Resource Saving Technologies for Rapeseed Cultivation at the Regions of the Russian Federation

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Abstract. The article describes prospects of resource saving technologies usage while rapeseed growth at regional agriculture. The importance of rapeseed in the chemical industry, energy, and oil production is considered. The article describes the importance, use, distribution and production of rapeseed in the world and in Russia along with its biological and botanical features. Strategic prospects for growing oilseed rape in Krasnoyarsk Krai are determined. The results of an experiment using resource-saving technologies for growing rapeseed in an agricultural enterprise in the Russian region are presented. Comparative characteristics of the use of resource-saving technologies per a hectare of grain crops and rapeseed are introduced at this article. The economic forecasting efficiency model of the use resource-saving technologies for rapeseed cultivation is presented. Technical, technological and organisational measures for resource saving technologies usage are offered at plant growing.

1 Introduction

At the present time rapeseed oil has attracted increasing attention as a source of renewable raw materials for the chemical industry and energy. Nowadays rapeseed is called “the crop of the future”. This plant has become a strategic crop for the agricultural production. Rapeseed can be used for producing foodstuff and animal feed and this renewable technical raw materials are widely used in industry and transport [1]. The growing importance of rapeseed dates from the end of the 20th century. During this period, people have started to use rapeseed for producing biodiesel [2]. In the last few years, the production of tractor engines operating on rapeseed oil with the addition of methyl essential oils has been established

There is the only one All-Russian Scientific Research Institute in the Russian Federation, where researches of rapeseed are being conducted. The Russian scientist V.P. Savenkov revealed that rapeseed oil is close to olive oil in terms of taste, and that is why this one is the best among all vegetable oils, which are available for food [3]. Rapeseed is widely used in the chemical industry, especially in lubricant production. It is the perfect crop for honey production. While processing the oil from rapeseed, a large amount of bagasse is left and it can be used as animal feed. This plant is a feedstock for biodiesel production, which practically does not differ from diesel fuel, but much more environment-friendly [4]. Rapeseed is a plant with high a potential. This crop makes a constructive contribution to resolving problems of agricultural holdings in the field of supplies, animal feed and technical aspects. It was discovered that from one tone of rapeseed raw materials one can get approximately 300 kg of oil and 700 kg of sprat. Rapeseeds are very small, so it is not easy for pressing while oil production. This specific feature of rapeseed and a certain chemical composition are taken into account in the development of rapeseed processing technologies

The chief agronomist of Agricultural production cooperative “Mezheninovsky” (Tomsk region at Siberia) revealed that rapeseed is a high value-added plant, but it demands the special growing technology. Acidic soils and loams are not suitable for this crop. It is important to use crop rotation and crop density standards while growing rapeseed. The farmers from Tomsk also note that development of domestic varieties of rapeseed is highly important in Russia. The main reason is that this crop has a high economic potential, which can be useful for resource-saving technologies [5].

The introduction of new equipment and advanced technology into production process makes it possible to increase the quality of products by 12-15 %. Organizational and economic measures allow an increase the production efficiency by 10-15 %. Rapeseed production technology includes the usage of complex targeted mineral and micronutrient fertilizers, protective equipment. Rapeseed cultivation demands a system of machines and mechanisms of the European level.

Nowadays, the great attention paid to the issue of increasing the efficiency in agriculture industry of Russia [6]. Reducing direct costs when getting the final product allows increasing the level of products profitability, producing by the agricultural industry. If we use traditional production technologies, a significant

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proportion of money is spent on production costs. At the same time, the result depends almost 80 percent on the prevailing natural and climatic conditions. The introduction of resource-saving technologies makes it possible to reduce the risk of such kind of exposure by 20-40 percent. So the further result depends on the optimal combination of agricultural production management and technologies.

Resource conservation on farms is a system of organizational, technical and technological activities, aimed at rational usage of resources. The system is based on the modernization of technological processes and the use of innovations. The important detail is that the growth rate of the number of products produced by agro-industrial sector directly depends on the level of their resource provisioning [7]. Resource-saving agricultural methods, equipment and machines allow to create favourable conditions for minimum influence on soil and agrocenosis. The main point of resource-saving technologies is to increase the efficiency of economic activity, reduce costs and expenses, and achieve the best output indicators.

In foreign countries the resource-efficient technologies are actively used in the field of crop production, especially system resources based on the use of precise agricultural techniques [8]. The USA (80%) and Germany (60%) are the leaders in implementation of agricultural technologies for precision farming. Resource-saving technologies are used in Great Britain [9] Denmark, the Netherlands, Brazil, China and Australia.

Intensive technologies play a crucial role in increasing the production efficiency and improving the competitiveness of rapeseed products. Almost 80% of the quality and competitiveness aspects depend on the production industry. About 20% of the rapeseed products quality depends on the process of refinement agricultural products, packaging, and storage. Applying new innovative approaches in the process of technological formation of product features makes it possible to increase the consumer cost of rapeseed raw materials.

2 Materials and methods

The level and rate of development of resource-saving technologies in Russia differ significantly from the indicators of other countries. The development index of resource-saving technologies in Russia is about 10% of the level of other countries. The reason of repeated increase in the cost of agricultural production is the slow introduction process of energy-efficient technologies due to price increase for material and energy resources. This fact has a negative impact on profitability and competitiveness of agricultural producers. Production primarily relies on the use of traditional technologies. Only in very limited areas, resource-saving technologies are used. The following indicators characterize the current state of agriculture in the Russian regions:

- low level of productivity compared to Western countries (no more than 10% of the level of developed countries);
- generated high-energy products: 4-6 times higher than in the developed countries of the West (in Russia, for example, for 1 hectare of arable land needed up to 250-280 kg of fuel, while in US patent it is only 140 kg);
- an irrational "excessive" number of technical, technological and energy resources are used with low usefulness. The average annual energy efficiency index of the energy-consuming equipment in Rissia never reaches 20%;
- high percentage of natural energy consumption. The modes of consumption of a larger diesel fuel share is about 30%, gasoline – from 11 to 16%, natural gas is about 20%, electricity and coal- from 10 to 11%;
- obsolescence of operational, repair and service systems;
- reduction of car park;
- lack of qualified personnel.

The analysis of the data received from farmers showed that the use of resource-saving technologies based on modern high-performance complexes of agricultural machinery makes it possible to minimize tillage and reduce the consumption of fuel, fertilizers and plant protection products. A lot of effective resource-saving techniques have already been developed in modern agricultural production [11].

Resource-saving cultivation technologies are based on the use of no-till or minimum tillage, as well as fruit-seed or grain-fallow crop rotations with a small fallow area [12]. Scientific research shows that ploughing is not always the best way of tillage. Technical re-equipment of the agriculture sector in Krasnoyarsk Krai, expansion of the plant protection products range and increase the use of mineral fertilizers allow to control the production process on minimal (resource-saving) tillage.

The introduction of advanced resource-efficient technologies for cropping with no-till and minimal tillage makes it possible:

- to reduce the consumption of energy resources by 1.4–1.9 times compared to traditional technology;
- to reduce the cost per 1 centner of winter wheat by 10-20 %.

At the same time, increasing crop productivity is a prerequisite for resource conservation. In calculating the crop yield based on 35 c/ha, the capital investments in equipment per 1000 tons of harvested crops are reduced by 1.4 times compared to the yield of 20 c/ha. It is possible to reduce energy consumption by 1.3 times through resource saving.

Most effectively, resource-saving cultivation technologies are used in wheat, corn, soybeans and oilseeds production.

3 Results

Recently Russia has been devoting increasing attention to the agricultural development and the application of resource-saving technologies in this industry. This trend is not legally established or published within a defined subroutine in "The State rural development program of agriculture and management of markets for agricultural products, raw materials and food for the period 2014 -

2020" [13]. Oil-bearing crops hold considerable potential, the demand for which is stable and tends to increase. In recent years, significant progress in our country has been made in the field of oilseeds production and crop yields increase (table 1).

Table 1. The yield of oilseeds in agricultural holdings of the Russian Federation.

Name of crop	2014	2015	2016	2017
oilseeds	12.9	13.6	14.6	14.6
sunflower	14/0	15.2	16.0	15.1
soya	12.4	13.6	16.0	14.7
mustard	5.9	5.1	5.5	7,0
winter rapeseed(canola)	17.4	19.8	18.5	22.9
spring rapeseed (colza)	11.4	10.0	10.2	14.4

Analysis of the data presented in the table 1 shows that about 100% of oilseeds grown in the Russian Federation tend to increase yields over 4 years. The increase in average yield for all crops is small – just about 2-3 units. Rapeseed showed the highest yield in 2017: winter rapeseed up to 22.9 tons/ha (30%) and spring rapeseed (colza) up to 14.4 tons/ha (26%).

Krasnoyarsk Krai is a leader in the field of grain and pulse harvest in the Siberian Federal District for more than ten years. Resource-efficient technologies for the cultivation of grain crops make up 54% (519.9 thousand hectares of the total area of cultivated grain crops 970.5 thousand hectares). Both domestic and foreign complex machines are used for tillage and sowing.

According to the program "The State rural development program of agriculture and management of markets for agricultural products, raw materials and food", the resource conservation is currently one of the priorities for improving the quality of crop production and preserving its stability in Krasnoyarsk Krai [15].

Resource conservation is a complex problem that requires targeted decisions in investment, financial, scientific, technical, credit, tax and legal aspects [16]. One of the methods of increasing efficiency of the agro-industrial complex is the restructuring of the management system considering the resource saving aspect [17]. Alongside process of resource saving, it is necessary to master innovative methods of development.

LLC "Uchkhoz Minderlinskoe" is actively involved in the experiment with the use of resource-saving technologies in the field of rapeseed cultivation. More precisely, technologies in this enterprise include such aspects like multifunctional equipment and new varieties of seeds and fertilizers. In the Sukhobuzimsky district of Krasnoyarsk Krai there was provided a research about the using of resource-saving technologies per a hectare of grain crops and rapeseed. The results of this research are presented in table 2.

Analysis of the data presented in the table 2 shows that the cultivation of rapeseed requires significantly fewer resources than grain cultivation. Meanwhile, the market cost of 1 ton of grain on average is 8 thousand rubles (depending on the variety), while market cost of 1 ton of rapeseed is about 22 thousand rubles. Therefore, the cultivation of rapeseed requires fewer resources, while its implementation cost for 1 ton is higher.

Table 2. Comparative characteristics of the use of resource-saving technologies per a hectare of grain crops and rapeseed in the Sukhobuzimsky district of the Krasnoyarsk territory.

Resource conservation	Grain crops	% in cost structure	Rapeseed	% in cost structure
Land resources (ha)	1	-	1	-
Human recourses (h./h/rub)	4089	10	1748	45
Machines (ha/rub.)	30705	72	532	14
Seeds (item/rub)	2629	6	311	8
Fertilizers (kg/rub.)	5128	12	1282	33
Total	42551	100	3873	100

The adaptation of advanced resource-saving technologies for cultivation of agricultural crops with no-till or minimum tillage make it possible to reduce energy resources consumption by 1.4–1.9 times compared to traditional technology, and lower the cost of production of 1 centner of winter wheat by 10-20 %.

The results of the use of resource-saving technologies in LLC Educational Experimental Farm "Minderlinskoe" are shown in table 3.

Table 3. The economic forecasting efficiency model of the use of resource-saving complex "Agrator" in Educational Experimental Farm "Minderlinskoe".

Indicator	Without navigation (per 1000 hektares)	With navigation (per 1000 hektares)	Difference	Effectiveness, rub.
Sown area, ha	83,2	12,8	70,4	-
Over-expenditure of seeds, t	20	5	15	195 000
Over-expenditure of fertilizers, t	16	3	13	49 400
Over-expenditure of fuel, l	602	111	491	18 167
Total				262 567

Modernization of the physical infrastructure in LLC Educational Experimental Farm "Minderlinskoe" will become a resource for increasing the effectiveness of agro-industrial production of rapeseed in Krasnoyarsk Krai. Besides, it will ensure training of highly qualified

specialists with specialized knowledge of the agricultural sector [18].

4 Discussion

Market analysis in China, Mongolia and the Union of the independent states, as well as the experience of Russian regions selling rapeseed abroad, revealed that rapeseed is a demanded export product [19]. Therefore, its production in Russia has steadily grown. According to data provided by Rosstat, rapeseed-sown area in Russia has increased by 126.8 percent over the past 10 years. In Lipetsk region there was a significant yield increase, so in 2019 it was a record - 22.3 centres per hectare (compared to 12.7 c/ha in 2009). Krasnoyarsk Krai has perspectives for rapeseed export to East Asian countries due to the geographical proximity of markets and growing demand for this product [20]. According to the results of the impact analysis in the field of resource-saving technologies in agriculture of Russian regions and abroad, it is appropriate to draw the following conclusions. Firstly, agriculture in Russia has smaller performance indicators in comparison to developed countries, as well as in the field of resource-efficiency technologies. Secondly, nowadays the implementation of resource-saving technologies has received renewed attention in the Russian Federation. More than half of farms currently use the technologies of advanced multifunctional equipment, fertilizing and precision farming systems. Krasnoyarsk Krai is the leader of grain production among Siberian regions. In order to increase the productivity of the crop industry, it is necessary to place special emphasis on the use of resource-saving technologies, multifunctional equipment, which can help to reduce both labour and material costs

5 Conclusion

For sustainable resource consumption and reducing production costs of rapeseed and other crops, the activities of agricultural organizations should be aimed at the introduction of technological, technical and organizational measures [21].

Technological measures include:

- introduction of energy and resource-saving technologies for cultivation with no-till and minimum tillage;
- replacement technologies of mechanized work, such as ploughing, which includes tillage before or during the process of sowing, as well as the use of zone herbicides.

Technical measures include:

- implementation of the high-performance combined equipment that provides the ability to perform multiple operations (tillage, mineral fertilizers, sowing, packaging) in one cycle;
- increasing the coupling of machine tractors and its operating speeds;
- rational aggregation of machines intended for comprehensive performance;
- strengthening the capacities of mobile equipment (tractors, combines, etc.);
- usage of alternative fuels;
- replacement of vehicles with normative useful life to reduce the diesel fuel consumption and the use of spare parts.

Organizational measures for resource conservation include improving the structure of cultivated land and cultivating of cost-effective and high-yield crops.

Due to the scarcity of material resources, agricultural enterprises in the Russian regions need to use an economic mechanism based on the use of resource-efficient technologies. The following resource saving options should be considered separately and in combination:

- usage of no-till and minimum tillage;
- usage of high-quality seeds of different varieties;
- application of high-performance equipment in combined and wide-reach machines;
- operational reconciliation of technologies;
- usage of integrated plant protection systems against vermin, diseases, and weeds;
- implementation of scientifically based doses of mineral and organic fertilizers;
- effective labour organization.

To increase performance indicators of agricultural productivity, it is necessary to organize the process of providing the regional agro-industrial complex with machines and equipment of operational efficiency. Moreover, it is also needed to continue using resource-efficient technologies and start mastering new techniques, such as precision agriculture [22].

One of the state support measures to encourage the acquisition of modern resource-saving equipment is the provision of property taxes. This measure enables to improve the efficiency of agricultural land use, increase the competitiveness of agricultural product, transform and integrate infrastructure and logistical support of agricultural production markets. New measures to support agriculture at the government level will allow for increasing exports, and this will allow agricultural enterprises to reach specified levels of production and exports [23].

The export of goods made on the basis of resource saving processing will significantly increase the profitability of this agroindustry, thus, more and more businessmen are showing interest in investing to the agrarian production [24].

The use of resource saving technologies in agriculture of the region is supported by the implementation of "The State rural development program of agriculture and management of markets for agricultural products, raw materials and food for the period 2014 - 2020" in Krasnoyarsk Krai. In this document, it is saying that the use of resource-efficient technologies is one of the high-priority areas of crop production [25]

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