Analysis of the state of cultivation and harvesting of mung bean and agro-biological requirements for threshing and separating its grain

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Abstract. Mung bean is one of the most important leguminous crops, and due to the increased demand in the market and the low demand for water in its cultivation, the area of Moss cultivation is expanding in Uzbekistan. Today, the area where mung bean is grown is more than 300 thousand hectares. With the increase in the area where mung bean is grown, the demand for the equipment used in harvesting it is also increasing. This creates the need to develop and introduce new technical means for mung bean harvesting. If we take into account that high-quality grain is obtained when mung is first harvested, dried, and then threshed, farmers and farms in our republic can thresh the mung crop without excessive mechanical impact on the mass to be threshed without damaging it. It is recommended to use a device that receives. In this case, the completeness of crushing and separating the grain should be at least 99%, the purity of the grain should be at least 96%, and the damage and destruction of the grain should not be more than 2%. For this purpose, it is desirable that the device has a combination of crushing and separation devices.

1 Introduction

Mung bean (Phaseolus aureus Piper or Vigna radiate (L) Wilzek) is an annual plant belonging to the butterfly species of the legume family (Lesominosol). The nutritional value of mung grain is high, it contains 24-28% protein, 8% lysine, 7% arginine, and its nutritional value is 1.5-2 times that of wheat and rye grains. is 1.5 times superior [1-4]. Mung bean is one of the oldest crops, it was cultivated 5-6 thousand years ago. Today, due to its nutritional value and moderate consumption, it is cultivated in large areas in India, Pakistan, Afghanistan, Iran,

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Burma, China, Vietnam, Japan, Africa, South American countries, as well as in Australia. In addition, mung bean is less demanding on water and naturally enriches the soil due to the accumulation of natural nitrogen in its roots [1-4].

According to the information of the World Food Organization (FAO), the volume of mung bean cultivation is increasing every year. 6.0 million last year. More than 100,000 tons of mung bean were grown, and Asian countries account for almost 90% of the harvest. India consumes most of the world's mung, which is why India accounts for more than 60% of the world's mung area. 1.3 million per year in India. tons of mung crops, followed by China (920 thousand tons), Myanmar (900 thousand tons), North Korea (600 thousand tons), Thailand (350 thousand tons), Indonesia (250 thousand tons), Pakistan (230 thousand tons), Uzbekistan (200 thousand tons) [5].

Among the Central Asian countries, Uzbekistan is the leader in mung cultivation and annual population consumption. In Uzbekistan, farmers and peasant farms are planting mung in the main part of the fields that have been cleared of grain, in order to get a double harvest from the land, to plant a repeated crop, to earn additional income and to improve the fertility of the soil [1, 2].

When cultivating mung bean, various technical means are used, including from ground-based techniques to flying vehicles [6-14].

The resulting mung bean grains are used as food, and the stems are well used as roughage. To improve the palatability of stems by animals, various equipment for grinding and preparing feed have been developed [15-23].

The mung bean is formed inside the pods, and the pods are formed alternately from the bottom to the top of the mung stem. For this reason, not all crops ripen at the same time. According to many years of observations, 20% of the pods located at the bottom of the stem are the first to ripen, 60% of the pods in the middle part ripen next, and 20% of the pods in the top part of the stem are underripe, and some are more. will be in k case. It is impossible to harvest mung after all the crops have ripened. The reason is that if the crop at the tip of the stalk is left to ripen, the pods at the bottom will open and the grain inside will be scattered. Therefore, when 80-85 percent of mung pods are ripe, they start harvesting them. There is another aspect in this, as soon as mung beans are ripe, the moisture in its stems and branches is high. That is why harvesting mung requires a special approach [3, 4].

2 Materials and methods

The current state of mung cultivation in Uzbekistan was formed based on the information of the Ministry of Agriculture and the State Statistics Agency. Data from 2015 to 2022 were obtained. The obtained data were divided into the area of cultivated mung and the gross harvest harvested in the same year, and they were presented in a diagram.

Mung harvesting methods were carried out on the basis of analysis of different methods used in mung harvesting around the world, based on literature sources. In world practice, mung harvest is harvested directly in a combine harvester, two-stage, i.e. first mowed, then threshing in the field itself after drying, and three-stage, that is, the methods of harvesting, transporting to the threshing floor and threshing are used. These methods are carried out using grain harvesters, stackers, harvesters, transporters, threshers and other equipment [1-4].

The first method can be harvested when the moisture content is below 20 percent, and this method is mainly used in the USA and Australia, where the stems and other vegetative organs of the moss are treated with defoliants or desiccants to reduce the moisture content. After the stalks are completely dry, the crop is harvested directly with harvesters [1-4].

In the second method, the main part of mung pods is harvested when they are ripe and thrown in rows in the field. After a few days, when the harvest in the piles has dried and the
moisture content has dropped below 20 percent, it is threshed with grain harvesters or other crushing devices and the grain is separated [1-4].

In the third method, the main part of mung pods is harvested when they are ripe. But in this method, they are thrown in rows in the field, and after drying or harvesting, they are transported from the field to the threshing floor. If the crop is dry, immediately, if not, after drying, it is threshed with grain combines or other crushing devices, and the grain is separated [1-4].

The method of mung harvesting in Uzbekistan and the technical means used in it were determined by directly visiting the farms during the mung harvesting season, based on seeing the process and the information received from the farmers.

3 Results and discussion

In recent years, mung cultivation has been increasing in Uzbekistan. The main reason for this is that it is grown on a large area as a repeat crop after grain due to its short vegetative period and low water demand. Below is the current state of mung cultivation in Uzbekistan, an analysis of its harvesting techniques and requirements for mung harvesting.

3.1 The state of mung cultivation in Uzbekistan

In Uzbekistan, mung cultivation after grain began in 2010, and since 2015, it has increased rapidly. If in 2015, mung was planted on 47,000 hectares and 60,000 tons were harvested, in 2016, this figure was 60,000 hectares and 90,000 tons, respectively (Figure 1). In 2017, mung was grown on 82,000 hectares, and in 2018, on 97,000 hectares, and 114,000 and 143,000 tons of grain were harvested in both seasons, respectively. Due to the increase in demand for mung in the foreign market, especially in India, Bangladesh and China, the area planted with mung in 2019 increased sharply and reached 141 thousand hectares. This was done by planting repeated crops on the fields that were freed from grain. This year, the harvest was 230,000 tons, and the yield was the highest.

Fig. 1. Field of moss grown in Uzbekistan and gross yield charts.

By 2020, the mung cultivated area reached 193000 hectares, and 285000 tons of grain were harvested this year. In 2021, the cultivated area of mung increased by 1.3 times and reached 250 thousand hectares, and in 2022 this indicator increased by 1.13 times to 284 thousand hectares, and the amount of mung grain harvested in these years increased even
more, reaching 305 thousand and it was 326 thousand tons. In 2023, more than 300,000 hectares of mung were grown.

It can be seen that in recent years, the volume of mung cultivation in Uzbekistan has increased. The main reason for this is, on the one hand, the increased demand for mung grain, and on the other hand, due to the water shortage in Uzbekistan, farmers are switching to growing crops that require less water. However, with the increase in the areas where mung is grown, the demand for its harvesting techniques is also increasing. This creates the need to develop and introduce new technical means for mung harvesting.

3.2 The state of mung harvesting in Uzbekistan

In Uzbekistan, a two-stage method is widely used for harvesting mung. In this case, mung crops are cut from the roots. After they dry and the humidity drops below 20 percent, the mung stalks in three rows are stacked in one row. The piled mung crop is then threshed with combine harvesters or trailed threshers (Figure 2) [10; 19].

When mung is threshed in combine harvesters, grain breakage and stem damage are high, and fuel and other costs for harvesting the crop also increase. In addition, the lack of harvesters during the harvest causes the crops to perish in the rain [19].

Trailer threshers are also currently in short supply due to the fact that they are mainly imported. In addition, they have high indestructibility due to the fact that the grain cleaning part is not able to separate the grain, and at the same time, the stem part of the mung crop, which has a high nutritional value, is thrown on the ground without being collected.

![Image of mung harvesting](image)

**Fig. 2.** The method and means of mung harvesting in Uzbekistan.

These shortcomings of the above technical means are constantly emphasized by peasants and farmers, and they express their opinions to researchers-scientists asking them to find a solution to this problem.

Based on this, it was considered urgent to develop an energy and resource-efficient threshing device used for threshing mung crops and separating grain in the conditions of Uzbekistan, and research was conducted in this direction.
The development of a device that ensures high-quality harvesting of mung crops at low costs requires the analysis of the structure, technical description and technological work process of similar devices, and taking into account their achievements and shortcomings, the development of a device that meets the demands of farmers and farmers in Uzbekistan is enough.

In order to develop a more perfect and improved grain thresher that meets the above requirements, a comprehensive analysis of existing threshers and threshing equipment is required. This makes it possible to have more detailed information about their advantages and disadvantages and to develop a cutting-separating device that performs the work process in a qualitative manner with low costs.

For this purpose, various existing devices used for threshing and separating grains of grain crops were analyzed.

### 3.3 Brief overview of grain crushing and separation devices

Simultaneously with the development of threshing devices for threshing grains of grain crops, research was also conducted on the creation of devices for separating free grains from threshed straw, i.e. separators. Such separators were initially used in threshers, which were used to thresh the grain or seeds of crops collected from the fields and brought to the threshing floor. Later, they became the main working part of combine harvesters and corn harvesters, which collect the harvest at once. In addition, grain separators are used in many stationary machines used to separate the seeds of rice and legumes, desert plants and seed grasses, and hemp.

According to the technological scheme, devices that separate free grains from straw can be divided into two types (Figure 3) [24, 25]:

1. A straw shaker with a key that separates the grain from the straw by shaking;
2. A rotary separator that separates the grain from the straw.

The advantage of the separation device of the first type is that it does not overload the grain cleaning unit due to low energy consumption and no additional grinding of straw.

However, their main disadvantages are their low permeability, the need for a large working surface (1.5 m² for 1 kg/s of mass), the size of the dimensions, and the high degree of grain indestructibility.

1 – transporter; 2 – drum; 3.6 – biter; 4 – straw shaker; 5 – rotor; 7 – separator deck; 8 – a section of the crushing apparatus; 9 – impeller.
From the results of the previously performed scientific and research studies, it became clear that in order to separate the grain from the straw at the specified level at the productivity of the threshing machine of 1 kg/s, the keyed thresher should have a working surface of 1.5 m² [24]. But providing such a working surface in small grain thresher leads to an increase in its dimensions.

The advantage of rotor separators is determined by their relative productivity and high grain separation. Due to this, in them, the grain mixture rotates several times along the axis on the cylindrical surface, and the processing distance increases, and the process of grain separation accelerates. This ensures proper separation of grain from chaff even in their small size. In addition, the rotor thresher, due to their active influence on the straw mass, also crush the unthreshed grains in the straw.

The main disadvantage of the rotor separators is the overloading of the grain cleaning part due to the large energy consumption and the high level of straw crushing.

The first type of grain separating devices includes the MV-2.5A grain separator, the keyed thresher of grain harvesters such as Don-1500, Enisey-1200, SK-5 "Niva", Klaas "Dominator-130", and the second type includes IRRI-AFT, The SM-72 grain harvester and Case-2366, Vayt-9700, Klaas "Leksion" grain harvester rotor separators can be given as an example.

The grain separation device of the Klaas "Dominator-130" combine harvester is similar to the grain separation device shown in Figure 3, a, and the grain separation device of the Case-2366 combine harvester is similar to the grain separation device in Figure 3, b.

In this case, the grain mass is transferred to the threshing machine 2 through the conveyor 1. The threshing machine grinds the grain and separates a part of the grain, and the rest of the grain together with the straw is delivered to the keyed straw shaker 4 using the return biter 3. In a straw shaker with a key, the free grains in the straw are completely separated.

In rotor threshing-separating devices, the grain conveyed through the conveyor 1 is crushed in the threshing part of the rotor 5 8, and a part is separated here. The remaining grains are separated in the separator part 7 of the rotor. When the straw is removed from the separator with the help of the throwing biter 6, the grain is delivered to the rotor through the shovel receiver 9.

As mentioned above, the disadvantage of straw shakers with keys is the low efficiency and low degree of separation of grains in the straw.

### 3.4 Requirements for threshing and sorting devices

In general, mung harvesting can be done in special open or closed areas with electricity, by driving the device with an electric motor or in field conditions by driving the tractor.

The productivity of firewood is from 5 s/ha to 40 s/ha, the stems are 0.5 m to 1.5 m long. The humidity of the stem of all types of crops harvested in the device should not be higher than 20%, and the humidity of the grain should not be higher than 18%.

The device must provide the following basic quality indicators when harvesting mung crops:
- crushing completeness is at least 99 percent;
- breakage and damage of grain maximum 2 percent;
- completeness of separation of free grains separated from beans is at least 99 percent;
- purity of threshed grain is at least 96 percent;
- grain perishability is maximum 2 percent;
- the degree of crushing of stems is less;
- the circuit breaker must work without jams and interruptions during operation.
4 Conclusion

In 2010, Uzbekistan began to grow mung on a larger area, and after 2015, attention to its cultivation increased, and now the area under mung cultivation has reached more than 300,000 hectares. With the increase in the area where mung is grown, the demand for the equipment used in harvesting it is also increasing. This creates the need to develop and introduce new technical means for mung harvesting. It is recommended to use a threshing device without excessive mechanical impact on the mass to be threshed in order to thresh the mung crop without destroying it and with less damage in the farmers and farms of our republic.

For this purpose, it is desirable that the device has a combination of crushing and separation devices.

References

6. A. Tukhtakuziev, Sh. Ishmurodov, E3S Web of Conferences 390, 01039 (2023)
7. A. Tukhtakuziev, Sh. Ishmurodov, IOP Conference Series: Earth and Environmental Science 1231(1), 012055 (2023)
11. Igor Kovalev, Dmitry Kovalev, Komil Astanakulov, Valerya Podoplelova, Dmitry Borovinsky, Svetlana Efà, E3S Web of Conferences 443 06014 (2023)
13. Igor Kovalev, Dmitry Kovalev, Komil Astanakulov, Valerya Podoplelova, Dmitry Borovinsky, Zinaida Shaporova, Svetlana Efà, E3S Web of Conferences 390 03014 (2023)