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Actual problems of breeding and seed production of agricultural crops in the Russian Federation

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Abstract. The purpose of the study is to analyze the current state of the system of breeding and seed production in Russia, as well as to identify the constraining factors of its development. A model of selection and seed production of agricultural crops is proposed. The costs for the construction of the seed breeding center are determined. The paper discusses some measures to create conditions for establishing the domestic seed fund of the most import-dependent crops at a level of at least 75%. Also, the research presented in this paper identifies an array of problems in seed production (high dependence on import supplies of hybrids, sowing of substandard seeds, violation of the time for variety shift and variety renewal) that lead to a shortfall in the yield and a decrease in the profitability of agricultural production.

1. Introduction

Domestic selection and seed production are the basis for the development of the crop industry, which products account for more than 40% of the total agricultural production of the country. Ensuring the country's food independence and the fulfillment of the tasks (laid down in the current State Program for 2013–2020) directly depend on its development.

The works of domestic scientists discuss the problems of regulatory support and organization of seed production (Berezkin, 2006), the functioning of the seed production system (Smirnova, 2010), as well as the quality and certification of seeds (Malko, 2004).

2. Research Methods

The study used the methods of comparison, calculation and design, the graphical presentation of the results, monographic research.

3. Results

Formed in the 20th century, the system of breeding and seed production successfully functioned and provided the country's agriculture with high-yielding varieties and high-quality seeds. This period was characterized by large-scale production of elite seeds and the first reproduction in the country. So,



only for 1976-1980, 840 thousand tons of elite were produced annually [1]. This system allowed to create a wide genetic diversity of the original breeding material, to increase the resistance of crops to diseases and pests, to create numerous varieties and hybrids of crops.

The conceptual model of breeding and seed production in the Russian Federation is presented in Figure 1.



Figure 1. Model of breeding and seed production of agricultural crops in the Russian Federation
Source: Compiled by the authors.

In recent years, profound structural changes have taken place in the crop production sector of the Russian Federation, which determined the current state of plant breeding and seed production of the most important crops in the country:

- The status of seed breeding of agricultural crops in the Russian Federation has not been determined. This situation is mainly due to the fact that the Draft Law "On seed production" has not yet been approved;
- Natural climatic and phytosanitary risks of crop production increased (droughts in 2010, 2012, 2015); the development of dangerous pests and diseases (locust pests in 2015, 2016, meadow moth, late blight, broomrape, etc.);
- The lack of necessary infrastructure for providing agricultural producers with high quality (certified) seed (planting) material of high reproductions of the best varieties;
- The material, technical, and technological base of breeding and seed production is outdated, which does not allow to effectively conduct the selection process and ensure the production of high-quality seeds of new zoned varieties. There has been a technological lag in the selection of crops that determine the food security of the Russian Federation. The share of seeding substandard seeds for major agricultural crops reaches 30%;
- There are serious problems in the system of staffing (caused by the reduction of the departments of breeding and seed production in a number of agricultural universities, the elimination by the Higher Attestation Commission of the specialty "Selection and Seed Production" for awarding the degree of candidate of sciences, low wages and housing for seed agronomists). As a result, there is no influx of young personnel into the industry, which leads to the "aging" of the composition of scientists, plant breeders, and specialized specialists in agricultural organizations;
- The bill on plant genetic resources has not been approved, which does not allow for the transfer of land under plant collections to the status of particularly valuable land and therefore are often subject to alienation.

It should be noted that earlier (in 70-80 years of the last century), 278 experimental production enterprises of the Russian Academy of Agricultural Sciences were engaged in seed production, which are now renamed as FSNB and subordinated to the Ministry of Science and Higher Education of the Russian Federation. These farms provided seeds for agricultural production, up to 80% of the need [1]. To date, their number has decreased almost four times, and they are in a difficult financial situation, which does not allow to effectively engage in industrial seed farming.

Industrial seed production is the production of high-quality seeds by a special technology in specialized seed farms, carried out by an industrial method using mechanized integrated points and seed plants for processing and storing seeds. At the same time, the cultivation of high-quality seeds is separated from the production of food and feed grains, which eliminates mechanical clogging of seed material.

All this does not allow agricultural producers to provide high-quality seeds and planting material of high reproductions of new zoned varieties.

For individual crops, the volume of seeds of domestic production and their quality do not meet the needs of agricultural producers in the required volumes. The share of sown seeds of domestic production remains high only for cereals and leguminous crops, especially for such important crops as corn (54%), sunflower (42%), sugar beet (19%), vegetables (50%) (Table 1).

Table 1. Share of sowing of domestic and foreign seeds of main agricultural crops in 2016.*

Name of crops	Domestic, %	Foreign, %
Vegetables	50	50
Sugar beet	19	81
Potatoes	22	78
Corn	54	46
Sunflower	42	58
Cereals and legumes	91	9

* According to the Department of Plant Production, Chemicalization, and Plant Protection of the Ministry of Agriculture of Russia.

According to these types of crops (with the exception of cereals and leguminous plants), we actually became dependent on imported supplies of hybrids, which cannot be used for subsequent reproduction. Moreover, if the share of seeds of domestic production in 2010 reached 72% in sunflower, 66% in corn, 47% in potatoes, 35% in sugar beet, then (as follows from the data of Table 1) these figures did not exceed 42%, 54%, 22%, and 19%, respectively, in 2016.

At the same time, the production of domestic seeds today is often uncompetitive due to the use of outdated breeding and seed equipment, lack of funds for the purchase of fertilizers, and plant protection products.

A high degree of debris, contamination, reduced viability of seeds, as well as their injuries during harvesting and part-time work (injuries of seeds of grain crops by harvesting machines can reach 30%, and up to 50% in grain cleaning equipment) leads to a decrease in field germination and disease resistance of plants to non-simultaneous ripening.

According to the Federal State Budget Institution "Rosselkhoz Center", the share of seeding of substandard seeds in major agricultural crops in some regions reaches 30%. Under such conditions, the variety realizes its potential yield only by 20-30%.

The scientifically substantiated variety shift terms and variety renewal terms are violated. Varieties that are repeatedly replanted in the on-farm seed production do not reveal their biological potential and gradually lose the leading role in increasing agricultural production, reduce their competitive advantages in quality in the domestic and global markets.

There is an illegal circulation of seeds (use for sowing seeds of unknown origin, reduced sowing, planting qualities).

The share of sowing of seeds of mass reproductions in total crops in the country is over 20%, which leads to the degeneration of varieties and a significant shortage of yield. In accordance with scientifically based recommendations, the seeding of mass reproductions is not allowed. The reasons for this situation are:

- Lack of funds from agricultural producers for the purchase of seeds of higher reproductions and the implementation of timely renewal and variety shift;
- Low seed quality;
- Lack of qualified personnel (seed agronomists) in agricultural organizations.

All this leads to a significant underperformance of the crop and a decrease in the profitability of agricultural production.

The yield of corn for grain in Canada, USA, Italy, France, Germany increases due to the intensification of production and reaches 7-10 t/ha, it is 5-6 t/ha in Poland and Hungary. In the Russian Federation, the average yield of maize for grain over the past five years (2011-2015) was about 4.6 t/ha, with the potential yield of domestic early ripening hybrids of maize over 12 t/ha.

The yield of sunflower in the Russian Federation is 1.4 t/ha. One of the reasons for this level of yield is the outdated material and technical base for the preparation of high-quality sunflower seeds. Currently, this is the only plant in the Russian Federation that meets modern requirements (in the Volgograd region).

In recent years, the production of sugar beet increased from 31 thousand tons in 2006-2010 to 40.0 thousand tons in 2011-2015. At the same time, the share of seeds of domestic breeding in crops has declined steadily and in 2016, constituting only 19% of the total.

The share of domestic varieties and hybrids of forage grasses is more than 70%. Currently, the need for grass seed is satisfied by only 50% and by 15-25% for legume grass. The main quantity of forage grasses seeds is grown by farms for their own needs. The marketability of their seed production does not exceed 10-15%, which is due to the lack of the necessary financial resources from agricultural producers for the purchase of high-quality seed. The demand for seeds of higher reproductions has sharply (2-3 times) decreased, which leads to a violation of the system of variety renewal and variety shift. The transition to on-farm seed production in the absence of the necessary material and technical base for seed production led to an increase in their poor quality in germination and contamination to 30–40% of the sowed lots (15–17% in 1986–1990), which predetermines a large loss of forage, reduction of seed yields and significant costs for their cleaning, as well as increased weed infestation. In the period 2011-2013 in the Russian Federation, several modern seed factories were built (LLC “Betagran-Ramon”, LLC “Sesvanderkhav-Agrotekhgarant”, LLC “Belorechensky Seed Plant”), allowing to produce seed that is competitive in its quality. However, the industry failed to ensure the introduction of advanced biotechnology methods into the selection process, as well as to organize the industrial cultivation of sugar beet seeds using modern technologies.

The combination of these factors does not allow to fully implement in practice the genetic potential of hybrids of domestic breeding and reduces their competitiveness.

The average annual capacity of the Russian potato seed market is estimated at 6-6.5 million tons, including 150 thousand tons of elite seeds. In agricultural enterprises, not more than 60% of the area is planted with tubers of high planting quality, including 50% of the varieties of domestic breeding. It should be noted the extremely low competitiveness of Russian breeding varieties in the sector of leading potato farms (the share of seed material of Russian varieties in household farms is traditionally higher, but its quality is often extremely unsatisfactory: fourth reproduction and below). High dependence on varieties of European breeding is the main risk factor in the field of providing agricultural producers of the Russian Federation with seed potatoes.

The low competitiveness of potato varieties of Russian breeding in the domestic and international markets is due to the extremely low levels of funding for research and development in the field of Russian potato, as well as many related problems.

At the same time, the selection and seed production of potatoes in the Russian Federation is practically not provided with modern material and technical base and infrastructure; there is a weak equipment of scientific laboratories and seed-growing centers with modern instruments, equipment and reagents.

The resource for the development of domestic potato farming lies in its low investment attractiveness at present due to the high resource intensity of production. This obstacle can be removed in a short time due to the use of new high-yielding varieties, the development of innovative production and processing technologies, including in healthy food and feed.

The capacity of the market of seeds of vegetables and melons is 10 thousand tons. Domestic selection of vegetables and melon crops has great achievements, but seed preparation remains unsatisfactory, which reduces the competitiveness of hybrids of domestic breeding. Import of vegetable seeds is about 50% of the total supply on the market.

According to the N. A. Timofeev Breeding Station of the Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev, the cultivation area and market capacity of cabbage, onion, carrot in Russia are presented in Table 2.

Table 2. Production and market capacity of seeds of hybrids of the first generation of major vegetable crops in the Russian Federation, on average, 2015-2017. *

Crop	Cultivation area, thousand hectares	The need for seeds, tons	Annual production, million tons	Capacity of market, billion rubles
Cabbage	113	30	2.7	1.8
Onion	88	300	1.5	2.4
Carrot	66	100	1.3	2.0
Total	267	430	5.5	6.2

* Table compiled on the basis of analytical data [2-4].

According to expert estimates of the above organization, the annual need for seeds of these crops is 430 tons, and the capacity of the seed market is 6.2 billion rubles. Seed imports in three crops range from demand: 60% for white cabbage, 80% for bulb onions, and 70% for table carrots. The expected economic effect from the import substitution of the assortment of foreign companies in Russia by domestic competitive F1 hybrids of cabbage, onions, and carrots can reach 4.65 billion rubles in year.

The deep crisis that breeding and seed production of vegetable crops in Russia is currently experiencing in Russia is explained by the outdated methods of breeding. As a result, domestic varieties and hybrids of vegetable crops are inferior in competitiveness to foreign analogues by such important criteria as complex resistance to diseases and pests, presentation, and leveling of finished products, suitability for industrial processing.

The experience of foreign companies shows that rapid response to market demands is due to the technology of the selection process, which is based on molecular and phenotypic labeling of selectionally valuable signs of inbred lines.

It is necessary to take into account that the competitive advantages of hybrids and varieties of foreign selection provided largely high-tech process of preparation of the seed (seed plants). In order to increase the competitiveness of domestic seed production of corn, sunflower, sugar beet, vegetable, and other agricultural crops, it is necessary to switch to the production of high-tech hybrid seeds of the 1st generation of these crops by 2025.

According to the Association "Greenhouses of Russia" in the Russian Federation, the area of greenhouse enterprises with photoculture is 300 hectares and by 2020, it will increase to 700 hectares. Domestic seeds of cucumbers and tomatoes are not produced in our country for the technology of year-round cultivation of vegetables with additional lighting.

Currently, there are the LLC “Gavrish selection center” in Russia (2.3 hectares of winter greenhouses and 1.2 hectares of film greenhouses) and the LLC “Poisk Breeding and Seed Production Complex” (2 hectares), as well as seed selection companies, namely LLC “Manul”, LLC SSA “Ilinichna”, LLC SSF “Partenokarpik-D”, operating in the leased areas of operating greenhouse complexes. These breeding and seed firms provide greenhouse enterprises with domestic seeds for 60% of the total demand.

In order to develop breeding and seed production for protected soil in the Russian Federation, it is necessary to increase the area of existing breeding centers by 5 hectares.

In order to fully provide the domestic production of the protected soil subsector with seeds, eliminate the dependence on imports, it is necessary to solve problems in the construction and modernization of seed breeding centers.

According to the Department of Crop Production, Chemicals and Plant Protection of the Ministry of Agriculture of Russia, we will present an approximate cost structure for the construction of the seed breeding center:

1. Modern winter greenhouses divided into blocks of 1.5-2 thousand m², which support an individual technological mode of growing vegetables (equipped with a system of drip irrigation, curtains, moistening, additional lighting, isolation from insects, seedling separation), 1 ha/150 million rubles.
2. A film greenhouse for primary seed production, 1 ha/10 million rubles.
3. A block boiler room and gas generator (3-5 MW), 50 million rubles.
4. Laboratories (molecular markers, phytopathological, seed control), 40 million rubles.
5. A warehouse complex with equipment, workshop for the production of seeds with equipment, dryers and seed preparation laboratories, workshops for the processing and packaging of seeds, 50 million rubles.

Total cost per 1 ha is 300 million rubles (at the rate of 1 euro = 60 rubles).

According to the Russian State Agrarian University - Moscow Agricultural Academy named after K. A. Timiryazev, the cost of material and labor resources for the creation of one F1-hybrid of biennial crops is about 70 million rubles, as it provides for work for at least 15 years, the use of highly qualified specialists, expensive protected soil and equipment.

Currently, with the aim of developing domestic seed production, the following measures are being implemented under the State Program for the Development of Agriculture and Regulation of Agricultural Products, Raw Materials, and Food for 2013–2020:

- Providing compensations for part of the cost of acquiring elite seeds of agricultural crops;
- Ensuring reimbursements (20%) of the direct costs incurred for the creation and modernization of seed breeding centers,
- Rendering unrelated support to agricultural producers for carrying out a complex of agrotechnological works, ensuring an increase in the production of seeds of vegetable crops, seed potatoes (1st and 2nd field generation, super-super elite and elite) per 1 hectare of sown area.

In December 2015, the Ministry of Agriculture of the Russian Federation held meetings of the Commission for the Selection of Investment Projects Aimed at Building and (or) Upgrading the Facilities of the Agro-Industrial Complex, at which 8 breeding and seed-growing centers worth 175.74 million rubles were recognized for co-financing from the federal budget in 2016.

Currently, the Ministry of Agriculture of Russia has received nine investment projects aimed at the creation and modernization of breeding and seed centers. The cost of facilities in accordance with regulatory costs is 804.0 million rubles, the estimated amount of subsidies is 160.8 million rubles.

According to the AIC governing bodies in the constituent entities of the Russian Federation, 87 seed breeding centers are planned to be commissioned in the regions up to 2020, of which 61 to be built and 26 to be modernized.

The aim of the program is to create conditions for the formation of the domestic seed fund of the most import-dependent crops at a level of at least 75%.

To achieve this goal it is necessary to solve the following main tasks:

- Development of promising technologies for seed farming of agricultural crops, ensuring a high reproduction rate and quality of the seed material obtained;
- Organization of industrial seed production of agricultural crops according to modern technologies in various agro ecological zones;
- Implementation of a set of measures aimed at stimulating the sale of seeds of hybrids of domestic breeding in the domestic and foreign markets;
- Creation of an effective system of rendering state services in the field of testing varieties and hybrids, seed production of agricultural crops and plant protection.

4. Conclusion

As a result of the implementation of measures of the State Program for 2013-2020 by 2020, domestic crop production can reach a qualitatively new level, which would not only provide for the country's domestic needs in agricultural products, but also significantly increase the export potential of the Russian Federation.

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