The Ecological and Economic Effectiveness of Sunflower Oilseed Production in Russia

S P Vorobyov$^{1*}$ and V V Vorobyova$^{1}$

$^{1}$ Altai State University, 61 Lenina pr., Barnaul 656049 Russia

E-mail: servsp@mail.ru

Abstract. The paper focuses on the impact of the specialization of agricultural enterprises on the economic efficiency of producing sunflower oilseeds. The authors analyze the consequences of violating the optimal specific gravity of sunflower seeding in the plowland structure of enterprises. The paper assesses current trends in the world market of sunflower seeds and identifies the place of Russia and its main regions in the gross collection of this agricultural crop. The example of agricultural producers in the Altai Krai shows that the increase in the area of sunflower seeding and the increase in the share of plowland reduced economic efficiency and increased the negative impact of the crop on the soil. The increase in yields is mainly due to the intensification of production when ecological requirements are violated. Little use is made of the reserve for bee pollination of sunflower yields. The disruption of the crop rotation system has resulted in highly specialized enterprises losing more than 20-25% of the gross sunflower seed collection, reducing the return on invested resources. The authors argue that increasing the effectiveness of sunflower cultivation is possible under scientifically based management systems oriented towards organic farming.

Keywords: Agricultural production · Production specialization · Sunflower · Economies of scale · Eco-efficiency of production · Optimal structure of seeding · Concentration of seeding

1. Introduction

Sunflower is one of the main oilseeds in the world. With the gradual expansion of oilseeds in the vegetable oil market, the specific weight of sunflower oilseeds in total oilseeds production remained stable (fifth place after soy, rapeseed, cotton, and peanut in the world economy). During 1965–2018, the gross collection of sunflower oilseeds in the world increased from 7,985.3 thousand tons to 51,954.8 thousand tons (6.5 times).

In 2018, the leading producers of sunflower oilseeds were Ukraine (27.3% of the gross world collection), Russia (24.6%), Argentina (6.8%), and China (4.9%). Ukraine, Russia, and Argentina formed the “sunflower triangle,” which forms the price conjecture on the world market of sunflower oil and sunflower oilseeds. India, the United States, and Kazakhstan accounted for only 3.9% of global oilseed production. EU countries accounted for 19.2% and other countries for 13.4% (figure 1).
Figure 1. The structure of the gross sunflower collection by the main producing countries in 2018, %.

Source: Calculated by the authors.

For 1992–2018, the growth rate of the gross collection of sunflower seeds in the world significantly exceeded the growth rate of the seeding area. This fact indirectly indicates an increase in crop yield in the overall farming system of machinery, using a productive variety of sunflower are predominantly first-generation hybrids. The highest crop yield in 2018 was observed in China (29.0 c/ha, which is 1.29 times higher than in 2011), Ukraine (23.0 c/ha, 1.25 times higher than in 2011), the EU (24.8 c/ha, 1.26 times higher than in 2011), and Argentina (21.1 c/ha, which is not significantly higher than the level achieved in previous years). Recently, in the rating of the major producing countries, Russia has consistently ranked seventh in sunflower yield (16.0 c/ha in 2018) (figure 2).

The negative impact of deep specialization in sunflower cultivation is mainly defined by the violation of the crop rotation system and frequent return of sunflower to the previous place of sowing. These lead to the accumulation of pathogens of various diseases and pests of sunflower in the soil, additional desiccation, and depletion of the soil.

Figure 2. The yield of sunflower in 2011–2018 for the main countries-producers, c/ha.

Source: Calculated by the authors.
The findings of A. V. Khatanskiy and N. I. Dvoryadkin indicate a decrease in the yield of sunflower in case of any violation of the recommended time frame for its return (under the rules, the optimal timing for the share of sunflowers in plowland of about 10%–12.5% is 8–10 years) to the same place. With the return every two years (the share of sunflowers in the arable land is more than 50%), the yield decreases by 24%. With the return period every four years (the share of sunflower crops in the arable land is more than 25%), the yield decreases by 18.2%. If the return period is six years (the share of sunflowers in plowland is more than 15%), the decrease is 11.4%. The cost price increases by 31.5%, 22.0%, and 12.8% relative to the crop rotation with sunflower return to its former place every eight years [3]. The negative consequences of early sunflower return to the previous seeding places are also evidenced [4, 5]. Scholars say that the maximum specific weight of sunflowers in arable land should not exceed 8.0%–10.0%. E. I. Artemova and K. N. Plachinda indicate that the increase in the efficiency of sunflower cultivation is associated primarily with the introduction of fertilizers into the soil, the improvement of the seed production system and variety exchange, and an increase in the share of hybrids [1].

2. Materials and Methods

The research’s theoretical and methodological basis was the results of the research in the field of identification and assessment of factors defining the economic and ecological efficiency of sunflower cultivation. The authors grouped agricultural enterprises of the Altai Krai to identify types of enterprises by the level of specialization using indicators of revenue from the sale of the main types of crop products contained in the industry annual reports of agricultural enterprises. When defining the indicator “production profitability,” the percentage of profit from selling specific types of agricultural products to their sales cost was taken into account. During the research, general scientific and special methods were used (comparison, monographic, normative, economic, and statistical). The standard Microsoft Office 2007 software package, including the Microsoft Excel package, was used to analyze statistical data.

The sources of statistical information were the Federal State Statistics Service (Rosstat), the territorial body of Rosstat in the Altai Krai and the Republic of Altai, and data from the Ministry of Agriculture of the Altai Krai. The sources of information about the financial and economic activities of agricultural enterprises were the data of the SPARK (System of Professional Analysis of Markets and Firms) network publication and the network publication “Center for Corporate Information Disclosure.” Data on the gross harvest and sunflower crops for the main countries of the world were taken from the database of statistical data of the FAO and the UN.

3. Results

In 1990–2019, the area of sunflower seeding increased from 2.7 million ha to 8.6 million ha (3.13 times) in Russia. This increase allowed to enlarge the gross harvest of sunflower oilseeds by more than 3.20 times. The main areas of sunflower cultivation with a sown area of over 300 thousand hectares are the Voronezh, Tambov, Volgograd, Rostov, Orenburg, Samara, and Saratov Regions, and the Krasnodar and Altai Krai.

However, the largest increase in sunflower acreage in absolute terms was observed in those regions that provided the lowest yield of sunflower (the Saratov region, Altai Krai, and other regions). Such structural shifts hindered the growth of the average yield across the country. Thus, in the Altai Krai, for 1990–2019, there was an increase in acreage from 134.8 thousand hectares to 717.3 thousand hectares (5.32 times). In some years, the yield varied from 3.4 c/ha to 10.2 c/ha.

Despite the observed processes of increasing the yield of sunflower in the main regions where sunflower is cultivated, we justify that the efficiency enhancement reserves of sunflower oilseeds production is the optimal implementation of elements of the management system, including placement in natural and climatic zones, production concentration, crop rotation systems, soil treatment, crop care, and bee pollination. In the Altai Krai, the sunflower is cultivated everywhere, i.e., in all seven natural-
economic zones. However, the highest concentration of crops was observed in the steppe (the proportion of site – 57.0% of all sunflowers in the region, the share of sunflower in arable land climatic zones – 15.1%) and forest-steppe parts (the share of the territory – 27.3% of sunflowers in the region, the share of sunflower in arable land climatic zones – 9.4%), being the most arid territories. This placement is quite optimal because it reduces the probability of spreading sunflower diseases and increases the pathogenicity of soils, provided that scientifically based crop rotations are observed, and certain agrotechnical requirements for soil treatment and care for crops are carried out. However, it is necessary to reduce the share of sunflowers in arable land of the main sowing farms. No more than 6.9% of sunflower crops are concentrated in the humid territories of the Altai Krai.

4. Discussion
The determining factor of the profitable cultivation of sunflower is its yield. In 2015–2018, when the yield of sunflower was higher than 12 c/ha, the profitability of production of oilseeds in the Altai Krai averaged from 66.1% to 91.0%. With a yield of 5–10 c/ha, it decreased to 59.4%–85.4%. With a yield below 5 c/ha, it further decreased to 30.3%–45.9% [2], which is more than two times lower than the achieved indicators for enterprises with higher productivity.

In 2018, 325 enterprises (44.5% of the total number) were engaged in sunflower cultivation in the region:

- main sphere – 33 enterprises;
- one of the two main spheres – 171 enterprises (mainly combined with crop farming, less often – dairy cattle breeding)
- one of the three main spheres – 121 enterprises.

In 2014–2018, sunflower cultivation belonged to the list of main production sectors (these enterprises were not specialized in oilseeds production) in more than 62.8%–68.8% of enterprises. On average, sunflower crops in this group were at the level of 780–810 ha, and the level of profitability of production reached 46%–62.4%. The concentration of crops in plowland in this group of enterprises did not exceed the optimal rate of 10%–12%.

An increase in the share of income from sunflower sales in the total income of enterprises led to an increase in the profitability of oilseeds’ production. Nevertheless, the yield of sunflower remained at the same level. Moreover, enterprises with a high concentration of sunflower in sales and plowland structure had a crop yield below the regional average by 6.0%–20.4% in some years. These enterprises did not provide a reduction in labor intensity and cost per unit of production.

Our research also shows that enterprises of the steppe and forest-steppe parts of the region, which concentrate most of the sunflower crops, underestimate such a reserve for increasing crop yield as bee pollination, which allows for a minimum cost to provide a yield increase of 40%–45%. Considering the norms of sunflower pollination and the actual density of bee colonies in rural areas of sunflower cultivation, the number of bee colonies can be increased more than five times.

5. Conclusion
Thus, increasing the specialization of enterprises in the production of oilseeds and increasing the seeding area and the share of sunflower crops in plowland allows for complete use of existing equipment and human resources. However, it did not lead to an increase in sunflower productivity, labor productivity, and lower production costs. The specialization was accompanied by a violation of the system of crop rotation, cropping patterns, reducing the needs of enterprises in frames with year-round employment (an increase of the seasonality of labor usage, the dispersed need for which arises only 1–1.5 months per year), rising unemployment in rural areas, and increased migration intentions of the working-age population. In modern conditions, many employers face the need for highly qualified personnel, without the possibility of closing even the quantitative need for personnel.
To increase the economic and environmental efficiency of sunflower cultivation, it is necessary to implement, first of all, internal reserves aimed at increasing the fertility of plowland in the organization of resource-saving processes, bee pollination, compliance with science-based crop rotation, optimal placement and concentration of crops, the use of modern technology, and compliance with zonal-oriented technologies of soil treatment and crop care.

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