Development of the design of pre-sowing mounted leveller TEA-7

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Development of the design of pre-sowing mounted leveller TEA-7

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Abstract. Crop cultivation technology is a complex of agronomic practices, carried out in a certain order, aimed at meeting the biological requirements of the crop and obtaining a given amount and quality of yield. The tasks can be solved by using different technological methods, which are selected individually not only for the crop as a whole, but also as the best option for each variety or hybrid, as applied to specific soil and climatic conditions. Development of new technologies and elements of cultivation technology, their maximum coordination with the biological requirements of crops and individual approach to each variety (hybrid) will allow to maximize the potential of the cultivated crop. In modern conditions, resource-saving technologies are one of the priority areas in modern agriculture, the development of which has become a priority task, because in modern crop production there are a number of problems: reduction of profitability of agriculture, significant depreciation of machinery fleet and the trend towards deterioration of soil fertility.

1. Introduction

Recently, the world has been widely promoting the cultivation of crops according to the system of No-till. The term "No-till" itself means "not to plow", however, this system excludes not only plowing, but also other types of mechanical impact on the soil. Sowing in this case is carried out in the unprepared soil directly on the stubble of the preceding crop by specialized drills. In our country the term – «zero tillage».

The history of this technology began with the advent of continuous-action herbicides, when fields treated with them were almost immediately ready for sowing, without risk to the seeds of crops. The first recommendations for practitioners were prepared by scientists in England and North America as a result of years of research, back in 1969. However, the main "boom" in the implementation of this technology has been in the last 10 years.

The positive aspects of no-till technology include such factors as: restoration of soil fertility, prevention of water and wind erosion, reduction of labor and energy consumption. This technology makes it possible to obtain sufficiently high yields at minimal costs.

Advantages of technologies with different tillage systems are shown in Table 1.

However, in addition to the advantages for different tillage systems there are also certain disadvantages. The main disadvantages of different tillage systems are shown in Table 2.

Table 1. The advantages of different tillage systems.

Intensive	Minimum	Zero
1. Deep soil structuring 2. effective, environmentally friendly control Against weeds, pests and pathogens	1. Reduction of fuel consumption by 10-30% (compared to intensive), reduction of labor intensity of technology 2. Sufficiently effective weed control	1. The intensity of erosion processes is significantly reduced 2. Moisture losses are reduced. 3. Fuel consumption is reduced by 30-80%. 4. Reducing the cost of production

It is obvious that with all the advantages the use of minimum and no-till technologies is not so harmless and requires a cautious approach in use. It should be noted that the use of these technologies is possible only at a high level of agrotechnics and with a significant rotation of cultivated crops in the rotation.

Table 2. Disadvantages of different tillage systems.

Intensive	Minimum	Zero
1. Disturbance of bacterial equilibrium in the soil 2. Increased energy and labor costs 3. Increased moisture loss 4. Increased wind erosion 5. Increased mineralization of organic matter	1. Increased crop infestation 2. Nutrient stratification by horizon 3. Decrease of nitrogen content in the first phase of vegetation 4. Accumulation of pesticides in the upper soil layer	1. Increased crop infestation 2. Increased need for nitrogen fertilizers 3. Stratification of nutrients by horizon 4. Increasing need for pesticide applications 5. Accumulation of pesticides in the upper soil layers 6. Cost of machinery

2. Materials and methods

The analysis of development of resource-saving tillage technologies and techniques shows that the prevailing method of tillage remains mechanical, taking into account the diversity of soil conditions, availability of flat, slope and contour farming, possibility of wind and water erosion control, implementation of soil, moisture and energy saving. Introduction of technologies of conservation agriculture contributes to reduction of labor and energy costs, restoration of soil structure, composition and biological diversity, minimization of environmental pollution.

The analysis of soil-protective tillage systems allows us to distinguish the most common ones.

Minimum zero processing (no tillage) provides for only one contact of tillage implements with the soil during the vegetation period - during sowing. Sowing is usually carried out in narrow furrows of 2.5-7.5 cm width simultaneously with one or more additional operations. Herbicides are used intensively to control weeds. Fuel savings can be as high as 70-80% with the no-till system.

Ridge machining (ridge tillage). In this case the soil is not tilled before sowing. Simultaneously with sowing, 1/3 of the soil surface is cultivated with lancet tines or row cleaners forming ridges. Sowing is carried out in ridges with a height of 10-15 cm. For weed control herbicides are used in combination with cultivation.

Striping (strip tillage). As in the case of ridging, in strip-till about 30 % of the soil surface is tilled with milling, disc or passive ripper implements. As a rule, this operation is combined with sowing.

Weeds are eliminated by herbicides in combination with cultivation.

Mulching treatment (mulch-tillage). Before sowing, the soil is loosened with the simultaneous crushing and preservation on the soil surface of the coarse-stemmed residues of row crop precursors. The depth of tillage is determined by the cultivated crop.

However, in the soil and climatic conditions of the Republic of Uzbekistan, namely the emergence of crusting of the soil surface and increasing costs of various types of herbicides to kill different weeds leads to the need for pre-sowing surface tillage. The use of tooth harrows and moths for this purpose does not always provide the agrotechnical requirements.

Review and analysis of existing sources, as well as preliminary studies have shown that the existing levelers in the Republic of Uzbekistan by their design are complex, heavy, energy-intensive, expensive, the working width is small (3-5 m), which is inefficient and not fully load the operated power (tractors) of high class.

3. Results and discussion

The proposed 7.0 m wide pre-emergence harrow eliminates the existing disadvantages. It can be operated on large and small sowing areas in aggregate with 2.0 t class tractors because of its folding side frames, in addition, due to the reduction of multiplicity of operations and minimal impact of agricultural machinery on the soil surface and efficient use of energy, has a great opportunity in preventing soil erosion and environmental protection. All these criteria lead to environmentally friendly products and reduce their cost. The innovative technology and rational design of the universal wide-cut leveller (it levels microrelief, loosens the surface sowing layer, breaks the clods and destroys the annual weeds and creates a mulchy surface) is aggregated with the new generation of domestic tractors for the ecological health improvement zone.

The tasks are the choice of technology, definition and development of a rational universal leveller design for preparation of sown fields during cultivation of any crops in the republic, at the same time to reduce operational costs, reduce the negative impact of domestic tractors on the environment (optimal fuel consumption, moderate exhaust gas waste, soil compaction and erosion, etc.) and conduct their tests in the laboratory-field and farm conditions.

The suggested leveller is used in the spring period on the fields ploughed under the plough with mouldboard and non-shafted implements and can also be used in the summer period before re-sowing) in aggregate with the new generation of domestic tractors.

Design and operation of the harrow. The harrow consists of the following assemblies: frame, right and left sections, hydraulic system, supports. The frame bars and sections are equipped with rippers, dozer blades and track levellers.

The frame of welded construction is a supporting element and serves for connection of the harrow to the tractor's hitch system. Brackets and eyes are welded in the front part of the frame to connect it to the tractor linkage.

In the middle part of the frame there are welded stands with brackets for mounting of hydraulic cylinders. Brackets for mounting ripper and supports are welded on longitudinal bars.

Right and left sections are of welded construction, with bars for connection to the frame.

Brackets for installation of rippers are welded on longitudinal beams of the sections. In the middle part of the sections there are brackets for connection of hydraulic system arms. The slats are used for installing the dozer blade.

Hydraulic system consists of two hydraulic cylinders, high pressure hoses, tees, retarder valves. Serves to actuate the lifting mechanism of the side sections.

The lifting mechanism consists of levers with supports and rods. Serves for folding and unfolding of side sections by means of hydraulic cylinders. In transport position, the sections are fixed in the spacer traps.

The mouldboards are leveling plates assembled in a row on the frame (6 x 995 mm and 2 x 498 mm) and reinforced at the bottom by a heat-treated strip.

The ripper consists of two parallel pipes connected by plates, tines fixed to the pipes, parallelogram mechanisms, springs, tension bolts. The ripper is designed for loosening the soil. It is installed on the brackets of the frame bars.

In operation the harrow rests on levelling plates, which ensure the required height position of the frame relative to the soil.

When the harrow is moving in the field, the soil crust is being broken up by the first row of operating tools - rippers, then the blade plates level the micro relief, the plate installed on the lower edge of the blades slightly compacts the soil before passing the second row of rippers, which ensures covering the moisture, the rippers installed on the wheel track, loosen the soil in the rut after the tractor pass.

General views of the pre-emergence leveller in aggregate with TS 130 tractor in transport and working position are shown in figures 1 and 2.

Figure 1. TEA-7 seedbed leveller in aggregate with TS 130 tractor (rear view).

Figure 2. Pre-seeding leveller TEA-7 in aggregate with TS 130 tractor (side view).

Table 3. Technical characteristics.

Name of indicators (parameters), dimension	Value of indicators (parameters)	
	According to TU and RE	actually
Type of product	hinged	
Coupled with tractors	wheeled class 2	TS 130
Design working width, m	7	7
Operating speed, km/hour	7-9	8.33
Overall dimensions of the machine in working position, mm:		
-length		
-width	1620	1650
-height	7000	7050
	1300	1330
Weight,kg	1525	1550
Productivity per 1 hour of prime time, ha/hour	4.9-6.3	5.83
Productivity per 1 hour of operating time,ha/hour	3.4-4.4	4.0
Loosening depth, cm		
- Loosening tool	5-7	6.9
-loosening tool	20-25	14.66
Degree of leveling of the field surface in one pass, %	75	73.3
Soil crumbling, fraction content, %, size		
-up to 50 mm	80	87.46
-over 100 mm	15	no
Destruction of soil crust, %	100	100
Destruction of annual weeds sprouts, %	95	98.4
Reliability coefficient of the technological process	0.97	0.99

The analysis of agrotechnical evaluation of leveller was carried out in the farm of Ok-Suv Andijan region. Soil in the farm is meadow-marshy, heavy loam with a level relief.

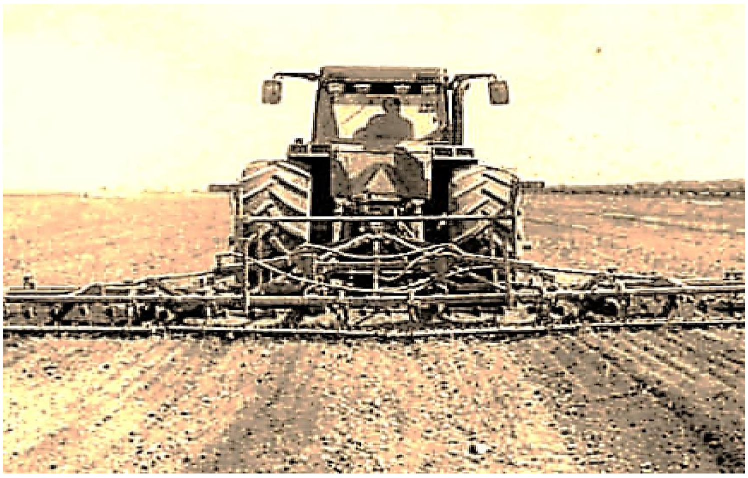

Figure 3. Pre-sowing leveller TEA-7 in aggregate with Magnum 8940 tractor in operation (rear view).

Soil moisture in the layer 0-10 cm was 16.47-17.54% (according to RE-14-18%), and soil hardness 0.10-0.12 MPa, which meets the requirements (according to RE not more than 0.8 MPa).

Pre-tillage - plowing after grain harvesting, with the height of ridges on average 12.36 cm.

Number of annual weeds per 1 m2 was 16.6 pcs. Indicators of test conditions of TEA-7 leveller were within the requirements of RE.

4. Conclusions

Laboratory and field tests of pre-seeding leveller TEA-7 in combination with Magnum 8940 tractor were carried out at a working speed of 8.33 km/hour. At the same time the actual working width was 7 m, which meets the requirements.

Evenness of the soil surface for one pass of the unit in transverse direction was 73,3% (according to the RE - 75%).

Working depth of loosening tools of the machine was set to 7 cm with the actual depth of 6.9 cm (according to RE - 4-8 cm).

The planned depth of track looseners was set on the depth of 15 cm and the actual depth received was 14,66 cm.

Quality of the machine's soil crumbling is within the allowable limits and soil fractions of the size less than 50 mm are 87,46% (in accordance with RE not less than 80%).

It provides increase of labor productivity at pre-sowing preparation of the soil up to 1,5 times at the expense of combining operations of loosening and leveling the soil as well as reduction of consumption of combustive-lubricating materials by 1,5 times.

Agrotechnical data in general correspond to the design documentation.

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