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Comparative Evaluation Of Machine Technologies For Cultivation Of Field Crops.

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ABSTRACT

The article presents the results of a comparative assessment of machine technologies for cultivating field crops under different soil cultivation options. As a result, it was found that the introduction of zero technology in the cultivation of crops in the southern steppe zone of the North Caucasus can significantly reduce the cost of production and the cost of production without reducing its quality indicators.
Keywords: soil cultivation, crops, productivity of soils.

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INTRODUCTION

The use of traditional technologies of cultivation of field crops with various types of soil cultivation (dump, waste-free) leads to significant material and technical and human costs. This in turn determines the increase in the cost of production and the reduction of its competitiveness [1-3].

The transition of agricultural commodity producers to the use of resource-saving technologies of cultivation, ensured an increase in the yield of cultivated crops with a decrease in the cost of production [4, 5].

One of the variants of these systems is the cultivation of field crops, both with minimal soil cultivation and without tillage (zero technology), which significantly reduced the costs of production and thereby increased the economic efficiency of crop production [6].

In recent years, farmers have been showing increasing interest in technologies for cultivating field crops without tillage (zero technology). In our country to study and master such technologies in production started on quite large areas, however, due to the lack of proper scientific justification, many agricultural enterprises in it were disappointed [7]. Meanwhile, the most literate and persistent received positive [8], and in some cases, high [9] results.

The aim of the research is a comparative evaluation of machine technologies for cultivating field crops under different soil cultivation options.

MATERIALS AND METHODS

The research was conducted in 2012-2017. with a total area of 4.3 hectares. In the study were three versions of the traditional technology (flat-top, layered, dump) and zero technology. To obtain comparable results, the same set (crop rotation) of cultivated crops (winter wheat, pea, soybean, spring barley) was selected.

The soil cover is represented by ordinary chernozem with a humus content of 3.2%. The average annual precipitation was 560-600 mm, temperature 9.6 ° C, and air humidity 56% [10].

Soil cultivation by traditional technology was carried out by known types of soil-cultivating aggregates characteristic for the south of Russia.

Under sowing of winter wheat, surface, shallow and dump tillage was carried out. In the cultivation of spring crops (spring barley, peas, soybeans), flat, stratified and dump tillage was carried out by combined and pre-operational machines with the necessary set of working elements [11, 12]. As noted earlier, one of the variants of the compared technologies is a variant of machine technology without tillage (zero technology).

RESULTS AND DISCUSSION

As a result of the research it was established that in winter the depth of the snow cover is 2 times greater on zero technology than in the different versions of traditional technology. The amount of productive moisture in a meter layer of soil according to the phases of crop vegetation is presented in Table 1.

The increase in the amount of moisture at zero technology reaches from 12 to 27 mm in relation to traditional technology.

Table 1: The amount of productive moisture in a meter layer of soil in the phases of crop vegetation, mm

Crop	Autumn	Spring	Bloom	Harvest	Autumn
Traditional technologies					
Spring barley	76	146	52	123	121
Soybean	69	111	40	97	101
Winter wheat	105	150	51	115	85

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Peas	72	143	100	144	113
Average	80	137	61	120	105
Zero technology					
Spring barley	91	170	76	137	132
Soybean	83	151	63	100	153
Winter wheat	107	162	70	128	123
Peas	88	161	125	145	117
Average	92	161	83	127	131
Increasing, mm	12	24	22	27	26

The density of soil addition during the period of research (Table 2) for the three horizons in different crop rotation crops is on average the same for all the technologies considered and is within the permissible values of 1.1-1.3 g / cm^3. This fact testifies to the absence of soil overconsolidation on zero technology.

Table 2: Density of soil addition (average for 2012-2017), g / cm^3

Horizon, cm	Spring barley	Soybean	Peas	Winter wheat	Average
Traditional technologies					
0-10	1,05	1,10	1,07	1,08	1,08
10-20	1,17	1,24	1,16	1,19	1,19
20-30	1,20	1,28	1,31	1,25	1,26
Zero technology					
0-10	1,09	1,10	1,15	1,12	1,12
10-20	1,20	1,23	1,28	1,24	1,24
20-30	1,23	1,27	1,30	1,29	1,27

The productivity of crops in the crop rotation under study (Table 3) increases by zero technology from 8% (winter wheat) to 38% (soybean).

Table 3: Change in yield (c / ha) of winter wheat, pea, soybean and spring barley

Technology	Years of research					Average	Change, %
	2013	2014	2015	2016	2017		
Winter wheat							
Basic	33,3	57,1	67,1	44,1	78,5	56,0	100
Zero	40,5	60,7	69,0	47,1	84,8	60,4	108
Peas							
Basic	22,1	33,5	48,0	49,7	54,1	41,5	100
Zero	21,6	37,2	58,8	63,6	64,3	49,1	118
Spring barley							
Basic	29,6	34,9	28,3	26,1	50,5	33,9	100
Zero	34,2	33,0	34,7	31,1	49,3	36,5	108
Soybean							
Basic	18,6	17,3	16,9	10,9	18,1	16,4	100
Zero	24,3	23,4	21,6	18,6	26,3	22,8	140

The effectiveness of applying zero technology on the example of winter wheat cultivation in comparison with basic technologies based on surface, shallow and dump soil treatment technologies is shown in Figure 1 and Table 4.

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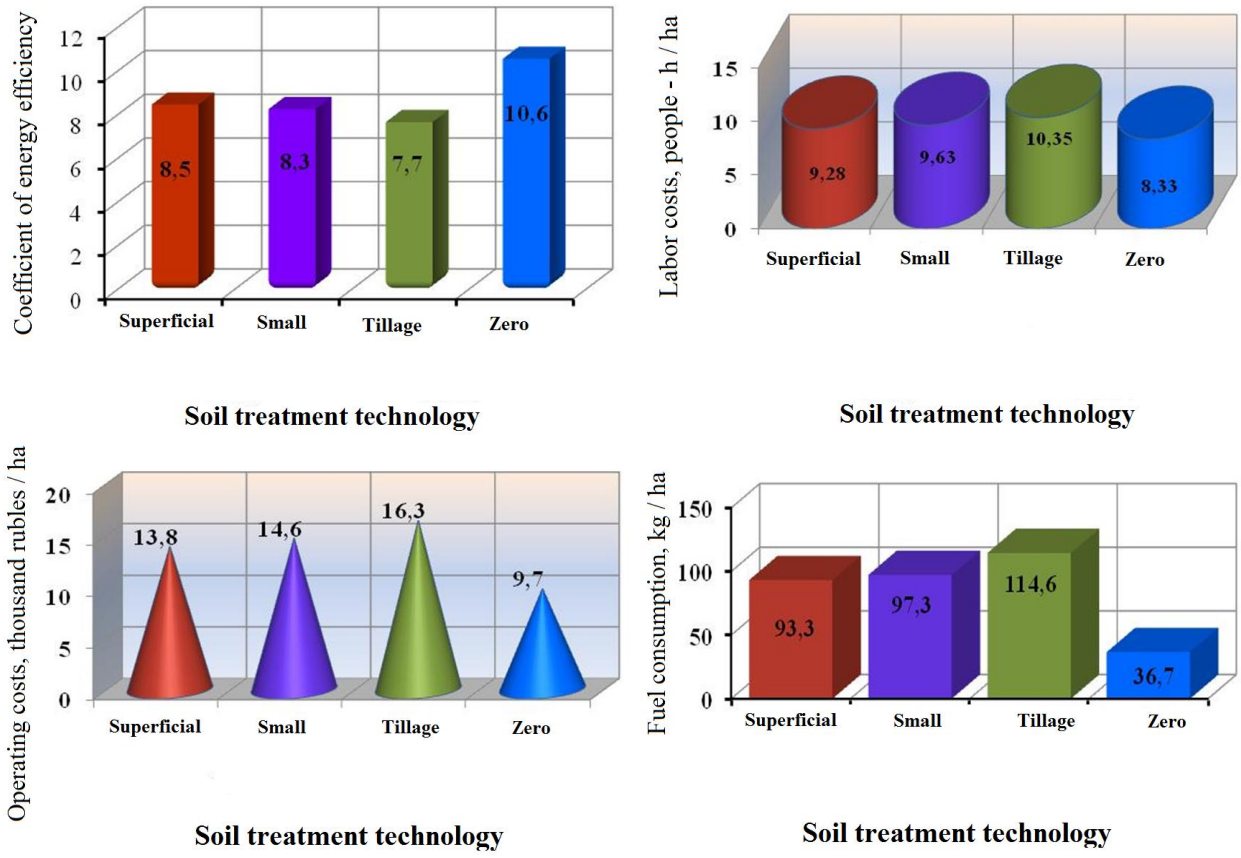

Figure 1: Efficiency of application of zero technology on winter wheat

Table 4: Calculation of the cost of production of winter wheat in comparable prices per 1 hectare

Deductions in rubles	Types of processing			
	Superficial	Small	Tillage	Zero
Salary	551,5	575,3	626,8	471,8
Fuels and lubricants	2832,3	2980,9	3610,1	1315,0
Seeds	3250,0	3250,0	3250,0	3250,0
Fertilizers	2140,2	2140,2	2140,2	2140,2
Remedies	2001,0	2001,0	2001,0	2026,0
Renovation	7917,9	8462,9	9175,8	6132,2
Repairs	2559,8	2714,4	2965,2	1834,0
Overhead	135,5	141,4	154,0	115,9
Total, rubles.	21388,1	22265,9	23623,1	17285,1
Cost ratio,%	124	129	137	100

With an increase in the coefficient of energy efficiency by 1.3 times on zero technology, labor costs were reduced by 1.1-1.2 times, operating costs by 1.4-1.7 times, fuel consumption by 2.5-3.3 times . These facts led to a decrease in the cost of winter wheat by 24-37%.

The toxicity of winter wheat grains is shown in Table 5.

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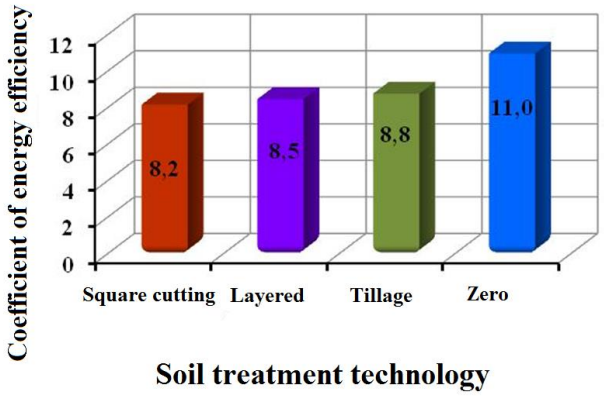
Table 5: Winter wheat grain toxicity indicators

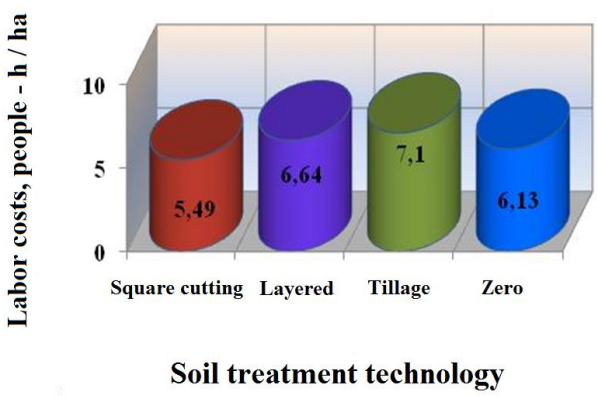
The name of indicators	Basic technology			Zero technology			Valid values
	The values of indicators for replicas						
	1	2	3	1	2	3	
Toxic elements, (mg / kg)							
Lead	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,5
Cadmium	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,1
Mercury	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	0,03
Mycotoxins, (mg / kg)							
Aflatokin B1	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	0,005
T-2 toxin	<0,001	<0,001	<0,001	<0,002	<0,003	<0,001	0,1
Ochratoxin A	<0,001	<0,001	<0,001	<0,002	<0,002	<0,001	0,005
Pesticides, (mg / kg)							
HCH	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	0,5
DDT	No	No	No	No	No	No	0,02
2,4D	No	No	No	No	No	No	Not allowed
Mercury organic	No	No	No	No	No	No	Not allowed
Radionculides, (Bq / kg)							
Cesium-137	0	0	0	0	0	0	60
Strontium-90	0	0	0	0	0	0	40

The analysis of the obtained results on the toxicity, mycotoxins, pesticides and radionuclides elements makes it possible to remove the question that on zero technology when using herbicides of continuous action leads to chemical contamination of the products obtained.

On spring barley, the performance indicators are similar to winter wheat. The decrease in fuel consumption in 2,2-2,6 times, maintenance work in 1,7-1,9 times on zero technology provides cost reduction by 46-57%.

In the case of peas, an increase in the coefficient of energy efficiency and a reduction in labor, fuel and operating costs (Figure 2, Table 6) with zero technology makes it possible to reduce the cost by 11-29%.





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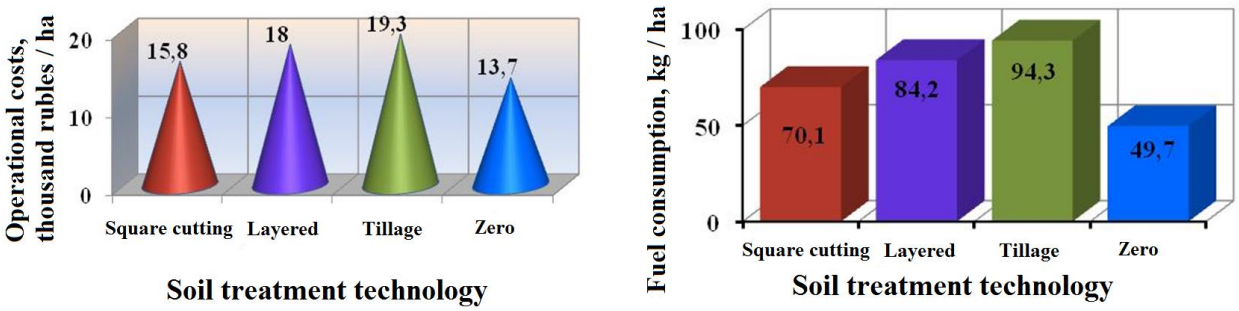


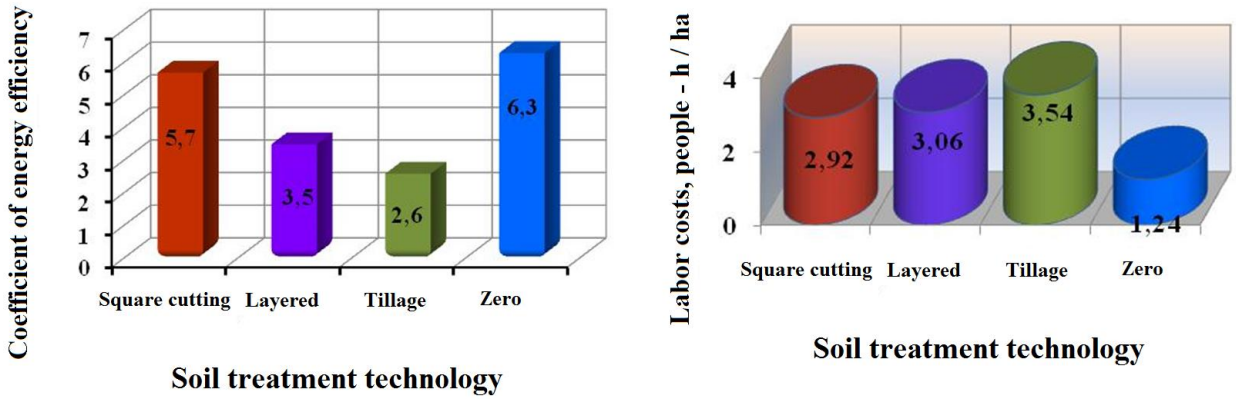
Figure 2: Efficiency of application of zero technology in cultivation of peas

Table 6: Calculation of the cost of production of peas at comparable prices per hectare

Deductions in rubles	Types of processing			
	Square cutting	Layered	Tillage	Zero
Salary	356,6	435,8	469,0	389,3
Fuels and lubricants	2190,3	2582,7	2954,3	1200,6
Seeds	5270,0	5270,0	5270,0	5270,0
Fertilizers	73,8	73,8	73,8	73,8
Remedies	400,0	400,0	400,0	400,0
Renovation	11353,4	12791,0	13539,7	10485,4
Repairs	2001,6	2319,1	2381,0	1675,4
Overhead	87,6	107,1	115,2	95,7
Total, rubles.	21733,2	23979,4	25203,1	19590,3
Cost ratio,%	111	122	129	100

The results for growing soybeans are even more effective when using a system without soil treatment (Figure 3, Table 7).

With an increase in the coefficient of energy efficiency in 1,1-2,4 times, a decrease in fuel consumption in 2,7-3,5 times, labor costs in 2,4-2,9 times, operating costs in 2,1-2,5 times when using zero technology. Against this background, an increase in the productivity of soybeans averaged 38%, which made it possible to reduce the cost of production by 1.8-2.0 times.



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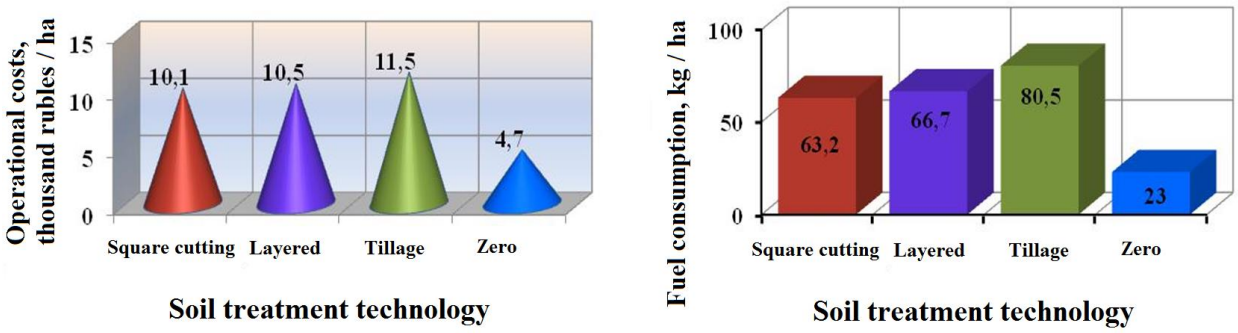

Figure 3: Efficiency of applying zero technology in soybean cultivation

Table 7: Costing of soybean production in comparable prices for 1 hectare

Deductions in rubles	Types of processing			
	Square cutting	Layered	Tillage	Zero
Salary	216,1	227,4	266,5	98,3
Fuels and lubricants	2309,8	2438,7	2942,0	838,7
Seeds	763,8	763,8	763,8	763,8
Fertilizers	688,8	688,8	688,8	688,8
Remedies	506,0	506,0	506,0	531,0
Renovation	5934,5	6142,4	6458,6	2851,0
Repairs	1681,6	1759,0	1861,9	927,6
Overhead	53,1	55,9	65,5	24,2
Total, rubles.	12153,5	12582,0	13553,2	6723,4
Cost ratio,%	181	187	202	100

CONCLUSIONS

Thus, the introduction of zero technology in the cultivation of crops in the southern steppe zone of the North Caucasus can significantly reduce the cost of production and the cost of production without reducing its quality indicators. In the future, it is planned to continue work on a comparative assessment of technologies, including assessment of the processes of migration of heat and moisture in the soil layers.

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