Determination of working indicators of New Holland TS-5060 combine for soy bean harvesting

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Abstract. The results of experimental researches to determine the working indicators of the New Holland TS-5060 combine for soybean crop harvesting are given. According to the results of performed experiments to determine the working indicators of the New Holland TS-5060 grain harvester in soybean harvesting process, the main time yield of the harvester combine was determined at 1.4 hectare/hour, the grain yield was defined at 96.5 per cent, and the loss in the combine thresher unit was at 0.6 per cent, it was found to be at the level of demand, however the grain loss and grain damage on the combine harvester were slightly higher than the specified requirements. That is why, it is recommended to use the number of revolutions of the combine pick-up reel in the range of 25-30 rpm, the number of revolutions of the threshing drum in the range of 750-800 rpm. Average square deviation and variation coefficient of these indicators are shown in following tables.

1. Introduction
Along with cotton, cereals, vegetables and melons, Uzbekistan pays special attention to increasing the cultivation of oilseeds. Currently, in the world oilseeds are grown on 140 million hectares of land planted in an area of more than a hectare. The most common of these is the soy bean 110 million hectare, sunflower 25 mln. hectare, rapeseed and cole-seed 15 mln. more than a hectare [1].

According to the data provided by the World Food Organization (FAO), soybean production in the world and in Uzbekistan is increasing year by year [1, 2]. If in the world in the 60s the soy bean was 20-30 million hectares, so far this figure is 110 million hectares. Intensive soy bean cultivation was introduced after the 1990s, and high-yielding soy bean varieties were created and more advanced technologies for its cultivation were developed. Significant growth has been observed in the economies of some countries due to the introduction of soy bean production and its added value.

That is why there is a growing interest in its cultivation among the countries of the world. Today, the largest soybean-growing countries are the United States, Brazil, Argentina, China, India, Paraguay, Canada, Bolivia, Uruguay, Ukraine, Russia and Indonesia, with 72 million in the United States, 57 million in Brazil, 47 million in Argentina and 12 million in China, 10 million in India, 6 million in Paraguay, 2 million in Canada, 1.5 million in Bolivia more than 1 million tons in Uruguay, Ukraine, Russia and Indonesia slightly less than a ton of soy bean is grown [1, 3].
In Uzbekistan, along with soy bean as the main crop, it is also planned to cultivate it as a secondary crop, and consistent research is being conducted in this regard. One of the main processes in soy bean cultivation is quality harvesting without damaging it. Various methods and tools are used to remove the soy bean. An analysis of the available methods and tools has shown that currently combine harvesters are mainly used for harvesting soy bean crops [4, 5, 6].

At the same time, the design of grain harvesters, grinders and grain cleaning units remains unchanged, and their technological parameters and operating modes are adjusted for shadow harvesting [7]. At the same time, in some places, combine harvesters equipped with a threshing machine are used to reduce losses, but this leads to an increase in costs. In addition, soybean harvesters have been developed and recommended for use in grain harvesters [8, 9].

Practical experiments have shown that as the soybeans ripen, due to the high humidity in its stem, the combine harvesters become clogged in the threshing apparatus during operation. For this reason, the method of desiccation before harvesting is also recommended to ensure that the stem dries out during harvesting [10].

Researchers have also noted that soybeans are harvested in a timely manner after ripening. This is because it has been found that harvesting soybeans before ripening or after ripening reduces grain quality and leads to increased mortality [11, 12, 13].

The most common side effect of soybean harvesting is loss, which is caused by spillage of grain under the influence of combine harvester rails, complete threshing in the threshing machine, and flying away in the grain cleaning section [7, 8, 14]. Therefore, in order to prevent grain loss during soybean harvesting, it is recommended to adjust the combine working parts to the optimal operating modes depending on the field yield, soy bean type and crop condition [15, 16, 17, 18, 19].

Currently, Dominator-130, New Holland TS-5060 and other combines are used in the field. In previous years, the process of harvesting soy beans with the Dominator-130 combine was studied and its performance and operating modes were determined [20]. It is now necessary to study the New Holland TS-5060 combine in soy bean harvesting and determine the optimal operating modes. Therefore, this combine has been studied in soy bean harvesting and performance indicators are important.

2. Research methods
Experiments to determine the performance of the New Holland TS-5060 combine in harvesting soybeans were carried out on an area of 4 hectares in the shade variety “Sava” planted in a double row scheme 60x30 cm.

Prior to the experiments Gov.ST 20915-2011 “Testing agricultural machines. Methods of determination of conditional testing” and the agro-phonological classification of the field and the soy bean to be harvested were determined.

ST Uz 63.01-99 “Testing agricultural machines. Combines for grain harvesting. The methods in the standard manual “Program and methods of testing” were used. The main performance indicators of the combine were its main time productivity, grain loss, grain cleanliness and damage in the bunker.

The combine's productivity was determined by chronometric time, minus the time spent on walking, turning, and stopping, and by the productivity of the main time. The grain loss was taken separately on the harvester part of the combine and on the threshing floor. In this case, the loss in the combine harvester was determined by the entire width of the bed, while the loss in the combine harvester was determined by sequential sampling of a certain part of the straw pile, which was harvested by the combine harvester.

Determination of grain cleanliness and damage was carried out by taking samples from the grain in the bunker and calculating their ratio by separating whole and damaged grains and foreign compounds in the sample. In order to increase the reliability of the results obtained in the experiments, they were analyzed by mathematical statistical methods used in practice, and statistical indicators were determined [21].

Installation height of the combine bed during the experiments - 20 cm; number of revolutions of the drum - 900 rpm; the gap between the deck and the drum: at the entrance - 10 mm; at the outlet - 10 mm;
the angle of opening of the blinds - 30 degrees; the number of revolutions of the fan was adjusted to 800 rpm. The operating speed of the combine varied in the range of 4-5 km / h depending on the mass of grain delivered to the grinder and the working conditions.

3. Results and discussion

The experiments were carried out on an area of 4 hectares, planted in a soy bean field planted on a double row scheme of 60 and 30 cm (figure 2). The agronomic classification of the field is given in table 1 below. In the experimental field, a soy bean cultivator was planted and the number of bushes was 1 running meter average, 149 grains, the average square deviation was 16.9 grains, and the coefficient of variation was 11.3%. The average height of a soy bean plant is 85.0 cm, the diameter of the stem is 7.1 mm on average at the bottom, and the height at which the pods are located at the bottom 16.7 cm.

| №  | Name of indicators                  | Average | Average square deviation | Coefficient of variation |
|----|------------------------------------|---------|--------------------------|--------------------------|
| 1  | Sort of soy bean                   | Savva   |                          |                          |
| 2  | Number of stalks, piece/run meter  | 149.0   | 16.9                     | 11.3                     |
| 3  | Height of plant, cm                | 85.0    | 13.6                     | 16.0                     |
| 4  | Diameter of stalk, mm              | 7.1     | 0.37                     | 5.2                      |
| 5  | Overall mass of plant, g           | 17.7    | 9.7                      | 54.8                     |
| 6  | Height Bottom pods part, cm        | 16.7    | 2.8                      | 16.7                     |
| 7  | Number of pods, piece              | 29.8    | 16.1                     | 54.0                     |
| 8  | Mass of pods, g                    | 10.4    | 60                       | 57.6                     |
| 9  | Grain number on pods, piece        | 2.3     | 1.1                      | 47.8                     |
| 10 | Grain mass on pods, g              | 6.3     | 3.8                      | 30.3                     |
| 11 | Moisture of soy bean, per cent     |         |                          | 14.3                     |
| 12 | Level of weed, per cent            |         |                          | 6.9                      |
| 13 | Relationship of grain than stalk   |         |                          | 1:1.6                    |
| 14 | Yield, c/haire                  |         |                          | 23.9                     |

It was found that the average number of pods per bush is 29.8 grains, the mass of beans is 10.4 grams, and the mass of grains in beans is 6.3 grams. According to these indicators, the ratio of grain to stalk was found to be 1: 1.6. One of the most important factors influencing the work process of the combine during the harvest is the moisture content of the shade, the degree of field weeding and productivity. When these parameters were determined in the experimental field, it was found that the average moisture content of the plant was 14.3%, the rate of weeding was 6.9%, the grain yield was 23.9 t/ha, and the field conditions were normal for combine operation.

After determining the agro-phone condition and field conditions in the experimental field, soy bean harvesting and determination of its performance were performed with a New Holland TS-5060 combine (see figure). According to the results of the experiments, the productivity of the New Holland TS-5060 combine in soybean harvesting was 1.4 ha/h in real time, and its productivity was 1.27 times higher than the productivity of the Dominator-130 combine in soybean harvesting [20].

When grain loss was detected during the operation of the combine, it was found that the figure was 2.9% in the combine's threshing floor and 0.6% in the threshing floor. Due to the fact that the soybean was planted, the pods were relatively high and the loss in the form of unharvested pods below the harvesting height was not very high. The loss in the combine harvester was mainly in the form of loose grain spilled on the ground, which was found to occur under the mechanical action of the jat motor and the reaper.
Figure 1. The process of harvesting soybeans with a New Holland TS-5060 combine.

The grain purity harvested by the combine was 96.5 percent, indicating that the working quality of the combine grain cleaning part was good.

Table 2. New Holland TS-5060 combine soy bean harvesting work-quality indicators.

| №  | Work-quality indicators       | Amount of work-quality indicators |
|----|------------------------------|----------------------------------|
| 1  | Basic time productivity, he/h | 1.4                              |
| 2  | Loss of grain, %              |                                  |
|    | - on combine header           | 2.9                              |
|    | - in combine thresher         | 0.6                              |
| 3  | Cleanliness in bunker, %      | 96.5                             |
| 4  | Damaging of grain, %          | 6.6                              |

One of the indicators of the poor quality of work of the combine was the high grain damage in it. At the same time, grain damage was 6.6 per cent and this was mainly in the form of grain damage. This indicates that soy beans are rapidly susceptible to mechanical impacts.

4. Conclusion
According to the results of experiments to determine the performance of the New Holland TS-5060 grain harvester in soy bean harvesting, the main time yield of the combine was 1.4 he/h, the grain yield was 96.5%, and the loss in the combine thresher was 0.6%, it was at the level of demand, but the grain loss and grain damage in the combine harvester was slightly higher than the established requirements. Therefore, it is recommended to use the number of revolutions of the combine pick-up reel in the range of 25-30 rpm, the number of revolutions of the drum in the range of 750-800 rpm.

References
[1] www.fao.org/statistics/oilseeds
[2] Astanakulov K 2020 IOP Conf. Series: Materials Science and Engineering 883 012137
[3] Sgarbossa M, Possenti J C, Bahry C A and Modolo A J 2018 Australian Journal of crop science 12 892-7
[4] Philbrook B D and Oplinger E S 2014 Agronomy Journal 81 251-8
[5] Butzen S 2015 FIELD FACTS 9(18) 2
[6] Paixão C S S, da Silva R P, Voltarelli M A, Cassia M T and Tavares T O 2016 Australian Journal of Crop Science 10 765-70
[7] Ojigova N M 2005 Development theory and methods technological influence during harvesting of soybean in Amur region Abstract Diss. … can. tech. sc. (Novosibirsk: DalSAU)
[8] Vyazmin M I 2011 Increasing efficiency the working of reaping hook unit of cereal harvesting combine “JOHN DEER 1048” at harvesting soybean in Amur region: Abstract Diss. …can.tech.sc. (Novosibirsk: DalSAU) 19 (in Russian)

[9] Vejasit A and Salokhe V M 2004 TRANSACTIONS of the ASAE 31(4) 40-4

[10] Griffin J L, Jones C A, Etheredge L M, Boudreaux J J and Lanclos D Y 2002 Harvest Aids in Soybeans-Application Timing and Value Louisiana State University Agriculture Research and Extension Center 22

[11] Santana A C, Carrão-Panizzi M C, Mandarino J G, Leite R S, da Silva J B and Ida E I 2012 Ciência e Tecnologia de Alimentos 32(2) 351-6

[12] Abbasi Surki A, Sharifzadeh F and Tavakkol Afshari R 2012 African Journal of Agricultural Research 7(36) 5118-27

[13] Gaikwad A P and Bharud R W 2017 International Journal of Current Microbiology and Applied Sciences 6(4) 1092-7

[14] Sharda A and Haag L 2016 Harvesting Soybeans. Soybean Production Handbook Kansas State University Agricultural Experiment Station and Cooperative Extension Service 52

[15] Bushchermohle M J and McNeill S G 1997 Drying, Handling and Storing Soybeans in Tennessee In: Soybean Production in Tennessee PB-1608

[16] Hamilton H E, Loewer Jr O J and Overhults D G 1973 Harvesting, Drying and Storing Soybeans UK CES AEN-25

[17] Helsel Z R and Minor H C 1993 Soybean Production in Missouri University Missouri Extension Service. Pub. G 4410

[18] Hurburgh C R 2008 Soybean Drying and Storage Iowa State University Extension PM-1636

[19] Willis J B 1997 Combining Soybeans Efficiently In: Soybean Production in Tennessee UT Agriculture Extension Service PB-1608

[20] Astanakulov K, Abdillaev T, Umirov A, Fozilov G and Hatamov B 2021 E3S Web of Conferences 227 07003

[21] Kobzar A I 2006 Applied mathematical statistics. For engineers and scientific-employees (Moskow: PhysMathlit)