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ECONOMIC EFFICIENCY OF WINTER WHEAT CULTIVATION BY VARIOUS TECHNOLOGIES

Elena Pismennaya (a), Evgeny Golosnoy (b), Maxim Sigida (c), Margarita Azarova (d)*
*Corresponding author

(a) Stavropol State Agrarian University, Zootechnical lane 12, Stavropol, Russia, pismennaya.elena@bk.ru
(b) Stavropol State Agrarian University, Zootechnical lane 12, Stavropol, Russia, golosnoi@mail.ru
(c) Stavropol State Agrarian University, Zootechnical lane 12, Stavropol, Russia, sigida@list.ru
(d) Stavropol State Agrarian University, Zootechnical lane 12, Stavropol, Russia, azarova778@gmail.com

Abstract

Export of domestic food products to the world market is one of the most important strategic tasks of Russia. To solve it, it is necessary to bring the agricultural sector to the improvement of the existing technological order and to form a new way out of the crisis and take a leading role in the international food market. The main food crop in the arid zone of south of Russia is winter wheat, the productivity of which is influenced by the use of traditional technology and the new - No-till (zero tillage) technology. So, the choice of the soil processing system of the commodity producer of JSC “Agrokhleboproduct” branch of “AgroKevsalinsky” is based on an understanding of the requirements of the market internal and external conditions, as well as the production, technological and soil-climatic conditions of agricultural land use of the Stavropol Territory. An analysis of the economic efficiency of winter wheat production at an agricultural enterprise showed that not only the choice of technology, but also the rational selection of predecessors in crop rotation had a decisive influence on the indicators. Reducing labor costs for the direct seeding technology by 29.5% and 54.6% per 1 ha and 1 ton respectively. Consequently, the use of technology without soil cultivation in the arid zone agribusiness allows JSC "Agrohleboprodukt" saturate rotations of new economically viable crops and increase the export potential of the food.

Keywords: No-till technology, winter wheat, predecessor.

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1. Introduction

Today, one from the list of challenges is facing the Russian government should totally ensure food security of the country and build up the export potential of agricultural products. The current dynamics of the agricultural industry is assessed as positive, the basis of which was the receipt of high and relatively stable crops obtained as a result of the improvement of traditional and the use of new technologies (Dridiger et al., 2018; Schlegel et al., 2019).

Russia Sowing area is 79.319 Mill. hectares, including No-till technology about 2 Mill. Ha, or 2.5%. The technology is most widely used in Rostov, Volgograd, Saratov, Samara Chelyabinsk, Kurgan, Novosibirsk, Omsk regions, Stavropol and Altai area and some other regions. The main reasons for the implementation of this technology, besides the soil and climatic (fight against wind and water erosion, moisture retention in the soil, soil enrichment and micro mesofauna etc.) are socioeconomic. The modern development of agricultural enterprises in Russia is determined by the need to increase labor productivity, due to the presence of large tracts of arable land and limited labor resources. No-till technology can increase labor productivity from 3 to 5 times and reduce total costs by 10-12% (Dridiger, 2018; Ullah et al., 2019).

2. Problem Statement

Arable land located in the dry zone of Stavropol region is 2132.0 thousand ha. The average yield of winter wheat is 2900 kg / ha, gross harvest - 1.53 million tons. The combination of natural factors in the dominant types of farms determines the advantage of grain-steaming and grain-steaming systems of agriculture of a soil-protective orientation.

Application of the conventional technology has led to the formation of eroded (2.2%) and deflated (13.3%) lands Connection the water and the wind erosion processes was detected on a square of 123 thousand ha (2.2%). The balance of nutrients in the arable land has become negative again and returned to the level of the 1960s (Acharya et al., 2019).

In order to create a rational system for using the land fund in Russian science and industry, a contradictory attitude has developed towards replacing the traditional technology with a new one - No-till. Several authors give examples of effective development and its influence on soil fertility and productivity of crops (Blanco-Canqui & Wortmann, 2019). Zero technology (direct sowing) is recommended by them for use in the arid zone, like an alternative to well-studied traditional technology. It helps to reduce negative natural processes, improve the agrophysical and agrochemical properties of the soil, reduce technological operations, minimize labor costs, growth yields, and reduce funding for forestry, irrigation and drainage, etc. (Dridiger et al., 2017).

Other researchers do not consider it acceptable for wide distribution because it becomes more difficult to control weed crops and the cost of acquiring herbicides increases by 15-50% depending on the crop and type of crop rotation, the presence of crop residues creates good conditions for the emergence of diseases and pests (Ferreira et al., 2020; Seipel et al., 2019). The large amount of residue reduces the effectiveness of fertilizing nitrogen and generates a danger of waterlogging of the arable layer. The problem of the spread of No-till technology is the use of imported systemic herbicides such as glyphosates (Liang et al., 2020; Sun et al., 2018). The disadvantage of the technology is the high price of the main technical

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equipment - direct seeders, which are produced abroad. In addition, the use of technology needs a high level of qualification of agronomic and technical personnel, etc. (Giannitsopoulos et al., 2019; Kan et al., 2020).

3. Research Questions

The studies were conducted in the stationary experiment for three years (2017-2019 years), laid on the territory of JSC “Agrokhleboproduct” branch of “AgroKevsalinsky” located in the arid zone of the Stavropol Territory. The maximum amount of effective temperatures of the arid zone is 3200-3500° C, the amount of precipitation per year is 421-430 mm., SCC (storage connecting circuit.)- 0.7 - 0.9.

In the study period the average annual air temperature was 11.2-11.8° C, while in 2018 it dropped to two degrees. In 2019, the mark grown up to the level of 10.1° C. The amount of precipitation in 2017 and in 2018 had a downward trend, which has a negative effect on the stock of productive moisture. Against the background of three years, weather conditions were the most severe only in 2019: high temperatures and the lack of precipitation during grain loading (late May – mid June) contributed to “grain capture”, which had a negative impact on winter wheat productivity (Pismennaya et al., 2019). The soils of agricultural enterprises are dark chestnut carbonate heavy loamy (Pismennaya et al., 2019).

The experiment was placed in 3-fold repetition, the area of one plot is 500 m2. Varieties of winter wheat (Zustrich, Bagira, Bagrat) are cultivated in the links of crop rotation: sunflower - winter wheat, chickpea - winter wheat.

4. Purpose of the Study

The goal of the study is the economic efficiency of winter wheat cultivation using various technologies in the conditions of an arid climate of the South of Russia (on the example of agricultural enterprises JSC "Agrokhleboprodukt" branch of "AgroKevsalinsky" in the Stavropol Territory).

The economic indicators of winter wheat cultivation (yield, production costs, prime cost, profits and profitability and others) were determined by two technologies - traditional and "zero", taking into account:

- the influence of predecessors: chickpeas and sunflowers,
- fertilizer application rates: herbicidal and fungicidal treatment,
- application of technological operations and agricultural machinery.

5. Research Methods

In accordance with the schedule of works carried out technological measures using appropriate units of agricultural fertilizer, herbicide and fungicide treatment by traditional technology tillage and No-till, shown in Tables 1 and 2.

Table 01. Technological operations of the No-till winter wheat cultivation system

Technological operations	Application rate	Composition of the agricultural unit
Presowing treatment with herbicides (“Sprut” Extra)	2 l/ha	Self-move sprayer Caffini
Sowing winter wheat	210 kg/ha	Buhler+John Deere 1890

Sowing fertilizer (ammonium nitrate)	100 kg/ha	Buhler+John Deere 1890
Early spring top dressing (ammonium nitrate)	100 kg/ha	MTF 1221+Amazone
Adding foliar (CAS)	100 kg/ha	MTF 80+OP 2000
Herbicidal Treatment (Ballerina)	0.4 l/ha	MTF 80+OP 2000
First fungicidal treatment (Altosuper)	0.5 l/ha	MTF 80+OP 2000
Second fungicidal treatment (Kolosal Pro)	0.4 l/ha	MTF 80+OP 2000
Insecticidal treatment (Borey/Northwind)	0.1 l/ha	MTF 80+OP 2000
Ingathering		Combine-harvester CLAAS

Table 02. Process operations traditional winter wheat cultivation technology

Technological operations	Parameters	Composition of the agricultural unit
Stubble	6-8 cm	Buhler+Salford 870
Stubble	10-14 cm	Buhler+Salford 870
Cultivation	8-10 cm	Buhler+Wil-Rich
Cultivation	6-8 cm	Buhler+Wil-Rich
Sowing winter wheat	210 kg/ha	Buhler+John Deere 1890
Sowing fertilizer (ammonium nitrate)	100 kg/ha	Buhler+John Deere 1890
Early spring top dressing (ammonium nitrate)	100 kg/ha	MTF 1221+Amazone
Adding foliar (CAS)	100 kg/ha	MTF 80+ОП 2000
Herbicidal Treatment (Ballerina)	0.4 l/ha	MTF 80+ОП 2000
First fungicidal treatment (Altosuper)	0.5 l/ha	MTF 80+ОП 2000
Second fungicidal treatment (Kolosal Pro)	0.4 l/ha	MTF 80+ОП 2000
Insecticidal treatment (Borey/Northwind)	0.1 l/ha	MTF 80+ОП 2000
Ingathering	-	Combine-harvester CLAAS

The timing of sowing winter wheat was determined by weather and climatic conditions. The seeding rate was 5 million germinating seeds per 1 ha.

6. Findings

The technological operations carried out in the farm during the cultivation of winter wheat, in the dynamics of the main tillage go through a number of stages: plowing, the use of chisels, zero tillage and traditional. An analysis of the use of technological operations showed that the No-till system relates to energy-saving technology (there are no operations - peeling of plant residues, pre-sowing cultivation) (table 3).

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Table 03. Compare of technological operations of winter wheat cultivation

Technological operations	Technology	
	No-till	Traditional technology
Plant debris peeling	-	+
Presowing cultivation	-	+
Fertilizing and rolling seeding	+	+
Autumn herbicide treatment	+	+
Early spring top dressing	+	+
Protection against diseases, pests, weeds	+	+
Ingathering	+	+

The calculation of the efficiency of grain production also showed that predecessors also have a decisive influence on economic indicators. With the same predecessor - chickpeas - the yield of winter wheat using direct sowing technology was 4.82 tons/ha, traditional - 3.41, labor costs per ha - 9.5 man-hours and 12.3, respectively (table 4).

Table 04. Economic efficiency of crop production using No-till technology (average for 2017-2019)

Indicator	Winter wheat	
	Predecessor	
	Chickpeas	Sunflower
Productivity from 1 ha, tons	4.82	2.8
Selling price 1 ton, rub.	13000.00	12000.00
Cash proceeds from 1 ha, rub.	66600.00	33600.00
Labor costs per 1 ha, person-hour	9.5	9.0
Labor costs per 1 ton, person-hour	1.97	3.21
Production costs, rub/ha	32125.00	30190.00
Cost, RUB/ton	6665.00	10782.00
Profit per 1 ha, rub.	34475.00	3410.00
Profitability level,%	107.0	11.3

The yield of winter wheat by the predecessor of sunflower in the No-till system was 2.8 tons/ha, traditional - 1.93 tons/ha, labor costs per 1 ha - respectively 9.1 people-hour and 7.0 people-hour (table 5).

Table 05. Economic efficiency of crop production by traditional technology (average for 2017-2019)

Indicator	Winter wheat	
	Predecessor	
	Chickpeas	Sunflower
Productivity from 1 ha, tons	3.41	1.93
Selling price 1 ton, rub.	13000.00	16000.00
Cash proceeds from 1 ha, rub.	44330.00	30880.00
Labor costs per 1 ha, person-hour	12.3	7.0
Labor costs per 1 ton, person-hour	3.61	3.6
Production costs, rub/ha	34125.00	25620.00
Cost, RUB/ton	8728.00	13275.00
Profit per 1 ha, rub.	16705.00	5260.00
Profitability level, %	49.0	21.0

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The predecessors had a significant influence on the cultivation of winter wheat using direct sowing technology: from an economic point of view, the cultivation of chickpeas turned out to be more profitable than sunflower, which turned out to be unprofitable. Therefore, chickpeas can be recommended for inclusion in crop rotation for cultivation without tillage. In addition, this crop enriches the soil with biological nitrogen and is the best precursor for winter wheat. When cultivating chickpeas, the highest costs for both technologies are associated with the use of plant protection products, but when sown without soil treatment, the cost of pesticides is greater (glyphosates are additionally used).

The level of profitability of winter crops of sunflower lower than Nute. At the same time, the sunflower is one of the most profitable and cost-effective crops for cultivation on technology untreated soil in the arid zone of the Stavropol Territory. The largest expense item for sunflower cultivation is pesticide treatment.

7. Conclusion

The cost structure of the No-till system is a significant reduction in fuel, depreciation, equipment repair, etc., then with the traditional one. The profitability of cultivating winter wheat after chickpea was 107% and 49, respectively, using direct sowing and traditional technology. The profitability level of sunflower crops was 11.3% and 21.0%, respectively. This serves as the basis for reducing labor costs per unit area and 1 ton of products using direct sowing technology by 29.5% and 54.6%, respectively.

On the basis of the research, it is recommended to develop the technology cultivation of crops without soil cultivation in the arid zone of the south of Russia and saturate rotations economically profitable crops, thus expanding the agricultural exports.

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