 thousand per

hectar, with 2 and 3 plants in alternate hills. In regions of less moisture the amount of plants per hectar is reduced to 40,000 with 2 plants per hill in dry regions - even to 30,000 and 20,000 (6). Since sunflower yield is largely conditioned by fall-winter water supply in soil, at the depth of 3 meters, we recommend that in the years of moisture deficiency or excess there should be an adequate decrease or increase of the plants per hectar.

Sunflower responds to fertilization well, particularly in the zones of sufficient moisture. On main types of black soil nitrogen and phosphorus are most effective when applied at fall ploughing. In contrast, the K application has no effect as black soil is rich in potassium. Tests have shown that in order to get maximum fertilization effect it is necessary to determine N/P ratio.

As the trials have shown the best fertilizer treatment consisting of 45 Kg N and 60 Kg P per ha yielded a gain of 3.9 centners per hectar. The value of extra seeds produced exceeds four-fold the cost for purchasing and applying the fertilizers. Low rates of nitrogen and phosphorus applied at planting also result in higher seed yield, e.g., 4-year tests at Krasnodar Research Institute have shown that application of 10 kgs of nitrogen and phosphorus per ha when used near the hills brings about average seed gain of 2 centners per hectar.

The Institute has worked out a method of spraying with pre-emergence herbicides (prometrin, isopropylchlorphenylcarbamate, and alipur) to control annual weeds in sunflowers; 70-90% of weeds are killed with the above herbicides. Thus promoting seed yield gain by 2-3 centners per hectar.

In northern and eastern regions early, rainy period aggravates sunflower harvesting. But if the standing plants are treated by chlorate of magnesium before harvest, seed moisture content is reduced from 26-28% to 12-14%.

At present sunflower is sown with tractor-mounted multirow check-row corn planters. The Institute scientists have developed a special simple attachment to the planter. The attachment ensures a precise number of seeds dropped into hills providing the density of crop recommended for the given region with no hand thinnings. Weeds in the inter-row spacings are eliminated and soils loosened by using conventional mounted cultivators manufactured in our agricultural machinery factories. Successful weed control in the rows is effected by cultivators with different harrow- and rotary-hoe-type devices attached to them.

Sunflower harvesting is carried out by self-propelled grain combines equipped with an attachment developed at the Institute. This makes it possible to cut only the sunflower heads for threshing, with no stalks harvested, and brings about maximum threshing out with minimum seed loss. Capacity of the re-equipped harvester is 2 hectars per hour.

Mechanization of sunflower cultivation has reduced labour costs. At present the costs are equal to those of cereal production. In an average year 2-2.5 manhours are required to produce one centner of seeds in main sunflower-growing districts.

New more productive varieties developed by our plant breeders and a new effective system of seed growing to supply collective - and state - farms with

planting seed are of great significance as they promote the increase of sunflower seed and oil production.

Sunflower breeding on experimental plots in our country was simultaneously started in 1912 in Krasnodar by V. S. Pustovoit, in Saratov by E. M. Plachek, in Kharkov by B. K. Enkin. Some time later sunflower breeding was commenced in Rostov by L. A. Zhdanov and in Voronezh by N. A. Uspensky. The most urgent problem of this research work was control of serious sunflower enemies - moth (Homoeosoma nebulella) and particularly broomrape (Orobanche cumana).

Varieties resistant to moth were produced very soon as peasants had cultivated local varieties with high percentage of plants with an armored layer in the seed. Repeated individual selection from these varieties soon brought about desired results.

A more difficult problem was breeding varieties resistant to broomrape. It should be noted that broomrape caused much damage to sunflower in Russia. There was a time when in many regions peasants had to give up producing sunflower because of broomrape damage. In the early stage of the work, from 1912 to 1926, in Saratov, Krasnodar, Voronezh and Charkov, broomrape resistant varieties were bred on the basis of local varieties. The broomrape problem seemed to be solved. However, the new varieties absolutely resistant to broomrape in the regions where they were developed were seriously attacked by it in new locations. A new more aggressive race called race B or "evil race" occurred there. The plant breeders were confronted with a more difficult problem as none of the local or improved varieties had forms fully resistant to the new race, or rather to the complex of races. However, plants subject to broomrape attack to a far lesser extent were detected on the farms of South Ukraine. These samples served as original material for the intensive and successful breeding work of V. S. Pustovoit (Krasnodar) and L. A. Ahdanov (Rostov) who in 1932 developed new broomrape resistant sunflower varieties. Thus, the broomrape problem has been successfully solved in the most economical way - by the breeding method.

Qualities of these varieties can be estimated as a result of comparative tests of broomrape-resistant variety VNIIMK 6540 and non-resistant variety VNIIMK 4036 under the conditions of heavy infection of broomrape, race B, in Rostov district (7).

Table 2 Sunflower yield affected by broomrape

Variety	% of plants affected	No. of broomrape flowering shoots per 100 plants	Seed yield centner per ha.
VNIIMK 6540	6	15	23.5
VNIIMK 4036	100	3100	3.5

As seen from the table, the production of new broomrape-resistant varieties has been the salvation of sunflower cultivation since no effective chemical or agrotechnical control measures have been developed.

I shall talk about this method of breeding later on after starting main results of breeding for oil content and earliness as principal features of the method and scheme of breeding are similar for all the breeding objectives. But I must emphasize the significance of inoculated plots for breeding broomrape-resistant varieties. V. S. Pustovoit was the first to establish in 1913 a plot of one hectar inoculated with broomrape. Subsequently, in 1928, when he began breeding for resistance to broomrape, race B, the Armevir area of 8 hectars was sown to 256 kgs for broomrape seeds.

It should be noted that at the present time all the experimental institutions in our country that conduct the work on sunflower breeding use only broomrape-resistant varieties and forms as parental material.

The next most important stage in research was breeding sunflower for oil content. Enormous work of great scientific and practical value has been done by our plant breeders in this respect. As a result of their work, economic returns from sunflower production in our country and abroad have been tremendously increased. Academician V. S. Pustovoit, an outstanding plant breeder of the USSR, has worked out a new most successful method and technique of sunflower breeding.

But 50 years ago, when V. S. Pustovoit started his research work on increase of sunflower seed oil content, many authoritative scientists treated it sceptically. They considered it impossible to combine high oil content and high seed yield. However, we all know that V. S. Pustovoit turned out to be right in the controversy. His results greatly surpassed even his ambitious hopes. V. S. Pustovoit and other breeders started their work with local varieties, as original material, the absolutely dry seeds of which contained 30-33% oil. In the first years some thousands of seed samples were analysed and none of them exceeded seed oil content of 33%. It was the limit reached by the best Russian farmers in the Ukraine, Voronezh province, Northern Caucasus and the Volga area.

The first twelve years of work gave no appreciable results. At the time broomrape-resistant varieties N7-15-163 and N631 cultivated on the area of 500,000 hectars did not differ from the best local varieties in oil content. However, within that prolonged period of research V. S. Pustovoit succeeded in working out not only the method of breeding, but also the most detailed technique of laboratory analyses and field tests that made it possible to determine with precision the characteristics of the breeding material studied on a very large scale. The breeding method and organization of the work made it possible not only to detect the most valuable biotypes from the abundant breeding material but to maintain and use them in the breeding program when required. Plant breeders will understand the task is not easy with cross-pollinated species since there is a high tendency to levelling of characters and the loss of valuable agronomic features by outcrossing.

But time has not been wasted. Pustovoit's perseverance in developing methods of breeding has not been in vain. By slight but definite advances

over many years he has proved the method, overcome the doubts of sceptics and amazed everybody with the great effectiveness of his work. In 1927 V. S. Pustovoit bred a new sunflower variety with 35% oil content, basis dry seed, as against the former 33%. Increase in oil content with no decline in yield evoked great hopes for future success. It can be traced in the table below.

Table 3 Stages of breeding high oil sunflower varieties in the USSR

Year	Variety name	% oil in absolutely dry seeds
1913	Local varieties	33
1927	Kruglik A-41	36
1935	VNIIMK 3519	43
1953	VNIIMK 6540	46
1955	VNIIMK 8931	49
1958	Peredovik	51
1964	VNIIMK 309	54

The breeding work which is under way now shows candidates for new varieties with 56-57% oil content.

Thus seed oil content has been increased by 21%; or relatively as compared with local varieties by 63%. Furthermore, the sharp increase in oil content has not caused decline of yield in new varieties. On the contrary, it has tended to augment yield. Characteristics of the main varieties sown on 5 mln hectars in our country and abroad are presented below (8).

Table 4 Characteristics of sunflower varieties cultivated in the USSR (Data of competitive variety testing, Krasnodar, 1962-1965)

Varieties	Growing period in days	% husk	% oil in kernel (dry basis)	% oil in seed (dry basis)	Seed crop centner/ha	Oil yield centner/ha
VNIIMK 6540	91	22.7	63.5	50.4	25.8	11.53
Peredovik	92	22.1	63.5	50.9	25.5	11.48
VNIIMK 8931	92	22.7	63.2	50.4	25.7	11.46
Armavirsky 3497	93	22.7	62.8	50.0	25.6	11.34
VNIIMK 1646	92	23.8	62.5	49.1	25.4	11.05

Promising sunflower varieties to be delivered for state variety testing in the near future have still higher productivity.

Table 5 Characteristics of sunflower variety N25987

Variety	Year	Growing season in days	% husk	% oil in kernel (dry basis)	% oil in seed (dry basis)	Seed crop centner/ ha	Oil yield centner/ ha
N25987	1964	94	20.1	66.5	54.5	33.6	16.1
	1965	85	19.1	64.0	53.0	27.7	12.9
	Avg.	90	19.6	65.3	53.7	30.7	14.5
K 8931*	1964	96	21.6	65.1	52.4	32.5	15.0
	1965	88	20.3	62.3	51.0	27.3	12.2
	Avg.	92	21.0	63.7	51.7	29.9	13.6

* check

On the basis of the above data it can be stated that in the near future all the collective - and state - farm fields will be sown to sunflowers of 55% oil content basis dry seed.

Expressive and convincing statistics based on the total crop in our country testify to actual oil percentage of the commercial sunflower seed. (9)

	1940	1950	1960	1961	1962	1963	1964	1965
Oil percentage of commercial seed	28.6	30.4	39.8	40.3	41.1	42.2	43.7	44.4
Oil yield at oil mills, %	25.4	28.0	37.9	38.4	39.2	40.4	42.0	42.5

Within 25 years oil content of commercial sunflower seed has increased due to breeding from 28.6% to 44.4%, on the average. In more important areas of sunflower production, such as the Ukraine, Kuban, and Moldavia oil content of the seed is still higher. In Kuban region, for example, average oil content of the sunflower seed crop of 1965 from the area of 360,000 hectars was 45.8%.

Oil percentage increase in the seed leads to sharp increase in oil yield at oil mills. The above data show that mean oil yield over all the country is 42.5% as against 25.4% in 1940.

The economic significance of the achievements in breeding for increased oil content is exceedingly great. Based on the estimates of recent years an additional 600-700 thousand tons of sunflower oil were obtained annually due to the high oil sunflower seed. Its oil content had equalled that of 1940, an additional 3 mln hectars of sunflower would have been required each year to get as much oil as we get now. The example speaks well for itself.

In principle the method of sunflower breeding developed by Pustovoit may be presented as follows:

Part of seed from each selected initial sunflower head (breeding elite) is sown for two years in specific nurseries (nurseries of progeny estimation) for thorough study in individual progenies of all the characters of practical value.

Remnant seed of those heads that proved to be the best as judged by two years of study, is sown in a special space-isolated nursery. It is called the nursery of purposive transpollination, V. S. Pustovoit attaches great importance to it as the heart of the breeding method. It is here that due to intercrossing of the superior with the superior the most important advance is made. Essential peculiarity of the scheme is wide use of inoculated plots that help to evaluate the breeding material for disease resistance at several stages of the breeding program. The scheme is illustrated diagrammatically on Page 25.

This method of breeding is widely applied by all the research institutes in our country as it has great value in breeding for immunity, oil content, early maturity and other characters. It is the eastern part of the country and Kazakhstan that need early varieties badly, the growing season being very short there. New early broomrape-resistant varieties such as, Krasnodarets, Armavirets, Chernyanka 66 and Enissei, bred by the above method have both high oil content (45-48%) and rather high yield, two times higher oil yield per hectar than old varieties.

Continuous growth of sunflower seed oil content ensues not only from replacing low oil varieties with high oil ones but also from improving regionized* varieties in the process of producing planting seed. It is due to the new system of producing planting seed - annual variety renovation - that the above improvement has occurred. In this system, each year research institutes deliver elite seeds of the most recent cycle to collective - and state - farms for sowing on seed-breeding plots. Super stock seeds and elites are produced at experimental stations according to Pustovoit's method that leads improvement of the main characters of the variety and in increase of seed oil content particularly. The method of improving planting seed is presented on Page 26.

Primarily the method does not differ much from that of breeding work permitting annual improvement of cultivated varieties. Yearly varietal renovation provides rapid improvement of the whole acreage sown to the variety. As a result, oil content of seed processed at oil mills is increasing annually. An example is given below showing the mean increase of oil content in commercial sunflower seed in Moldavia, where one and the same variety, VNIIMK 1646, was produced with no substitution.

Year	1956	1960	1965
Oil content of seeds, %	34.6	39.9	45.5

Consequently, one variety, VNIIMK 1646, has averaged a 1.3% mean gain of oil content for the last eight years in Moldavia. It amounts to 1.2% in the whole country. Such gain in oil content results from using new

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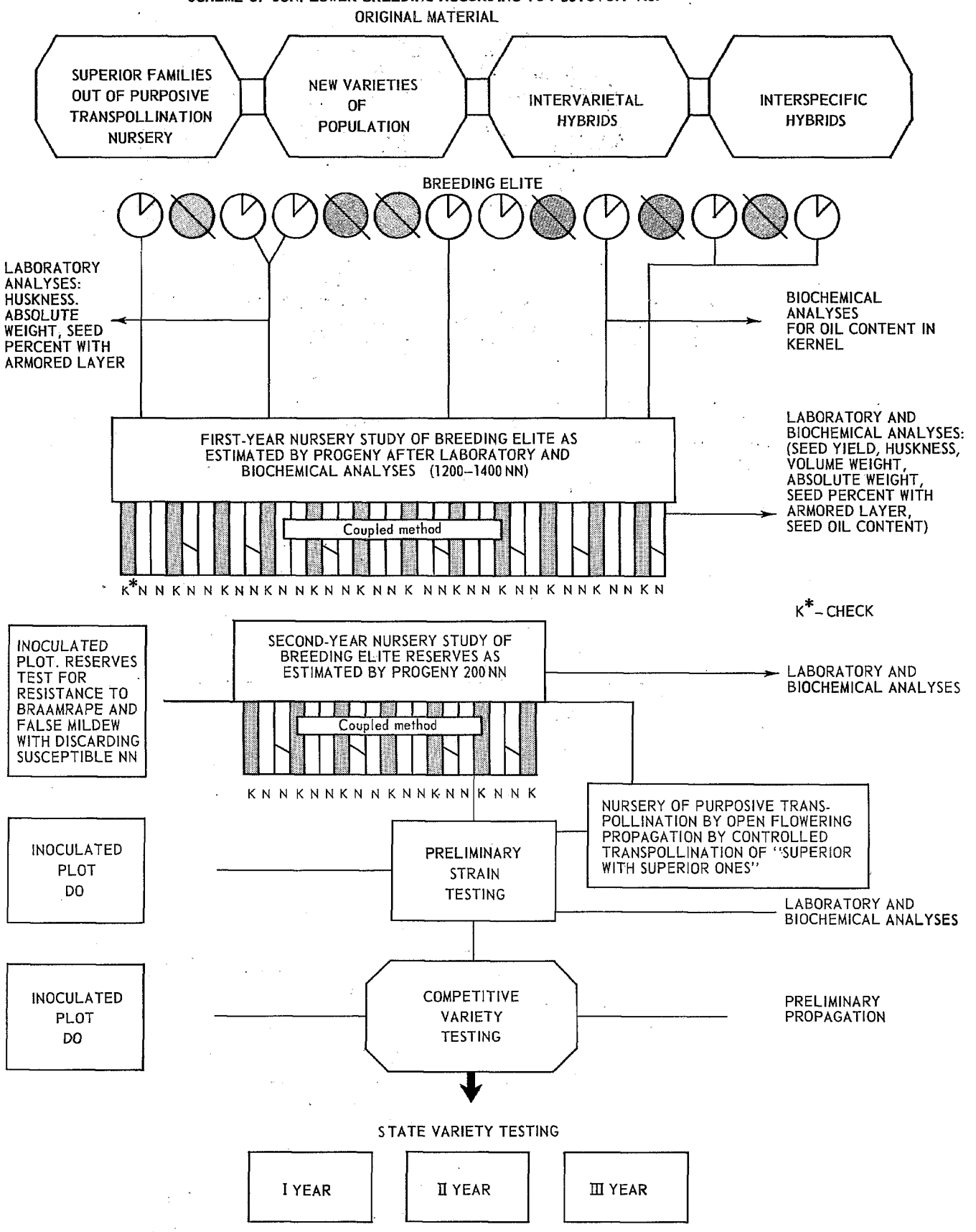
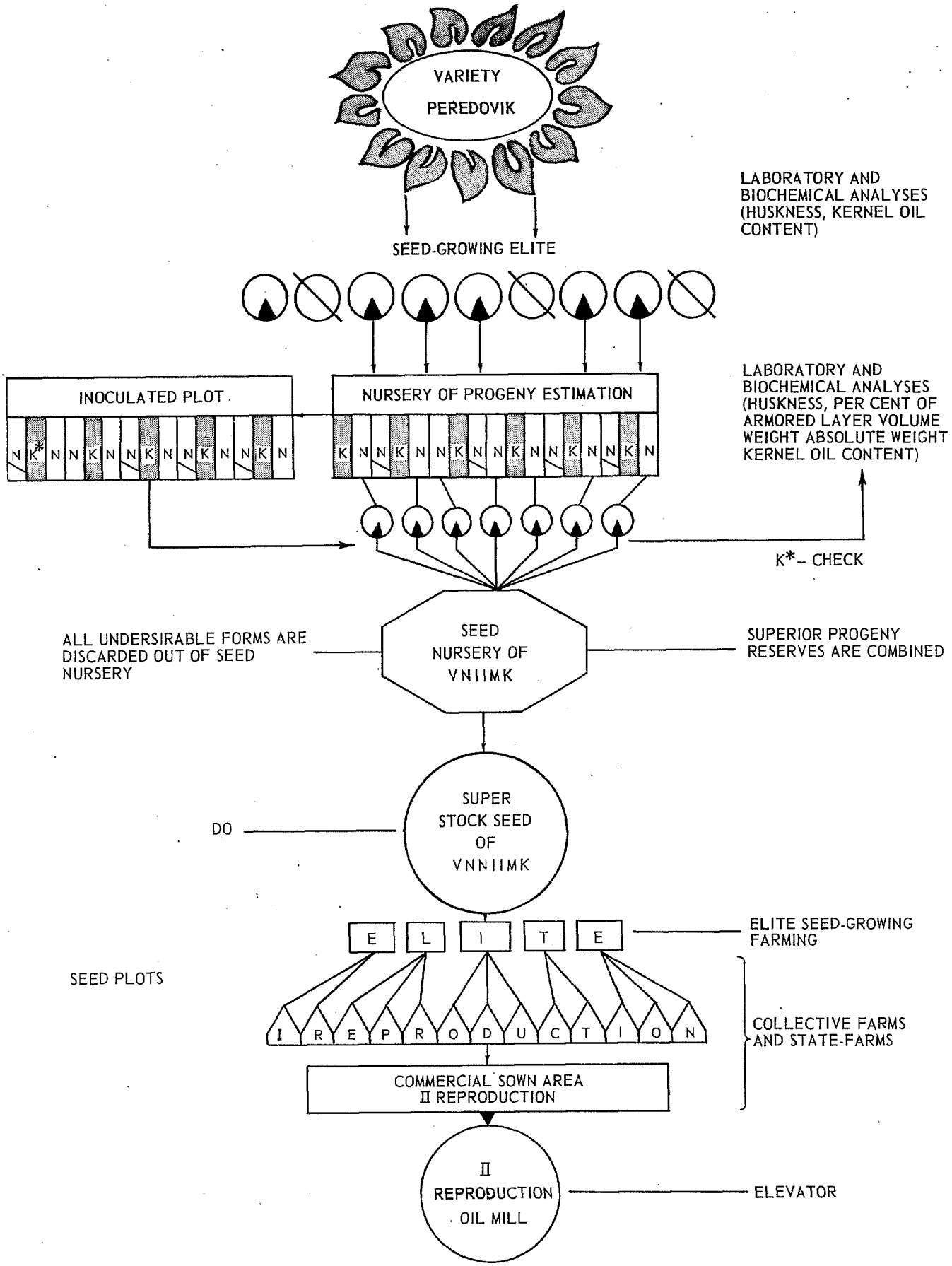
* varieties approved by state for cultivation in certain regions as a result of competitive variety testing.

SCHEME OF SUNFLOWER BREEDING ACCORDING TO PUSTOVOIT V.S.



SCHEME OF IMPROVING SUNFLOWER SEEDAGE AND ANNUAL VARIETY RENOVATION (VNIIMK)



methods of producing planting seed and yearly varietal renovation.

Such is the role of breeding and production of planting seed for the sunflower crop now. In the near future the best prospect of further advance is offered by the work commenced on interspecific hybridization and utilization of heterosis with self-pollinated lines. The report on the first item will be delivered by the author of the work, G. V. Pustovoit.

The second item pertains to working out a method of producing interstrain hybrids based on the utilization of male sterility that will result in obtaining hybrid seed in quantity. Other ways of heterosis breeding are used, namely, selection with inbreeding and composing synthetic varieties from inbred lines.

In the experiments of our Institute one cycle of recurrent selection from the original variety, with evaluation of one generation pollinated lines on sister progenies released after intercrossing, increased yield 6% compared with standard method of breeding.

The first synthetic varieties (from 14 and 8 lines) when tested in 1965 exceeded the check-variety VNIIMK 8931 in oil yield by 8-10% whereas the best of new varieties developed by method of selection showed a gain of only 5%.

Line-hybrid method has a fuller effect, yield being obtained from F_1 of selfed lines. In this case methods of producing bulk hybrid seeds (100%) are of particular importance. The problem can be solved by utilizing heritable male sterility. In most cases in the material found sterility is genetic and is independent of cytoplasm. Though the problem of controlled crossing is only partially solved by genetic-type sterility, it may be of some use.

Sterility inherited from maternal plants through cytoplasm is found in sunflower too. Difficulties arise from the lack of the lines with complete fixing ability. Hopes are set on replicated selections from self-pollinated lines combined with "analysing" crossing aimed at the development of superior fixing properties. Four years' investigation show an increase of sterile plants from 23% to 75-90%.

In 1965 comparative tests included several interstrain hybrids produced on the basis of sterility (with partial discarding dioecious plants from maternal rows). They all exceeded check VNIIMK 8931 in seed and oil yield. Two best hybrids yielded an increase in oil of two centners per hectar (115-116%). These hybrids differ from checks not only in higher yield, but also in 3% higher oil content.

In a preliminary test superior late-ripening hybrids exceeded check-variety in seed yield by 14-19% and in oil yield by 17-20%. Thus the possibility of combining self-pollination with hybridization on the basis of male sterility opens new prospects for sunflower breeding.

COMMENTS FROM THE FLOOR MADE DURING PRESENTATION OF PAPER BY A. Y. PANCHENKO

1. Sackston: The centner used here is a metric cwt. or 100 kilos. So when you hear centners just put on two zeros and think in terms of kilos per hectar or pounds per acre.

2. Sackston: I was trying to help Dr. Panchenko express in English the precise nuance of meaning of the Russian and I think it would be best expressed as overall seed science except we have no such term.

   Kinman: Seed technology?

   Sackston: It is more than seed technology because there is physiology involved as well.

   Kinman: (inaudible comment)

   Sackston: O. K. then, seed technology.

   Kinman: We have different universities in the U.S. giving Ph.D.'s in seed technology.

3. Durksen: This was because of moisture, not because of disease?

   Panchenko: No, no, it is a question of moisture.

4. Panchenko: We translate it as corn bean.

   Sackston: We call it field bindweed.

5. Kinman: About 30 inches by 30 inches.

6. Sackston: I wonder if I might interject here. This could be very easily worked out on the 30 x 30 inch check-row spacing. When you put in one plant per hill you get 20,000 plants per hectar or 8,000 per acre, 2 plants per hill you get 40,000 per hectar. One plant in one hill, 2 in the next, one the third, 2 the fourth, you get the odd number 30,000 per hectar. Their 50,000 is 2-3, 2-3 and 40,000 is 2-2 all the way across, 30,000 is 2-1-2-1 and 20,000 is just one plant per hill. This is the beauty of the metric system it is easy to convert.

7. Sackston: Again, here, may I interject a word for those who are not familiar with broomrape. It is a parasitic plant dependent on its host for nourishment. It attaches itself by suckers to the root of the host plant and derives its nourishment from the host but then flowers above ground producing vast numbers of tiny seeds. Anyway you can see in Table 2 there are over 3,000 such flowering parasitic stocks per 100 plants or over 30 parasitic plants growing up to a height of a foot or so from each sunflower plant on the susceptible variety in heavily infested soil. When he talks about this with emotion you can understand it because these resistant varieties were literally their salvation.

Panchenko: I can see that this problem may be compared with the problem of rust-resistant varieties of wheat in Canada to broomrape in our country.

8. Sackston: Before we go any farther I think it would be worthwhile pointing out that the vegetative period in days in Soviet figures means time from emergence to maturity rather than from time of seeding to maturity. They feel that it is unfair to take in the seed germination period which may vary from a few days to two weeks depending on soil conditions. So the period of vegetative growth always is taken as emergence to harvest.

Panchenko: We consider this alright because sometimes seeds lay in the soil two weeks sometimes they emerge in five days.

9. Sackston: This is the actual production in the factory or in the processing plant from the seed.

DISCUSSION

Orellana, R. G.: I wonder what type of rotation you use in growing sunflowers in Russia?

Panchenko: In different regions of our country there are different rotations. I shall give you the ususal crop rotation at Krasnodar. It is a rotation of 8 to 10 fields.

1. Alfalfa
2. "
3. Winter wheat
4. " "
5. Casterbean
6. Winter wheat
7. Sunflower
8. Winter wheat
9. Flax, mustard, coriander
10. Corn

Panchenko: This is the rotation at our experimental station. Because we are an oil research institute we set up our rotation with oil plants. Field 9 will be sown with plots of several different crops. In collective and state farms field 5 may be sugar beets, and field 9 flax or small grains.

Johnson, Ken. What is the rainfall there?

Panchenko: Our country is so wide, 616 mm. per year at Krasnodar.

Robinson: What is the interval between sunflower harvest and winter wheat planting?

Panchenko: Usually we harvest sunflowers at the beginning of August. When we left for Canada the early varieties were mature. Now the whole process of harvesting sunflowers is underway. We sow winter wheat in the last decade of September and beginning of October. I guess that is what you mean by your question. You think that the volunteers are a problem after you sow winter wheat?

Robinson: No, you answered my question.

Panchenko: There is no difficulty.

Durksen: When you select for a high oil content over these long periods and obtain the increases in oil content do you simultaneously obtain any appreciable change in oil composition, different acids and so on?

Panchenko: Yes, Yes, When we went from 33 to 55% oil content there was not only increase of quantity but of the quality. Linoleic acid is increased very significantly. It is the main character that is changed in quality of oil.

Heiser: Have branched, small-headed sunflowers become established as weeds in your country?

Panchenko: No.

Heiser: They never occur as weeds?

Panchenko: No. Mme. G. Pustovoit now has 30 species of genus Helianthus - some for 20 years and we see no danger of weed species of Helianthus occurring in natural conditions.

Kinman: You mention the term recurrent selection in the last part of your lecture. Many of us plant breeders in this country would call Academician Pustovoit's method a form of recurrent selection. Does your terminology agree with this or not? We would think of the method, Pustovoit's method, as one of the forms of recurrent selection.

Panchenko: Yes, Yes.

Kinman: And as such one of the most extremely useful forms of breeding.

Sackston: The difference I think is that it is not so much recurrent selection as continuous selection because he never stops for even a year.

Kinman: This is what we mean by recurrent selection.

Sackston: Yes, it is a continuous thing, this is the essential aspect of his work, never stopping.

Kinman: Not necessarily. There are all forms of recurrent selection. This is simply one of the forms.

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