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Design of Intelligent Header for Longitudinal Axial Flow Corn Combine Harvester

Changzhong Wu[1],[*], Fan Ge[2], Guangchao Shang[1], Guitao Wang[1], Mingpeng Zhao[1], Liang Wu[1], Hengshuai Guo[1]

[1]School of Mechanical Engineering, University of Jinan, 250022, China

[2]Qilu Normal University, Jinan, Shandong 250013, China

[*] Corresponding author's e-mail: me_wucz@ujn.edu.cn

Abstract: The header is the core part of the corn harvester. This time, the main theoretical components of the header are systematically analyzed and designed to provide a basis for the manufacture of the corn harvester. The header part includes a grass divider, a stem pulling rod and a clamping conveyor chain. Stick picking is a key component of the ear picking device of a corn harvester. Therefore, it is very important to study the relationship between the movement state of corn stalks between pick sticks and the structure and movement parameters of ear picking.

1. Introduction

In recent years, the rapid development of science and technology in my country, increasing mechanization and reducing labor has become a development trend, and agricultural machinery has also received attention[1]. As a large-scale, fast and accurate agricultural machinery, the combined corn harvester solves the problems encountered by farmers during the harvest season, reduces losses, helps farmers out of poverty, and brings great benefits to economic development. Corn harvesting is a key step in food production . In recent years, it has become more and more human-machine interactive, which requires the increasing degree of mechanization of corn production[2]. The improvement of the degree of mechanization is mainly reflected in the following aspects of manual conversion to mechanization: seeding, fertilization, plant protection, and grain harvesting. The focus is on using machines to harvest corn ears and automatic corn peeling.

2. The Overall Design of the Header

When the corn combine harvester is working on a large area of land, the ground is inevitably uneven. The header is the first part of the automatic corn harvester that touches the corn crops, and it is also a key part of the harvester. The cutting head is located at the forefront of the corn harvester. It is connected to the tractor by a screw connection through a front suspension of a certain size. It is equipped with a special hydraulic cylinder to control the lifting of the cutting head to adapt to different terrains and different corn varieties. The purpose of adjusting the upper and lower spacing of the header is to make the corn harvester equipped with it able to adapt to different corn scion positions. At the same time, it is also for the harvester to quickly pass through the pothole ground and stepped ground encountered during work operation. Improve and improve. After design and modification, a distance of one decimetre above the ground can allow the header divider to pass through. The row spacing can be adjusted by unscrewing the shaft sleeve bolt of the ear picking mechanism, that is, the sliding coupling sleeve can be adjusted left and right. After the adjustment, the bolts are tightened, and the spacing between 450mm and 700mm

after reloading can be adapted. Front-end header of the longitudinal axial flow corn combine harvester. In order to adapt to different corn varieties and complex geographical environment, the graduation header designed this time is a five-row header with a total width of 3000mm. The design turning radius of the header is about 1.5 meters, which can adapt to various topography and landforms for harvesting operations[3].
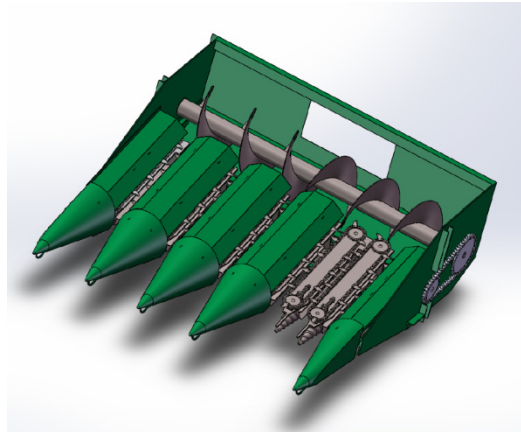

Figure 1. General structure

3. Line Spacing Adjustment Mechanism

In order to be able to adapt to different corn varieties and corn planting row spacing, the row spacing adjustment device is specially designed and installed on the header frame. The line spacing adjustment system is realized by the sliding between the mechanical track and the guide groove[4]. In order to realize the row spacing adjustment of automatic corn combine harvester, the header must be raised to the highest limit height before adjustment. The hydraulic system is used to control the upper and lower adjustment of the header. The automatic control of the hydraulic system can realize the uniform automatic adjustment of the header. The advantages of adopting the hydraulic system adjustment method are obvious, easy to operate, and can be accurately adjusted. From an economic point of view, the common equipment of hydraulic systems on agricultural equipment makes hydraulic equipment less expensive and has better economic performance. Therefore, the header designed this time uses a hydraulic control system to adjust the line spacing .

4. Part Design

After comprehensive assembly, the functional decomposition method in mechanical design is applied to each part of it, and modular thinking is used to decompose the longitudinal axial flow combined corn harvester header. The idea is: after the total function is determined, the sub-functions are determined, and finally the structural design of each part of the header is performed to achieve each sub-function.

4.1. The crop divider analysis and design

Corn crops with a growth range within a fixed distance are separated from the crops outside by the crop divider to form an effective working range. Under the action of the crop divider, the corn crops within the working area are collected onto the clamping and conveying device , So that corn stalks can be cut off and transferred in a subsequent cutting, as a means of improving efficiency [5].

By analyzing the effect of plant height, ear height, plant center of gravity and stem water content on the critical angle , the critical angle is most affected by the corn height, followed by the stem water content, ear height, and natural plant height, with the least impact Is the center of gravity of the plant. Through multiple experimental data collection, the critical angle of corn is distributed between 21° and 31°. The relationship between the critical angle a of corn plant breakage and the opening width *l* and height *h* of the crop divider is *tga=h/l*.

4.2. Rotating speed of the puller chain cutter shaft

The cutting method of the cutting knife equipped on the puller chain of the header part of the corn harvester is a typical unsupported cutting, so it has a higher linear speed of the blade end. After a large number of practical application experiments and theoretical research experiments, it can be concluded that when the cutting blade is chopping corn stalks, the linear velocity of the blade end of the moving blade should be above 30m/s.

In the operation of cutting the corn on the cutting table, the radius of gyration will change correspondingly with the different structures of the cutting blade. For example, when the radius of the crank of the hammer knife is r1, and the radius of gyration of the hinge point is r2, for example, its radius of gyration is R1=r1+r2. When the linear speed of the cutter end on the dial chain is V≥30 m / s can achieve a good shredding effect that meets the requirements.

4.3. Determination of blade inclination angle α

The determination of the inclination angle of the chopping blade is a very critical issue, because different cutting inclination angles can produce different operating stability forces, and also affect the working resistance of the corn harvester cutting head when cutting corn[6]. The actual use research shows that the relative sliding of the cutting blade can greatly save the cutting force of the cutting table, thereby saving power. In order to enable sliding cutting when cutting the corn stalk on the puller chain, the sliding cutting force T must be greater than the friction force F between the corn stalk and the blade itself, that is, T>F. Since T=Ntgτ (τ is the angle of sliding cutting); F=Ntgθ (θ is its friction angle), it can be concluded that a necessary condition is that when τ>θ, it is possible to produce a sliding cutting force when the cutter cuts corn stalks . A large number of experiments show that this angle is more conducive to cutting at 25-40°.

4.4. Calculation of ear picking device

The linear speed analysis of the reel chain and the linear speed of the stalk pulling roller : when the harvester travels forward at a speed, the corn plants move at opposite speeds relative to the machine , that is, the linear speed of the reel teeth is parallel to the direction of travel of the machine When it is equal to the speed of the machine, it can best maintain the stability of the crop. In order to maintain the minimum impact force on the plant during operation, it is necessary to achieve that the speed of the plow chain parallel to the direction of travel of the machine is equal to the speed of travel of the machine.

The angle between the travel direction of the machine and the moving direction of the dial chain is generally 20 degrees to 25 degrees . Under normal circumstances, the common operating speed of corn harvesting is about 6.7 kilometers per hour, we chose 1.1 kilometers per hour at this time, and finally obtained the linear speed of the dial chain : V_b=1.1 m/s V_j=2.05m/s.

The linear speed of stem pulling is related to the effective length of the stem pulling roller, the speed of the grass chain and the length of the corn plant passing through the stem pulling roller . The diameter D of the stem pulling roller is determined according to the two conditions of grasping the stem without grasping the ear . Through theoretical calculation and experiment, it is obtained:D=85~95mm, select 95mm.

The gap between the stem pulling rollers is adjustable from 5 to 15 mm to adapt to the rolling of corn stalks with different diameters. Power consumption NZ=5.05kw , power consumption is small, to meet the power distribution needs of the whole machine.

4.5. Design of chain and sprocket

According to the working environment and structure, the load is medium impact and the working condition coefficient f1=1.4. Chain width: 21.6mm; pitch: 37.75 mm; roller diameter: 16 mm; inner chain plate width: 22 mm; pin diameter 9 mm; select C6 type long pitch roller chain. Choose the sprocket tooth profile radius R=20 mm; tooth thickness S=12 mm; tooth root radius r=8 mm; tooth width b=18 mm.

Power required for clamping and conveying: The power consumption is composed of three parts of power consumption: chain clamping to overcome friction, vertical elevation of corn stalks and horizontal conveying. After calculation, the required power for clamping and conveying is 2.0kw , and the power consumption is small, which achieves the ideal effect .

4.6. Analysis and design of the twisted dragon
The auger is a screw conveyor. The corn harvested crops are added from the feed inlet. The machine operates. During this process, the shaft moves and the spiral blade normal thrust acts on the corn crops. At the same time, the corn is forced to produce friction, where the force includes the friction from the spiral blades and the radial component of the thrust generated by the rotation of the shaft, which makes the corn rotate around the shaft diameter, but it is The rotation of the leaves is different, because the gravity of the material is related to the existence of the friction force of the trough. In addition to the radial component, the other axial separation acts on the crop to make it do along the trough Axial movement.

The blade of the spiral is generally made into a standard form, that is, the generatrix of the spiral surface is a straight line perpendicular to the axis of the spiral. The screw diameter is 400 mm, the pitch is 400 mm, the shaft diameter is 170 mm, and the power consumption is N=0.86 KW.

5. Conclusion
Based on the timely harvest of corn, the corn late harvest technology of different varieties of corn is studied. Focus on studying the structural parameters of the corn ear picking device, and determine the effects of the motion parameters such as the ear picking plate and the stalk pulling speed on the picking effect of the corn ear, so as to achieve better results under the premise of reducing the corn biting rate and the stem stalk breaking rate Ear picking effect. Through the optimized design of the header system, the harvest height of the header is reduced, and the adaptability of the corn harvester to late ear droop and straw lodging is improved. At the same time, on the basis of the existing grain combine harvester, through the research of the general technology of different crop headers, the wheat and corn are harvested, and the versatility of the harvesting machine is realized.

About the author
Changzong Wu (1977-), male, Weifang, Shandong Province, E-mail: me_wucz@ujn.edu.cn; Tel: 13698637583.

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