Adaptability Specifications of No-Till Farming in the Krasnodar Territory

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Abstract. Soil cultivation technologies, applied in the farming system of the Krasnodar region and their impact on changes in the soil organic composition, have been analyzed. Advantages and disadvantages of no-till farming technology, the relationship between the mechanic means in-use and agrotechnical requirements, have been substantiated. Strategy for obtaining competitive agricultural products with a minimum production cost, has been stated. Advantage of multifunctional units in applying no-till farming, has been shown. Crop rotations, recommended for no-till farming application in conditions of the Krasnodar Territory, have been analyzed. Fuel economy in applying no-till farming can reach 40...50%.

1 Introduction

Main task of increasing the competitiveness of agricultural enterprises is to further reduce production costs, increase labor performance and soil crop-producing power. Agricultural system of the Krasnodar Territory states that approximately 19% of the arable land area of the Krasnodar Territory, no-till farming technology is applicable in practice, considering physical and mechanical characteristics of soil varieties [1, 2, 3]. No-tillage farming is not recommended for heavy drained black soil (chernozem), but where possible, this powerful lever should be used to reduce costs and increase the competitiveness of agricultural enterprises. In our country market economy situation today, special attention is paid to the widespread introduction of energy-saving technologies for cultivating and harvesting agricultural crops [4, 5, 6, 7]. Essence of such technologies is to support the industry of competitive products with targeted use of human-regulated factors. Basis of energy-saving technologies is the complex concentration of all factors: new varieties and hybrids, fertilizers, pesticides, growth regulators, new technical means and other production resources, ensuring their highest pay-back on a high-quality product [8, 9, 10, etc.] Each new technology is distinguished not only by original agricultural techniques, but also by innovative means of mechanization [11, 12, etc.] and their rational exploitation [13, 14]. Thus, Austrian scientists H. Spiegel, G. Dersch, Hesch J., A. Baumgarte, believe that appliance of new technologies has a specific effect, associated with changes in soil organic composition [2].

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There are several generally accepted types of tillage – conservation tillage technology (including in-use no-till farming, ridge tillage, mulch tillage technologies), conventional tillage, minimum tillage, reduced tillage technologies.

Zero-tillage farming, during the cropping season, provides for only one contact of tillage implements with the soil – during sowing. Sowing is carried out, as a rule, in narrow grooves of 2,5-7,5 cm wide, simultaneously with one or more additional operations. Herbicides are intensively used to control weeds. With zero-tillage system, the savings can reach 70-80% [1].

Some enterprises apply for zero tillage, but this requires a special approach to crop rotation and mechanization of cultivated crops. Particular attention is paid to weed destruction by herbicides, by use of direct sowing seeders, sprayers, and harvesting equipment. In Krasnodar Territory, the following equipment is widely used: the "Great Plains" and "Kinze" (the USA) direct sowing seeders, the "Tuman-1" self-propelled sprayers, the grain harvesters are used without choppers, but, instead of them, two spreading rotors are required for non-grain crop part, which evenly spread the straw, sunflower stems and grain maize, across the header working width.

2 Materials and methods

In 2004, Kuban State Agrarian University conducted research on no-till farming [3]. Maslov G., Nebavsky V. believe that "no-till farming, using no-till technology, most effectively solves the energy-saving problem in crop production. Advances in agricultural science, agricultural engineering and chemical industry, which produce fertilizers and herbicides, have created the necessary preconditions for introduction of direct seeding technologies. They are used in cultivating winter and spring grains, in sowing row crops and overseeding grasses, as well as in overseeding grains in places of winter crop perishing during overwintering. In Brazil and Argentina, direct seedingowing is used by 60% of the planting acreage, in the USA – by 23%, in Russia significantly less" [3]. Over the past years, there have been successes and failures with zero tillage, on some farms of the Krasnodar Territory, the study and implementation of new no-till farming technology and direct seeding of various crops, are ongoing. The goal of experts is searching methods of cultivating crops with minimal labor and energy costs, ways to increase soil fertility, and protect the environment. It is clear, that with introduction of free prices for all goods and services, the transition to world prices for energy resources, fertilizers, pesticides, equipment, spare parts and other industrial goods, used in agricultural production, is inevitable. In this regard, we have analyzed the world experience of farming on a new basis and have made an attempt to analyze the advantages and disadvantages of individual elements of resource-saving technologies for soil cultivation and direct seeding, which have already been practically mastered in regions, ones are prone to erosion in certain countries of the world.

3 Results and discussions

Designated strategy for reducing costs and producing competitive agricultural products is formulated in Figure 1.

Directions of the strategy are presented in three blocks (Fig. 1): organizational-technological, technical and economical. The first includes development of resource-saving technologies with direct seeding, rational crop rotation, monitoring of soil physical properties and introduction of precision farming elements for differentiated chemical application.

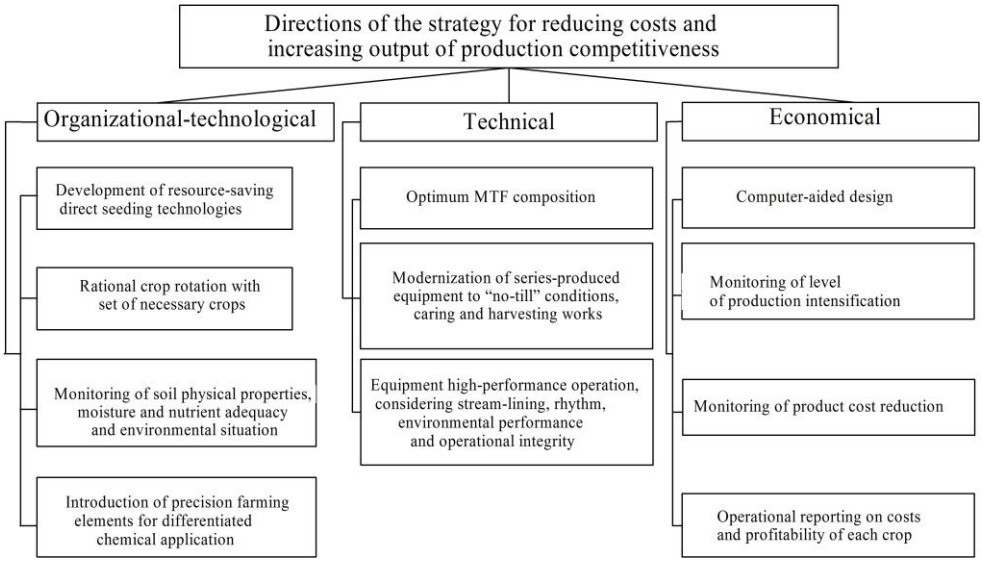

Fig. 1. Main blocks of strategy for increasing competitive product output and cost reduction applying no-tillage farming system

Second block – the technical one (Fig. 1) – provides optimization of MTF composition and structure for technology implementation for cultivated crops for each agricultural enterprise. This block is necessary, because the unreasonably inflated range of technical equipment in the world market does not allow experts to make the right choice in purchasing certain machines. Many people choose equipment from the "John Deere" (the USA), the "CLAAS" (Germany), the "Caterpillar" and many others. But in contrast to the subjective opinion of individual experts, the correct solution for technical equipment can only be the optimization of MTF composition, according to the criterion of minimum operating costs for performing entire volume of mechanized work by agricultural producer. It is only important to skillfully compile the initial information for calculations, and this can only be done by highly qualified experts, who have basic understanding of production mechanization, agricultural technology and resource-saving technologies. The more objectively and competently the initial information for the calculation is prepared, the higher quality and effectiveness of the calculation results will be. In present conditions of high prices for equipment, every mistake in preparation of information is fraught with a decrease in enterprise efficiency. Unfortunately, not all farms, implementing no-till farming technology, are aware of these issues. Some farms, without any optimization, apply for relatively cheap, but convenient and reliable Belarussian equipment. Tractors and grain harvesters of the Republic of Belarus have long been in great demand in Russia and other regions.

Second technical block (Fig. 1) draws attention to the equipment modernization in conditions of zero tillage, crop care and harvesting. Here we mean, considering the zonal characteristics of natural and climatic factors, that each machine must comply with. For example, considering peculiarity of zero tillage and direct seeding using crop stems uncrushed, harvested in crop rotation, combine harvesters, in harvesting cereal crops, sunflowers, corn, peas, should operate without a chopper, but have a device in the form of two rotary distributors across the field of uncrushed stems along the header working width. Unshredded stems are evenly distributed across the field, reliably sealing moisture, and preventing soil erosion. Direct sowing seeders work well against such surface, easily

cutting the stems and forming a groove in soil for coulters. Belarussian combine harvesters are equipped with such devices.

Difficulties of "no-till" technology lie in the application of solid manure to for soil fertilization, since with "no-till" technology, moldboard plowing is excluded. Farms, implementing resource-saving technology, incorporate solid manure into soil, using the "BDT-7A" heavy disc-harrow. This is the only operation to loosen the topsoil, and it is carried out only on one crop rotation field per year, where 100 tons of manure are applied per hectare. Manure is applied by mounted spreaders from heaps, evenly distributed across the field in a checkerboard pattern, considering working width of the "RUN-15" spreader. By next year, the neighboring field is fertilized, etc. Set of crops in crop rotation is selected, considering rational effect on soil fertility, predecessors, zero tillage specifications, etc. Typically, winter cereals, peas, sunflowers, grain maize and silage, perennial grasses, are cultivated. Scientific observations established, that in crop rotation fields, where zero tillage has been applied for a long time (more than 7...8 years), the humus content in it, increases by an average of 0,1 percent per year.

Obvious advantage of "no-till" technology is the minimum range of machines for mechanizing cultivation processes. Here, it is better to apply for multifunctional units [15, 16].

Another mandatory direction in the technical block (Fig. 1) is the organization of the equipment high-performance operation, that is, compulsory adherence to stream-lining, rhythm, environmental performance and operational integrity. These directions are not limited to only no-till farming. They are important and useful for any technologies, requiring coordination of operations in performing complex production processes: harvesting – its transportation – servicing the units – post-harvest operations.

What are the undeniable advantages of "no-till" technology and direct seeding? Experts in the field of zero tillage note the following advantages:

– increasing the humus content in topsoil;
– soil protection from erosion and deflation;
– saving energy, fuel and labor costs in cultivating crops in crop rotation;
– reducing the need for equipment and labor;
– high efficiency of field work in conditions of limited timing and tight deadlines;
– elimination of carbon losses from soil, compared to moldboard plowing.

Thus, in our region, zero tillage technology can be used on lighter and not waterlogged soils. The region's agricultural system [17] recommends the main types of crop rotations with a deficit-free humus balance for flat agricultural landscapes of the Northern zone. Crop rotation № 2 is most suitable for no-tillage (Table 1).

Table 1. Seeding-down structure for the № 2 crop rotation according to the farming system [17]

№ 2 crop rotation		
Number of fields, pcs	Crop	Crop rotation field square, %
2	Lucerne	16.8
1	Pea, soy	8.3
6	Winter spiked crops	49.8
3	Tilled crops (sugarbeet, sunflower, maize)	25.1

Disadvantages of "no-till" technology include the following:

– increased consumption rates of chemical agents for weed destruction, diseases and agricultural pests;
– it takes at least five years until the arable horizon acquires desired structure and physical-mechanical properties to switch from conventional technology to "no-till" technology;

– increased soil density and low air permeability, reducing the soil porosity, especially the non-capillary one;
– requiring clear monitoring of soil contamination with heavy metals that does not exceed the buffer capacity;
– ineffective incorporation of solid organic fertilizers into soil by disc harrows;
– formation of ruts in fields after harvesting equipment that passes through wet soil;
– mulching fields with crop residues delays spring warming of soil and start of seeding tiller crops.

4 Conclusions

Solving any problem has its pros and cons, advantages and disadvantages. However, if agricultural producers have a desire, then disadvantages can be eliminated and advantages can be increased. Thus, increasing competitiveness of agricultural enterprises, applying for no-tillage technology, is possible by saving fuel by 40...50 percent, reducing machine range and their number, as well as increasing the humus content in soil by 0,1 percent annually. Modern knowledge, innovative technology, chemical means, and precision farming system will allow us to raise "no-till" and direct seeding to a qualitatively new level, which will change our understanding of the already outdated farming system.

References

1. Ya.P. Lobachevsky, L.M. Kolchina *Current state and development trends of tillage machines*, (M.: FGNU "Rosinformagrotekh", 2005) 116
2. H. Spiegel, G. Dersch, J. Hösch and A. Baumgarte *Tillage effects on soil organic carbon and nutrient availability in a long-term field experiment in Austri* die Zeitschrift Die Bodenkultur **58 (1–4)** (2007).
3. G.G. Maslov, V.A. Nebavsky *Zero tillage – cost savings* Rural machine operator, **3,** 34-35 (2004)
4. G. G. Maslov et al. *The advanced rational process flowsheets for cropping spiked cereals* IOP Conference Series: Earth and Environmental Sciencethis link is disabled, **659(1)**, 012038 (2021)
5. A.A. Lukmanov, N.A. Loginov, F.N. Safiollin *Technologies for cultivating spring wheat on leached chernozems of the Middle Volga region* Agrochemical Bulletin, **1** 3–7 (2022)
6. E. M. Yudina, A. S. Serguntsov, S. K. Papusha, M. R. Kadyrov *The principles of improving the technology of grain crop cultivation*, IOP Conference Series: Earth and Environmental Science, **954(1)**, 012092 (2022)
7. G.G. Maslov, N.A. Rinas, E.M. Yudina, N.V. Malashikhin *Technological and technical improvement of crop cultivation processes* International Transaction Journal of Engineering, Management and Applied Sciences and Technologies, **11(8),** 118 (2020)
8. *Systems of conservation agriculture and crop cultivation. Treatment of crop residues in the "No-till" system (ridge tillage, mulch tillage, strip tillage system)*, MVPS-45, second edition, 132 (2020)
9. *Federal Register of Technologies for the Production of Plant Products. Technology system* 517 (M.: GNU "Informagrotech", 2000)

10. L.S. Sokolova *Minimum tillage - issues of socially-oriented modeling of technological processes* Modern studies of social problems, **7**, 9 (2012)
11. I.B. Berenshtein, N.P. Shabanov *Resource-saving technologies for harvesting grain (spike) crops* News of agricultural science of Tavrida, **10 (173)**, 62–73 (2017)
12. G.G. Maslov, V.P. Lavrentev, E.M. Yudina, A.D. Taran *Improving the process of harrowing and sowing crops* Indo American Journal of Pharmaceutical Sciences, **6(4)**, 7060-7064 (2019)
13. E.M. Yudina, N.A. Rinas, S.K. Papusha, A.S. Brusentsov, G.E. Samurganov, *Completing of modern energy-saving machine-tractor units* IOP Conference Series: Earth and Environmental Sciencethis link is disabled, **839(5)**, 052029 (2021)
14. A.V. Palapin *Optimization of the type, composition and structure of the combine fleet of the Krasnodar Territory, considering flexible multifunctional units* Tractors and Agricultural Machinery, **7**, 53–54 (2013)
15. A.V. Palapin, N.A. Rinas *Multifunctional unit for harvesting and sowing* Rural machine operator, **7**, 6-7 (2014)
16. G. G. Maslov et al. *Rational System of Multifunctional Aggregates For Mechanization Of Plant Growing* Research Journal of Pharmaceutical, Biological and Chemical Sciences, **9(5)**, 1177–1185 (2018)
17. A. N. Korobka, S. Yu. Orlenko, E. V. Alekseenko et al. Farming system of the Krasnodar region on agrolandscape basis (Krasnodar: Education-South, 2015)