Research on the Design of Cutting Table Mechanism of Leafy Vegetable Harvester Based on Computer Technology

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Abstract. In view of the fact that vegetable harvesting in my country is still manual harvesting, with large labor force and low efficiency, a universal harvesting machine for stem and leaf vegetables has been developed. This machine has the advantages of simple operation and high efficiency. This article focuses on the machine design, working principle and technical situation of the harvester for stem and leaf vegetables. The modified machine has been verified by practice and realized the predetermined design function.

Keywords: Leaf and Stem Vegetables, Harvester, Design, Computer Technology

1. Introduction

My country is a large vegetable production country. With the adjustment of the rural industrial structure and the development of the vegetable industry the demand for vegetable production machinery is increasingly urgent [1-3]. In recent years, facility vegetable production has spread all over the country, major breakthroughs have been made in vegetable seeding and transplanting technology, and irrigation and plant protection technologies have advanced by leaps and bounds [4-5]. However, the mechanization of vegetable harvesting has progressed slowly, especially the mechanization of leafy vegetable harvesting. It is blank [6]. In 2008, the sown area of vegetables increased to 1.864×107hm², and it increased at a rate of 7% every year. Among them, the sown area of leafy crops was 6.057×106hm², accounting for 32.5% of the total sown area, and the output accounted for 30.5% of the total vegetable output [7-8]. With the rapid development of my country’s economy, the general public’s demand for fresh vegetables has increased year by year and the prices of fresh vegetables in some provinces and cities remain high, and the supply is in short supply [9-10]. The main reason is that vegetable farmers can’t put vegetables in the field in time. reward. In the entire production process of leafy vegetables, harvesting and processing operations account for more than 60% of the total labor volume. The quality of harvesting operations directly affects the storage, processing and sales of vegetables, thereby affecting market prices and economic benefits. Due to the complexity of harvesting operations, the degree of automation of harvesting operations is still very low. At present, domestic leafy vegetable harvesting operations are mainly done manually, requiring laborers to bend over constantly, which is labor intensive. Therefore, it is of great significance to
develop mechanized harvesting technology and research and develop leafy vegetable harvesting machinery.

2. Overall structure design
This research combines the development trend of leafy vegetable harvesters at home and abroad, condenses scientific issues from the key technology of leafy vegetable harvester design and manufacture that meets my country’s national conditions, and adopts theoretical research, a combination of law exploration and experimental verification, and cutting-edge technology research. Combining engineering application demonstrations, concentrating and integrating the respective advantages of scientific research institutes and equipment manufacturing companies, to carry out research on the key scientific theories and core design and manufacturing technology of leafy vegetable harvester design and manufacturing. The research results will directly promote the mechanization of vegetable harvesting in my country. The overall technical route is shown in Figure 1.

![Figure 1. Overall technical route](image)

2.1. The structure of leafy vegetable harvester
The objects harvested by this machine are stem and leaf vegetables. It is mainly divided into vegetable harvesting part, vegetable collecting part and walking control part. The overall design plan is shown in Figure 2. The specific components are divided into: operating handle bar, vegetable collection box, rear fixed wheel, engine, variable speed gear box, blower system, cutting gear box, cutter, frame, front floating wheel It is composed of 10 components.
2.2. **Working principle of vegetable harvester**

The harvester is equipped with two cutting devices with and without roots. When used for harvesting with roots, install the harvesting device with roots, and the single-acting cutter is driven by the vegetable cutting motor for reciprocating plane movement; when used for harvesting without roots, When roots are harvested, a harvesting device without roots is installed, and the cutter motor drives the upper and lower cutters to reciprocate through two cutter eccentric wheels. The harvester cuts the vegetables during the forward process, and the cut vegetables are constantly pushed by the vegetables in front, and pushed along the mesh transition plate to the two vibrating rods, and the soil entrained when passing through the mesh transition plate is vibrated. The vegetables are transported to the endless belt conveyor at the same time; due to continuous harvesting, although the center of gravity of the vegetables tilts forward, they will not fall forward due to being pushed, and they will be transported to the rear end of the conveyor in an orderly manner, and the conveyor will pass through a The reducer and belt drive continuously send the vegetables that fall in an orderly manner to the collection device. The technical parameters of the equipment are shown in Table 1.

**Table 1.** Main parameters.

| The main parameters                  | Numerical value |
|--------------------------------------|-----------------|
| Operating ability/(hm² • h⁻¹)        | 0.35~0.4        |
| Harvest rate/%                       | ≥95             |
| Cleanliness/%                        | ≥90             |
| Supporting power/kW                  | 18              |
| Driving speed/(m • s⁻¹)              | 0.2~0.3         |

2.3. **The structural design of the machine tool**

(1) Design a horizontal cutting knife with adjustable height and angle to achieve the purpose of high efficiency and carpet cutting. In order to adapt to the realization of carpet cutting from the roots of leafy vegetables in different fields, the machine designed by this institute adopts horizontal cutting knives with adjustable height and angle, and each cutting knife realizes the angle and the angle according to the slope of the planting ground. Adjust the height and optimize the best cutting angle (Figure 3). The engine's power output is through the effective coordination of the speed-regulating gearbox, the crankshaft and the cam, and the cutting force and cutting frequency are reasonably output. This can ensure that the vegetables are cut neatly and the depth of the stubble is consistent. It is not only conducive to the neat harvest of vegetables, but also convenient for farming. Block follow-up.
The wheeled walking mechanism is designed to meet the requirements of field operations with different widths, and the distance between the walking wheels is convenient and adjustable. Since the leafy vegetable planting mode is ridge planting, the harvesting method must be one ridge one harvesting. It is necessary to ensure the straight line of the leafy vegetable harvester. Therefore, this puts higher requirements on the design of the walking chassis. The walking wheel designed in this study is floating and adjustable for the front wheel, which can be automatically adjusted up and down according to the flatness of the field, so as to ensure that the vegetables are cut neatly when the machine is working, and it also plays a beneficial role in protecting the cutter. Due to the use of guide wheels, the implement can be flexibly adjusted according to the straight line requirements of the ground ridge during the traveling process, so as to ensure that the traveling wheel of the implement is always kept in the ditch. In order to meet the agronomic requirements of different crops, the wheel center distance designed by this machine is adjustable.

Design the parallel control system of the landing gear of the conveying device and the fine-tuning device to realize the height adjustment of the conveying device and the cutting knife. The flexible field steering of leafy vegetable harvesters and the convenience of running on flat ground are a bright spot in the development of modern vegetable harvesters. The designed parallel control system of the landing gear of the conveying device and the fine-tuning device can realize the adjustment of the height of the harvesting device so that it is off the ground. This system makes the equipment travel more flexible, the field U-turn is faster, reduces the driver's operation difficulty, and improves the work efficiency of the equipment.

2.4. Design verification and improvement
The research and development of this project embodies the full integration of production, education and research. The design work is jointly completed by the agricultural department organized by the scientific research institutions and Nantong Fulawei Agricultural Equipment Co., Ltd., using mature technology. The processing of the parts comes from the Fulawei company and machinery processing enterprises with advanced equipment and complete quality assurance system in Jiangsu and Zhejiang to ensure the quality of the parts. However, in the actual trial production and field trials, some product problems were also exposed. Some improvements have been made in response to existing problems:

(1) The fan was originally selected from a fan produced by a Qingdao fan company. This fan has a simple structure, mature technology and low price. The test results show that this fan will be used when it is vertical. It brings inconvenience to the installation of the engine and the whole machine, and the material of the fan cover is cast steel, which is bulky, inconvenient to operate, and the wind pressure does not meet the requirements. For this reason, the design idea is changed, and the design according to the task book It is required to redesign the appropriate fan with the matching size of the engine specifications and related parts on the market, and ensure the size requirements through the
mold; (2) The prototype of the first round of design and manufacture is mainly used for the harvest of vegetables in the form of flat land planting such as spinach and cabbage. For vegetables growing on ridges (such as edible sweet potato leaves), this machine cannot be harvested. In order to improve the applicability of this machine, the ground wheel walking and adjustment mechanism has been improved to increase the range of its height adjustment, not only on flat ground. Harvesting can also be performed on the ridge, which broadens the use performance of the machine.

3. The main technical parameters and performance indicators of the machine

In this study, an ideal leafy vegetable universal harvester was obtained through the trial production test of 2~3 wheel prototypes, which can realize the carpet cutting of leafy vegetables. Its technology is leading in China, which can improve the level of mechanization of leafy vegetable harvesting in Jiangsu Province and accelerate the The integration of international advanced technology. The technical parameters and indicators of the equipment are as follows:

3.1. Technical indicators
Operating capacity: 0.33~0.40hm²/h; harvest rate: \( \geq 98\% \); supporting power: 18.4kW; driving speed: 0.2~0.3m/s.

3.2. Economic indicators
(1) The cost of mechanical harvesting is 60% lower than the cost of manual harvesting; (2) The operating efficiency is more than 50% higher than the efficiency of traditional machines; (3) The annual production capacity is 300 sets; (4) The development of a universal harvester for leafy vegetables. The operating procedures and related standards.

4. The harvest test of leafy vegetables

On June 19, 2013, the performance test of the stem and leaf vegetable harvester was carried out at the vegetable planting base of Wenming Village, Haimen Town, Haimen City, Jiangsu Province. The greenhouse covers an area of about 0.04hm², with a specification of 8m \( \times \) 50m. The harvested variety is cabbage, the overall harvest is good, the stubble is neat, and the height is 3~5cm. During the harvesting process, the damage to the stems and leaves of the cabbage is small, the use is flexible and the operation is convenient. However, some problems have also been exposed: First, the harvesting form of this harvester is disorderly harvesting, and the harvested vegetables are disorderly and disorderly, and the follow-up work of vegetables is very large. This problem is determined by the structure of the machine. If you want to meet the orderly harvesting, the structure of the machine should be further improved; the second is that the machine is harvested on flat ground, and the walking wheel is walking in the vegetable field, not in the ditch. The early stage of the greenhouse planting did not consider mechanical harvesting, . When planting, it is planted in pieces, and there is no ditch for the machine to walk. When the machine is walking in the vegetable field, the field itself is not flat, and the wheel sometimes rolls on the cabbage, which brings certain difficulties to the machine to walk, so if you want to consider Use the machine to harvest, then in the early stage of vegetable planting, the ditch should be reserved for the machine to walk when harvesting.

Computer technology big data analysis and calculation formula:

\[
AT(i, j) = \sum W_{CD}(i, j) \cdot \frac{TD}{UD} \tag{1}
\]

\[
W_{CD}(i, j) = \frac{tp}{RBW} + RTT + FS \tag{2}
\]

In the above calculation formula, \( tp \) represents the transmission parameter, RBW corresponds to the transmission bandwidth between resources, RTT represents the network delay, FS represents the
time required for format conversion, and TD corresponds to the data size, Between resources $R_{i}$ and $R_{j}$ in $W_{CD}[i,j]$, and the communication time corresponding to the UD data block.

After several tests, the overall applicability of the machine is still good. Regardless of the quality of the machine harvest, the height of the stubble, the damage to the vegetable stems and leaves, or the working efficiency of the machine, the convenience and flexibility of operation have fully reached expectations. Design goals. However, because the mechanized vegetable harvesting is a systematic project, the problem cannot be solved completely from the harvesting link alone. Therefore, in the beginning of the field planting, the harvest of machinery should be considered, to prepare for the subsequent harvesting work, so that the agronomy of vegetable planting and agricultural machinery can be fully integrated, only in this way can the machinery give full play to its performance and complete each harvest well jobs.

The use of wheeled rear-wheel-guided front-wheel drive chassis system facilitates the use of front-engine front drive, which makes the overall structure of the harvester compact, and can effectively ensure that the harvester runs in a straight line and does not deviate from the vegetable cultivation field. The horizontal cutting knife with adjustable height and angle is used to cut the leafy vegetables in a carpet style to ensure that the leafy vegetables are harvested clean; the horizontal cutting knife can be exchanged to enable the harvester to meet different harvest requirements while ensuring the harvest quality. Vegetables are harvested. The flexible field steering of leafy vegetable harvesters and the convenience of running on flat ground are a bright spot in the development of modern vegetable harvesters. The designed conveying device hydraulic landing gear and hydraulic fine-tuning device parallel control system realizes the height adjustment of the harvesting device and keeps it off the ground. This system makes the machine tool more flexible, reduces the difficulty of the driver's operation, and increases the efficiency of the machine tool.

5. Conclusion

The stalk and leaf vegetable harvester designed by this institute can complete the predetermined design function through preliminary tests, and realize the mechanized harvest of stalk and leaf vegetables. The harvesting efficiency is 0.33–0.40hm2/h, which is dozens of times that of manual harvesting, and the machine has the advantages of simple structure, convenient operation and maintenance. The design and research of this machine is of great significance for improving the efficiency of vegetable harvesting, reducing labor intensity, promoting the process of mechanization of vegetable planting, and accelerating the progress of my country's high-efficiency facility agriculture.

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Design of a bundling mechanism for vegetable harvesting machinery(2020KJ12).

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