

## Study on corn threshing and separating device with low damage

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**Abstract:** In the harvesting process of corn, the way of direct harvesting can effectively improve the efficiency of harvesting and economic benefits of corn industry. Therefore, in the future corn industry, the way of grain direct harvest is one of the main forms of corn industry harvest in China. However, in the actual corn harvesting process, there are many problems such as high corn grain crushing rate and unclean removal. The main reason is that there is a big gap between the performance and parameters of the corn harvesting machinery used in China and the advanced corn harvesting equipment, which can not meet the current corn harvesting demand in China. Firstly, this paper analyzes the problems existing in the current corn direct harvest mode in China, and finds out that the main reason restricting the promotion of corn direct harvest is the performance problems of the direct harvest equipment; secondly, it analyzes the working principle of the corn direct harvest threshing device and the working forms of several main corn threshing devices, and puts forward the optimal configuration design group of the low damage combined corn threshing and separation device. In addition, the optimal experiment of damage rate and degumming rate is carried out, and the combination mode of low damage combined corn threshing and separating device is determined, which can effectively improve the degumming rate of corn direct harvest and threshing work, and effectively reduce the damage rate of corn, etc. the application effect of its popularization and application can effectively improve the recovery efficiency and economic efficiency of corn direct harvest link in China. Benefit.

It is the key link to realize the mechanization of corn planting to implement the mode of direct harvest of corn in the harvesting link. Adopting the mode of direct harvest of corn can effectively reduce the intermediate steps in the harvesting link, greatly reduce the workload of the harvesting personnel, improve the efficiency of harvesting, improve the economic benefits of the corn industry, and also drive the surrounding areas based on this. The formation of a perfect corn industry chain is conducive to the optimization of industrial structure, so it should be actively promoted and applied in the future development of corn industry.

At present, our country pays more and more attention to the problems of agriculture, rural areas and farmers, especially for the mechanization of agricultural industry. We have invested a lot of resources from the aspects of human, material and financial resources as well as the research and development of relevant equipment. At the same time, we have also issued relevant preferential policies for the circulation of rural land, encouraging intensive and large-scale agricultural production mode, variety promotion, etc., for the investment of large-scale mechanical equipment. Under this premise, the corn industry adopts efficient and mechanized harvesting mode, which has become an inevitable development trend of the current corn industry development.

### 1. Analysis on the problems of corn direct harvest

Although the mode of corn direct income is popularized day by day in our country, there are still some problems in the actual production and application process, which restrict the popularization of the mode of corn direct income.

One is the lack of suitable corn varieties. In China, corn has a wide planting area, so there are many kinds of corn to be planted. However, there is no relevant research institution to research and

develop suitable varieties for corn direct harvest mode, coupled with the limitations of China's climate conditions and sowing mode, which makes the existing corn varieties in China can not meet the production needs of direct harvest mode.

The second is the shortage of corn direct harvest machinery. Although a high degree of mechanization operation is adopted in the process of corn direct harvest, most of the mechanization devices are still in the stage of experiment and promotion, which can not meet the requirements of large-scale promotion and application. At present, the corn direct harvest device being applied has the disadvantages of high grain damage rate and low production efficiency, which is difficult to meet the demand of China's corn industry scale.

The third is the lack of drying equipment suitable for direct collection mode. In the areas where the corn direct harvest mode has been used, there is a certain lag in the construction of supporting facilities of the mode. Not only the damage rate of corn remains high, but also the subsequent drying process mainly depends on the natural drying method. The drying efficiency is low and there is no supporting facilities such as matched drying room, which further aggravates the industrial losses such as mildew of damaged corn grains. It reduces the economic benefits of corn industry.

The fourth is the lack of corn varieties suitable for direct harvest mode. The direct harvest mode has higher requirements for corn varieties and water content of corn grains. However, at present, the water content of the corn varieties that we popularize and use far exceeds the water content requirements of the suitable direct harvest mode. In addition, the current cultivation mode shortens the growth cycle of corn, further improves the water content of corn grains, which is not conducive to the direct harvest mode.

## **2. Analysis on the working principle and device form of corn direct harvest device**

At present, the mainstream of corn kernel is mainly axial-flow threshing device. In this mode, the threshing device has better performance in improving the removal rate and reducing the damage rate, which can effectively improve the efficiency of corn direct harvest.

### **2.1 Analysis on the working principle of corn direct harvester**

At present, the threshing methods adopted by the widely used corn direct harvester can be generally divided into impact threshing, kneading threshing, comb brush threshing, rolling threshing and vibration threshing. Among them, the impact threshing mode mainly depends on the impact of the separation device, which destroys the connection between the corn grain and the main body, and its threshing efficiency is directly proportional to the impact frequency and strength of the device, but to a certain extent, its damage rate to the corn grain will increase; the rubbing threshing mode mainly uses the mechanical elements of threshing to increase the friction and collision with the corn grain. In this threshing mode, the main factors determining the threshing efficiency are the gap between the corn stick and the mechanical components and the number of fillers: the threshing mode of comb brush is similar to the kneading mode, which mainly depends on the close contact between corn and threshing parts, so that corn can complete threshing in the process of passing; the rolling threshing mode is through The mechanical components of threshing exert pressure on corn to complete the threshing of corn. In this threshing mode, it can produce less impact force, so it has less damage to corn. The last one is vibration threshing mode. The working principle of this mode is to realize the threshing process by using the vibration action of components in close contact with corn, which determines the effect of this threshing mode. The key factor of the rate is the frequency and amplitude of the vibration of the mechanical parts.

### **2.2 Common combination forms of corn direct harvesting and threshing device**

In the process of corn direct harvest, the use of threshing and separation device can effectively improve the threshing efficiency of grains and apply to a wide range of crops, so it has a wide range of application conditions. However, in the process of corn direct harvest, not only the efficiency of threshing should be guaranteed, but also the integrity of grains should be improved as much as possible to reduce the damage rate of grains. The key to solve this problem is to optimize or even

innovate the separation devices of Different Threshing forms. Currently, the combination forms of several widely used threshing separation devices are mainly shear flow type, axial flow type (transverse axial flow, longitudinal axial flow) and shear axial flow combination type.

1) The principle of the separation device of the cutting flow pattern is to use the cutting flow threshing device and the bond type Ligusticum chaser to complete the threshing and separation of corn grains. The specific working process is to input corn according to the tangent direction of drum rotation, and separate corn along the tangent direction of drum rotation after the threshing process. Taking such a threshing mode can effectively reduce the time of corn threshing and improve the threshing efficiency; however, there will be some disadvantages in this mode, and corn will enter the high-speed rotating drum. In addition, its separation function is weak, so it can not complete the separation work well, so special separation device is needed to complete the separation work.

2) The working principle of the axial-flow separation device is to design a special axial-flow threshing device. When corn enters the device, it will move from top to bottom along the spiral channel in the period, and at the same time, it will do a certain centripetal movement along the decreasing spiral radius in the process of this composite movement to achieve the threshing work. The threshing mode takes a long time, but the external force of corn is relatively uniform in the period, so its threshing effect is significantly higher than that of the cutting flow device, and the rate of grain damage will be significantly improved, its applicable crop types are more extensive, and it can also effectively complete the separation of grains and sundries, which has a relatively wide application prospect.

The corn threshing and separating device of axial flow type is divided into two kinds: horizontal and vertical axial flow. The basis for distinguishing is according to the difference of corn entering direction in the threshing process, in which the corn entering along the section direction of the threshing barrel rotation becomes the horizontal axial flow, and the corn moves according to the spiral and axial direction after entering. In this process, the threshing and the separation from the sundries are completed; the vertical The axial flow separation device is that corn is put in and moves axially in the drum along the axial direction of the drum. In this process, the removed grain enters the collection device through the drum hole, and then the separated debris moves axially in the drum and is discharged from the other end.

### **2.3 Structure and principle of threshing and separating device with longitudinal axial flow mode**

The main part of the vertical axial corn threshing and separating device is mainly composed of roller, top cover and concave plate. The drum in the threshing device can be divided into material input, threshing, separation and other parts according to different functions, and there are spiral parts set according to parameters such as the diameter of thresher in the drum, which are responsible for corn threshing; the top cover of the separation device has a spiral channel cast in advance according to the threshing needs to guide corn to move according to the specified route; finally, The intaglio of the separating device is divided into threshing concave and separating concave according to different functions, which are respectively installed at the front and rear ends of the separating device.

The specific working principle of the vertical axial flow corn threshing and separating device is to transport the corn brought by the conveyor to the material input part of the threshing device, and enter the threshing working part with the threshing concave inside and the external covering top cover; at this position, the corn moves axially and centripetally along the spiral channel, and then passes through the hammering and vibration of the mechanical parts of the threshing unit. In the way of operation, the threshing work is completed, and the threshed grains will enter the collection part of the threshing device along the cavity of the concave, and the rest of the sundries will continue to move along the axial direction of the roller. After reaching the discharge outlet, they will enter the special recycling device or be abandoned directly.

### 3. Verification and analysis of optimal parameter combination of vertical axial corn threshing and separation device

Based on the comparative test of the components of the vertical axial flow corn threshing and separating device with different structural parameters, the performance, the rate of threshing and the rate of breakage were analyzed, and the best combination mode of the vertical axial flow corn threshing and separating device was selected. It was determined that the right and straight round tubes should be the best, and the main body of threshing in the construction of this part In order to maintain a good rate of threshing and reduce the rate of grain damage, the design speed of the roller is not more than 300 rpm, and the most suitable threshing diameter is about 60mm, too high or too low, which is not conducive to the improvement of the rate of threshing. After obtaining the best combination mode of the vertical axial corn threshing and separating device, in order to obtain the specific working parameters of the device, several corn varieties were selected for experimental verification and analysis. In order to improve the intuitiveness of the experiment, a common vertical axial flow threshing and separating device is set as the control group. The separating parts of this device are mainly the threshing main body of the conventional grid concave and trapezoidal bar teeth. As a contrast, it is convenient to intuitively get the advantages of the combined vertical axial flow corn threshing and separating device in the rate of net removal and the rate of damage.

After determining the best combination mode of the low damage combined vertical axial corn threshing and separation device, the field threshing was carried out according to the same speed and material input as the conventional vertical axial corn threshing and separation device of the control group, and the integrity and the rate of threshing were measured after the threshing. It should be noted that in order to ensure the accuracy of the test results, we should select several groups of Maize Varieties with controllable size gap and small water content gap to verify and analyze.

The validation results of the optimal parameter combination of the low damage combined threshing and separation device are shown in Table 1.

At the same time, the validation results were statistically analyzed, and the test data of the optimal parameter combination of the low damage combined threshing separation device were analyzed, and the efficiency of the device in improving the rate of corn grain removal and reducing the rate of damage was obtained (see Figure 1 for the results).

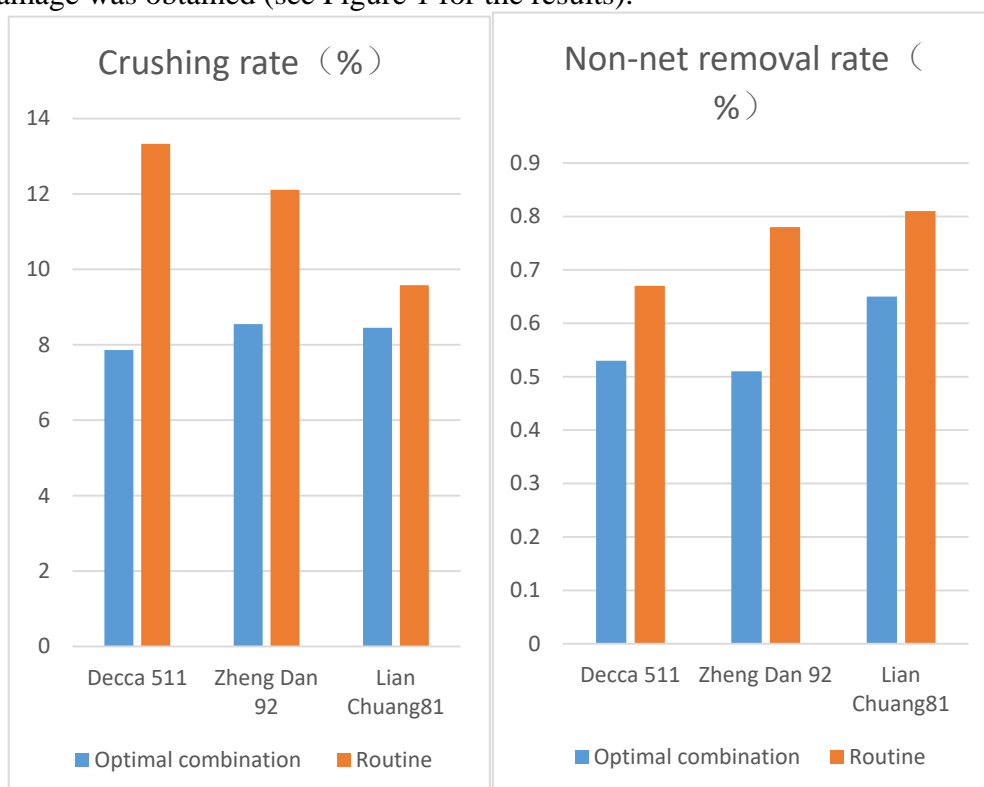


Figure 1 Validation and comparative test of optimal combination under different varieties

Table 1 Verification and comparison test results of optimal combination

Maize varieties	Test index	Optimal combination	Routine
Decca 517	Crushing rate /%	7.95	13.67
	Non-net removal rate /%	0.53	0.67
Zheng Dan 958	Crushing rate /%	8.67	12.28
	Non-net removal rate /%	0.51	0.78
Lian Chuang808	Crushing rate /%	8.62	10.13
	Non-net removal rate /%	0.65	0.81

From table 1 and Figure 1, we can draw the conclusion that in the experiment of different varieties of corn, the device with the optimal parameter combination of the low damage combined threshing and separating device can significantly reduce the damage rate caused by threshing compared with the conventional vertical axial flow corn threshing and separating device, and significantly improve the threshing and separating rate, which will be applied in the future It is expected to achieve better economic benefits.

#### 4. Conclusion

China is a big country of corn production, with a large corn planting area, and the trend of the whole process mechanization is becoming increasingly obvious under the current development prospect. Although we are also vigorously implementing the mechanization of corn production process, especially in the aspect of grain direct harvest, we have done a lot of work, but there are still problems of high moisture content, high damage rate and low dehydration rate of grains, which restrict the development of China The working efficiency of corn harvesting in China. Therefore, in the process of research, this paper makes a comparative analysis of the threshing and separation device, and finds out the best combination mode of the device that can maximize the rate of corn grain removal and reduce the rate of grain damage, that is, the combined threshing and separation device with low damage, which is mainly composed of round head nails, combined threshing intaglio plate and matched separation device. And through the comparative test and demonstration, the relevant data are obtained, which directly shows that the use of low damage combined threshing and separation device can significantly reduce the damage rate of corn seeds, improve its removal rate, effectively improve the efficiency of corn threshing, and help to improve the economic benefits of China's corn industry.

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