Chapter 2
Potato Consumption Pattern, Crop Acreage, Bulk Yields, Yielding Capacity, and Priority Lines of Innovative Development

Sergey Valentinovich Zhevora

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FAO [1] estimates that the global consumption of potato and potato products per capita is about 35 kg a year, while the average for the European region is 85 kg per capita and that for Russia is 90 kg per capita.

The average annual amount of potato consumed for food purposes in the Russian Federation is estimated at 13–14 million tons. In order to achieve advanced processing into potato products (French fries, potato chips, dry mashed potatoes), about one million tons are needed. The need for potato seed for categories of agricultural organizations (AO), peasant (private) farms (PPF), and individual entrepreneurs (IE) with a total planting area exceeding 300,000 hectares is about one million tons [2, 3]. It is extremely difficult to assess the real volumes of potato used for seed and fodder in the category of small individual farms, although the estimate indicator here may be five to six million tons. Average annual storage losses in farms of all categories can be estimated at 1.5 million tons, while export shipments can be estimated at 150,000–200,000 tons.

Thus, the level of domestic production of potato in Russia should not be less than 22 million tons. Lowering this level may result in a deficit of commercial potato in the overall balance and, therefore, an increase in the share of imports. The estimated import ratio in total potato consumption is 300,000 to 350,000 tons. It is mainly an early "new" potato, which is characterized by growth in demand and volume of

S. V. Zhevora (✉)
Russian Potato Research Centre, Moscow Region, Russia

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sales on the retail networks during the off-season when last year's crop stocks are almost out in May and consumers are at least 2 months away from the beginning of supply of commercial potato of a new crop.

According to official statistics at year-end 2019, the area under potato in Russia in farms of all categories was 1,256,000 hectares, including in the category of agricultural organizations – 170,000 hectares; peasant (private) farms and individual entrepreneurs – 135,000 hectares; and small individual farms – 951,000 hectares (Table 2.1).

The bulk yield of potato in farms of all categories in 2019 was 22.0 million tons; in particular, 7.5 million tons were produced by agricultural organizations and peasant farm enterprises. The analysis showed that for the period from 2013, the share of individual farms in potato production has decreased from 77.7% to 65.8% with a simultaneous increase in the share of agricultural organizations from 13.8% to 21.0% and peasant (private) farms and individual entrepreneurs from 8.6% to 13.3% (Fig. 2.1) [4–6].

Most likely, further decrease in the share of individual farms in the total volume of potato production can be expected in the following years, and their dominance in the market of commercial potato will be further decreased. A possible increase in gross output of commercial potato in agricultural organizations, peasant farm enterprises, and individual entrepreneurs can be achieved in part by expanding the areas and especially by increasing yields.

The index of average potato yielding capacity in 2019 in the category of agricultural organizations was 28.4 tons per hectare, while in the category of peasant (private) farms it was 22.7 tons per hectare, at an average yielding capacity in farms of all categories of 15.3 tons per hectare (Table 2.2).

Table 2.1 Planting area, bulk yield, and yielding capacity of potato in farms of all categories in 2018[a]

	Farms of all categories	Including:			Was in farms of all categories in 2018	2019 as a percentage of 2018
		agricultural organizations	Peasant (private) farms and self-employed entrepreneurs	Individual farms		
Area, thousand hectares	1256	170	135	951	1325	94.8
Bulk yield, thousand tons	22,080	4630	2924	14,525	22,395	98.6
Yielding capacity, tons per hectare	17.8	26.4	22.7	15.3	17.04	104.5

Source: compiled by the authors

[a]According to ROSSTAT, with due account for the returns of the 2016 All-Russian Agricultural Census

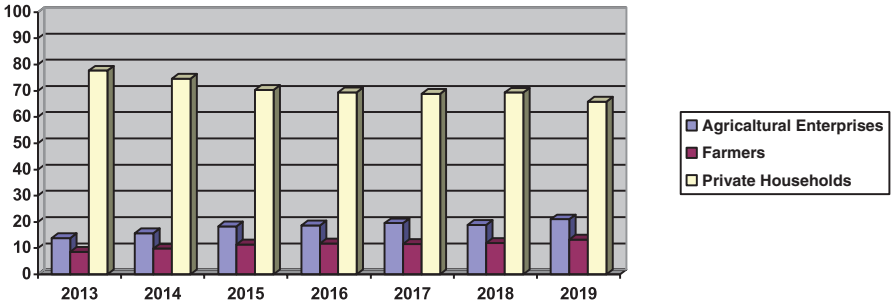

Fig. 2.1 The bulk yield structure of potato by categories of farms (% of the total volume of production). (Source: compiled by the authors)

Table 2.2 Potato-yielding capacity by categories of farms of the Russian Federation, tons per hectare

Farm categories	2013	2014	2015	2016	2017	2018	2019
All farm categories	14.7	15.3	16.4	15.8	16.3	17.0	17.8
Agricultural organizations	19.8	20.7	23.4	22.6	25.8	25.6	28.4
Peasant (private) farms and self-employed entrepreneurs	17.6	18.5	19.6	18.6	20.6	21.4	22.7
Individual farms	13.8	14.1	14.8	14.2	14.2	15.0	15.3

Source: compiled by the authors
[a]According to ROSSTAT, with due account for the returns of the 2016 All-Russian Agricultural Census

In the near term, projected indicators of average potato-yielding capacity in agricultural organizations applying modern technologies can stabilize at 26–28 tons per hectare. Peasant farm enterprises will likely remain at a lower yield level of 21–23 tons per hectare, largely due to the more backward material and technical base of most peasant farm enterprises as compared to that of agricultural organizations, as well as the farmers' still more difficult access to leasing equipment, bank loans, fertilizer subsidies, fuel, and other resources.

For most agro-enterprises, which have the necessary material and technical base and established distribution channels, the volume of potato production will most likely continue to be stable. However, a significant potential for real growth in the volume of potato production can be employed in the category of peasant (private) farms and individual entrepreneurs. To increase the efficiency of potato production in this category of farms, development of cooperation between farms in the production and sales of commercial potato and potato seed may be especially important. The accumulated experience of domestic and best foreign practices shows that within the framework of interfarm associations, farmers, becoming members of the cooperative and complying with its charter, do not lose economic and commercial independence, but relieve themselves of problems related to sales of products, delivery of seed stock necessary for its production, or obtainment of other services. At the same time, all available resources and capabilities of each member of the

cooperative are employed in a rational manner with a view to reducing the cost of production, improving the quality of the final product, and making a profit [7].

High efficiency of cooperation between farms in the area of production and trade of potato seed and commercial potato is confirmed by long experience of best international practices of countries with high level of potato industry development (France, Netherlands, United States, etc.). Taking this into account, cooperation between farms based on voluntary association of potato-growing peasant (private) farms, as well as economically strong individual entrepreneurs could become one of the most efficient and promising areas in the development of the potato-growing industry in Russia. Otherwise, small enterprises alone will find it increasingly difficult to stay on the market due to their higher costs of production and hence lower profitability. Creating the most favorable conditions for the development of cooperation between farms could significantly affect the increase in potato production efficiency in the category of private farms and would allow them not only to increase their sale volumes using their existing traditional distribution channels, but also to adjust supplies of high-quality farm products to modern large retail networks.

In the present context, further development of large-scale commercial potato production is impossible without a streamlined system for providing potato-growing agricultural enterprises, peasant (private) farms, and individual entrepreneurs with seeds of elite classes and top-breeding generations [8, 9]. In this regard, increasing the production volume and dramatically improving the quality of original and elite potato seed becomes one of the key priorities of stable and profitable maintenance of the potato-growing industry [10–14].

According to the results of the monitoring held by FSBI "Rosselkhoztsentr," 788,800 tons of potato seed were planted in agricultural organizations and peasant (private) farms in 2018 (Table 2.3).

The analysis for the period 2011–2018 shows that a considerable proportion of potato seed, which fails to conform with applicable regulatory requirements of stan-

Table 2.3 Results of quality monitoring of potato seed produced by FSBI "Rosselkhoztsentr" for 2011–2018

Years	Planted, thousand tons	Checked		Complies with applicable regulatory requirements of standard	
		Thousand tons	%	Thousand tons	%
2011	889.3	706.9	79.5	460.4	65.1
2012	1064.8	1028.8	96.6	798.1	77.6
2013	794.6	599.0	75.4	504.0	84.1
2014	826.6	597.1	72.1	515.3	86.3
2015	884.4	653.1	73.8	563.7	86.2
2016	828.5	637.1	76.9	564.6	88.6
2017	743.1	568.1	76.5	490.3	86.3
2018	788.8	594.4	75.4	507.2	85.3
2019	777.3	601.2	77.3	537.7	89.4

Source: compiled by the authors

dards and varies in various years within the range 12–35%, is planted annually in agricultural organizations and peasant (private) farms.

The situation with the use of the available potential of domestic potato varieties also requires serious improvement. In 2018, 442 potato varieties were presented in the National Register of selection achievements allowed for use, of which 235 varieties (53.4%) were created by domestic originators and 207 varieties (46.6%) were created by foreign originators. That said, the share of varieties created by domestic originators in the total amount of planted seeds following the results of the 2018 monitoring was only about 20%. Leading positions in terms of potato seed volumes were held by varieties such as Gala (81,600 tons), Red Scarlett (78,800 tons), Lady Claire (25,500 tons), Nevsky (24,000 tons), Rosara (21,400 tons), Udacha (15,400 tons), Queen Anne (13,900 tons), Innovator (10,900 tons), Colomba (10,700 tons), and Labelle (9700 tons). Of ten leading varieties in terms of potato seed volumes, eight varieties were created by foreign originators, and only two varieties were created by Russian originators (Udacha and Nevsky).

A similar analysis conducted more than 10 years ago showed that four domestic varieties were in the top five of the leaders – Nevsky, Udacha, Elizabeth, Lugovskoy – with only one foreign variety – Romano [15]. Based on the expert assessment, the share of varieties of foreign selective breeding programs in the total potato seed volume in large agro-enterprises can be estimated at 80–85%, in peasant (private) farms –at 60%, and in individual farms at the level of 40–50%, although exact statistics for these indicators are not available. Although Russian breeders have created many new promising varieties with higher yields and resistance to diseases and pests over the last years, apparently, for a considerable part of major producers it is still profitable to import seed stock of varieties of foreign selective breeding rather than spend years reproducing Russian varieties. In any case, a large proportion of varieties created by foreign originators, especially in the sector of large-scale commercial potato production, could pose a real threat of further substitution of Russian varieties.

One of the main reasons for the low level of potato-yielding capacity in many regions has been the high rate of infection of seed stock with contagious phytopathogens. This fact is pointed out by many agricultural enterprises, as well as private farms, and especially, individual farms, where multiyear breeding generations of potato are often used for planting, which are severely affected by viral, bacterial, or fungal infection. The biological features of potato as a clonal crop plant contribute to rapid accumulation of infections in the case of reproduction of seed stock. The situation is further aggravated by the fact that many potato producers do not observe spatial isolation of seed plantings from plantings of commercial potato; phytosanitary and variety rogueings and protective measures are not always carried out in an efficient and timely manner.

The deterioration of the situation with the correlation between potato seed volumes of Russian and foreign varieties is also mainly due to the fact that the technological level of domestic original seed production and the technological infrastructure of most institutions – originators of Russian varieties – are simply not comparable to the level of modern Western European breeding and seed production centers and

companies. In this regard, taking effective measures aimed at modernizing the material and technical base of selective breeding and seed production of potato and creating modern breeding and seed production centers are becoming one of the most crucial tasks in potato-growing industry development in Russia. The implementation of investment projects aimed at establishing and (or) modernizing agro-industrial facilities under the sub-program "Development of Selective Breeding and Seed Production of Potato" of the Federal Scientific and Technical Program for the Development of Agriculture for 2017–2025 will be important in this case [8, 9].

The situation in the area of scientific support and innovative development of potato-growing industry also needs fundamental improvement. The wide application of innovative technologies of selective breeding and seed production, increasing the competitiveness of domestic selective breeding and their accelerated promotion of production, should become the top priorities. This, in turn, requires a significant increase in the methodological level and in the volume of work by scientific institutions in the most important areas of fundamental and exploratory applied research, including:

- Creation of new promising potato varieties with predefined agronomic characters based on traditional selective breeding and modern methods of marker-assisted and genome-selective breeding.
- Conservation, maintenance, and development of bio-resource genetic collections for the selective breeding of new domestic varieties for various purposes and the establishment of shared use centers for breeders on this basis.
- Creation and expansion of a DNA marker base and the search and development of new DNA markers necessary for the mass and effective application of marker-based breeding.
- Development of new high-efficiency methods and technologies for the direct editing of the potato genome in order to produce genotypes with predefined agronomic characters for subsequent selective elaboration.
- Development of methods for the diagnosis of phytopathogens and creation of highly sensitive test systems based on PCR technologies, enzyme-immunoassay, and immunochromatographic assay to identify potato viruses and bacteria.
- Application of modern biotechnological techniques and meristem tissue technologies for the production and clonal micropropagation of in vitro stock and creation of a competitive pool of new promising varieties of original potato seed.
- Development of efficient technologies of potato growing, harvesting, storage, and protection from pathogenic agents affecting potato and abiotic stresses.

FSBSI "All-Russian Lorch Potato Research Institute," being one of the leading research centers in Russia for selective breeding and seed production of potato, currently coordinates scientific research within the framework of the implementation of the subprogram "Development of Selective Breeding and Seed Production of Potato in the Russian Federation" (Federal Scientific and Technical Program for the Development of Agriculture for 2017–2025).

One of the largest nuclear stocks of potatoes, comprising more than 800 specimens of wild and cultural species, complex interspecific hybrids, and varieties of

different geographic origin, has been formed in the breeding center of the All-Russian Lorch Potato Research Institute. This nuclear stock is constantly replenished due to receipts from the world collection of the All-Russian Institute of Plant Genetic Resources named after N. Vavilov, the International Potato Center (CIP, Peru), and other breeding centers.

Practical result of the selective breeding activities of the institute in recent years consists of the creation of new original potato varieties of various ripening periods and various intended use.

Table varieties for early production:
Meteor, Gulliver, Krepysh, Zhukovsky Early, Udacha
Long-storage table varieties:
Velikan, Kolobok, Fregat, Babushka, Il'inskiy
Table varieties for diet food (health food):
Vasilek, Fioletovyi, Severnoe Siyanie, Siurpriz
Varieties intended for processing into French fries:
Favorit, Fritella, Nadezhda, Vostorg, Navigator, Ekstra
Varieties intended for processing into crisps potato:
Vympel, Grand, Barin, Debiut, Krasa Meshchery, Iziuminka
Varieties intended for processing into mashed potatoes:
Krasavchik, Noktiurn, Signal, Brianskiy Delikates
Industrial varieties for starch production:
Divo, Malinovka, Nakra, Nikulinskiy.
Varieties for amateur gardeners:
Sineglazka 2016, Golubizna, Lorch

For all of these varieties, the laboratory of meristem tissue technologies has centralized in vitro production of certified nuclear seed stock for the original potato seed production, as well as the production of minitubers and super-superelite potato varieties from the potato-breeding center of the All-Russian Lorch Potato Research Institute, based on requests from interested agricultural organizations and agro-enterprises on a contractual basis.

In the coming years, innovative development of the potato-growing industry will largely depend on the efficient implementation of high-priority measures, which include:

- Creating conditions for obtaining stable indicators of potato-yielding capacity in the commodity sector (agricultural organizations and peasant farm enterprises) at a level of 25–26 tons per hectare, which will allow achieving stable bulk yield of commercial potato in farms of these categories at a level not lower than seven to eight million tons.
- Increasing the level of average potato yielding capacity in the category of individual farms up to 17–18 tons per hectare, which even with the expected decrease in areas in this category of farms allows achieving the bulk of yield at least 14–15 million tons and to satisfy real demand in the light of the long tradition of domestic production of potatoes for a considerable part of the population.

- Increasing the efficiency of the use of varietal resources, especially the best domestic selection achievements, and creating conditions for a more rapid increase in production volumes and increasing the quality of potato seed, as well as market promotion of new promising varieties of domestic selective breeding.
- Development and strict compliance with modern standard standards, specifications, flow charts, and scientifically based specifications of production of original, elite, and reproduction potato seed.
- Increasing the level of potato marketability through the use of high-quality domestic seed stock, efficient plant protection products, and introduction of innovative farming techniques.
- Development of potato-processing industry and promotion of the implementation of efficient capital investment project for the creation of modern hi-tech processing companies able to produce a large amount of various types of potato products which have a general run (French fries, potato chips, dry mashed potatoes), as well as ready-to-eat products (pasteurized potato) and processed foods (peeled potato in vacuum packaging, etc.).
- Infrastructure development of the potato and potato products market and creation of regional and interregional logistic centers for the sale of commercial potato and potato seed as well as potato products.
- Development and support of cooperation between farms and improvement of investment opportunities for the creation of modern technical base of potato production in this category of farms.

Successful implementation of the abovementioned high-priority measures and key priority decisions in the near future will largely contribute to the innovative development of the industry, provision of the stable output of potato, creation of modern logistical systems of market promotion of domestic potato and potato products of guaranteed quality, and reduction of import dependence.

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