

Development of the Harvesting and Bundling Machine for Chives

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Abstract

Chive is a perennial plant with a strong growth capacity and can be cultivated in various ways. The mechanisation of the chive harvest is inadequate, with bundling operations relying mainly on manual labour. This results in a large workload and low efficiency. The chives harvesting and bundling machine is designed, which composed of the following parts, a blade harvesting device, belt transportation device, metering device, collecting device, bundling device, electronic control system, and a car frame. The machine we designed does not need a knot-tying mechanism, bundles quickly, has a simple structure, high reliability and low cost. After promotion, it can greatly improve labour productivity, reduce the labour intensity of vegetable farmers, and protect the income of vegetable farmers and growers.

Keywords: Chives harvester, Conveyor belts, Blade cutting, Crank mechanism, Bundling device.

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I. INTRODUCTION

Chives are a perennial vegetable that originates from China and is consumed throughout the year [1-3]. Chives are cultivated in approximately 5~6% of China's vegetable fields and are harvested 4~5 times per year [4-7]. The unique planting and growth characteristics of chives make the harvesting process labour-intensive, time-consuming, and costly. In some cases, farmers are unable to hire workers to harvest the chives, which negatively impacts their enthusiasm for planting chives [8-10]. This also hinders the development of the chives industry chain. It is important to find ways to reduce the cost of harvesting chives.

At present, most of the agricultural machinery related to chives on the market is mainly divided into single functions, such as harvesting, transportation, and final shaping, bundling, and packaging [11]. There is no integration process in between, which requires farmers to complete the harvesting process in steps. This increases operational costs and time required, and if different stages are carried out separately, it may lead to a decrease in the quality of chives as the process progresses. In addition, the current chives bundling machine requires a knotting action, which involves a complex mechanism and results in high cost and maintenance [12-24]. Therefore, the original intention of our design is to help farmers more efficiently complete the process of harvesting and bundling chives, saving labour costs.

II. Overall Scheme Design

The chives harvesting and bundling machine is composed of the following parts, a blade harvesting device, belt transportation device, metering device, collecting device, bundling device, electronic control system, and a car frame.



Figure 1: Schematic of the developed chives harvesting and bundling machine

Fig.1 illustrates the schematic of the developed chives harvesting and bundling machine. As can be seen from the figure, it is a semi-automatic integrated machine for harvesting and bundling chives. The blade harvesting device, located at the bottom of the front end of the main car body, for cutting chives along the roots. The belt transportation device, located at the upper part of the blade harvesting device, capable of gripping and fixing chives and transporting the chives upward to the bundling device. The metering device, located at the lower part of the discharge end of the belt transportation device, for collecting chives transported by the belt transportation device and slide the quantitative leaks into the collecting device. The collecting device, located at the lower part of the slide end of the measuring device, is used to keep the chives in a vertical or near-vertical state. The binding device, located at the upper part of the collecting device, can tighten the rubber hand on the chives in the collecting device. The discharging device, located at the lower part of the collecting device, can enable the finished chives to drop down from the collecting device to the ground. A control system is used for the action control of each motor.

III. The working principle of the chives harvesting and bundling machine

3.1 Device of Blade Harvesting

The device of blade harvesting comprises a cutting blade 1, a cutting drive motor 5, and a pair of straight-toothed bevel gears 2, as shown in Fig.2.

To cut chives, the main body of the vehicle is equipped with straight-toothed bevel gears 2 fixed through the bevel gear fixing bar 4, and a cutting drive motor 5. The bevel gears have an axle intersection angle of 90 degrees. The cutting blade 1 is affixed to the output shaft of the bevel gear 2, while the input shaft of the bevel gear 2 is connected to the output shaft of the cutting drive motor through a coupling. The cutting drive motor can rotate the cutting blade.

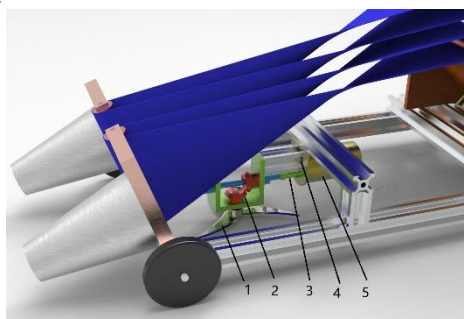


Figure 2: Device of blade harvesting

3.2 The Belt Transportation Device

The belt transportation device comprises two transport belts 2 of different lengths (720mm and 700mm respectively), a pair of front rollers 1, a pair of rear rollers 3, and two rear roller drive motors 4, as shown in Fig.3. The two front rollers are positioned vertically in the main body, while the two rear rollers are positioned horizontally. The ends of the transport belt are attached to the front and rear rollers, and the other ends are attached to the other set of front and rear rollers. The shafts of the two rear rollers are connected to the rear roller drive motors. The two rear pulleys are connected to the shafts of the two rear pulley drive motors. The belt transport device clamps and fixes the chives during cutting and transports them upwards to the bundling device after cutting is complete.

The gap between the two belts in the belt transport unit can be adjusted by modifying the distance between the front and rear pulleys.

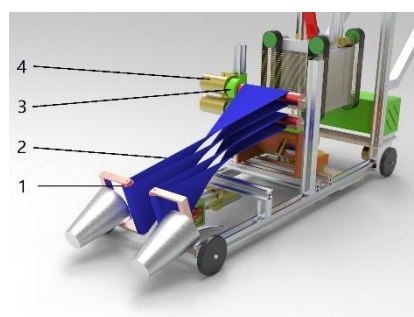


Figure 3: The belt transportation device

3.3 The Metering, Collecting and Bundling Device

The metering device comprises a sliding platform 7, a metering plate 6, and a metering plate drive motor. The sliding platform is fixedly mounted on the main vehicle body. The metering plate can be horizontally rotated above the sliding platform, and the metering plate drive motor can rotate the metering plate. The metering plate and sliding platform can selectively create or release the collection space between them. When the collected chives do not reach the required amount, the collection space is formed. Conversely, when the collected chives reach the required amount, the collection space is released, causing the chives to slide down to the collecting device 8 for the bunching.

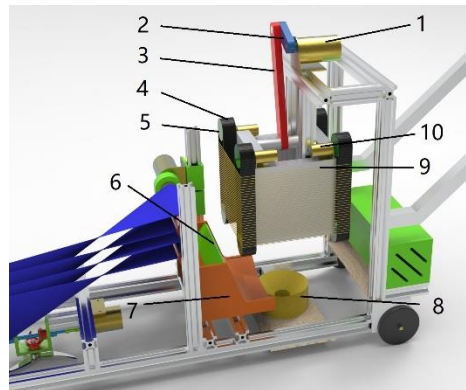


Figure 4: Chives binding machinery device

The bundling device comprises four rubber band transport belts 4, each mounted on two belt wheels 5. The upper four belt wheels are connected to the four rubber band transport belt drive motors 10 with one-to-one corresponding transmission. The lower four belt wheels are mounted on the bracket. Additionally, the device includes a crank slider mechanism and a bundling device drive motor 1. The crank slider mechanism drives the bracket, which moves vertically. The rubber band transport belt has a groove on the outside, and the rubber band is tightened onto it. When the rubber band reaches the lowest end of the lower pulley, it automatically falls off and tightens on the chives in the collecting device.

IV. Application and Prospect

At present, with the adjustment of the agricultural industry structure and the development of agricultural technology, agricultural production is facing new challenges and opportunities. Traditional agricultural planting methods often rely on manual labor, resulting in high labor intensity and low efficiency. Farmers need to invest a considerable amount of time and effort in the cultivation, harvesting, and processing of chives. Mechanized operations offer a solution to the prevalent issues of heavy reliance on manual labor, large workloads, and low efficiency in the post-harvest processing of chives [25]. This has the potential to improve the overall efficiency of agricultural production, alleviate the labor pressure on farmers, enhance the quality of chives, and consequently increase farmers' income levels. Fig.5 illustrates the developed prototype of chives harvesting and bundling machine.



Figure 5: The prototype of chives harvesting and bundling machine

After being promoted, it can significantly enhance labour productivity, decrease the labour intensity of vegetable farmers, and safeguard the income of both vegetable farmers and growers.

V. CONCLUSION

There are limited practical options for harvesting and bundling chives, as most bundling machines require complex and costly knotting mechanisms. Therefore, we have designed a semi-automatic machine for harvesting and bundling chives. The machine adopts a crank slider mechanism, conveyor belt, and rubber band to achieve automatic bundling of chives without the need for a knot-tying mechanism. It is characterized by rapid bundling, simple structure, high reliability, and low cost.

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