Comparative analysis of rape seed production in Russia and Kemerovsk region

Ekaterina Kondratenko, *Olga* Soboleva, *Alexander* Vidyakin, *Tatiana* Miroshina, *Daria* Raushkina, and *A. V.* Zhdanov

Kuzbass State Agricultural Academy, 650056, st. Markovtseva, 5, Kemerovo, Russia

Abstract. The purpose of the research is to conduct a comparative analysis of rapeseed production in the territory of the Russian Federation and the Kemerovo region. During 2011-2019, on the territory of the Russian Federation (RF) and the Kemerovo region, a comparative analysis of the sown area, yield, gross harvest of spring rape was carried out. The research results showed that over the past 9 years, from 2011 to 2019, the sown area, both in the Russian Federation and in the Kemerovo Region, has doubled. At the same time, there is a strong variation in this indicator. The variation coefficient ranged from 43.3% to 54.1%. On the territory of the Russian Federation and in the Kemerovo region, an increase in the yield of spring rape is observed by 1.13 times and 1.04 times, respectively. It was revealed that an increase in the gross harvest of spring rape seeds occurs on the basis of an extensive development of production due to an increase in the sowing area and yield.

1 Introduction

Spring rape or colza *Brassica napus L.* is an important annual herbaceous oilseed crop of the cruciferous family. Not found in the wild. In culture, it is known for 4 thousand years BC [1]. According to D.N. Pryanishnikov (1963) began to cultivate rapeseed in Russia in the 18th century [2].

Rape is a cross between spring rape and cabbage (*Brassica oleracea*). S.V. Goncharov and L.A. Fedorchuk (2018) believe that rapeseed is superior to many agricultural crops in terms of nutritional and fodder merits. So, in the production of oilseeds, spring rape takes the 2nd place, second only to soybeans, ahead of sunflower [3].

According to S.K. Sandhu, G. Singh (2018), rape is the main oilseed crop and ranks third in the world in terms of production among oilseeds [4].

The largest world producers of rapeseed are: Canada - 14.2 million tons, China - 13 million tons and India - 6.5 million tons [5].

One of the important problems in fodder production is to increase the production of vegetable protein for animal husbandry. It can be solved by cultivating high-protein crops, including winter and spring rapeseed, which are used for the production of green fodder and silage, as well as in the form of cake and meal, grass meal and seeds for animal feed as high-energy protein supplements to concentrated feed.

Rape seeds accumulate 40-50% fat and 20-30% protein [6]. The meal obtained from rape seeds allows 1 ton of meal to balance 10 tonnes of compound feed in terms of protein

[7]. Its fats and proteins are of great biological importance. Rapeseed fats contain unsaturated fatty acids (oleic, linoleic and linolenic), which are not synthesized in the body of animals, but must be supplied with feed.

M.G. Dawood, M.S. Sadak (2014) believe that the cake remaining after the oil is extracted from the rapeseed is rich in protein and can be used as animal feed. As a fodder crop, rapeseed provides a good yield of nutrients. 1 kg of rapeseed flour obtained from rape seeds contains 400-450 g of fat and up to 380 g of protein, which is 1.9-4 times more than in pea, wheat and barley flour [8].

The fodder value of rapeseed is that its vegetative mass serves as fodder for cattle in early spring and late autumn, when the productivity of perennial grasses decreases. This allows the use of green forage to be extended by 25-30 days. Vegetative mass of rape is valuable forage that is not inferior in protein content to legumes. With a yield of 400 c/ha, each hectare gives 6400 c.u. and about 820 kg of digestible protein, which is significantly more than in the green mass of corn and sunflower. With good moisture supply, it is capable of producing 2-3 mows of green mass, because it has the ability to grow back, its crops can be used for grazing.

W. Long et al. (2018) confirm that rapeseed contains 25% protein and 40-42% oil, 60% oleic acid and 8.8% linoleic acid [9].

By subjecting proteins to heating with solutions of mineral acids, the researchers found all essential amino acids in the seed hydrolysis products, the main ones of which are lysine in an amount of 1.24%, methionine - 0.64%, cystine - 0.72% and methionine + cystine 1.32%. Most of the amino acids are derivatives of fatty acids, which have an amino group [10].

F.E. Açikgöz et al. (2014), based on scientific studies, found that rapeseed has a rich nutritional composition. It is a good source of vitamin C, crude protein, crude fiber and minerals [11].

According to Glazieli Marangoni de Oliveira et al (2015), rapeseed can also be used for human food purposes. Thus, rapeseed oil is used for salads and frying, as well as for the production of margarines and other food products [12].

The World Health Organization (WHO) estimates that cardiovascular disease causes 17.7 million deaths worldwide each year, or 31% of all deaths. At the same time, it is known that rapeseed products with a high content of unsaturated fatty acids have proven themselves well in the prevention of diseases of the cardiovascular system [13].

E.A. Weiss et al. (2000) confirm that rapeseed has the highest ratio of unsaturated fatty acids among vegetable oils. Rapeseed oil contains about 65% oleic acid, 20% linoleic acid, 9% linolenic acid and 2% stearic acid [14].

According to A.S. Tan et al. (2009), a high content of oleic and linoleic acids over 20% indicates a high quality of the oil. Rapeseed oil, rich in linoleic acid, lowers cholesterol and triglyceride levels, improves blood cell viscosity and thus prevents embolism [15].

A. Namvar, T. Khandan (2015) identified and claim that rapeseed oil helps to lower cholesterol levels in the human body, as it is rich in two important essential fatty acids: linoleic acid (ω-6 fatty acid) and α-linolenic acid (ω-3 fatty acid) in a ratio of 2:1, which is ideal from the point of view of human nutrition [16].

M.C. Martínez-Ballesta, R. Dominguez-Perles, D.A. Moreno et al. (2010) found that the concentration of minerals in rapeseed can vary depending on the culture of agricultural technology, region of production, species and various plant organs [17].

P. Malagoli, P. Laine, L. Rossato, A. Ourry (2005) believe that rape is also capable of absorbing high levels of nitrates from the soil. Therefore, rapeseed cultivation can be used to reduce nitrogen leaching in autumn and winter [18].

T. Emrebas (2010) argues that rape has a number of advantages over other oilseeds. It can be winter or spring; the growing season is shorter than that of other oilseeds; it has a

higher yield per unit area; the seeds have a fairly high oil content; improved varieties do not contain erucic acid and glucocyanate, and each stage of growth from sowing to harvest is suitable for mechanization [19].

In the Kemerovo region in 2019, spring rape was cultivated on an area of 74.1 thousand hectares and was widely used not only for fodder purposes, but also for the production of seeds. Farms of the region use rape for green fodder for the preparation of silage and haylage. In the rations of feeding farm animals, rapeseed cake and meal are used.

The purpose of the research is a comparative analysis of rapeseed production in Russia and the Kemerovo region.

2 Objects and methods

The object of research was rapeseed cultivated on the territory of the Russian Federation and the Kemerovo region.

To characterize the dynamics of rapeseed production in the period 2011-2019 on the territory of the Russian Federation, the data of the official website of the Federal State Statistics Service of the Russian Federation [20] were used, on the territory of the Kemerovo Region - the official website of the Federal State Statistics Service of the Kemerovo Region [21].

The analysis of the dynamics of the cultivated areas, yield and gross harvest of rapeseed in the studied territories was carried out to identify the level of development of the production of this crop and the reserves of its development.

Mathematical processing was carried out according to B.A. Dospekhov. The variability of the studied indicators was assessed by the magnitude of the range of variation, defined as the ratio of the difference between the maximum value of the trait and the minimum to its maximum value, expressed as a percentage (V, %) [22].

3 Results and discussions

The analysis of the conducted scientific research revealed a significant increase in the acreage of rapeseed on the territory of the Russian Federation (RF). In 2019, according to the Federal State Statistics Service of the Russian Federation, it amounted up to 1,547.5 thousand hectares, with most of it accounted for spring rape, the area of which reached 1356.7 thousand hectares, while the winter crop was only 191 thousand hectares, which is 7.1 times more (Fig. 1).

On the territory of the Russian Federation for the period under review 2011-2019 the total growth of the area under crops of rape was 653.95 thousand ha (73.2%). According to our data, the sown area increased due to the expansion of spring rapeseed by 639 thousand hectares (89.1%), the increase in the area of winter rape was 15 thousand hectares (8.4%).

The sown area on average in the country in the studied series of years underwent significant changes from year to year. The maximum sowing areas of spring rape were in 2018-2019. - 1386.86 thousand hectares and 1356.70 thousand hectares, the minimum in 2011 - 717.58 thousand hectares. Its value varied under winter rape within 98.09-276.37 thousand hectares with an average value of 174.9 thousand hectares (V=64.5%), under spring rape - 717.58-1386.86 thousand hectares (V=48.2%) with the average value is 913.8 thousand hectares.

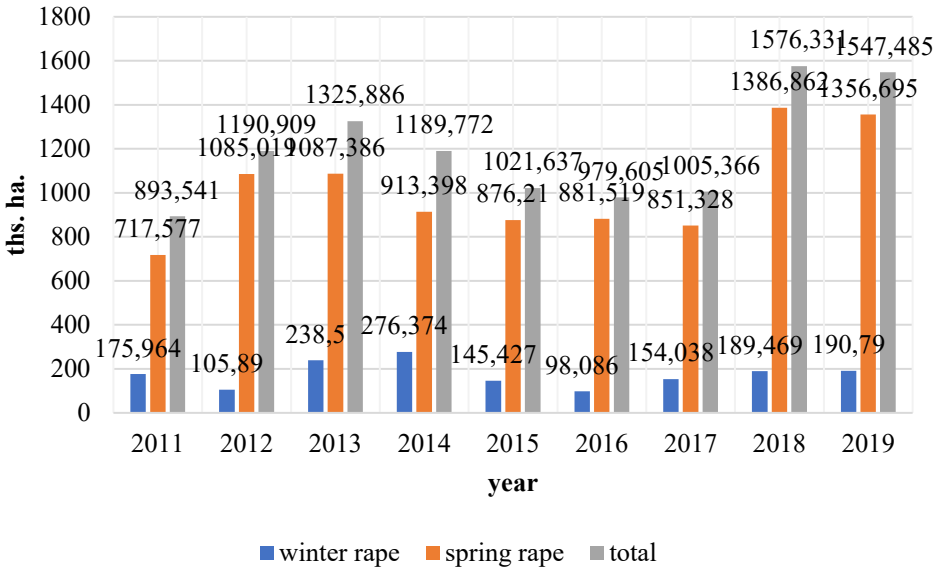

Fig. 1. Dynamics of the planting acreage of rapeseed in the Russian Federation for the period 2011-2019, ths.ha.

Analyzing the dynamics of sown areas by federal districts of the Russian Federation, it can be noted that in 2019 the largest share of all rapeseed crops in Russia fell on the Siberian Federal District (SFD) - 44.0% (680 thousand hectares). The Central Federal District (CFD) with an area of 317.3 thousand hectares ranked second in the country. Rape crops in the Siberian Federal District are 2.1 times higher than those in the Central Federal District.

Among the regions of the Siberian Federal District, the leading position is occupied by the Altai Territory, where 186 thousand hectares (12.0%) were sown in 2019. The Kemerovo region took sixth place with a sowing area of 74.1 thousand hectares, which is 4.8%. This is a fairly good result. Consequently, it is necessary to use the existing economic potential and new resources for the production of rapeseed in the study area.

Over the years of research on the territory of the Russian Federation (2011-2019), the gross harvest also changed significantly. Table 1 shows its dynamics. It has been established that the gross harvest of spring rape seeds is 3.7 times higher than that of winter rape.

An annual increase in the gross harvest of rapeseed was revealed. Its value varied from 854 thousand tons to 1662 thousand tons, with an average value of 1337.8 thousand hectares (V = 49.6%). The maximum increase in the gross harvest of rapeseed seeds was observed in 2018-2019, during this period there was an increase in the sown area and yield of this crop. The minimum is 2011, 2012 and 2015. Such fluctuations occurred due to a decrease in yields in these years and sown areas allotted for rapeseed.

Table 1. Dynamics of the rapeseed gross harvest in the Russian Federation, 2011-2019.

Indicator	2011	2012	2013	2014	2015	2016	2017	2018	2019	V, %
Gross harvest, thousand tons										
Winter Rape	261	140	348	396	235	138	284	290	351	64,6
Spring Rape	611	714	761	788	641	699	959	1313	1311	53,5
Total	872	854	1109	1184	876	837	1243	1603	1662	49,6

Comparative analysis of the yield of winter rape and spring rape cultivated in the fields of the Russian Federation for 2011-2019 shows that the highest average yield is formed when growing winter rape (Table 2). Its average value was 15.5 c/ha over the years of the study, with year-to-year variability from 13.21 c/ha to 18.38 c/ha. It was found that the yield was 1.8 times higher in winter rape compared to spring rape. On average, for 9 years, the yield of spring rape was 8.48 c/ha.

From the above, it follows that the highest average yield is formed during the cultivation of winter rape; on average for 2011-2019, it amounted to 15.48 c/ha.

Table 2. Variability of yield (c/ha) of spring rape and winter rape, t/ha, RF, 2011-2019

Year	Spring rape	Winter rape	V, % between rape species	Both rape species
	average	average		average
2011	8.51	14.83	42,6	9,75
2012	6.58	13.21	50,2	7,17
2013	7.00	14.56	51,9	8,36
2014	8.63	14.35	39,8	9,95
2015	7.32	16.21	54,8	8,57
2016	7.93	14.08	46,7	8,54
2017	11.27	18.44	38,9	12,37
2018	9.47	15.34	38,3	10,17
2019	9.66	18.38	47,4	10,74
среднее	8.48	15.48	–	9,51
V, %	45.5	27.8	–	33,0
НСР $_{05}$	0,2	0,3	–	0,4

On average, over 9 years, the range of variation in the yield of spring rape was 45.5%, winter rape - 27.8%. The variability of the yield of spring rape is higher in comparison with the yield of winter rape. On average for the period 2011-2019, winter rape plants formed a higher yield than spring rape plants. The positive features of winter rapeseed determine the desire to search for studies of the possibility of its cultivation in the territory of not only the country, but also in Siberia, to which the Kemerovo region belongs. The analysis shows that winter rapeseed is not spreading in the crops of farms due to insufficiently developed assortment of varieties and cultivation technology.

From the standpoint of adaptive crop production, the problem requires a solution based on the study of the specific growing conditions of this culture. Unfortunately, there is practically no scientific data on the features of the development and formation of the yield of winter rapeseed in this ecological niche (Kemerovo region).

As in the country as a whole, in recent years in the Kemerovo region there has been an increase in the area occupied by spring rape. So, if in 2011 the sown area was 34.6 thousand hectares, then in 2019 it was already 74.1 thousand hectares, that is, more by 39.5 thousand hectares (an increase of 114.2%) (Fig. 2). With an average sown area of 61.9 thousand hectares, the coefficient of variation was V = 53.3%. The maximum areas were allocated for this crop in 2019, the minimum - in 2011 and 2017.

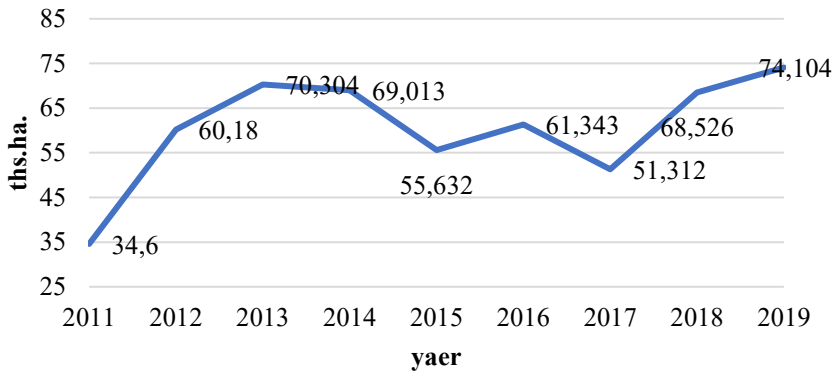

Fig. 2. Dynamics of rapeseed areas in the Kemerovo region, ths.ha.

On the territory of the Kemerovo region, along with the rapid expansion of the cultivated areas for rapeseed, the volume of its gross harvest is steadily growing. If in 2011 34.42 thousand tons of spring rapeseed were collected, then in 2019 it is already 85.05 thousand tons, an increase of more than 50.63 tons (147.1%) (Fig. 3).

From the data in Figure 3 it can be seen that an increase in gross harvests of rapeseed occurs due to an increase in the sown area and due to an increase in yield.

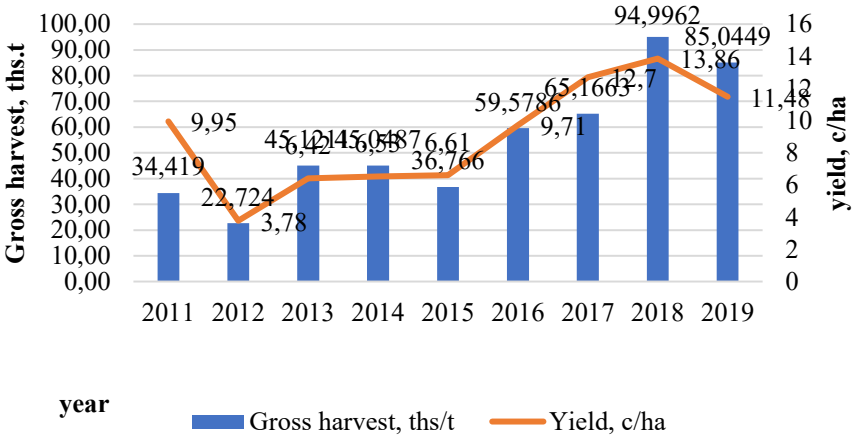

Fig. 3. Dynamics of gross harvest and yield of spring rapeseed in the Kemerovo region, 2011-2019.

It was found that the average yield for these years was 9.0 c/ha. In 2018, a record yield of seeds of this crop was obtained for the region - 13.86 c/ha.

Table 3. Comparative characteristics of rapeseed yield, RF, Kemerovo region, 2011-2019

Crop	Lim of yield, c/ha	Average yield, c/ha	V, %
the Russian Federation			
Spring rape	6.58 – 11.27	8.48	45.5
Winter rape	13.21 – 18.38	15,48	27.8
Kemerovo region			
Spring rape	3.78 – 13.86	9.00	72.6
HCP_{05}		0.17	

A comparative analysis of the yield of spring rapeseed cultivated in the Russian Federation and the Kemerovo region shows that the highest average yield is formed in the Kemerovo region, the excess was 1.12 times. The year-to-year variability of its value ranged from 6.58 c/ha to 11.27 c/ha (RF) and from 3.78 c/ha to 13.86 c/ha (Kemerovo region). A high degree of variation in the yield of spring rape was revealed during cultivation on the territory of the Kemerovo region V = 72.6%, this indicates an insufficiently developed technology of cultivation of rape in this ecological sphere.

4 Conclusions

Comparative analysis of the planting acreage on average for the period 2011-2019, allotted for rapeseed in the Russian Federation and the Kemerovo region, shows that the sown area increased by 682 thousand hectares and 39.5 thousand hectares, respectively. It was found that on the territory of the Russian Federation, winter rape plants formed a higher yield than spring rape plants. The average yield of spring rape was 8.48 c/ha, winter 15.48 c/ha, which is 1.8 times more than spring rape. The positive features of winter rapeseed determine the desire to search for studies of the possibility of its cultivation in the territory not only of the country, but also in Siberia. From the standpoint of adaptive crop production, the problem requires a solution based on the study of the specific growing conditions of this culture. Unfortunately, there are practically no scientific data on the features of the development and formation of the yield of winter rapeseed in this ecological niche.

The observed trend in the development of spring rapeseed production indicates that in the agro-climatic conditions of the Russian Federation and the Kemerovo region, this crop is cultivated successfully and can reasonably claim further growth and increase in the export of the obtained products, including outside the country.

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