Advances in Economics, Business and Management Research, volume 147
Proceedings of the International Conference on Policies and Economics Measures for Agricultural Development (AgroDevEco 2020)

Economic Assessment of Production and Forecasting the Yield of Oilseed Cole Crops in the Non-Chernozem Zone of Russia

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***Abstract* — The article presents evaluation of the oilseed market, spring camelina, in particular. For this, research experiments were carried out on the basis of educational research and innovation center "Agrotechnopark" at Ryazan State Agrotechnological University. The research was carried out in accordance with generally accepted methods and recommendations. The analysis of experimental data was carried out in the context of individual varieties and hybrids and sowing dates. Ratnik, Salsa KL and Ozorno varieties of spring camelina were selected for the research. Sowing was carried out in two periods: 1st and 2nd decades of May. The authors found out that the most promising variety for agricultural enterprises of Ryazan region is Ozorno variety. It provides the maximum yield and profit and / or profitability. In addition, in connection with the average long-term data, it is advisable to carry out sowing in the first decade of May.**

Keywords — oilseed market; spring camelina; periods; economic efficiency; region.

I. INTRODUCTION

In order to increase the profitability of the crop sector, it is important to expand the range of crops grown, paying particular attention to those that have constant and high consumer demand. Among these important crops are oilseeds, used for food, technical, feed and other purposes.

The main oilseed crops in the non-chernozem zone of Russia can be considered spring rape and sunflower. In the last decade, sown areas have been growing for such interesting and promising crops as spring camelina, oil flax, spring rape, white mustard, winter rape.

In 2019, the areas under sunflower and rape increased in Ryazan region. Total oilseeds occupied 151 thousand ha and 295.5 thousand tons of oilseeds were harvested. This was twice the level of 2015 in terms of oilseeds. Moreover, the largest increase in gross yield was achieved in sunflower, more than 2 times. The maximum areas in the region were located in Sarajevskiy, Skopinskiy, Mikhailovskiy and Miloslavskiy districts of Ryazan region and those were up to 20 thousand hectares in each district.

Camelina is a quickly growing crop that is able to escape from summer drought, which is not uncommon in the southern part of the Non-Black Earth Zone of Russia. This early maturity increases the seasonal load for grain harvesters by an average of 10–15 %. Harvesting of camelina in July favors the creation of conditions for the effective control of weeds over a long period of time after the harvest, thereby contributing to better soil preparation for the next crop.

Another reason for the popularity of camelina is its low cost and high productivity. Like rape, 1 kg of camelina gives about 400 grams of oil and at the same time it is unpretentious and resistant to diseases and pests.

II. PROBLEM STATEMENT

In this regard, the scientific hypothesis during field research was to determine the most effective varieties and hybrids of camelina when different planting dates. Economic efficiency was assessed by a combination of absolute and relative indicators, including cost, revenue, profit and profitability. In addition, with the help of statistical approximation methods, the prospects of growing spring camelina in Ryazan region were estimated.

III. MATERIALS AND METHODS

Field experiments of the research work were carried out on the basis of educational research and innovation center "Agrotechnopark" at Ryazan State Agrotechnological University (RSATU) and its subdivision, the experimental agrotechnological station located in the southwestern part of Ryazan district of Ryazan region.

In general, 2015–2019 had favorable conditions for the growth and development of oilseed cole crops, including spring rape and camelina, but were marked by different periods in terms of heat supply and rainfall.

The humus content in the tillage horizon is 2.9–3.1 %, which is typical for this type of soil in the region. The reaction of the soil is medium acidic pHxl – 5.0. Hydrolytic acidity is low and does not exceed 2.6 MEq/100 g of soil. The amount of absorbed bases is 15 M-equiv/100 g of soil, the degree of saturation of soils with bases is not more than 70 %.

There were two field experiments:

Experiment 1. The yield of varieties and hybrids of spring rape at different periods of sowing. Investigations took place in 2016–2019. The objects of the experiment were hybrids of foreign selection Salsa KL, Ozorno (Rapool company) and domestic variety Ratnik. The productivity of spring rape was studied at two sowing periods: 1st and 2nd decades of May. The seeding rate of spring rape variety Ratnik was 2.5 million germinating seeds/ha and that of German hybrids was 1.25 million pcs/ha. The replication was fourfold.

Salsa KL was sown using innovative Clearfield technology and Nopasaran herbicide 1.2 l/ha. The herbicide was used in a tank mixture with adhesive Dash 1.2 l /ha. Nopasaran was used in the phase of 4–6 true leaves, taking into account the early development of weeds and focusing on the vulnerable stages of the most harmful groups of weeds in the experimental agrotechnological station. When growing Ozorno and Ratnik, herbicide Galion, BP (aqueous solution), 0.3 l/ha was used. Treatment with Galion, BP (aqueous solution) was carried out in the phase of 4–6 true leaves, before the crop budding. The flow rate was 250 l/ha.

Experiment 2. Yield of spring camelina at different sowing period and seeding rates. The experiment was conducted in 2015–2019. The object of research was variety Yubilyar, breeding of Penza Scientific Research Institute of Agriculture.

Factor A – sowing period: 1st and 2nd decades of May; Factor B – seeding rates: 5; 6; 7; 8 million of germinating seeds per 1 hectare.

The record plot area was 20 m^2. The two-factor field experiment was based on four repetitions when the second presowing cultivation fertilizers were applied in a dose of N135P60K60 (background).

The scientific research on the topic of work at the experimental agro-technological station of RSATU was carried out in accordance with generally accepted methods and recommendations.

The production costs of agricultural technologies were determined on the basis of technological maps calculated in relation to specific production conditions, as well as the standards used in the agro-industrial complex of Russia. When calculating economic indicators, actual prices for November 2019 were used. To calculate the predicted indicators, the built-in least-squares algorithm in MS Excel IFR was used.

IV. Results and Discussion

The analysis of the oilseed market showed positive dynamics in the development of the oilseed segment of crop production and the oil and fat industry in Russia. In the first half of 2019, the export of vegetable oils, rapeseed and sunflower reached their maximum values. Analysis of the price situation showed its stability, which is due to the high reserves of sunflower and soy.

Sown areas of oilseeds also grew. As compared to 2018, they increased by 4.6 % and reached 14.5 million ha. At the same time, camelina remains in low demand of farmers. Its area in 2019 was 66 thousand hectares. The low interest in camelina is due to the fact that its oil is not refined, therefore, mass demand is limited. However, the demand in pharmacies for unrefined oil remains high as well high selling prices.

2019 was characterized by satisfactory climatic conditions, which allowed obtaining high productivity of oilseeds in general and camelina in particular. As a result, the total gross yield for all oilseeds in the Russian Federation in 2019 was 22.5 million tons, which exceeded the previous year by 3 million tons or 15 %.

Another significant development trend in this industry is the implementation of large investment projects for the processing of oilseeds. It should be noted that all enterprises are located in the regions of the Central Black Earth Region (Kursk, Lipetsk, Orel, Voronezh), which is explained by both the growth potential of the raw material base and the promising market for finished commodities.

The economic efficiency of oilseed cultivation depends on yield indicators and the amount of production costs spent to manufacture a unit of production. When calculating, the higher the yield is, the higher the income is received, the lower the cost is and, as a consequence, the higher the profitability of production is.

The highest yield of spring rape in the experiment was obtained at the first sowing period in the first decade of May and that was 20.8 dt/ha (Salsa KL). The maximum yield was obtained in 2016 on the same option, 24.8 dt/ha. The maximum yield of spring rape was observed on options using Clearfield, regardless of the sowing period. On average, the growth, development, yield structure and yield of domestic variety Ratnik were not inferior to hybrid Ozorno values.

In the conditions of the southern part of the Non-Black Earth Zone of Russia, sowing in the first decade of May is recommended, as the most productive period for spring rape. The economic efficiency of the production of spring rape seeds in experiments conducted in the Non-Chernozem zone of Russia is presented in Table 1.

TABLE I. Calculation of the economic effect of the production of spring rape varieties and hybrids when different sowing periods

Sowing period	Variety / hybrid	Average yield, dt/ha	The cost of 1 dt, rub.	Total costs, rub.	Revenue, rub.	Profit, rub.	Profitability, %
1st decade of May	Ratnik	19.0	1.187.3	22.559	39.900	17.341	76.8
	Salsa KL	20.8	1.195.6	24.869	43.680	18.811	75.6
	Ozorno	19.5	1.156.8	22.559	40.950	18.391	81.5
2nd decade of May	Ratnik	18.4	1.226.0	22.559	38.640	16.081	71.2
	Salsa KL	20.1	1.237.2	24.869	42.210	17.341	69.7
	Ozorno	18.0	1.253.2	22.559	37.800	15.241	67.5

[a.] LSD_{05} dt/ha, by yield, interactions AB 2016 – 1.63; 2017 – 1.78; 2018 – 1.67; 2019 – 1.47.

The calculations showed that the cultivation of spring rape is economically feasible. The profitability of the company is more than 50 %. This is due to the fact that the revenue from the sale of the product exceeds the costs of its cultivation. It should be noted that the use of the Clearfield system gives a higher yield. The most cost-effective option of the technology is to sow Ozorno variety in the first decade of May (81.5 %)

Additional gross growth exceeds the purchase and implementation costs of Clearfield. As a result, the profitability of the production and sale of rape reaches 70 %.

To obtain the predicted yield, the standard procedure (building a trend) was used. Based on the actual data, linear and polynomial trends were built (Fig. 1).

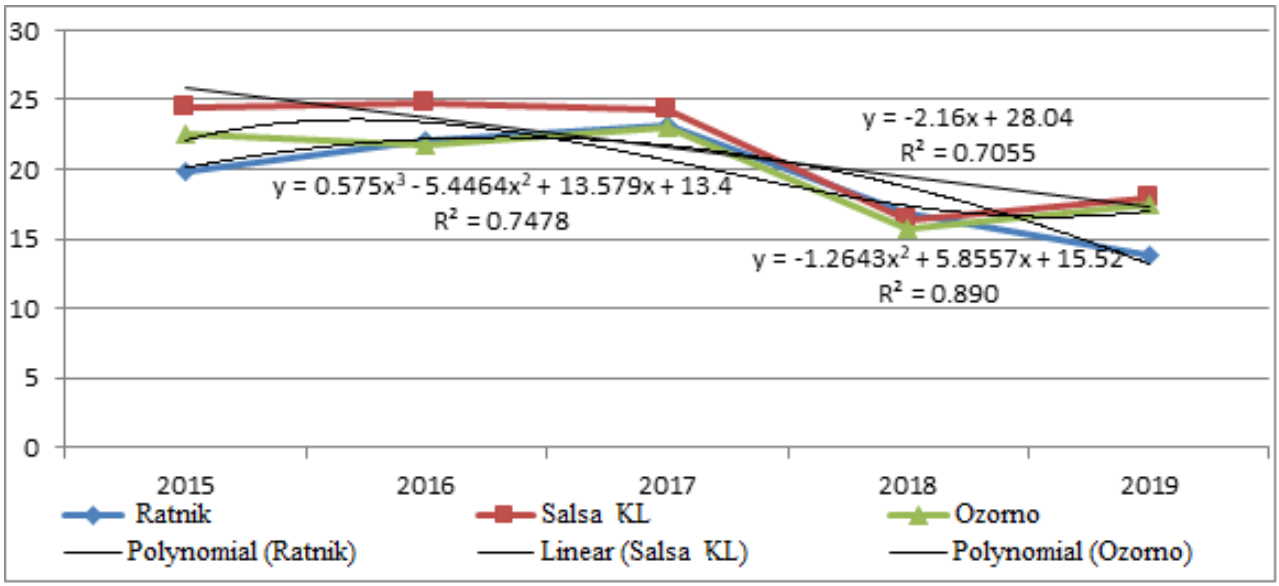

Fig. 1. Spring rape yield forecast with the help of the least square method

Since the coefficient of determination exceeds 0.7, one can conclude that the forecast will be reliable (Table 2).

TABLE II. THE FORECAST FOR CHANGES IN SPRING RAPE YIELD

Variety	Regression equation	Approximation coefficient	Productivity, dt/ha		
			fact	*forecast*	
				2020	*2021*
Ratnik	$y = -1.264x^2 + 5.855x + 15.52$	R^2=0.890	13.9	15.08	12.92
Salsa KL	$y = -2.16x+28.04$	R^2=0.705	17.4	19.05	24.91
Ozorno	$y = 0.575x^3-5.446x^2 + 13.57x + 13.4$	R^2=0.747	17.9	22.96	38.76

Even if current prices remain, the profitability of production will increase (Fig. 2).

The maximum number of seeds in the 5-years experiment with spring camelina was obtained on crops with a seed rate of 7.0 or 8.0 million seeds/ha (13.8–13.8 dt/ha) when the first sowing period (1st decade of May). The maximum yield was noted in the most favorable for the production of camelina 2015 and 2017 on options with higher seeding rates (15.2–15.6 dt/ha).

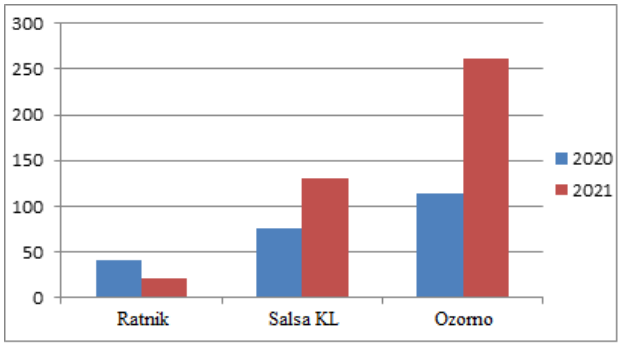

Fig. 2. The profitability forecast for spring rape cultivation, %

Analyzing the productivity indicators of spring camelina, 7.0 million germinating seeds/ha should be considered the optimal seeding rate for crops in the region. The maximum yield of spring camelina was obtained at the first sowing period in the first decade of May.

Based on the technological map, the economic effect of growing spring camelina is determined depending on the sowing period and seeding rate in the conditions of the Non-Black Earth Zone of Russia.

Next, the economic effect of growing spring camelina is determined (Table 3). The selling price of spring camelina is 18,000 rubles/t and total costs are 16,493.5 rubles.

TABLE III. THE CALCULATION OF THE ECONOMIC EFFECT WHEN GROWING SPRING CAMELINA, DEPENDING ON THE SOWING PERIOD AND SEEDING RATE

Sowing period	Seeding rate, mln. pcs/ha	Average yield, dt/ha	The cost of 1 dt, rub.	Total costs, rub.	Revenue, rub.	Profit, rub.
1st decade of May	5	12.1	1.363	21.780	5.287	32.05
	6	12.8	1.289	23.040	6.547	39.69
	7	13.8	1.195	24.840	8.347	50.60
	8	13.5	1.222	24.300	7.807	47.33
2nd decade of May	5	11.7	1.410	21.060	4.567	27.69
	6	12.2	1.352	21.960	5.467	33.14
	7	12.8	1.363	21.780	5.287	39.69
	8	13.2	1.289	23.040	6.547	44.06

The calculations showed that the cultivation of spring camelina in Ryazan region is economically feasible. This is evidenced by profitability. To get the maximum economic effect, sowing is recommended in the first decade of May with a sowing rate of 7 million pcs/ha. Profitability will be 50.6 %. According to the results of investigations, the sowing rate should be 8 million pcs/ha to achieve the maximum economic effect when camelina sowing in the second decade of May. In this case, one gets a profit of 44 kopecks for each invested ruble.

Next, predictive calculations to determine the prospective yield of spring camelina are carried out (Fig. 3).

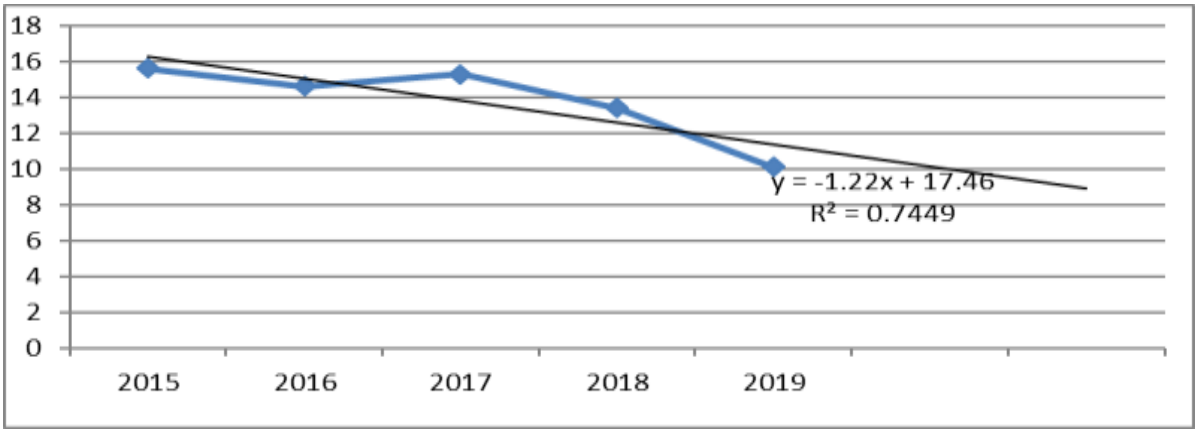

Fig. 3. Forecasting the yield of spring camelina with the help of the least square method

In order to obtain the predicted yield values, the standard procedure (building a trend) was used. Based on actual data, a linear trend was built.

Since the coefficient of determination exceeds 0.7, one can conclude that the forecast will be reliable (Table 4).

TABLE IV. THE FORECAST FOR CHANGES IN THE YIELD OF SPRING CAMELINA IN RYAZAN REGION

Spring camelina	Yield, dt/ha						
	fact					*forecast*	
	2015	2016	2017	2018	2019	2020	2021
	15.6	14.6	15.3	13.4	10.1	10.14	9.0

With the current dynamics of the yield of spring camelina, a serious adjustment should be expected. According to the results of the forecast in 2021, the yield of this crop will not exceed 9 dt/ha.

V. CONCLUSION

Thus, the analysis confirms the prospects for the development of the industry for the production and processing of oilseeds. The analysis of the experimental data showed that the crop is resistant to pests and diseases. A wide range of varieties and hybrids of spring camelina allows enterprises to conduct efficient business activities and diversify the composition and structure of marketable products. Natural and climatic conditions showed that the most promising variety of spring camelina for Ryazan region is Ozorno. It provides the maximum yield and gross yield. And when sowing it in the first decade of May, one can get the maximum economic efficiency. Profitability will be more than 80 %.

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