Efficiency of potato production: analysis of variation and differentiation of regions of the Russian Federation

V Osipov, S Zhevora and N Yanushkina

1 Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, 49 Timiryazevskaya str., Moscow 127550 Russia
2 Market Economy Institute of the Russian Academy of Sciences, 47 Nakhimovsky prospekt, Moscow 117418 Russia
3 Lorch Potato Research Institute, 23 Lorch str., Kraskovo village, Moscow region 140051 Russia

E-mail: vs.ossipov@gmail.com

Abstract. The article makes an attempt to research the statistical dependencies characterizing the potato production efficiency in the subjects of the Russian Federation. Solutions to food security problems are revealed through the achievement of threshold values for the production and self-sufficiency of individual products. So, for the production of potatoes, the threshold value of food security is set at 95%. Achieving threshold values is extremely important for achieving food security, but it is equally important to assess the role of Russian regions in the production of potatoes, as well as to assess the efficiency of production in agricultural organizations, private household plots, and farms. The conducted economic and statistical analysis shows that the average yield for agricultural organizations is higher than for personal subsidiary farms by 1.5 times. Comparison with farms is also not in favor of the latter. Agricultural organizations have the opportunity to observe the technology of potato cultivation, buy new varieties, high-yielding and resistant to pests, apply fertilizers. Small farms are unable to meet the requirements of technology due to their scale, which affects the degeneration of the genetic line and the fall in yield.

1. Introduction

The problem of the effectiveness of potato cultivation in the regional aspect does not receive enough attention in the scientific circles of Russia. Therefore, one can point out only a few authors who addressed the problem under consideration, including B. M. Albogachieva, I. S. Lobyrev, M. I. Lukinykh, A. S. Sorokovikova [7], V. Stepanov, R. V. Shamilev, S. R. Shamilev. V. Stepanov, considering the production of potatoes through the prism of economic sanctions, comes to the following conclusion: if there is a shortage of the gross domestic collection, "imports from developing countries will easily cover the disadvantage"; therefore, the sanctions will not have a significant impact on the potato market [5].

In our opinion, B. M. Albogachieva, conducting an analysis of the efficiency of potato production in the republic of Dagestan, correctly identifies the key factors of the low productivity of the crop in question: the lack of cultivation technologies; lack of seed production; lack of primary sorting and storage [1].
With criticism of the approaches used, one can refer to the work of S. R. Shamilev, as the author applies the correlation-regression method to assess the relationship between the gross harvest of potatoes, acreage, and yield [8, 9]. This categorically can not be done, since these indicators are linked by a mathematical formula: yield = gross yield / area. In turn, M. I. Lukinykh, when assessing the impact on the gross harvest of potatoes, highlights factors such as the amount of fertilizer applied, the number of plows, the number of potato harvesters, potato consumption per person, etc., which we think is the right approach and does not contradict the postulates of econometrics [3].

2. Methods
In conducting the study, general scientific and special methods and tools of economic research were used: a set of scientific methods of the abstract logical method; economic and statistical method, cluster analysis, institutional analysis method.

3. Results
Developing the cycle of works devoted to the efficiency of potato production in Russia, let us turn to consideration of the variation and differentiation of production in the context of the subjects of the Russian Federation. To do this, we turn to the multidimensional grouping (cluster analysis) and highlighting the regions in which the most potatoes are produced with greater efficiency (Figure 1).

![Figure 1. Grouping of subjects of the Russian Federation according to indicators characterizing potato production in 2016(Note: built by the author in the Statistic software package).](image)

According to the information presented in Figure 1, the 2 clusters (groups) are distinguished, which are divided into 4 subgroups. To characterize the selected subsets, let’s calculate descriptive statistics (Table 1).

| Table 1. Quantitative characteristics of the selected groups of Russian regions (average values by subgroups). |  |  |  |  |
|---|---|---|---|---|


The number of subjects, units

|                | 1 group | 2 group |
|----------------|---------|---------|
|                | 1.1     | 1.2     | 2.1     | 2.2     |
| The number of subjects, units | 18      | 23      | 9       | 30      |
| Sown area, thousand hectares | 447.6   | 1939.9  | 11180.3 | 4840.7  |
| Gross yield, thousand tons     | 53.0    | 227.5   | 1142.1  | 488.1   |
| Productivity, c / ha           | 125.4   | 162.5   | 220.8   | 196.2   |

Note: calculated by the author in the Statistic software package.

The data presented in table 1, indicate that the subgroup 1.1 includes subjects with the lowest values, these are mainly regions that are in harsh weather and climatic conditions: North-West, Siberia, and the Far East.

The highest values are observed in subgroup 2.1, these are large subjects:

- Volga FD: rep. Bashkortostan, rep. Tatarstan, the Nizhny Novgorod region, which accounted for 47% of all the sown areas of the federal district and 45% of the gross yield;
- Central FD: the Bryansk region, the Voronezh region, the Kursk region, the Tula region, which accounted for 50% of the area and 48% of the crop;
- Siberian FD: the Altai region and the Krasnoyarsk region, with values in 38% of the area and 42% of the crop.

The leadership of the selected entities is explained, first of all, by favorable climatic conditions for potato cultivation, as well as by the local sales market (in these Federal Districts live more than 50% of the population of Russia).

Having identified the peculiarities of regional potato production using the statistical data of Rosstat, we will analyze the structure by types of producers.

Historically, three types of agricultural commodity producers have been formed in Russia: agricultural organizations (ACO), personal subsidiary farms (PSF), and peasant farms (PF).

Consider the gross potato harvest in the federal districts in 2016 (Figure 2).

![Figure 2](image.jpg)

**Figure 2.** The structure of the gross potato harvest by types of commodity producers by federal districts in 2016, % (Source: compiled by the author according to Rosstat, Yearbook “Regions of Russia 2017”).

4. Discussion
The information presented in Figure 2 clearly shows that the personal subsidiary farms dominate in the production of potatoes. At the same time, the variation in the category of private farms is equal to 9%, which is an insignificant value (ACO = 43%, PF = 45%). The average for federal districts is 76% ± 6.

The established pattern is stable in time and has been observed in Russia for a quarter of a century already; the specific weight of the category was 83% in 1993, in 1997–91%, in 2000–92%, in 2010–84%.

The revealed pattern is inherent not only in Russia but also in all the former Soviet republics. If we take the main potato producers in the post-Soviet space [4], then we obtain the distribution presented in Table 2.

Table 2. The structure of the gross potato harvest in the context of the main producing countries in the post-Soviet space in 2016.

| Commodity producers       | Russia    | Belarus   | Ukraine   | Kazakhstan |
|---------------------------|-----------|-----------|-----------|------------|
| Facilities of all categories, thousand tons | 298,991.2 | 5,986.0   | 21,750.3  | 3,545.7    |
| Agricultural organizations | 14.8%     | 13.3%     | 1.6%      | 7.5%       |
| Peasant farms             | 8.8%      | 5.8%      | 0.6%      | 34.7%      |
| Households                | 76.4%     | 80.9%     | 97.8%     | 57.8%      |

Source: compiled by the author based on data from the national statistical services of the countries represented.

The information given in Table 2 confirms our assumption: since the largest share in the structure of potato production is occupied by households, while in Russia, Belarus and Ukraine the shares of this category are significant and exceed 75%, Kazakhstan stands out with 58% in households.

From the position of the Government, it is beneficial when private farms are engaged in potato cultivation (in other matters, as well as in other crops): first, the issue of employment in rural areas is partially resolved; second, the production of potatoes is an additional source of income for villagers, which means that household income increases; third, the problem of providing the remaining 60% of the population with potatoes is partially solved.

But this medal also has a downside, which lies in the low efficiency of such production, which is due to a number of factors and, above all, the lack of resources for the formation of a technological chain ranging from seed material to the delivery of potatoes to the final consumer.

As an illustration of the assumption, we will compare the average yields of three types of producers, with 80 constituent entities of the Russian Federation being included in the working population, which is explained by the presence of regions in the Russian Federation that are not suitable for potato cultivation.

For comparison of averages in two and more aggregates in Statistics, one uses either Student's t-statistics or Fisher's F-test. In our case, using the first indicator is not very convenient, since we would have to compare producers in pairs. As a result, we choose the second approach. As a result of the calculations carried out using the Statistic software package, we get the actual value $F = 25.06$ with $p <0.05$ (table value $F = 3.04$), which indicates a significant discrepancy between the average values of potato yield. Visualization of the established differences is shown in Figure 3.
Figure 3. Average values of potato yield by farm categories in 2016 (Note: built by the author in the Statistica software package).

According to the information given in Figure 3, the average yield for agricultural organizations is higher than for personal subsidiary farms by 1.5 times, and for farms – by 14%.

5. Conclusion
The results obtained do not contradict logic, since agricultural organizations withstand the technology of cultivation of this crop, buy new varieties resistant to pests and yielding high yields, use mineral and organic fertilizers, treat crops with insecticides. In turn, personal subsidiary farms do not have such opportunities due to their scale, respectively, the genetic line degenerates and yields decrease.

Table 3. Dynamics of potato yield in major producing countries.

| Year | RUS | BLR | UKR | KAZ | CHN | IND | DEU | USA |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| 1990 | 99  | 135 | 117 | 113 | 113 | 157 | 258 | 329 |
| 1995 | 118 | 131 | 96  | 85  | 134 | 163 | 314 | 363 |
| 2000 | 105 | 132 | 122 | 106 | 140 | 186 | 433 | 427 |
| 2010 | 100 | 214 | 132 | 143 | 157 | 199 | 399 | 449 |
| 2015 | 159 | 194 | 161 | 186 | 172 | 231 | 438 | 469 |
| 2016 | 153 | 205 | 166 | 190 | 170 | 205 | 444 | 490 |
| Average, 1990-2016. | 123 | 166 | 130 | 135 | 147 | 186 | 392 | 417 |

Source: compiled by the author based on data from the Food and Agriculture Organization of the United Nations (FAO).

As evidence of the idea put forward, we compare the yield of potatoes in major producing countries in China (99,122 thousand tons in 2016 or 26% of world production), India (43,770 thousand tons or
12%), and the Russian Federation (31,108 thousand tons or 8%), Ukraine (21750 thousand tons or 6%), USA (19991 thousand tons or 5%), Belarus (5986 thousand tons or 2%), and Kazakhstan (3546 thousand tons or 1%) for the period 1990-2016.

According to the information presented in Table 3, in all the countries under consideration, there is an increase in yields in the reporting period compared with 1990 (the most significant increase is in Germany, 1.7 times). If we consider the presented data from the point of view of efficiency, then in Germany and the USA, the yield is much higher than in the post-Soviet countries (more than 3 times different from Russia), which confirms our hypothesis about the main factor affecting the yield – the availability of technology cultivation.

References
[1] Albochachieva B M 2010 Economic efficiency of potato production in various categories of farms Regional Problems of Economic Transformation 3 pp 91-98
[2] Lobyrev I S 2012 Potato farming in Russia and the Bryansk region, current state, problems and development prospects Bulletin of the Bryansk State University 3(2) pp 46-50
[3] Lukinykh M I 2016 The study of potato production in the middle Urals Agrofood Policy of Russia 12(60). pp 31-34
[4] Osipov V, Zhevora S and Bogoviz A 2018 Monitoring of potato production in Russia and its forecast until 2020 Economics of Agriculture of Russia 3 pp 58-63
[5] Moneymaker factory 2018 Potato production by import substitution policy: figures, statistics, opinions (http://moneymakerfactory.ru/biznes-idei/importozameshenie-kartofelya/)
[6] Potato Union 2018 Russian potato market in 1990-2013 (http://www.welikepotato.ru/articles/blog/manufacture/1006)
[7] Sorokovikova A S 2017 The state of the potato market in Russia In the collection: Scientific research of students in solving actual problems of the agro-industrial complex materials of the regional scientific-practical conference (March 17, 2017) (Irkutsk, Russia: Irkutsk State Publishing House Agrarian University named after A. A. Ezhevsky) pp 323-327
[8] Shamilev R V and Shamilev S R 2013 Analytical and economic rationale for increasing the production of potatoes in the Russian Federation and FD Modern Problems of Science and Education 4 pp 252
[9] Shamilev S R 2016 Evaluation and analysis of the dynamics of the efficiency of potato production in the federal districts of Russia Electronic multidisciplinary scientific journal with a portal of international scientific and practical conferences Internet Science 1 pp 18-35
[10] Bogoviz A V, Lobova S V, Alekseev A N, Vukovich, G G, Grönlund A Y 2018 Economic stimuli for creation of highly-efficient jobs on the basis of the new internet technologies Advances in Intelligent Systems and Computing 622 pp. 617-623