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**ZERO SOIL TREATMENT TECHNOLOGY AS ELEMENT OF
ECONOMIC EFFICIENCY IN CULTIVATION**

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Abstract

Based on research and analysis of obtained results, production experiments and statistical data we determined zones of no-till technology implementation depending on soil and climatic conditions, recruitment and biological characteristics of crops. Direct sowing technology had an advantage in growing peas and winter wheat. So compared to traditional technology, the use of no-till technology increased crops, respectively: crop yields - by 4 and 10%, gross production value - by 0.9 and 3.8 thousand rubles, profit - by 0, 7 and 1.3 thousand rubles. It reduced the cost of 0.7 and 1.3 thousand rubles and production costs by 1.2 2 thousand rubles; and the level of profitability was higher by 11 and 16%. In the cultivation of winter rapeseed, maize for grain and sunflower using traditional cultivation technology, there is an advantage over the direct sowing technology and the difference, respectively, to the crops was: a crop yield was higher by 0.65, 0.4 and 0.24 t / ha; gross output value - 13.6, 4 and 6.8 thousand rubles, profit - by 9.8, 0.9 and 2.5 thousand rubles; and the level of profitability was higher by 8, 2 and 7%. The reduction in production costs of direct sowing technology is due to the absence of the need for tillage and the savings associated with the lack of purchase of tillage equipment, reduction in the number of equipment, etc. With direct sowing technology, there is an increase in the cost of pesticides by 30-50%, the use of mineral fertilizers - by 15-30%.

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1. Introduction

Resource conservation in agriculture can be carried out in different directions: using methods of ecological landscape agriculture, reducing the number of technological operations, reducing the cost of costs in the nutrition and plant protection systems, introducing perennial grasses into crop rotations and in many other ways. The main reserve of energy saving in crop production is the improvement of tillage (Lollato, Diaz, & DeWolf, 2019).

Various ways have been proposed to minimize this energy-intensive process. But, according to Mtyobile, Muzangwa, and Mnkeni (2019) the resource saving was reduced to reducing the depth of tillage, carrying out several technological operations with one tool (up to 4-5) in one pass across the field, improving the working bodies and reducing the traction efforts of the tillage equipment.

However, studies show that with the use of traditional machines, the entire minimization often comes down to replacing plowing with rootless processing methods, unjustified simplification of technology, or replacing mechanical operations with herbicides. In most cases, the quality of processing remains unsatisfactory and gives a low economic effect (Demir & Gözübüyük, 2019; Haramoto & Pearce, 2019; Obade, 2019). Obviously, a dispute about the advantages and disadvantages of dumping and dumping tillage methods, especially proposals to universalize the use of each of them, which has been going on for the last decades, can only be resolved on the basis of new conceptual approaches to the technology of growing crops using a new-generation agricultural equipment. In this regard, the technology of cultivation of agricultural crops without tillage, which in the world is called No Till technology or direct sowing technology, is an issue of great interest. In Russia, it is called zero tillage technology or zero soil treatment technology. This technology is becoming more and more widespread in the world according to (Volters, Vlasova, Perederieva, Trubacheva, & Tuturzhans, 2018); it covers about 150 million hectares.

Zero soil treatment technology gained such a spread due to the fact that with the maximum possible reduction in production costs, the yield of cultivated crops simultaneously increases, which makes this technology the most cost-effective (Rosario-Lebron, Leslie, Yurchak, Chen, & Hooks, 2019).

2. Problem Statement

The main principle of the No-till system is to use the natural processes that occur in the soil (Mehra, Sarkar, Bolan, Chowdhury, Desbiolles, 2019; Reeves, Somasundaram, Wang, Finn, & Dalal, 2019).

Similarly was observed in the studies occurred by (Kassam, Friedrich, & Derpsch, 2019; Schmidt, Mitchell, & Scow, 2019), when intense mechanical action on the soil in the form of plowing, disking, cultivation, harrowing, etc. leads to increased aeration of the soil, violation of its structure, reduction of water absorption and water retention, enhanced mineralization of organic matter.

The loss of agrophysical and biological factors of soil fertility not only leads to a decrease in potential and effective fertility, but also to erosion and deflation, with the result that in a few years you can lose a fertile soil layer (Bavougian, Sarno, & Knezevic, 2019; Rosario-Lebron et al., 2019; Hernandez, Slater, & Corbala, 2019; Perederieva, Vlasova, Volters, Trubacheva, & Shutko, 2017; Schmidt, Mitchell, & Scow, 2019).

With zero soil treatment technology, the soil is not machined before sowing and in the process of plant care - operations for plowing, disking, cultivation are completely absent. Plant residues remain on the soil surface and favour better accumulation and retention of moisture for cultivated plants (Gura & Mnkeni, 2019; Reeves et al., 2019; Sperow, 2019; Zhou, Zeng, Chen, Tu, & Qin, 2019).

Higher yields of crops cultivated by zero soil treatment technology, while reducing production costs, also provide higher economic efficiency of this technology compared to conventional soil-based tillage, which is crucial for the development of this technology in market conditions.

3. Research Questions

Calculations of the economic efficiency of production of basic agricultural crops were carried out. These crops are cultivated in three different soil-climatic zones of the Central Ciscaucasia: extremely arid, arid, and unstable moistening.

4. Purpose of the Study

The main goal of the research is to determine the economic efficiency of crop cultivation using No-till technology in the major soil-climatic zones of the Central Ciscaucasia.

5. Research Methods

Studies that were occurred to determine the economic efficiency of cultivation of field crops using zero soil treatment technology were carried out on the basis of agricultural enterprises located in three different soil and climatic zones of the Central Ciscaucasia: extremely arid, arid and unstable moistening zones. After harvesting the previous crops using direct sowing technology, the herbicide of continuous action Glyphosate, 1.4 l / ha + dicamba, 0.3 l / ha was applied twice. The sowing of crops was carried out by direct sowing machines. Grain harvesting was performed by NewHolland combines in the “Slavyanka” harvester unit. During the growing season of winter wheat, the Prima Donna herbicide of 0.4 l / ha + Garnet 0.12 l / ha was used. “Borey” insecticide, 100 g / ha + fungicide was used against blasts. Recommended varieties and hybrids were used for these cultivation zones.

Also we used a calculation of the economic efficiency of agricultural production according to the traditional method, using technological charts and current regulatory costs and prices.

6. Findings

Experiment 1. In the conditions of arid continental climate, with an average annual precipitation of 428 mm, of which 70% during the warm period and SCC 0.7-0.9, the soil cover is represented by southern black soil. The calculation of the economic efficiency of grain maize and pea grain production, sunflower oilseeds, winter wheat grains after various predecessors showed that the weather conditions and a high level of cultivation technology had a decisive influence on these indicators. Considering the structure of costs in the cultivation of culture with this technology, we noted a significant reduction in the cost of fuel, maintenance, wages, etc. due to the rejection of tillage (hulling, basic tillage, cultivation, etc.), reducing the

number of units, tools, as well as more efficient use of arable land. This was the basis for reducing by 40-50% of labour costs per unit area and 1 t of products. At the same time, to obtain the planned level of crop yields as compared to the traditional system, it is necessary to: increase the doses of fertilizers, additional treatments with herbicides of continuous action, purchase of new specialized agricultural equipment (seeders, sprayers, headers), consistent implementation of the technology. In general, it should be recognized that the cultivation of such crops as winter wheat and sunflower using direct sowing technology in 2018 from an economic point of view proved to be beneficial. At the same time, low yields of peas and maize due to extremely dry conditions predetermined the unprofitability of their cultivation (the loss per 1 ha of crops, respectively, was -620 and -2410 rubles, respectively) (Table 01).

Table 01. Economic efficiency of crop production in Shangalinsky Farmery of Petrovsky District

Indicator	Winter wheat			Peas	Sunflower	Grain maize
	predecessor					
	Peas	Sunflower	Grain maize			
Productivity from 1 ha, t	6,1	4,26	5,7	1,95	1,69	2,0
Selling price 1 t, rubles	11000	10000	10000	10000	20000	10000
Proceeds in cash from 1 ha, rubles	67100	42600	57000	19500	33800	20000
Labor costs per 1 ha	12,8	12,8	13,8	13,8	13,4	13,4
Labor costs per 1 t, man hours	2,10	3,01	2,42	7,08	7,93	6,70
Production costs, rubles / ha	36512	33120	35140	20120	25620	22410
Cost, rubles / t	5986	7775	6165	10318	15160	11205
Profit per 1 ha, rubles	30588	9480	21860	-620	8180	-2410
Profitability level,%	84	29	62	-3,0	32	-11

Comprehensive economic assessment of zero soil treatment technology use 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

Experiment 2. In a dry climate, using the field of Vodopyanov Farmery in Petrovsky District, where the soil cover is represented by dark chestnut soils in 2018, in general, the productivity of similar crops turned out to be lower compared to the indicators of the agricultural complex “Shangalinsky” located within the same administrative district.

The calculation of the economic efficiency of the production of winter rapeseed, winter wheat, grain maize, sunflower indicates a profitable production of these crops, with the exception of grain maize, in dry conditions even for the area where the farm is located during the study period.. Level of productivity, choice

of culture, technology of cultivation, weather conditions had the decisive influence on these indicators. Considering the structure of costs in the cultivation of culture with this technology, we noted a significant reduction in the cost of fuel, maintenance, wages, etc. due to the refusal of tillage (peeling, basic tillage, etc.), reducing the number of units, tools. This was the basis for reducing by 30-50% of labour costs per unit area and 1 ton of products. At the same time, to obtain the planned level of crop yields in comparison with the traditional system, it is necessary: an increase in the doses of fertilizers applied, additional treatments with herbicides of continuous action, the acquisition of specialized seed drills, and rigorous implementation of technology elements. In general, it should be recognized that the cultivation of agricultural crops (winter wheat) using no-till technology is economically advantageous. According to preliminary calculations, the economic efficiency indicators for the cultivation of winter wheat, sunflower and winter rapeseed provided a level of profitability of about 29-80%, which is significantly lower than in the previous period (table 02).

Comprehensive economic assessment of the use of "zero soil treatment" 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 particular soil-climatic zone.

Table 02. Economic efficiency of crop production in Vodopyanov Farmery in Petrovsky District

Indicator	Winter wheat			Peas	Sunflower	Grain maize
	predecessor					
	Peas	Sunflower	Grain maize			
Productivity from 1 ha, t	4,57	4,35	4,29	2,4	2,36	1,55
Selling price 1 t, rubles	11000	10000	10000	19000	20000	10000
Proceeds in cash from 1 ha, rubles	50270	43500	42900	45600	47200	15500
Labor costs per 1 ha	12,8	12,8	13,8	13,8	13,4	13,4
Labor costs per 1 t, man hours	2,80	2,94	3,22	5,75	5,68	8,65
Production costs, rubles / ha	34512	33720	33140	29120	26256	22110
Cost, rubles / t	7552	7752	7725	12133	11125	14265
Profit per 1 ha, rubles	15758	9780	9760	16480	20944	-6610
Profitability level, %	46	29	30	57	80	-30

Experiment 3. It was conducted in Krasnoselskoye Farmery in the Grachevsky district of the Central Ciscaucasia, which belongs to the unstable humidification zone, characterized by continental, unstable humidification during the year (hydrothermic factor is 0.9-1.1) and a rather high heat supply of the growing season. Annual precipitation is 450–550 mm. The soil of the experimental plot is ordinary black soil with low-humus and a heavy clay loam.

The calculation of the economic efficiency of grain maize and winter wheat production after various predecessors, such as sunflower oilseeds and winter rapeseed, showed that these conditions were influenced by harsh weather conditions, the level of cultivation technology. It should be recognized that the level of productivity of the analyzed crops turned out to be lower than in the earlier analyzed farms of Petrovsky district, which significantly reduced the economic efficiency of crop production and the level of profitability was only 1-25% (Table 03).

Table 03. The economic efficiency of crop production in Krasnoselskoye Farmery in the Grachevsky district in 2018

Indicator	Winter Wheat			Peas	Sunflower	Grain Maize
	Predecessor					
	Peas	Sunflower	Grain Maize			
Productivity From 1 Ha, T	3	4,2	3,8	1,6	1,61	2,73
Selling Price 1 T, Rubles	11000	10000	10000	19000	20000	10000
Proceeds In Cash From 1 Ha, Rubles	33000	42000	38000	30400	32200	27300
Labor Costs Per 1 Ha	12,8	12,8	13,8	13,8	13,4	13,4
Labor Costs Per 1 T, Man Hours	4,27	3,05	3,63	8,63	8,32	4,91
Production Costs, Rubles / Ha	32560	33720	33620	27250	26820	23110
Cost, Rubles / T	10853	8029	8847	17031	16658	8465
Profit Per 1 Ha, Rubles	440	8280	4380	3150	5380	4190
Profitability Level, %	1	25	13	12	20	18

Considering the structure of costs in the cultivation of culture with this technology, we noted a significant reduction in the cost of fuel, maintenance, wages, etc. due to the rejection of tillage (hulling, basic tillage, cultivation, etc.), reducing the number of units, tools, as well as more efficient use of arable land. This was the basis for reducing by 40-50% of labour costs per unit area and 1 ton of products. At the same time, to obtain the planned level of crop yields as compared to the traditional system, it is necessary to: increase the doses of fertilizers, additional treatments with herbicides of continuous action, purchase of

new specialized agricultural equipment (seeders, sprayers, headers), consistent implementation of the technology.

Of particular interest is the comparison of economic indicators of crop cultivation using traditional technology and no-till technology. Based on the research and analysis of the results, production experiments and statistical data, we determined dependence on the soil and climatic conditions, recruitment and biological characteristics of crops – and the zone of the no-till technology implementation:

To ensure the sustainability of the soil cover, the preservation and accumulation of organic matter in the soil, stabilize yields and reduce the cost of crop production, it is recommended to cultivate crops using the no-till technology in the arid zone and unstable moistening zone with an annual rainfall of 390-540 mm on southern black soil, ordinary, chestnut and dark chestnut soils of various particle size distribution mainly formed on less loams. Basically, the optimal soil and climatic conditions are typical for the central part of the Stavropol Territory, corresponding to the arid zone and unstable wetting zones, where farms using no-till technology are concentrated.

For the main crops in crop rotations (winter wheat, grain maize, peas, winter rapeseed, sunflower) cultivated on the farms of the analyzed zones, Table 04 presents the economic efficiency indicators obtained in 2018, depending on the technologies used.

Analysis of the data presented in Table 04 showed that the direct sowing technology had an advantage in growing peas and winter wheat. So, compared to traditional technology, the use of no-till technology increased crops (peas and winter wheat), respectively: crop yields - by 4 and 10%, gross production value - by 0.9 and 3.8 thousand rubles, profit - by 0, 7 and 1.3 thousand rubles; reduced the cost of 0.7 and 1.3 thousand rubles and production costs - by 1.2 2 thousand rubles; and the level of profitability was higher by 11 and 16%.

In the cultivation of winter rapeseed, maize for grain and sunflower using traditional cultivation technology, there is an advantage over the direct sowing technology and the difference, respectively, to the crops was: crop yield was higher by 0.65, 0.4 and 0.24 t / ha; gross output value - 13.6, 4 and 6.8 thousand rubles, profit - by 9.8, 0.9 and 2.5 thousand rubles; and the level of profitability was higher by 8, 2 and 7%.

The reduction in production costs of direct sowing technology, in comparison with the traditional one, is due to the absence of the need for tillage and, as a result, the savings associated with the lack of purchase of tillage equipment, reduction in the number of equipment, maintenance personnel, and consequently fuel and amortization, wages, etc. At the same time, with direct sowing technology, compared to traditional technology, there is an increase in the cost of pesticides - by 30-50%, the use of mineral fertilizers - by 15-30%.

Table 04. Economic efficiency of crop production in the arid zone and the zone of unstable humidification of the Stavropol Territory, depending on the cultivation technology used in 2018.

№	Indicators	Unit Of Measurement	Peas		Winter Rapeseed		Winter Wheat		Grain Maize		Sunflower	
			Traditional	No-Till	Traditional	No-Till	Traditional	No-Till	Traditional	No-Till	Traditional	No-Till
1	Productivity From 1 Ha, T	T/Ha	2,52	2,61	2.2	1.55	3,9	4,28	3,6	3,2	1,86	1.62
2	Selling Price 1 Ton, Rub.	Thousands Rubles	10	10	21	21	10	10	10	10	20	20
3	Proceeds In Cash From 1 Ha, Rub..	Thousands Rubles.	25,20	26,1	46,2	32,6	39,00	42,80	36,00	32,00	37,20	32.40
4	Labor Costs Per 1 Ha,	Man-Hours	5,35	3,53	5,05	3,12	6,98	5,23	7,34	3,58	7,36	4,21
5	Labor Costs Per 1 Ton, Man-H.	Thousands Rubles	22300	21100	28900	25100	36000	34000	32500	29400	30200	27900
	Production Costs, Rubles / Ha	Thousands Rubles	22,3	21,1	28,9	25,1	36,0	34,0	32,5	29,4	30,2	27,9
	Cost, Rub / T	Thousands Rubles.	8,8	8,1	18,7	16,2	9,2	7,9	9,9	10,1	17,9	17,2
6	Profit Per 1 Ha, Rub.	Thousands Rubles	2,9	5,0	17,3	7,5	2,96	8,8	3,5	2,6	7,0	4,5
	Profitability Level, %	Thousands Rubles	1,2	1,9	7,9	4,8	0,8	2,1	1,0	0,8	3,8	2,8
7	Productivity From 1 Ha, T	%	13	24	27	19	8	26	11	9	23	16

One of the factors that increase production costs is the purchase of expensive specialized seed drills, sprayers, liquid fertilizer aggregates, and strict implementation of technology elements.

In general, it should be recognized that the cultivation of crops using no-till technology is economically beneficial.

However, a comprehensive economic assessment of the use of "zero soil treatment" technology and the determination of its effectiveness only for 2018, which was characterized by extremely dry conditions, is not an objective assessment. Determination of economic efficiency 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 particular soil-climatic zone.

Thus, the successful implementation of no-till technology depends on a number of factors: the soil and climatic conditions of the area where the farm is located, the development of crop cultivation technology through the optimization of crop rotation, an integrated approach to the plant protection system, the construction of a fertilizer system and the 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 in the zone of unstable moistening of the Central Ciscaucasia.

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 rotation, 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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