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Modern direction for agricultural development in the Republic of Uzbekistan

A Igamberdiyev¹, S Alikulov¹, P Berdimuratov¹, B Artiqbaev¹, U Berdimurodov¹ and O Usarov¹

¹Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan

asqar1959@mail.ru

Abstract. In the conditions of the Republic of Uzbekistan, much attention is paid to the efficient use of irrigated land, the introduction of modern resource-saving technologies, and universal equipment that can ensure competitiveness, increase productivity and obtain high crop yields. A solution to the problem is proposed by replacing single-operation, simple equipment with more advanced ones - multifunctional, universal, or combined units. Therefore, reducing the number of passes by combining two or more technological operations using universal or combined units of pre-sowing tillage and sowing in cotton rows between rows can provide an increase in productivity, lower operational and energy costs. Traditional conventional single operational methods of tillage and sowing are becoming more and more expensive in terms of time, energy costs, metal consumption, the number of machines needed, and also lead to disruption of the soil structure and compaction due to the greater number of passes. In the conditions of irrigated agriculture in Uzbekistan, the combination of primary processing with sowing is considered unacceptable except for pre-sowing treatment and the sowing of repeated crops. With a high probability, a promising and necessary way is a combination of pre-sowing treatment and sowing.

1. Introduction

In the Republic of Uzbekistan, much attention is drawn to the effective use of irrigated lands, the introduction of modern resource-saving technologies, and universal equipment that can ensure high crop yields.

In the action plan for further development of the Republic of Uzbekistan in 2017-2021, in particular, the following objectives are set out: “..... by 2030, more than doubled the volume of gross domestic product by optimizing sown areas, rational use of land and water resources, introduction of modern intensive agricultural technologies and modernized agricultural machinery”[1].

For the resolution of this problem, it is necessary to develop, manufacture, and commission new-generation equipment with significantly higher technical and economic indicators, ensuring competitiveness and increasing labor productivity by 3-4 times.

The purpose of the study - is to increase productivity, reduce operational, energy costs, and improve quality indicators for tillage and sowing by optimizing parameters and combining the working bodies of the tractor unit machine.

2. Methods



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A research methodology is based on a systematic approach, which allows revealing the relationship between the parameters of combined tillage and sowing working bodies, physic and mechanical properties of the soil and quality performance

The forwarded task can be solved by replacing single-operation, simple equipment with more advanced ones - multifunctional, universal, and combined units capable of quick change of working bodies with their various types [2, 3].

Currently, in the Republic, there has arisen a demand for development, production, and use of multifunctional, universal, and combined units. Since these problems are especially relevant, since the current economic situation requires the fulfillment of mutually exclusive tasks: on the one hand, obtaining stable crops, saving energy resources, preserving soil fertility, and preventing the negative effects of anthropogenic impact on the soil, expressed in compaction of the cultivated horizon. This approach will reduce the number of necessary machines for performing technological processes in the cultivation of crops by 4-5 times. At the same time, the total metal consumption of the units will decrease by 2–3 times, and capital investments - by 1.5–2 times [4-7].

Upon using multifunctional, universal, and combined units, the degree of utilization of the power of the used tractors can be optimal due to the simultaneous execution of several technological operations in one pass. Due to the use of these units, the energy required to perform several technological operations in one pass will be reduced [8-14].

In Uzbekistan, promising areas for the development of agricultural units are:

- increasing the productivity of machine-tractor units based on modern tractors and high-speed agricultural machines;
- creation of a family of unified machines based on developed models;
- replacing single-operation, simple agricultural machinery with more advanced - multifunctional, universal and combined;
- use of innovative hydraulic drives and electric drives in the designs of multifunctional, universal and combined agricultural machines that automatically control the technological parameters of machines (processing depth, working tool working width) within the agrotechnical requirements and rational loading of engines of modern tractors;
- improving reliability, reducing metal consumption, improving the quality and performance indicators of agricultural machines.

In this regard, the development, production, and introduction of new generation equipment into agricultural production is a basis for increasing the level of labor productivity and production volume.

Multifunctional, universal, and combined machines and units combine several basic and pre-sowing technological processes in one pass across the field. This reduces the negative impact of tractors and agricultural machinery on the soil, reducing the cost of fuel, labor, and other materials, increasing the quality and productivity of the soil, reducing the amount of tillage and retaining moisture. Usually, in all these units, the combination of tillage and sowing machines occurs [20]. Tillage machines consist mainly of working bodies, which are placed on the frame sequentially and provide for cutting plants, loosening, crumbling, leveling, and compaction of the soil. As a sowing part, there mainly are used the conventional seeders with a mechanical or pneumo-mechanical sowing device.

It should be noted that there are many ways of primary, pre-sowing tillage and sowing of agricultural crops, as well as multifunctional, universal, and combined units, which, each of them has its positive and negative sides. However, in the conditions of irrigated agriculture in Uzbekistan, the combination of primary processing with sowing is considered unacceptable except for pre-sowing treatment and the sowing of repeated crops. With a high probability, a promising and necessary way is a combination of pre-sowing treatment and sowing.

Main advantages and disadvantages of units with a different combination and combination of tillage and sowing are:

- combined units composed of single-operation machines can use their parts as independent machines in other types of work, which increases the versatility of such units to load them more fully during the entire period of use;

- as a part of the unit, the presence of gaps in joints leads to a deviation of working bodies from a given trajectory, processing depth, angle of installation of the cutting edge of the blades worsens the quality of the operation;

- The serial connection of machines through the coupling devices leads to an increase in the kinematic length of the unit, which negatively affects its maneuverability.

For the zone of Uzbekistan, it is necessary to choose one of them that makes it possible to increase labor productivity, reduce hectare fuel consumption, terms of tillage and sowing, and also increase the yield of cultivated crops [15-18].

One of the features of the recommended units is that the working bodies sequentially placed on the frame interact with soil, stems, or with living organisms - plants.

Therefore, the main requirement for these units is to contribute to increasing soil fertility, to ensure the normal growth and development of cultivated crops [19]. Besides, the units must satisfy the following requirements:

- a) technical, which includes the purpose, characteristics of the technological process and the quality of its implementation, targeted use, availability, maneuverability and general technical characteristics of machines;

- b) operational, convenience and ease of management, the coefficient of use of working time, traction, the number of staff, etc. ;

- c) economic - service life, reliability, performance, fuel consumption, etc.;

- d) production and technological, which include the mass of the machine, the scale of production, the complexity and cost of manufacturing, and other special requirements.

Requirements listed above together constitute agrotechnical requirements and are of paramount importance in the development and construction of working bodies and the machine as a whole [19].

For the conditions of Uzbekistan, an important feature is that most tillage and sowing units work in an abrasive environment, which leads to the rapid wear of the working bodies. Therefore, in the development and design of promising units, complex tasks may arise to improve their operational and production-technological characteristics, increase universalization and level of unification, reliability, weight reduction, etc.

It is important to note that the current state of agriculture throughout the world requires the accelerated development of conservation technologies for the production of crops. They are based on wide-grip tillage and sowing machines, for the aggregation of which energy-efficient agricultural tractors are required.

Among the world's most powerful wheeled tractors, John Deere, Case IH, New Holland, and Claas are playing a leading role. Their tractors are equipped with economical engines of constant power with a safety factor of torque of 27-67%. This allows for a wide load range to ensure maximum engine power efficiency. Appropriateness of their use will depend on the soil and climatic conditions of farms, size, the technologies used, and aggregated machines.

A range of manufactured equipment for domestic and foreign production is quite wide. For this reason, there is a need for theoretical coordination of the parameters of tractors and universal machines from the point of view of rational aggregation, use, and characteristics of operating conditions.

3. Research and discussions

We have studied the technology for processing cotton rows between crops of winter wheat and the parameters of the working bodies. As a result, an energy-saving technology has been developed that processes the soil of cotton rows between crops of winter wheat at the level of agrotechnical requirements.

Recommended technology provides for layer-by-layer soil cultivation between rows. In this technology, the width of the layered tillage is subject to the following condition:

$$b_1 > b_2 > b_3 \tag{1}$$

here b_1, b_2, b_3 , is a width of the corresponding layer-by-layer processing by working bodies in the first, second, third layers, m.

To fulfill the recommended technology according to agrotechnical requirements, $b_{m1} = 17 \text{ cm}$, $b_{m2} = 17 \text{ cm}$, $\alpha_m = 26^{\circ}50'$, values of working bodies treating the first and second soil layers are accepted as acceptable parameters.

For high-quality presowing cultivation of the soil, it is recommended to use a skating rink, designed to perform the functions of the support wheel and chop the soil lumps with knives. The shape of the skating rink corresponds to the parameters of the furrows in the rows of cotton, it is accepted that the grinding conditions of the soil layer and lumps along the entire width are the same, the knives act on soil particles and lumps vertically (Fig.1).

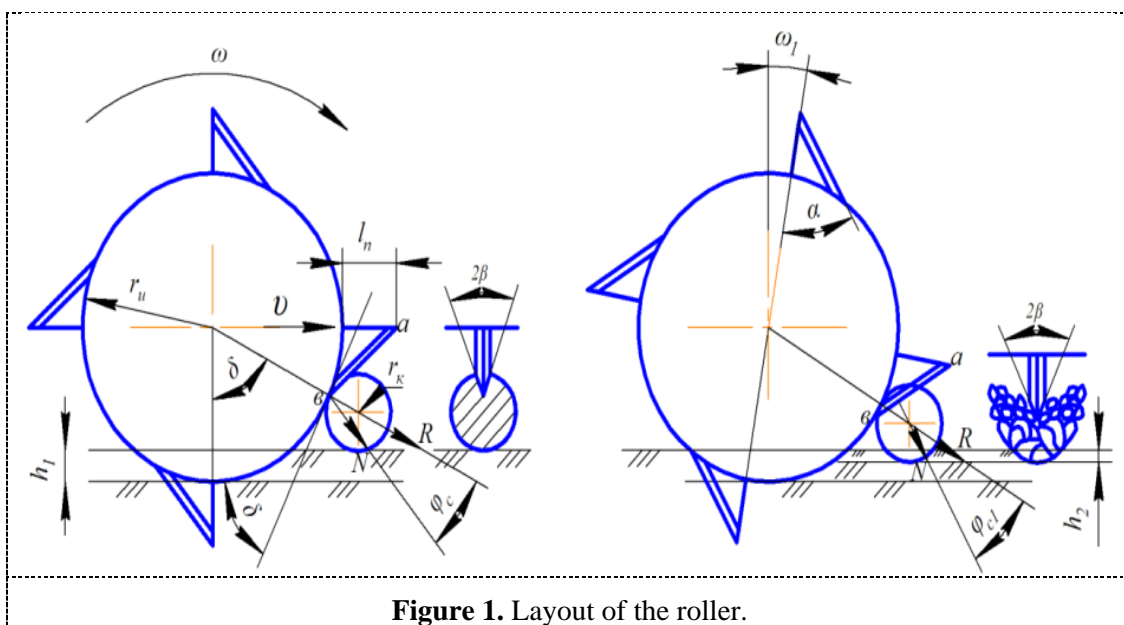


Figure 1. Layout of the roller.

Accordingly, a small radius of the roller r_u is set according to the following expression (fig.3)

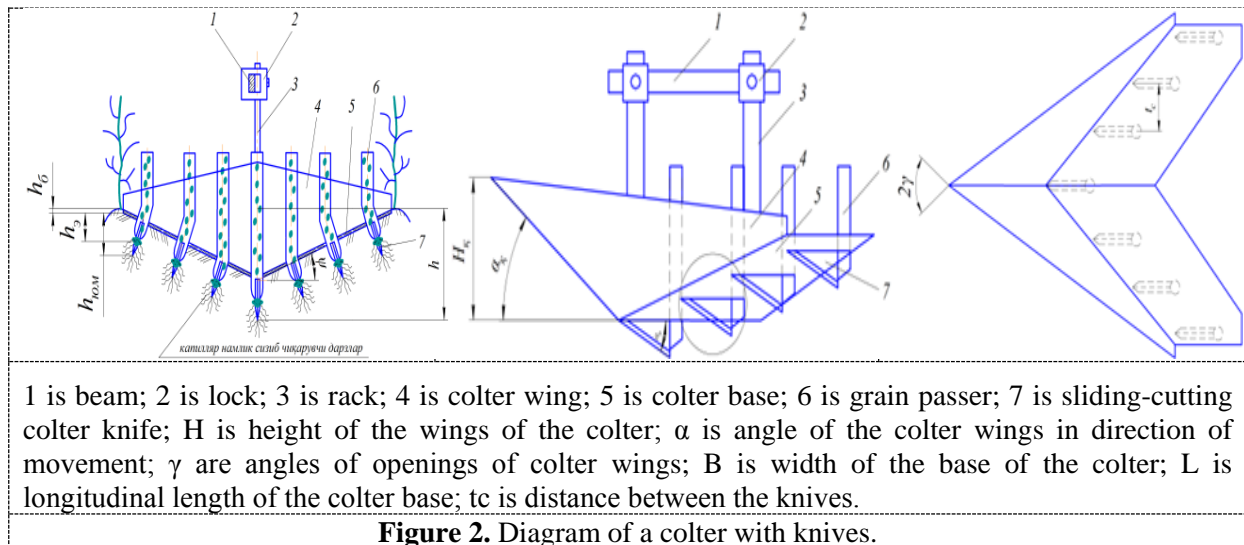
$$r_{\min} = r_k \cdot ctg^2 \frac{(\varphi_c + \varphi_m)}{2} + \frac{h_1 - h_2}{1 - \cos(\varphi_c + \varphi_m)} \tag{2}$$

Here: r_k is a radius of lump, m; φ_c is the detection angle of soil friction, degrees; φ_m is the angle of internal friction of the soil, hail; h_1 is the immersion depth of the roller in the soil, m; h_2 is the depth of immersion of the lump in the soil, m.

In values of $r_k = 0.05 \text{ m}$, $h_1 = 0.03 \text{ m}$, $h_2 = 0.01 \text{ m}$, $\varphi_c = 33^{\circ}$, $\varphi_m = 48^{\circ}$, a small radius of roller is assumed to be $r_u = 0.0920 \text{ m}$, the large radius is $r_m = 0.2395 \text{ m}$

A high probability of appearance of an embankment when the roller collides with clods of soil has become the reason for equipping it with knives. It was established that, at low humidity, clods of soil are deformed, the likelihood of cracking from pressure during initial contact increases, that the contact surface of a knife acting on clods with high pressure in the initial phases is effective, and in other phases, there may be cases when gliding knives cut open clods. Reasons are explained that when turning the knife to a known angle from the contact point, destruction occurs in the clods of soil even before a knife reaches another contact point, that the slip coefficient decreases, and that the selection of the effective length of the knife edge leads to a decrease in resistance.

At the next stage, there was developed a new design of a simple, sliding colter with knives (Fig-2).



The technological process of a sliding colter with knives adapted to work on the furrows of the rows of cotton is as follows. The knives on the base of the colter are designed so that during operation they cut into the soil at an obtuse angle and glide through it. In the process of sowing, knives plunging into the soil loosen it and create beds with a certain lip. A seed-passing tube mounted on the back of the knives scatters the grain, while slightly compacting the bottom of the groove.

The left and right colter wings should create an even profile aligning the topography of the aisles, grinding clods of soil, and eliminating bumps. This condition is expressed by the density of the soil or the depth of immersion of the bases in the soil.

For the colter wings to glide over the row-spacing with less friction and not to create an embankment, they are inclined at an angle equal to the angle of external friction in the direction of movement.

The immersion angle of the colter knives in the soil is selected from the condition of cutting off plant residues or sliding. This condition is selected by the minimum cutting or sliding time.

Economic tests of tillage and sowing working bodies of an experimental seeder and identification of their economic efficiency are given. In the field and economic experiments, the main attention was paid to the quality of pre-sowing treatment and the sowing of winter wheat in cotton rows between crops at the agrotechnical level, uniformity of seed germination, and density according to the transverse and longitudinal parameters of the surface area. In field experiments, the total resistance of the unit was determined during operation, at idle, when the unit moves without a seeder and in different types of the seeder. Results of many years of field tests are summarized, the accuracy of the unit design is introduced, and the design of the combined unit is improved according to local conditions (Fig.3).

Quality indicators of the unit in recommended parameters and operating modes were at the level of acceptable requirements and satisfied the initial requirements. This technical solution made it possible to carry out high-quality pre-sowing processing and sowing of winter wheat at the lowest cost, which reduced production by 25%, increased labor productivity by 26%.

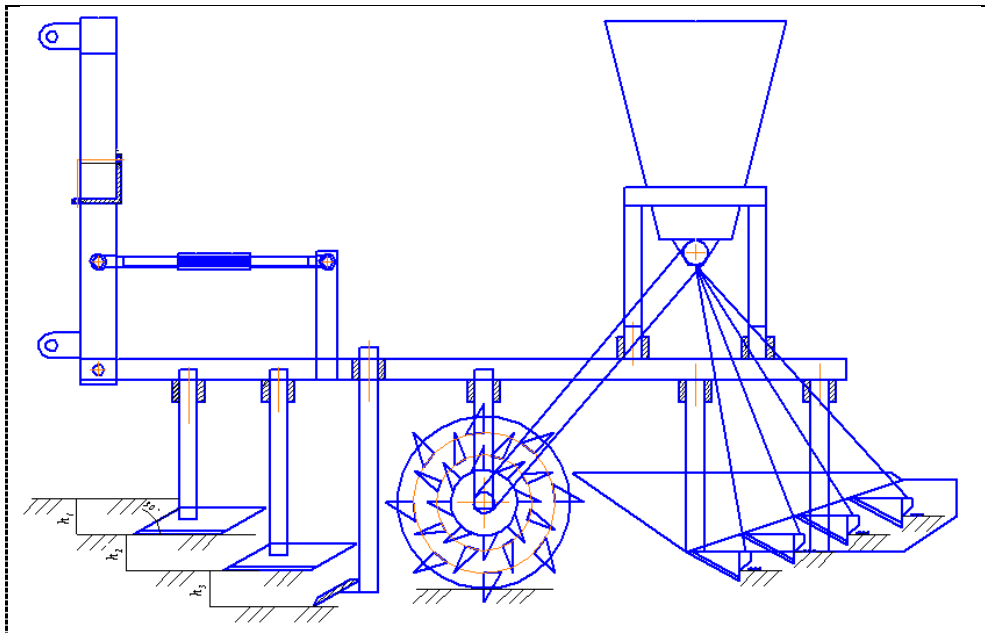


Figure 3. Combined Sowing Machine Diagram.

4. Conclusions

1. A combined unit for pre-sowing tillage and sowing was more effective.
2. Pre-sowing layer-by-layer tillage before sowing winter wheat between rows of cotton provides energy and energy conservation.
3. To implement the technology of pre-sowing tillage in accordance with the agrotechnical requirement, there are recommended acceptable parameters of the working bodies.
4. Colter efficiency is ensured by such acceptable parameters as the immersion angle of the knives, the length of the sliding-cutting knife, the thickness of knives, and the angle of sharpening. The angle of knife sharpening $\beta = 30^\circ$, length of the cutting tip $l_m = 30$ cm, installation angle about the direction of movement $\gamma = 300$ provides a good seal of wheat seeds.
5. Combination of pre-sowing treatment and sowing to ensure energy and resource conservation, increase labor productivity by 25%, reduce energy costs by 20.6%.

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