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В збірнику представлені тези доповідей науково-педагогічних працівників, наукових співробітників, аспірантів та студентів НУБіП України, провідних вітчизняних і закордонних вищих навчальних закладів та наукових установ, в яких розглядаються завершені етапи розробок.

The Proceedings presents abstracts of reports of scientific and pedagogical workers, research staff, graduate students and students of the NULES of Ukraine, leading domestic and foreign higher educational institutions and scientific institutions, in which completed stages of development are considered.

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ERGONOMIC OF SMART TECHNOLOGIES OF CONTROL OF MACHINE USE OF SELF-PROPELLED BEET HARVESTERS

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The available literary sources [1-5] contain information on the technologies of growing and harvesting sugar beets and separate data on the assembly and use of modern machine units and the use of machine complexes in farms of various organizational forms of ownership (Fig. 1). Recently, the agricultural production of sugar beets has been equipped with new equipment from domestic and foreign manufacturers. However, in the existing literature there is no systematized data on recommendations for the assembly and use of machine complexes for growing and harvesting sugar beets.

Fig. 1. The combined weed remover provides trouble-free cleaning even with heavy weed growth.

Existing technologies for growing and harvesting winter wheat were studied based on data from literary sources. The composition of the complexes of machines for the production of sugar beets was determined based on the analysis of the data of agricultural machinery manufacturers. Technical and economic indicators of machine units and machine complexes were calculated on a PC according to the methodology and program [1]. In recent years, in connection with the reform of the agricultural sector of Ukraine and a significant violation of price parity for agricultural products, in particular, sugar beets and services for the countryside (fuel, fertilizers, pesticides, machinery, etc.), there has been a trend of a significant decrease in the production of domestic equipment, purchasing power and insecurity manufacturers, as well as material and technical support of mechanized production. As a result, during the years of Ukraine's independence in 2023, the gross harvest of sugar beets decreased by 3.3 times and the sown area decreased by 4.4 times. In order to stop the decline and further increase the production of sugar raw materials and sugar in Ukraine, scientific support and corresponding intensive technologies are necessary, which will make it possible to obtain the yield of root crops at the level of 45-50 t/ha, sugar content 17.0-18.5%, sugar yield - up to 9 tons per hectare (Fig. 2). It is known that 80-100 liters of bioethanol can be produced from a ton of sugar beets.

Important factors in increasing the volume and efficiency of sugar beet production are the increase in the level of agricultural machinery and mechanization due to the introduction of modern machine complexes. The highest yields of sugar beets are obtained when grown after legumes, annual and perennial grasses in one cut. Sugar beets remove a significant amount of nutrients from the soil per ton of root crops: nitrogen 5, phosphorus 1.3, potassium 5 kg. Therefore, in order to obtain high yields, it is necessary to provide the soil with a sufficient amount of nutrients during the main cultivation, or additionally apply fertilizers during sowing and during the growing season of plants. We calculated the need for machines for these operations under the conditions of applying fertilizers in three terms: for the main tillage (superphosphate - 250 kg/ha and potassium magnesium - 160 kg/ha), during sowing

(ammonium nitrate - 130 kg/ha) and in growing season for plant feeding (ammonium nitrate – 160 kg/ha).

Fig. 2. Ergonomic armrest with programmable elements and control panel.

In order to obtain high-quality root crops and ensure the reproduction of soil fertility, it is planned to apply 40 t/ha of manure (on 25% of the area) and to spread chopped chaff (23 t/ha) on the field. It is known that friendly and full seedlings are obtained when seeds are wrapped in warm moist soil, when its average daily temperature at a depth of 10 cm is 5-6^{0}C. The depth of sowing seeds in conditions of sufficient moisture and on heavy soils prone to waterlogging is 2-3 cm, with unstable and insufficient moisture - 3-4 cm. According to the recommendation of the sugar beet research institute, the density of root crops for the harvesting period should be equal to 115-120 thousand/ha in areas of sufficient moisture, unstable - 110-115, insufficient - 100-105 thousand/ha. Planters of domestic and foreign production meet the above requirements of agricultural machinery. The industry of the world's leading countries, including Ukraine, produces a variety of equipment for one-, two-, and three-phase methods of harvesting sugar beets. The most common method of harvesting in Western Europe is the single-phase, that is, the combine method. In particular, OJSC "Ternopil Combine Plant" also offers the KS-6B-10 "Ternopil" self-propelled beet harvester (Table 1), which replaces three separate machines - the BM-6B beet harvester, the OGD-6A root cleaner and the KS-6B root harvester, which are used during two-phase harvesting, as well as a BM-6B string picker, a KVTSB-1,2 or AZK-6-01 digger-roller and a PNBV-1,6 or AZK-6-02 root picker-loader for a three-phase harvesting method.

The KS-6B "Ternopil" self-propelled beet harvester performs the following operations in one pass: cutting and spreading the beet on the field, trimming the remains of the beet from the heads of root crops, digging them up, cleaning them from the soil and plant residues, accumulating them in a bunker, followed by unloading them into field carts on transshipment or in the body of vehicles. Root crops from under the harvester can also be fed to a vehicle moving nearby. Active disc diggers are the main type of the combine's excavating working bodies. By

Table 1

Technical characteristics of combines for harvesting sugar beets

Indexes	Brand	
	KS-6B-10 "Ternopil"	SF-10-2
Nominal power, kW/hp	185/252	275/374
Operating speed, km/h	5-10	6-12
The number of collected lines	6	6
The width of the rows, cm	45	45 or 50
Productivity per hour of prime time, ha	1.35-2.70	1.62-3.24
Hopper capacity (m^3/t)	5/3,7	15/11
Mass of the harvester, kg	11800	16220

special order, the harvester can be equipped with rotary forks, vibrating-oscillating plowshares or "passive disk-ploughshare" type diggers. The harvester is equipped with an automated system of driving along the rows of beets, systems of automatic control of technical and technological parameters. The new KS-6B-10 "Ternopil" beet harvester is equipped with hydraulics from the Italian firm Bondioli Pavesi and the German HANSA FLEX.

According to the research the fuel consumption per harvested hectare of sugar beets with the KS-6B-10 harvester is 50.4-54.5% lower, and the labor costs are 2.56-2.74 times lower than with a complex of machines in the warehouse BM-6B+OGD-6A+KS-6B. This testifies to the significant advantages of the single-phase method of harvesting with the KS-6B-10 harvester. Beet harvesters of leading European companies - Franz Kleine and Holmer (Germany), Matrot and Moreau (France), TIM (Denmark), work according to the same (single-phase) method. Agrifac (Netherlands) and others. The FRANZ KLEINE RL 200 SF "MOUSE" beet loader-cleaner is a self-propelled machine that provides high productivity - up to 250 tons per hour of prime time. Simultaneously with the load, root crops are cleaned from the ground and plant residues, which significantly improves the quality of the products and reduces the percentage of contamination when delivered to the sugar factory.

We have calculated the operational need for machine complexes for the production of sugar beets on an area of 1,000 hectares according to two criteria: the minimum specified costs and labor costs. Up to ten competing units were used in each operation of the technological process. As can be seen from Table 4, the composition of the complex of machines, based on the criterion of the minimum stated costs, includes domestic and CIS equipment, and according to the minimum cost of working time (labor), the equipment of far-off countries is mainly more productive and reliable.

The data show that the use of a complex of machines based on domestic equipment and the CIS countries, compared to the equipment of distant foreign countries, makes it possible to reduce capital investments by almost 2.3 times, by 1.9 times – the specified costs and by 1.7 times - direct operational costs, but require 9.5% more work time (labor) and 4.6% - fuel costs.

Conclusions. The technological process and complexes of machines for growing and harvesting sugar beets available in most farms are outdated and do not meet the modern requirements of technical progress. We substantiated the technical and economic indicators of promising machine units and machine complexes for the production of sugar beets according to the criteria of the minimum expenditure of working time (labor) and reduced costs. The use of a complex of machines, calculated according to the criterion of the minimum expenditure of working time (labor) makes it possible to obtain only lower labor costs, but has significantly larger capital investments and reduced costs of funds. Considering the financial difficulties, it is advisable for most grain-sowing farms to use cheaper domestic and CIS equipment. For the production of grain in large specialized financially capable farms, more reliable and productive equipment from countries far abroad should be purchased.

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