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Analysis of the Coils Used in Soil Drilling

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Abstract: In general, following this, the biological system "soil-plant-atmosphere" is considered. An artificial soil-cultivating working body is introduced into this system, which is created according to the biological prototype of a bionic object related to this system and functioning in it. The result is the adaptation of the working organ, bringing it to the resemblance of a living organism and giving it certain geometric shapes, movement dynamics (multi-contact impact) and the properties of a living prototype. In this case, methods of general systems theory, agricultural mechanics, continuum mechanics, integral and differential calculus are used.

Keywords: soil, tillage, technologies, parameters, roller, resource-saving, atmospheric, working bodies, soil-protective.

INTRODUCTION. An increase in agricultural yields is inextricably linked with improving the quality of soil preparation, the purpose of which is to create the required structure and density of the seed layer. In this regard, special attention should be paid to the processes of loosening, rolling and leveling the soil. Existing designs of serial tillage rollers cannot provide the required quality of loosening, compacting and leveling the soil surface, especially in soil-climatic zones with insufficient precipitation. The solution to this problem is to use a mechanical-bionic approach to analytically describe the optimal shapes and parameters of the working bodies of soil-cultivating rollers in order to more effectively influence the soil. Currently, bionics methods are widely used in the development of design schemes and justification of the parameters of various agricultural and soil-cultivating machines. Therefore, to justify optimal parameters and operating modes, it is necessary to use agricultural technical bionics in combination with a biosystems approach. The purpose of the research is to develop theoretical prerequisites for the bionic substantiation of the parameters of the working parts of a ring-cutting soil-cultivating roller.

MATERIAL AND METHODS. The scientific foundations for substantiating the rational parameters of agricultural machines and tools were laid by Academician V.P. Goryachkin, who was the first to apply the laws of mechanics to describe the processes of operation of agricultural machines and implements. Doctor of Technical Sciences, Professor A.N. Gudkov It was proposed to take into account the nature of living matter of plants, animals and soil when theoretically considering the technological processes of machines and tools. Living organisms living in the soil, as a result of evolutionary development, have improved digging limbs with ideal geometric parameters and kinematics of movement, which allows them to loosen and compact it most effectively with minimal energy consumption. The initial data for substantiating the parameters are the physical and mechanical properties of the soil: soil deformation index, shear modulus, lateral expansion coefficient and friction coefficient.

In modern agriculture, many technologies for cultivating agricultural crops are known: extensive, intensive, industrial, integrated, biological, adaptive, landscape, soil-protective, moisture-saving, resource-saving, environmentally friendly, etc., designed to increase natural soil fertility, improve the quality of crop cultivation, increase their productivity. With the advent of powerful tractors, the intensive impact of traditional means of mechanization caused over-compaction of the soil and dispersion of its top layer, which negatively affected soil fertility. Ultimately, such technologies were recognized as energy-intensive, which led to a sharp reduction in the number of technological operations performed and simplification of the remaining ones; single-operation mechanization tools began to be replaced by combined ones. To date, the most energy-intensive branch of agriculture remains crop production, which accounts for 70% of all costs, including more than 40% for operations related to soil cultivation. The main task when implementing any technology is to reduce labor costs, energy and resource conservation while simultaneously increasing the yield of cultivated crops and, as a consequence, reducing production costs. Many scientists and agricultural specialists have reliably established that the use of conservation technologies reduces the number of passes of units across the field, preserves soil fertility, and minimizes environmental pollution from fuel combustion products. One of the main conditions for the successful implementation of such cultivation technologies is the use of agricultural machines of a higher technical and technological level. The massive use of herbicides and pesticides has given impetus to the introduction of energy-saving, minimum and zero tillage and sowing technologies into the agricultural system.

DISCUSSION

The largescale introduction of new technologies has influenced the need to take additional measures to combat water and wind soil erosion, improve the conditions for moisture accumulation and its conservation in the top layer of soil. Currently, domestic and foreign manufacturers and enterprises produce a wide range of agricultural machines for basic and pre-sowing tillage, sowing and mechanized care of crops, designed to implement resource-saving and soil-protective farming technologies. The world experience of scientists and agricultural producers in the cultivation of cultivated plants shows that most technologies for the production of agricultural products differ fundamentally depending on the characteristics of each crop, the soil and climatic conditions of the region and the preferences of the producer of these products. Consequently, as the number of technologies increases, the need for technical means for their effective implementation also increases. Accordingly, with the development of scientific and technological progress in crop production, the adaptation of technological processes and technical means to the natural, climatic and soil conditions of a particular region of the country is becoming increasingly important.

RESULTS

Any technology for cultivating agricultural crops, as a rule, includes: basic and pre-sowing tillage, sowing and care of crops (mechanized, using row cultivators, or chemical - sprayers), harvesting and transportation of crops. If we take into account that there is no alternative to sprayers, harvesters and vehicles, then the main reserve for energy savings remains the operations of preparing the field for sowing, sowing and caring for crops, which account for up to 50% of energy costs. In addition, conservation technologies should be aimed not only at preserving the humus layer of the soil, but also at combating wind and water soil erosion, accumulation and preservation of soil moisture in the root layer during the growing season of plant development. Rolling is the cultivation of soil with special agrotechnical tools - compacting rollers. Rollers can have different shapes and designs: smooth, ring-spur, ring-toothed and others. Their choice depends on the mechanical composition of the soil, structure, humidity, degree of loosening of the soil and the sown crop. But no matter what you choose, SV Machines are able to satisfy any request.

Figure 1. KW rubber wedge roller

The KW rubber wedge roller (diameter: 580 mm) can be used universally and is especially recommended when strip reconsolidation is strictly necessary. Whether in wet or dry conditions, light or heavy soils, the wedge roller performs very reliably. Thanks to the rubber rings, the rubber wedge roller optimally forms compacted strips in the seed furrow. The space between them remains loosened at the same time, so that water and air exchange are possible. This targeted reconsolidation creates a capillary effect that, even under dry conditions, favors the supply of soil moisture to the seedlings. A large amount of precipitation, on the contrary, seeps into uncompacted soil. Individually adjustable scrapers clean the roller precisely and reliably even under the most difficult conditions. An optional harrow is available for additional crumbling and leveling.

Figure 2. Tubular roller

The SW tube roller (diameter: 520 mm or 600 mm) is a simple and inexpensive entry-level model. Due to its low weight, the roller is especially suitable for tractors with low lifting power. Reconsolidation is carried out transverse to the direction of travel with good crumbling quality and an open soil surface structure. Especially on light soils, the tubular roller has a high load-bearing capacity and a powerful drive. Thanks to the twisted arrangement of the durable pipes, the roller is highly stable and operationally safe. The tube roller is also an ideal choice for incorporating liquid manure and for cultivating the soil after spreading the liquid manure.

The larger roller (diameter: 600 mm) provides higher load-bearing capacity and re-consolidation. In addition, the tubular roller is particularly smooth in running and rolling. An optional rear harrow is available for additional crumbling and leveling

Figure 3. TW tandem roller

The TW tandem roller (diameter: 520 mm/380 mm) is mainly used for seedbed preparation as it provides a good crumbling effect. This effect is achieved due to the different peripheral speeds of the small and large rollers, which are observed especially on light and medium soils.

Thanks to the pendulum suspension, the tandem roller ensures optimal ground contour following by both rollers. An optional harrow is available for additional crumbling and leveling.

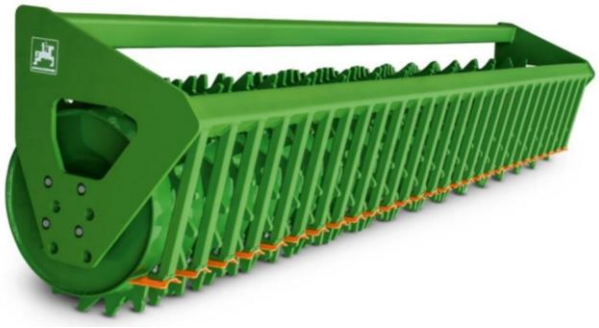

Figure 4. PW toothed roller

The PW toothed compaction roller (diameter: 600 mm) ensures continuous reconsolidation over the entire working width. The welded teeth create a good crumbling effect and also form more fine soil. Adjustable scrapers ensure clogging-free operation even on sticky soils and large amounts of plant matter.

The scrapers, coated with hard metal as standard, guarantee a long service life even under the most difficult operating conditions. The optimal area of application is medium and heavy soils, where the toothed compaction roller has a high load-bearing capacity and a powerful own drive. An optional harrow is available for additional crumbling and leveling.

Figure 5. Rubber wedge roller with Matrix KMW tires

The rubber wedge roller with Matrix KMW tires (diameter: 650 mm) is the ideal roller with the largest diameter of all rollers and offers advantages not only due to its size. The flexibility of using the roller, as well as high load-bearing capacity on almost all types of soil and under all conditions, is ensured due to its size. Thanks to the Matrix profile tires, a powerful drive is provided, so that the traction requirement is very low.

With strip reconsolidation, the Matrix profile provides good crumbling quality with a sufficient amount of fine earth. Individually adjustable scrapers clean the roller precisely and reliably even under the most difficult conditions. An optional harrow is available for additional crumbling and leveling.

Figure 6. DW disc roller

The DW disc roller is designed for use on heavy and wet soils. To prevent the roller from clogging with soil, it is equipped with separately screwed, adjustable scrapers. Thanks to its high dead weight of 220 kg/m working width and narrow tines, the disc roller ensures good reconsolidation on heavy soils and also good crumbling quality. The lumps are cut and the stones are pressed into the soil.

Thus, the roller leaves a cleared soil surface and thereby ensures a low tendency to siltation, as well as good air and water exchange. An optional following harrow is available for additional crumbling and leveling..

Figure 7. DDW Double Disc Roller

The DDW double disc roller (diameter: 2 x 600 mm) with a weight of 270 kg/m working width is the heaviest in the range of rollers. This roller can be used on almost all types of soil, but the optimal application area is heavy and sticky soils. Here, high load-bearing capacity is ensured, high throughput is guaranteed and, due to the robust and heavy construction, resistance against stones.

Wear-resistant disc elements provide good crumbling, cut lumps and provide strip, deep reconsolidation. Thus, the roller leaves a cleared soil surface and thereby ensures a low tendency to siltation, as well as good air and water exchange.

Figure 8. WW corner roller

The WW corner roller (diameter: 580 mm) is used primarily on medium to heavy soils without stones, where it specifically cuts clods. It features a bent profile with good cutting and crumbling quality. Wedge-shaped rings provide strip reconsolidation with a penetrating effect and optimal crumbling. An optional spring knife system is available. Intensity-adjustable spring knives clean the gaps between the rings and further crush lumps.

Figure 9. U-profile roller UW

The U-profile roller UW (diameter: 580 mm) is especially recommended when high load-bearing capacity, high throughput and at the same time a leveling effect are a priority. The open U-profile roller is purposefully filled with soil, thereby reducing wear and compacting the soil through soil-to-soil contact. Reconsolidation is carried out in the direction of movement without intensive influence on the depth.

The U-profile roller performs its job particularly well on light soils. Thanks to its design, the U-profile roller is also relatively lightweight and very wear-resistant. An optional spring scraper system or harrow is available.

Figure 10. Double U-profile roller

The double U-profile roller (diameter: 2 x 580 mm), like the simple U-profile roller, is recommended when high throughput and at the same time a leveling effect are a priority. Due to the soil-to-soil contact of U-profiles, wear is extremely low. Thanks to twice the number of U-profile rings on two rollers, the double U-profile roller provides even higher load-bearing

capacity. In addition, due to the narrower ring spacing, the roller provides a more aligned return compaction in the direction of travel than a simple U-profile roller.

CONCLUSION. The operations of each of these technologies can be implemented mechanized, through basic moldboard or non-moldboard tillage, surface tillage of the soil using serial machines and units. Others use minimal or no tillage, leaving stubble and crop residues on the field surface or incorporating straw into the soil. Having analyzed the known technologies for pre-sowing field preparation, we can conclude that the soil before sowing is treated with cultivators, disc, tooth and needle harrows, as well as soil-cultivating rollers. Rolling before sowing ensures the destruction of soil lumps, as well as partial leveling of the field surface. However, the problem of high-quality preparation of the field for sowing using tillage rollers is currently not sufficiently solved. Therefore, it is necessary to justify the optimal basic design parameters of a soil compaction tool containing new working parts, which include, in particular, ring sealing elements and pointed rippers.

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