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ECONOMIC EFFICIENCY OF WINTER WHEAT CULTIVATION ACCORDING TO TRADITIONAL AND ZERO TECHNOLOGY

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Abstract

The article substantiates the possibility and economic feasibility of cultivating winter wheat using zero technology. The research revealed that using direct sowing technology, the top mulch layer of plant residues promotes better moisture of the underlying layer and reduces the soil temperature. In this connection, by the time of sowing of winter wheat, according to the zero technology, in the layer of 0.0-0.20 m it was within 15.6-26.8 mm, and according to the traditional technology 10.2 -23.8 mm with the generally accepted technology, the number of ergonomically valuable aggregates is reduced compared to zero technology. According to the traditional technology, in the phase of full ripeness of winter wheat, it almost doubles, and is in the range of 6.4 -7.4%. The presence of this fraction can lead to such negative phenomena in agriculture as erosion and deflation; water resistance of soil aggregates during the spring growing season of winter wheat with zero technology is within 68 -72%, and according to the traditional – within 66-70.1%. With traditional technology, an increase in soil density is observed compared to direct sowing by 0.03-0.04 g /sm^3. This convincingly shows that as a result of intensive mechanical action on the soil, a certain amount of dust-like fraction is formed. Biological processes occurring in the soil during the decomposition of the mass of plant residues contribution to the optimization of agrophysical indicators, lead to decomposition of soil cultivation of winter wheat using zero technology from an economic viewpoint; the level of profitability is about 110-140%.

Keywords: Winter wheat, tillage, zero technology.

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1. Introduction

The history of farming has 10-15 million years and is closely connected with the dump soil treatment system (Yushchenko, 2014). However, at the end of the twentieth century, such a tillage system did not suit agricultural producers. It turned out that the dump soil treatment system has many drawbacks. The main disadvantages include the following: a decrease in soil fertility, a decrease in the content of humus, high energy intensity, low productivity, this system could not cope with the destruction of diseases, weeds and pests (Dorozhko, Penchukov, Vlasova, & Borodin, 2011; Esaulko, Dorozhko, & Drepa, 2013).

The growth of the power supply of agriculture, and with it the intensity of tillage did not provide the expected increase in crop yields, led to increased water and wind erosion processes, especially in arid regions (Dridiger, Drepa, & Matveyev, 2015; Yushchenko, 2014).

Successful development of agricultural production is possible only through the use of zonal farming systems, the widespread introduction into the production of energy-saving, soil-protective technologies of cultivation of agricultural crops (Skuryatin, 2014).

Tillage is the most energy-intensive and expensive process in agricultural production. On average, it accounts for 40% of energy and 25% of labor costs of the total field work (Nestyak & Mambetalin, 2011). With the wrong choice of reception or processing system, negative processes appear, the economic efficiency of production decreases. The soil is rapidly losing humus, sprayed, condensed, erosion intensified. Therefore, each method of tillage should be rational, and the payback of costs should be maximal (Rykov, Kambulov, & Kambulov, 2016; Pozdnyakova & Magomedtagirov, 2018).

2. Problem Statement

To properly address the issues of tillage, we need deep theoretical knowledge of the requirements of plants to the environment in which they are cultivated, the laws of the processes that take place in the soil, their changes under the influence of various processing methods (Glab, Puzynska, Puzynski, & Iskakov, 2016; Sivandaev, Efremov, & Volkov, 2018). In recent years, tillage has been further developed in both theoretical and practical directions. Soil-cultivating tools have become more advanced, combined tillage units have appeared, which simultaneously perform several technological methods, information technologies have been used in the design of agricultural machinery. The systems of basic, pre-sowing tillage and maintenance of crops have been improved, the need for differentiation of depth and number of treatments in the crop rotation has been brought, a system of soil-protective treatment has been developed for areas where water and wind erosion is manifested (Davidenko, Shol, & Schol, 2016; Esaulko, Trubacheva, Vlasova, Igolnikov, & Sidorov, 2016; Dorozhko & Petrova). However, all adapted tillage systems have one common drawback, they are very energy intensive. Therefore, each method of tillage should be rational, and the payback of costs should be maximal (Rykov, Kambulov, & Kambulov, 2016; Pozdnyakova & Magomedtagirov, 2018).Therefore, No-Ttill ecological and energy-saving technology was widely introduced and widely used on 100 million hectares in Brazil, Argentina, USA, Canada, Australia, France and other countries. Now this technology is being actively tested in Ukraine, Russia and Kazakhstan (Bakirov, Polyakov, Khalin, & Balandina, 2018; Goryanin & Shevchenko, 2018).

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3. Research Questions

On the basis of studying the agrophysical and agrobiological indicators of soil fertility and determining the yield of winter wheat cultivated in the zone of unstable moistening according to traditional and zero technology, the economic efficiency of its production is determined.

4. Purpose of the Study

The main purpose of the research is to conduct research on the comparative assessment of the impact of traditional technology and No-till technology on soil fertility and the efficiency of agricultural production of winter wheat in the cultivation under conditions of the central Ciscaucasia.

5. Research Methods

According to the traditional technology, we applied technologies and technological methods of cultivation of agricultural crops recommended for the zone of unstable moistening .During the growing season of crops, regardless of technology, the recommended plant protection scheme was used according to harmful objects.

Observations, surveys, sampling and analyzes on the fixed fields were carried out according to generally accepted methods in the main phases of cultural development.

The composition of the traditional processing technology for winter wheat included the following operations:

1. Disk peeling in two tracks DB – 6.6 to a depth of 6-8 and 10 -12 sm
2. Disking “Diskator” in 1 track to a depth of 10-12 sm
3. Cultivation KPS-4 to a depth of 8-10 sm
4. Pre-sowing cultivation KPS-4 to a depth of 6 -8 sm
5. Sowing with the traditional technology was carried out by the drill NWS 3.6

The composition of the traditional processing technology under the sunflower consisted of the following operations:

1. Disking BDK-4 to a depth of 6 -8 sm.
2. Plowing PLN-8-35 to a depth of 20 -22 sm
3. Spring harrowing SG-12 + 12 BZSS-1,0
4. Cultivation KPS-4 to a depth of 8-10 sm
5. Cultivation to a depth of 6-10 sm
6. Sowing SUPN-5,6

Sowing with zero technology was carried out with Super Walter W 630 stubble seeder.

6. Findings

As a result of the research, we found that the contamination of winter wheat crops cultivated by zero technology tends to decrease, indicating stabilization of the agrocenosis of field crops, increasing the

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competitive ability of crops and the manifestation of the alleleopathic mechanism of the effect of the cushion from plant residues on weed seeds.

When cultivating winter wheat after winter rape, the bulk of plant residues up to 76.1%, to the crop sowing is concentrated in the soil layer 0-10 sm. In the lower part of the arable and in the subsurface layer the mass of winter rape remains is only 5.1% of the total masses. By the full ripeness of winter wheat in a layer of 0-10 sm, the mass of plant residues is 22.0%. When using direct sowing technology, the top mulch layer of plant residues contributes to a better moisture of the underlying layer and reduces the temperature of the soil.

During the entire period of research, the results show the advantage of direct sowing technology in the preservation and accumulation of productive moisture to traditional technology. Direct seeding provided higher rates of productive moisture relative to traditional technology. Before sowing a culture using zero technology in a layer of 0.0-0.20 m, it was in the range of 15.6-26.8 mm, and according to traditional technology it was 10.2-23.8 mm. The supply of productive moisture in the arable and meter layers to the tillering stage increases and reaches its maximum values - for winter wheat in the arable layer it is 27.8 mm and 24.0 mm, and in meter 160.0-150.0 mm. By the phase of full ripeness, there is a decrease in the supply of productive moisture and by the phase of full ripeness in the arable layer it is 12.1-10.2 mm and in the meter 96.1 and 84.9 mm, the traditional technology provides lower rates.

With the generally accepted technology, the number of agronomically valuable aggregates is reduced compared to zero technology, the amount of the lumpy fraction increases, it should be noted that the dust fraction is formed in large quantities. According to the traditional technology, it almost doubles in the phase of full ripeness of winter wheat and is in the range of 6.4-7.4%. The presence of this fraction can lead to such negative phenomena in agriculture as erosion and deflation; water resistance of soil aggregates during the spring growing season of winter wheat with zero technology is within 68-72%, and according to the traditional – within 66-70.1%. With traditional technology, an increase in soil density is observed compared to direct sowing by 0.03-0.04 g / sm3. This convincingly shows that as a result of intensive mechanical action on the soil, a certain amount of dust-like fraction is formed, which causes an increase in the density of the soil. Biological processes occurring in the soil during the decomposition of the mass of plant residues contribute to the optimization of agrophysical indicators, leading to soil decompression.

In the cultivation of winter wheat using direct sowing technology, production costs are significantly reduced in relation to traditional technology for such items of expenditures as fuel and lubricants – by 1009 rubles / ha, or by 50.2%, depreciation and equipment repair – by 577 and 173 rubles / ha, or 23.7% (Table 1).

Table 01. The influence of the technology of cultivation on the structure of the cost in the cultivation of winter wheat

Cost items	**Conventional technology**		**Direct seeding**		**Cost reduction**	
	rub / ha	**%**	**rub / ha**	**%**	**rub / ha руб./га**	**%**
Wage	1134	7,9	1003	8,0	131	11,6
Fuels	2009	14,0	1000	8,0	1009	50,2
Amortisation	2438	17,0	1861	14,9	577	23,7

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Equipment repair	731	5,1	558	4,5	173	23,7
Autotransport	626	4,4	439	3,5	187	29,9
Seed	800	5,6	800	6,4	-	-
Fertilizers	2305	16,1	2305	18,5	-	-
Poisonous chemicals	1333	9,4	1933	15,5	+600	+45,0
Other	565	4,0	495	4,0	70	12,4
Direct charges	11941	-	10394	-	1547	13,0
Household expenses	2388	16,7	2079	16,7	309	12,9
Total costs	**14329**	**100,0**	**12473**	**100,0**	**1856**	**13,0**

Such a reduction in the cost of direct sowing technology, in comparison with the traditional, is associated with the uselessness of the work on tillage and, as a result, the possibility not to purchase soil-cultivating equipment and powerful tractors to it. At the same time, with direct sowing technology, there is an increase in the cost of toxic chemicals – by 600 rubles / ha, or 1.4 times, compared to traditional cultivation technology, which is associated with the additional use of a continuous action of the glyphosates group before sowing winter wheat.

At the same time, the costs of applying the recommended and estimated doses of mineral fertilizers for both cultivation technologies are the same and amounted to 2479 and 4435 rubles / ha. In general, the production costs for the cultivation of winter wheat according to the traditional technology amounted to 14,329 rubles per 1 hectare, according to the direct sowing technology – 12,473 rubles. That is, with direct sowing technology per 1 ha, less expenditure is required by 1,856 rubles, or 13.0%. The high cost of mineral fertilizers has led to the fact that the lowest cost price and the highest profitability of grain for both technologies are obtained without their introduction.

In the cultivation of winter wheat according to the traditional technology, production costs significantly increase in relation to technology without tillage for such items of expenditures as the wage fund – by 557 rubles / ha, or 34.5%, fuel and lubricants – by 1,750 rubles / ha , or 59.1%, depreciation and repair of equipment – by 698 and 223 rubles / ha, or 27.1%.

Such an increase in production costs according to the traditional cultivation technology is due to the main and pre-sowing tillage, which requires tillage equipment and powerful tractors for their aggregation. The cost of purchasing seeds and pesticides in both cultivation technologies are the same –1140 and 1935 rubles / ha, respectively. On average, production costs per 1 hectare of sowing in the cultivation of winter wheat using the traditional technology amounted to 19,653 rubles, while using the technology without tillage –1,607 rubles, which is 3,652 rubles, or 18.6%, less. The reduction in production costs significantly affected the economic efficiency of the cultivation of winter wheat using the technology without tillage. Despite the high cost of mineral fertilizers, the highest profits and profitability were obtained in the cultivation of winter wheat according to the technology without tillage with the introduction of the recommended dose of mineral fertilizers (Table 2).

The use of the estimated dose of fertilizers leads to a decrease in the economic efficiency of cultivation, since the increase in yield does not pay back the cost of purchasing fertilizers.

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Table 02. The impact of technology and fertilizers on the economic efficiency of the cultivation of winter wheat

Indicator	Common technology		Zero technology	
	recommended	calculated	recommended	calculat
Productivity with 1 ha, tone	4,25	4,49	5,14	5,40
Selling price 1 ton, rubles	7900	7900	7900	7900
Cash proceeds from 1 ha, rubles	33575	35471	40606	42660
Labor costs per 1 hectare, people	10,1	10,6	4,6	5,2
Labor costs per 1 tone, people	2,4	2,4	0,9	1,0
Production costs, rubles / ha	21036	25807	17483	22275
Cost, rubles / tone	4950	5748	3401	4125
Profit per 1 ha, rubles	12539	9664	23123	20385
Profitability level, %	59,6	37,4	132,3	91,5

In general, we recognized that the cultivation of winter wheat by zero technology from an economic point of view is profitable, according to preliminary calculations, the profitability level is about 110-140%.

A comprehensive economic assessment of the use of "zero" technology and the determination of its effectiveness is possible only for a longer period, taking into account all the crops of crop rotation and in comparison with the traditional technology of their cultivation for a specific soil and climatic zone.

7. Conclusion

Thus, the successful implementation of No-till technology depends on a number of factors: the soil and climatic conditions of the farm location, the development of crop cultivation technology through optimization of crop rotations, an integrated approach to the system of protecting plants from pests, diseases and weeds, building a fertilizer system and rational and professional use of external materials. Only this will ensure the erosion resistance of the soil cover, the accumulation of organic matter in the soil, increase in yield and reduce the cost of crop production.

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