



## Features of Specialization and Placement of Oil Crops Production in Krasnoyarsk Krai

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**ABSTRACT:** In modern conditions, the Russian state pays special attention to the development of meat and dairy farming, as well as grain and beet sugar production, while the level of state support for oil crops producers remains minimal and, in most regions, does not exist at all. Moreover, the produced oil crops and available processing capacity do not satisfy the country's needs for vegetable oil. The need to increase the production and processing of oil crops, as well as their efficiency, determines the relevance of the research topic. The study contains scientifically based recommendations for improving the placement of oil crops production in Krasnoyarsk Krai. The authors consider the features of oil crops production in the region, assess the efficiency of production and its determining factors, and consider oil crops production placement in agricultural organizations in natural and climatic zones of the Krai. Based on the correlation and regression analysis, the economic efficiency of the concentration of oil crops production in the region is assessed and promising production districts are determined (Abansky, Krasnoturansky, Minusinsky, Nazarovsky, Rybinsky, Sukhobuzimsky, and Sharypovsky), where average yields reach 17.2 c/ha and production profitability amounts to 21%.

**Keywords:** Krasnoyarsk Krai, agriculture, oil crops, rape.

### I. INTRODUCTION

According to the Federal Law "On the Development of Agriculture", the state agrarian policy is an integral part of the state socio-economic policy aimed at sustainable development of agriculture and rural areas [1]. At the same time, in the decree of the Government of the Russian Federation "On the State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials, and Food Markets", many measures are envisaged to implement this law [2]. The role of the state agrarian policy is increasing in terms of import substitution and increase in competitiveness of Russian products, as evidenced in the works by several researchers [3-5]. In the Doctrine for Assessing Food Security, the share of Russian agricultural, fish, and food products in the total volume of commodity resources (taking into account carry-over stocks) in the domestic market for relevant products was determined as a criterion, which has threshold values for several products [6, 7]. This figure should be at least 80% for vegetable oil [8]. As of 2017, the provision amounted to 94% [6].

Savchenko *et al.*, (2013) note that the consumption of vegetable oil per capita (about 8 kg) remains at the level of 1990, which is 2.5-3 times lower than per capita consumption in the EU and the US. It is necessary to process about 6 million tons of seed oil annually, including 4 million tons of sunflower seeds, to ensure the standard level of consumption of vegetable oil [9].

According to Donchenko *et al.*, due to the high value of oil crops, their production in Siberia in recent years not only has restored after the decline in production in the 1990s but also has exceeded the 1990 level by a factor of 3-3.5. Thus, the area occupied by the main oil crop – sunflower – during this time increased by a factor of 3.4

and gross yield – by a factor of 3.2. The main production of oil crops is located in Altai Krai, as well as the Omsk and Kemerovo regions. Production is growing rapidly in Krasnoyarsk Krai and the Novosibirsk region. The main oil crop in the Siberian Federal District is sunflower (55.1 % of all oil crops production). However, rape production has been growing rapidly in recent years. The use of rape for the production of biofuel, as well as oilcake and protein-vitamin supplements, seems to be promising [10].

As Pyzhikova and others note, "The high demand for rape oil crops is due to the versatility of the crop, as rape oil can be used in food production, pharmaceutical, and cosmetic industries, as well as in chemical, metallurgical, textile, leather, soap, and dye industries" [11].

One of the main problems in the production of oil crops is a significant level of dependence on foreign seed. For a number of items, the share of imported seeds is from 20 to 80% (sunflower seeds – 59%, winter rape – 46%, soybean – 29%). Therefore, in accordance with the federal scientific and technical program for the development of agriculture in 2017-2025, it is planned to develop subprograms for the selection and seed production of several crops. The key tasks include the introduction of technologies for breeding highly productive oil crops and reduction of the level of dependence on foreign counterparts [12].

A significant contribution to the study of the current state and the solution of issues of specialization and placement of oil crops was made. Their works served as a scientific basis for the research [9, 10, 13-21].

### II. PROPOSED METHODOLOGY

#### A. General description

In previous studies, in order to develop the placement

of sown areas of oil crops, agricultural methods were proposed (the development of unused arable land, as well as new territories, including northern, the optimization of the structure of crop rotation).

We used a complex of research methods to comprehensively analyze the features and identify prospects for specialization and placement of oil crop production in the region.

Using the abstract-logical method, features of the production of oil crops, as well as factors influencing the placement and specialization of agricultural production, were revealed.

Using the statistical research method, the dynamics of the main indicators characterizing the development of oil crops production in Krasnoyarsk Krai were revealed and the influence of various factors on the level of profitability of oil crops production in the region was determined based on the developed economic and statistical model.

On the basis of the monographic method, the assessment of production placement of oil crops in agricultural organizations by zones of the region was carried out.

The application of the calculation-constructive method made it possible, based on the grouping of districts by harvested area, to determine those more promising for the development of oil crops production in Krasnoyarsk Krai.

### B. Algorithm

1. The main factors influencing the specialization and placement of oil crops production from the differentiation of natural (environmental) resources to significant seasonal fluctuations in prices for agricultural products were specified. These factors should be the basis for the development of the placement of oil crops production in the context of natural and climatic zones (Eastern, Western, Central, and Southern).

2. Based on the developed economic and statistical models, a direct relationship between productivity and the level of profitability of oil crops production was revealed. Thus, profitability will increase from 21.6 to 62.7% with an increase in productivity from 5 to 95 c/ha. At the same time, unprofitableness is observed with the marketability of oil crops under 15%; marketability should be increased to 65% since its further growth will not contribute to increased profitability.

3. The proposed grouping of the districts of the Krai according to the harvested area of oil crops made it possible to evaluate the economic efficiency of the concentration of oil crops production and identify more promising districts (Nazarovsky, Rybinsky, Minusinsky, Krasnoturansky, Abansky, Sharypovsky, and Sukhobuzimsky). The harvested area of oil crops in these areas exceeds 2,000 ha, which ensures a yield of 17.2 c/ha and profitability of 21.4%.

### III. RESULT ANALYSIS

According to Altukhov, "Improving the territorial and sectoral distribution of labor is the core of solving the problem of the rational placement of the country's productive forces, improving the efficiency of the economy, its industries, and markets. In modern conditions, this is especially true for domestic agricultural production, operating in conditions characterized by a significant variety of natural and territorial factors" [14, 15]. In addition, Russian

producers have to deal with deeply specialized and highly competitive agro-industrial production of the largest exporting countries of agricultural products, raw materials, and food, in which the level of state support for agriculture significantly exceeds that in Russian agriculture.

As Silaeva and Kochetkov note, "Placement and specialization are concrete forms of the social division of labor that are closely interconnected. The distribution of agricultural production is a geographical division of labor between the individual territories of the country, which acts as the basis for agricultural specialization. In turn, the development of specialization gives completeness to the placement process, exerting a strong influence on it" [18].

Vinnichuk and Pogorelova in their writings note that "oil crops territorially have a wide range of cultivation in world production. A variety of climatic zones, natural conditions of which do not always ensure high production efficiency of oil crops, play a role in the placement of crops in accordance with their biological requirements and zonal features. Oil crops play an important role in solving the country's food problem, being the main source of seed oil and protein" [16].

When solving the complex and multifaceted problem of territorial placement and specialization of agricultural production Donchenko *et al.*, propose to take into account the influence of many interconnected internal and external, natural and market factors [10]. The main factors of specialization and placement of oil crops are the following:

1. Differentiation of natural resources with fluctuations in bioclimatic potential determines the natural zoning of Siberian regions (steppe, forest-steppe, etc.).

2. Redistribution of raw material zones of the processing industry, primary processing, and pre-sale preparation of products to be sold are mainly carried out in places of production.

3. Change in the structure of food consumption in the direction of increasing the proportion of its highest quality and most valuable types (meat, milk, egg, vegetable oil) and decreasing the share of potatoes, bread, and baked goods.

4. With the growth of transport tariffs, the concentration of agricultural production in the areas of specialization and delivery to the markets of finished (processed) food products for consumption accelerates in order to reduce transaction (transport) costs for the delivery of products.

5. The course on import substitution leads to an intensification of inter-regional food exchange (regional and, accordingly, zonal specialization in the regions takes a more pronounced character).

6. Formation of territorial-industrial clusters, different territorial hierarchies, industrial unions, etc. accelerates under the influence of the general laws of production development.

7. Development of regional agri-food markets and their infrastructure facilities (wholesale and logistics centers, wholesale food markets, etc.) continues.

8. Significant seasonal fluctuations in prices for agricultural products lead to the construction of storage facilities for grain and other food products directly from large agricultural producers.

Cultivation of oil crops in Krasnoyarsk Krai is one of the promising segments of agricultural production in the region. The sown area of oil crops for 2013-2017 has more than doubled and amounted to 53,764 ha. Their

share in the structure of sown areas of crops also increased from 2.1% in 2013 to 4.6% in 2017 (Fig. 1). Various oil crops were grown in Krasnoyarsk Krai during the study period: soybeans, rape, sunflower, saffron milk cap (Table 1). The total harvested area of oil crops for 2013-2017 increased by 62.9%. At the same time, the largest share among oil crops is occupied by spring rape crops (95.3%). This indicates the expansion of the range of use of this culture and its fitness to the climatic conditions of the region. The productivity of oil crops as a whole increased during the study period by 23.5 c/ha.

Also, there is an increase in the productivity in each of the crops: sunflower – by a factor of 2.1 to 6.6 c/ha; spring rape – by 48.8% to 12.5 c/ha, soybeans – by 40% to 7 c/ha.

During the study period, oil crops production was effective in 2014-2017 and unprofitable in 2013. The highest profitability was recorded in 2016 (24%) and marketability – in 2014 (85.3%). Moreover, from 2013 to 2017, the production cost of 1 c of oil crops increased by a factor of 1.5 and the selling price – by a factor of 1.8 (Table 2).

**Table 1: Dynamics of sown areas and yield of oil crops in Krasnoyarsk Krai\*.**

Indicator	2013	2014	2015	2016	2017	2017 to 2013, %
Total harvested area, ha						
Oil crops – total	26,297	26,957	25,518	31,727	42,845	162.9
Soy	829	182	295	772	1,484	179.0
Spring rape	25,327	26,204	24,972	30,378	40,832	161.2
Winter rape	0	480	0	0	0	—
Sunflower	141	50	251	513	482	341.8
Other	0	41	0	64	47	—
Yield, c/ha						
Oil crops – total	8.1	7.1	9.2	9.5	10.0	123.5
Soy	5.0	6.0	11.3	8.1	7.0	140.0
Spring rape	8.4	7.1	9.2	9.5	12.5	148.8
Winter rape	0	6.2	0	0	0	—
Sunflower	3.1	6.4	9.0	8.9	6.6	212.9
Other	0	10.3	0	2.7	7.0	—

\*According to the materials of the Agri-industrial complex of Krasnoyarsk Krai in 2011-2015, 2014, 2016, 2017 [22-25].

**Table 2: Economic efficiency of oil crops production in Krasnoyarsk Krai\*.**

Indicator	2013	2014	2015	2016	2017
Cost value of 1 c, rubles	1,096.8	961.8	1,273.9	1,442.9	1,653.0
Selling price of 1 c, rubles	1,048.5	1,002.7	1,637.2	1,899.0	1,872.7
Marketability, %	32.9	85.3	75.8	68.4	64.0
Profitability (loss ratio), %	-4.6	4.1	22.2	24.0	11.7

\*According to the materials of the Agri-industrial complex of Krasnoyarsk Krai in 2011-2015, 2014, 2016, 2017 [22-25].

In order to identify the influence of a number of factors on the efficiency of oil crops production in agricultural organizations of the region in 2017, we built a model of the dependence of the profitability level (y) on the yield of oil crops ( $x_1$ ), level of marketability ( $x_2$ ), and specific weight of oil crops in the total sown area ( $x_3$ ).

As a result, the following equation (1) was obtained:

$$Y = 0.4421 + 0.0057x_1 - 0.000011x_1^2 + 2.1483x_2 - 1.8340x_2^2 - 16.4772x_3 + 56.6513x_3^2 \quad (1)$$

The multiple correlation coefficient of the presented relationship is  $0.60 \pm 0.05$ . There is a direct relationship between the features and factors in the model. The relationship between the level of profitability and the yield and marketability of oil crops is average and low with crops.

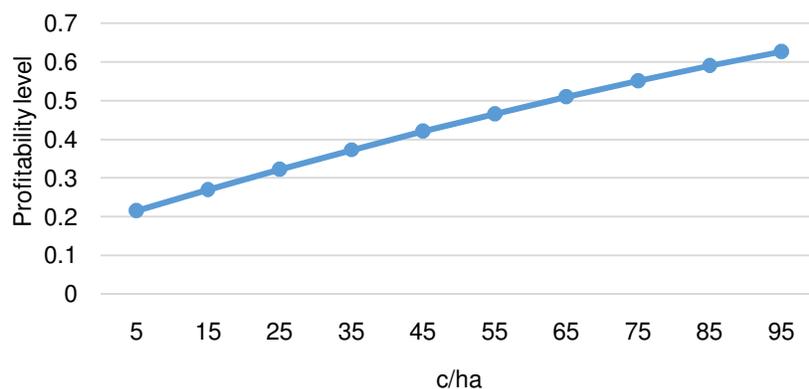
Based on the presented equation, dependence was revealed (Fig. 2). It was determined that with an increase in the yield of oil crops the level of profitability increases with average values of marketability and sown area. At the same time, each subsequent increase in productivity by 10 c/ha ensures an increase in profitability by 5%.

It should also be noted that for 54 agricultural organizations in the region growing oil crops, the yield of their seeds in weight after refinement varies from 0.7 to 33.8 c/ha.

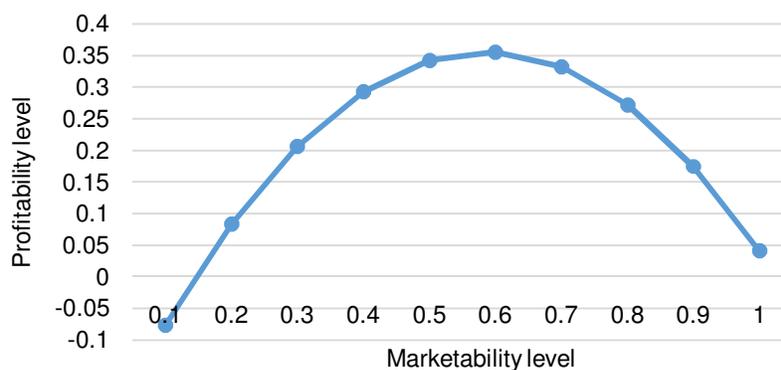
Based on the curve of the dependence of the profitability level on the level of marketability of oil crops, it was revealed that unprofitability is observed at a level of marketability under 15%.

Profitability rises to 35.6% with an increase in marketability to 65% and profitability decreases with a further increase in marketability. Thus, profitability was 33.2% with marketability of 70% and only 4.1% with 100% (Fig. 3).

Let us consider the features of oil crops placement in the context of natural and climatic zones for a more detailed study of the region's specialization (Table 3). There are five natural and climatic zones in Krasnoyarsk Krai: East, West, Central, South, and North. Cultivation of oil crops is carried out in all areas except for the North, where natural and climatic conditions are less favorable.



**Fig. 2.** Relationship between the profitability level and oil crops productivity with average values of marketability and sown area.



**Fig. 3.** The influence of the marketability level on the profitability level with average values of yield and sown area.

**Table 3: Production placement of oil crops in agricultural organizations by zones and districts of Krasnoyarsk Krai in 2017.**

Zone (district)	Harvested area, ha	Gross production, c	Yield, c/ha	Specific weight, %	
				in crops	in production
1	2	3	4	5	6
Krasnoyarsk Krai	42,845	428,734	10.0	100.0	100.0
Eastern zone	11,212	73,744	6.6	26.2	17.2
Abansky District	5,070	32,980	6.5	11.8	7.7
Dzerzhinsky District	48	730	9.0	0.1	0.2
Irbeysky District	300	290	0.97	0.7	0.08
Kansky District	716	3,371	4.7	1.7	0.8
Nizhneingashsky District	605	3,957	6.5	1.4	0.9
Rybinsky District	3,183	13,770	4.3	7.4	3.2
Sayansky District	150	100	0.7	0.4	0.02
Uyarsky District	1,140	18,546	16.3	2.7	4.3
Western zone	11,276	89,597	8.0	26.3	20.9
Achinsky District	1,305	30,537	23.4	3.0	7.1
Bogotolsky District	1,000	4,570	4.6	2.3	1.1
Nazarovsky District	2,084	40,838	19.6	4.9	9.5
Uzhursky District	250	3,312	13.2	0.6	0.8
Sharypovsky District	6,637	10,340	1.6	15.5	2.4
Central Zone	8,367	142,679	17.1	19.5	33.3
Berezovsky District	980	11,716	12.0	2.3	2.7
Bolshemurtinsky District	200	2,064	10.3	0.5	0.5
Yemelyanovsky District	100	231	2.3	0.2	0.1
Sukhobuzimsky District	7,087	128,668	18.2	16.5	30.0
Southern Zone	11,990	122,714	10.2	28.0	28.6
Yermakovsky District	450	2,076	4.6	1.1	0.5
Idrinsky District	1,032	15,840	15.3	2.4	3.7
Krasnoturansky District	3,437	43,522	12.7	8.0	10.2
Kuraginsky District	1,992	21,050	10.6	4.6	4.9
Minusinsky District	3,314	25,871	7.8	7.7	6.0
Shushensky District	1,765	14,355	8.1	4.2	3.3

We found that the main production of oil crops is concentrated in three climatic zones: Central, Southern, and Western. In the reporting year, they accounted for 33.3, 28.6 and 20.9% of gross production in the region, respectively. Most of the acreage of oil crops is concentrated in the Southern zone (28%), as well as in the Western and Eastern zones – (26.3 and 26.2%, respectively). At the same time, the highest yield was observed in the Central zone (17.1 c/ha).

In each zone, it is possible to identify areas-leaders in the production of oil crops. Thus, the Sukhobuzimsky District of the Central zone accounted for the largest share of production of the Krai (30%) with the share of crops of 16.5%.

In the Southern zone, the leading region is the Krasnoturansky District, which accounted for 10.2% of production and 8% of the sown area of the region.

In the Western zone, it is the Nazarovsky District, where 9.5% of all production and 4.9% of the sown area of oil crops are concentrated. At the same time, the highest value of oil crops was recorded in the Achinsky District (23.4 c/ha).

In the Eastern zone, the main producer of oil crops is the Abansky District, which accounted for 7.7% of gross production in the Krai.

#### IV. DISCUSSION

For the further development of oil crops production in Krasnoyarsk Krai, it is necessary to assess the effect of the concentration of production on its effectiveness. For this, we carried out an analytical grouping of agricultural regions of the Krai based on the harvested area of oil crops (Table 4).

**Table 4: Economic efficiency of the concentration of oil crops production in Krasnoyarsk Krai.**

Indicator	Grouping of areas by harvested area, ha			On average
	under 1,000	from 1,001 to 2,000	from 2,001	
Number of districts in the group	11	5	7	8
Average area under crops in one district, ha	436	1,447	4,402	2,095
Proportion of the harvested area of oil crops in the total harvested area, %	1.3	5.6	7.5	4.6
Yield, c/ha	3.9	9.1	17.2	10.0
Profit per 1 ha of crops, rubles	527.8	1,056.5	2,635.9	1,405.9
Production profitability, %	4.1	9.6	21.4	11.7
List of districts in the group	Dzerzhinsky Yemelyanovsky Sayansky Bolshemurtinsky Uzhursky Irbeytsky Yermakovsky Nizhneingashsky Kansky Berezovsky Bogotolsky	Idrinsky Uyarsky Achinsky Shushensky Kuraginsky	Nazarovsky Rybinsky Minusinsky Krasnoturansky Abansky Sharypovsky Sukhobuzimsky	—

We identified three groups of districts, the first of which included 11 districts with a harvested area under 1,000 ha. The values for this group do not exceed the average data for the region. Thus, the yield here amounted to 3.9 c/ha and the profitability of production – to 4.1%. There is an increase in production and economic indicators in each subsequent group. The third group includes areas with a harvested area of 2,001 ha, the average area of sowing oil crops in which is 4,402 ha, which is 2.1 times higher than the average in the Krai.

The share of the harvested area of oil crops in the total harvested area in this group is also above the average value by 2.9% and makes up 7.5%. The average yield in the districts of this group amounted to 17.2 c/ha and the profitability – to 21.4%, which is 1.7 and 1.8 times higher than the average for the region, respectively.

Thus, at the present stage, an increase in the area of sowing is important for increasing the efficiency of oil crops production in the region. At the same time, the development of placement and deepening of specialization are possible when carrying out a complex of measures: organizational-economic, financial, organizational-technological, environmental, etc.

#### V. CONCLUSIONS

1. The development of the agro-industrial complex of both Russia as a whole and its separate regions makes it necessary to concentrate the production of agricultural raw materials and their processing in those territorial zones where there are organizational, economic, and climatic conditions that ensure their greatest effectiveness. The need to increase the production of oil crops is due to the fact that they can give the greatest energy output per unit area and cost for human and animal nutrition. Moreover, the specialization and placement of oil crops production in the region are influenced by many internal and external factors that must be taken into account.

2. In Krasnoyarsk Krai, the total harvested area of oil crops increased by 62.9% during the study period. Spring rape crops account for 95.3% of the area of all oil crops, which indicates the expansion of the range of the use of this crop and its adaptability to the climatic conditions of the region. Also, soybeans, canola, sunflower, and saffron milk cap are grown in the region. In 2013-2017, oil crops productivity increased as a whole by 23.5 c/ha and for each of the crops as follows:

sunflower – by a factor of 2.1 to 6.6 c/ha; spring rape – by 48.8% to 12.5 c/ha, and soybeans – by 40% to 7 c/ha.

3. A direct relationship between the yield of oil crops and the level of profitability of their production is revealed based on the correlation-regression model. Effective marketability at the level of 65% was also determined, while marketability below 15% revealed a loss.

4. As we found, the production of oil crops is carried out in four climatic zones of the region: Central (33.3%), Southern (28.6%), Western (20.9%), and Eastern (17.2%). Most of the acreage of oil crops is concentrated in the Southern zone (28%), as well as in the Western and Eastern zones (26.3% and 26.2%, respectively). At the same time, the highest yield was observed in the Central zone (17.1 c/ha).

5. Based on the analytical grouping of agricultural regions of Krasnoyarsk Krai, the economic efficiency of the concentration of oil crops production was assessed and promising districts for their production were identified: Abansky, Krasnoturansky, Minusinsky, Nazarovsky, Rybinsky, Sukhobuzimsky, and Sharypovsky.

6. Of interest is the study of increasing the production of oil crops in promising districts, considering the available capacities, used technologies, and sales channels, including outside the region. It is important to develop the state support in this area.

7. One of the promising areas for further research of oil crops is the introduction of a closed cycle in agricultural organizations, including the cultivation, processing, and, sometimes, sales of oil crops. Testing of this direction is already being carried out at the Solyanskoye farm of the Rybinsk district. This will expand production, deepen specialization, and increase efficiency through independent regulation of prices for raw materials, as well as processed and finished products.

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**Conflict of Interests.** The authors declare that there is no conflict of interest to disclose.

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