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Research status of Rice direct seeding device in China

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ABSTRACT

Aiming at the problems of rice seedling raising, transplanting and so on, low production efficiency and low mechanization efficiency, we popularize the rice direct seeding technology, through investigating and studying the development status of representative rice direct seeding machine in China, analyze its basic structure and working principle, and put forward the existing problems and development suggestions of rice direct seeding machine. Research shows that rice direct seeding technology has a broad development space in China. It is necessary to further optimize the design of key components such as seed metering devices and improve independent research and development capabilities to improve the versatility and efficiency of the rice direct seeding machine, so that China's rice direct seeding technology can Rapid development.

Keywords: Rice direct seeding technology; seed metering device; development status; structure and principle

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Introduction

In the 1990s, China's rice output increased rapidly, and it became one of my country's main grain crops. The annual planting area is $3\times10^7 hm^2$, and the rice output accounts for two fifths of the country's total grain output. In all aspects of the mechanization of rice production, the most difficult is the mechanized cultivation of rice. The mechanization level of rice planting is low, which is far from the level of mechanized planting of major food crops such as corn. This situation seriously restricts the output of rice and the level of agricultural mechanization in my country. Therefore, the level of mechanized rice direct seeding needs to be greatly improved.[1-2]

The traditional rice planting technology is to complete rice planting by raising seedlings, pulling seedlings, transporting seedlings and transplanting, which requires complex mechanical varieties and requires multiple processes to complete, which greatly reduces the efficiency of rice planting and increases the labor intensity of farmers. In order to improve the efficiency of rice planting and reduce the labor burden of farmers, rice direct seeding technology has been vigorously developed in recent decades. At present, the United States mostly uses mechanical air spreading, and each aircraft can sow $66hm^2$ per day. Japan uses mechanical spreading and side strip fertilization technology, which saves one-fifth the cost of traditional rice transplanting and can also improve fertilizer utilization. China's rice direct seeding can be divided into mechanical water direct seeding and mechanical drought direct seeding. Water direct seeding is mainly applicable to the south, and drought direct seeding is mainly applicable to the north. Most drought direct seeders are modified from wheat seed drills.[3-4]

Rice mechanical direct seeding technology is a rice planting technology. Rice direct seeding can greatly reduce the time used for rice planting, save labor, reduce the labor burden of farmers, and improve the efficiency of rice planting. This technology eliminates multiple steps in the rice transplanting planting method, sowing rice seeds directly in the land, so that the rice planting process is greatly reduced, and the mechanized direct seeding of rice can greatly save energy and compare with machine transplanting Reaching water resources is an ideal method for rice cultivation.[5]

The rice direct seeding machine can be divided into three types according to the different seeding methods: mechanical, pneumatic and vibrating.[2]

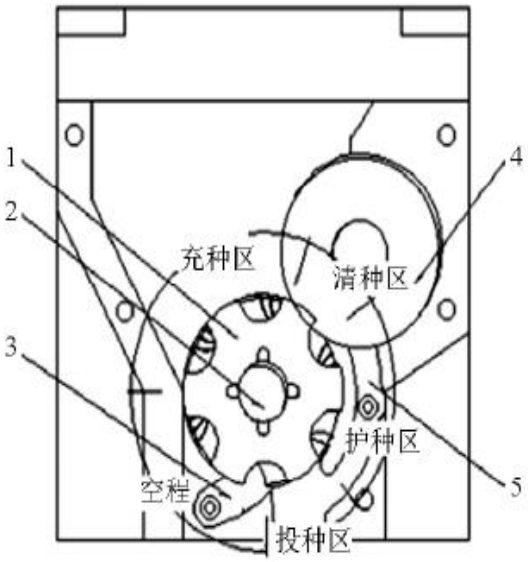
In this paper, the paper introduces the seeding apparatus of mechanical, pneumatic and vibrating rice direct seeding machines, and analyzes their basic structure and working principle.

Development status of seeding machine for mechanical rice direct seeding machine

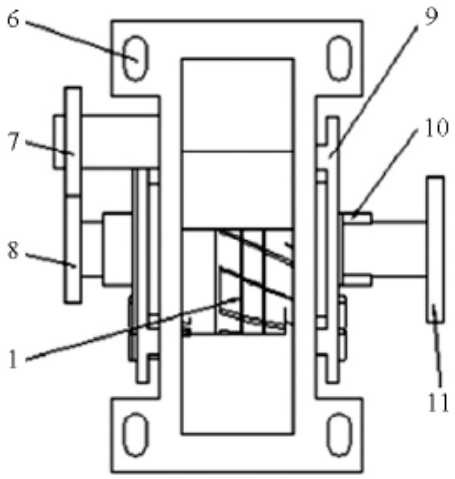
The mechanical rice seeding machine seed metering device can be divided into outer groove wheel type rice seed metering device, horizontal disc type seed metering device, belt type seed metering device and finger clip type seed metering device. According to the different shape of the groove wheel, the outer groove wheel seed metering device can also be divided into inclined groove type seed metering device, straight slot type seed metering device and toothed seed metering device.[6] By using the EDEM, Xu Hao and others obtained the shape of slot hole, spiral angle of slot and working speed of slot wheel.Nowadays, agricultural operations require fine seeding, so the straight-groove seeder is not suitable for mechanized direct seeding of rice, and the straight-groove seeder has pulse phenomenon and uneven seeding.Therefore, he Liannan and others designed rice and wheat with spiral groove type seeding device, Xu Yonglei and others designed spoon type rice direct seeding machine, Li Lanlan and others designed slide type hole wheel type rice precision seeding device[7-11]

In this paper, a spiral-slot rice hole seeding device was designed by Tian Liquan and others[12]For example to introduce. The seeding

device is mainly composed of spiral groove seeding wheel, clear seed rolling brush, elastic seed protection arc plate, push seed scraping piece and so on. Its structure diagram is shown in Fig .1. The working principle is that the rice bud seeds fall into the seeder by the seed box and fill it to complete the filling process, the rice bud seeds rotate around the spindle to reach the seed clearing area under the action of spiral groove wheel rotation, and under the action of clear seed rolling brush, the excess seed removal is retained in the seed filling area for the next seed filling, and under the action of groove wheel rotation, the rice bud seeds enter the seed protecting area, and the elastic seed protecting board can not only ensure that the bud seeds do not get out of the spiral groove to reach the seed casting area smoothly, but also can not damage the bud seed because of the fixed gap between the seed protecting board and the groove wheel. Finally, the rice bud seeds discharge the seed drainer under the push of the seed scraping piece in the seed casting area.



（a） Main view



(b)Top view

Figure 1 Spiral seeding apparatusStructural schematic diagram. 1. spiral groove seeding wheel 2. spindle 3. push and scrape piece 4. clear seed roll brush 5. protect seed arc plate 6. upper assembly hole 7. clear sprocket drive sprocket

MALEKI and so on also designed a kind of spiral groove seeding device[13-14]The optimum combination of diameter, width and depth of spiral groove is determined. The seeding uniformity is better, but the hole formation is poor,It is difficult to realize precise acupuncture sowing.

A case study of horizontal disc seederning device for rice direct seeding machine with small amount of rice and so on[15]Introduction. The seeder is mainly composed of seed barrel, seed pusher, horizontal disc, seed discharge axis and other components, and its structure schematic diagram is shown in figure 2.

Its working principle is that when working, rice seeds are filled into the seed cylinder under the action of gravity and fill the holes in the horizontal disc. The bevel gear on the horizontal seeding shaft meshes with the bevel gear on the vertical seeding shaft to transmit power to The horizontal disk installed on the vertical shaft of the seed row drives the rice seeds in the seed bucket to rotate, and the seed scraper scrapes off the excess seeds on the type hole, so that the rice seeds filled in the type hole reach the next seeding port. The double action of the seed device and the gravity of the rice seeds enters the next seed port to complete the seeding operation.

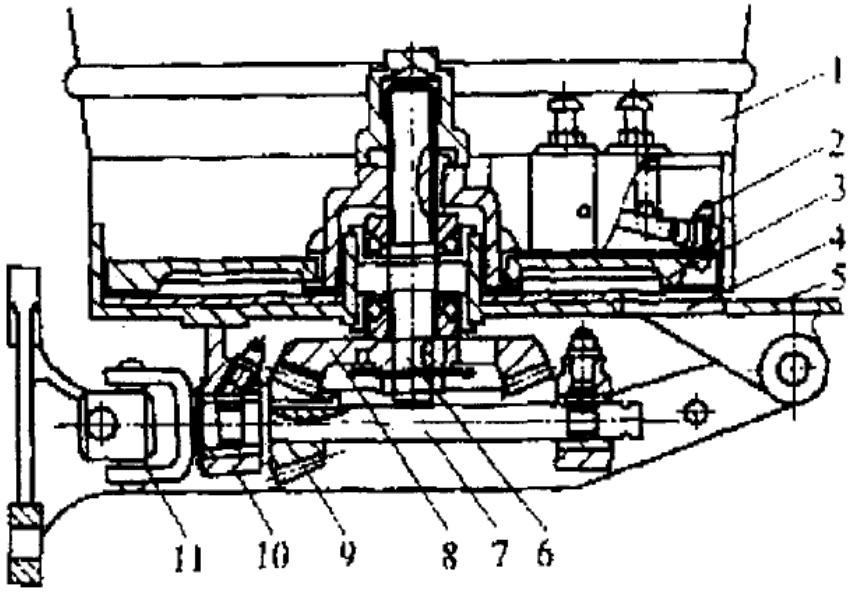


Figure 2 Horizontal disc seeding deviceStructural schematic diagram. 1.seed barrel 2. push seeder 3. horizontal disc 4. lower seed mouth 5. base 6. row vertical axis 7. horizontal row vertical axis 8. bevel gear 10. support 1 1. universal joint shaft

A case study of rice belt seeding device designed by Xu Jialiang et al[16]Introduction. The seeding device is mainly composed of seed box, seeding belt, inoculation funnel, seed filling partition board, and main and follower roller, etc. The structure diagram is shown in Fig .3.

The belt seeding device uses a special seeding belt with the shape of rice bud on the surface specially made of flexible material. The seeding belt is mounted on the main and follower rollers, and the angle between the installation direction and the level of the seeding belt is larger than the accumulation angle of rice seeds. Under the action of gravity and inertia, rice seeds will be thrown into the inoculation funnel and then discharged by the seeding tube to realize the whole process of seeding. The results show that the natural accumulation angle of rice seeds is 45°, and when the dip angle of sowing belt is within 47°~65°, the filling effect is the best.

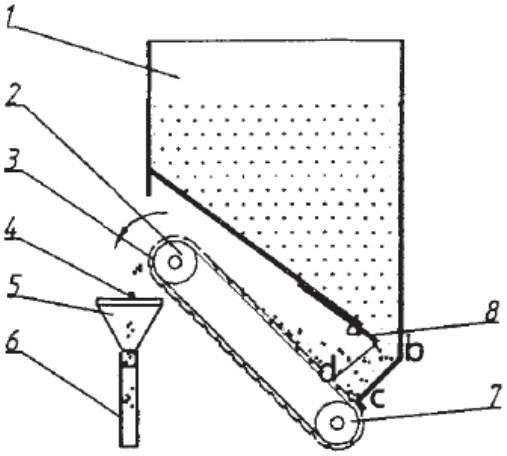


Fig .3 Type metering deviceStructural schematic diagram. 1.seed box 2. Active roller 3. Sowing belt 4. Rice seed 5. Inoculation funnel 6. Sowing tube 7.the driven roller 8. filling partitions

The invention relates to an ejector ear spoon type rice precision hole direct seeding device designed by Tian Liquan and the like[17]For example to introduce. The seeding device is mainly composed of seed box, ear spoon, rotating disc, cleaning brush, seed guide roller, seed feeding tube and so on, as shown in Fig .4.

The seeding shaft drives the rotating disk to rotate clockwise. The seed pick ear spoon installed on the rotating disk is driven to rotate to scoop up the rice seeds. When passing through the seed cleaning area, the unstable seeds at the edge of the ear spoon will be cleared The brush is swept into the seed filling area for the next seed filling. The seeds in the middle of the ear spoon will continue to rotate with the ear spoon. When the seed guide area is reached, the seed pick ear spoon will take the seed under the action of the seed guide roller The hinge of the ear spoon and the rotating disk is the center of rotation and rotates backward. The torsion spring connecting the ear spoon and the rotating disk accumulates. When the top of the ear spoon exceeds the seed guide roller, the role of the ear spoon in the torsion spring It rotates rapidly downward and finally contacts the stopper. The rice seeds in the ear spoon are ejected from the seeder through the seeding tube due to the combined effect of inertial force and centrifugal force to realize the seeding operation.

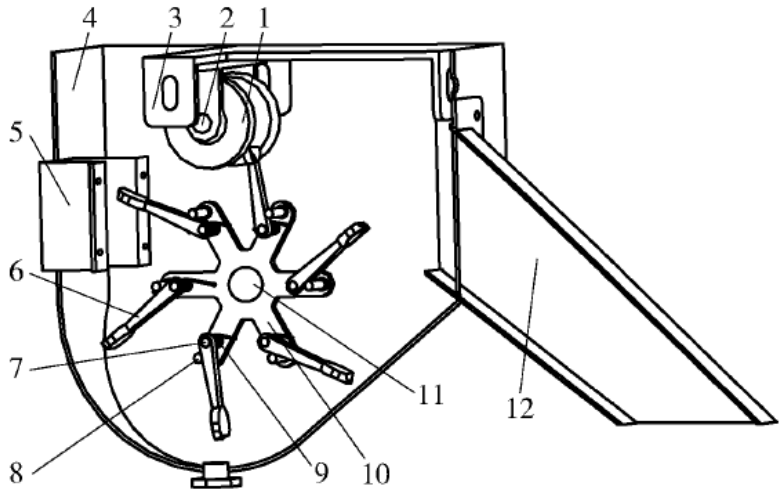


Fig .4 Ejectable ear spoon type rice precision hole direct seeding device Structural schematic diagram. 1.guide roller 2. roller frame 4. seed box 5. clear brush 6. take seed ear spoon 7.scoop of shaft 8.stop lever 9. torsion spring 10. rotating disc 11. seeding shaft 12. Seed tube

Bruce Peterson and so on also designed a spoon type seeding device18 With the rotation of the seeder, the seed spoon can be accurately filled, thus it is easy to realize the uniformity of sowing.

Development Status of Pneumatic Rice Plant Seed Drainers

Compared with mechanical rice seeder, pneumatic rice seeder has higher precision and easier precision, but it has more complex structure and high manufacturing cost. Pneumatic rice seeding device mainly includes air blowing type, air pressure type and air suction type.[19]Compared with the mechanical seeder, the air-blowing type is only improved in the field of seed clearing, and the mechanical stiff seed clearing is replaced by air-flow cleaning, which reduces the damage of rice seeds in the process of seed clearing.[20]In recent years, pneumatic rice seeder has been developed to a great extent. Yang Junjun and others have designed double-disk high-speed pneumatic rice seeder, Xing He and others have designed pneumatic rice seeder, Wei Haiming and others have designed pneumatic suction vertical disc rice seeder, Zhang Shun and others have designed pneumatic rice seeder.[21-24]

Air-suction seeding device designed by Zhai Jianbo et al.[25]For example to introduce. The seeding device is mainly composed of seed box, cam, push rod, seeding shaft, seeding disc, gas chamber, housing and other components, and its structure schematic diagram is shown in figure 5.

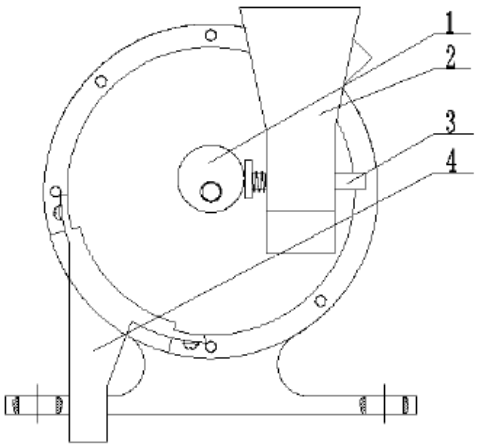
In the process of rotation, the pad will stir the seeds to prevent the accumulation of seeds, resulting in the situation that the seeds can not be sucked. In the process of rotation, when the type hole on the plate reaches the negative pressure chamber, the seed will be adsorbed by the plate to the rice seed. Under the action of its own gravity and positive pressure, the rice seeds will be separated from the seed tray and entered into the seed feeding tube to complete the seeding operation.

Air pressure metering device designed by Li Zhaodong and others[26].For example to introduce. The mechanism is mainly composed of seed inlet branch pipe, seed filling chamber, seed discharge roller, seed cleaning gas nozzle, cushion, seed protection gas nozzle and other components, and its structure is shown in figure 6.

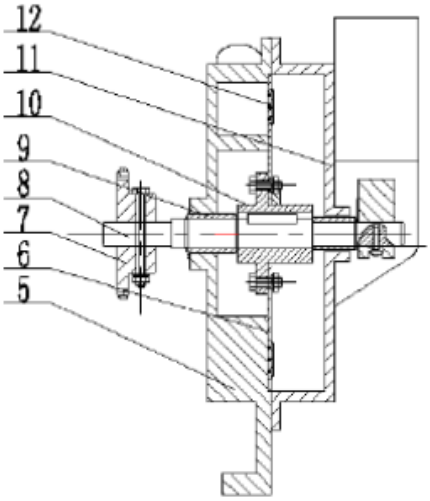
When the seeding device is working, the seeds enter the seed filling chamber from the inlet branch pipe by their own gravity, and then enter the type hole opened on the seeding roller under the combined effect of the interaction force between the seeds and the friction force between the seed and the seeding roller In the middle, as the seeding roller rotates to enter the seed cleaning area, the extra seeds outside the mold hole will be re-entered into the seed filling room under the action of the air flow sprayed by the seed cleaning nozzle, and the seeds in the mold hole will enter the seed protection area. The airflow from the seed gas nozzle will form a uniform and stable air pressure under the action of the pad to press the seeds into the hole to prevent the seeds from falling. Then the rice seeds will rotate into the seeding area with the seeding roller. Under the double action of centrifugal force, the detached hole enters the seed guide tube to realize the seeding operation.

Development status of seeding device for vibrating rice direct seeding machine

The vibration type seeding device is used less, Zhang Chaolong and so on designed the small vibration type rice bud seeding direct seeding device[27]In this paper, a kind of precision seed metering device for non-circular seeds with hole-wheel type is studied by Liu Cailing and others[28]For example to introduce. The seeding device is composed of seed box, brush gear, seed protection device, seed discharging wheel, electromagnetic vibration feeder, directional seed feeding mechanism, scraping device and so on. The whole machine structure is shown in Fig .7.



(a) Main view



(b)Left view

Fig .5 Schematic diagram of the structure of suction metering device. 1. cam 2. seed box 3. push rod 4. guide tube 5. chamber 6. Sprocket 7. sprocket 8. sprocket 9. sleeve 10. flange 11. housing 12. Comb bars

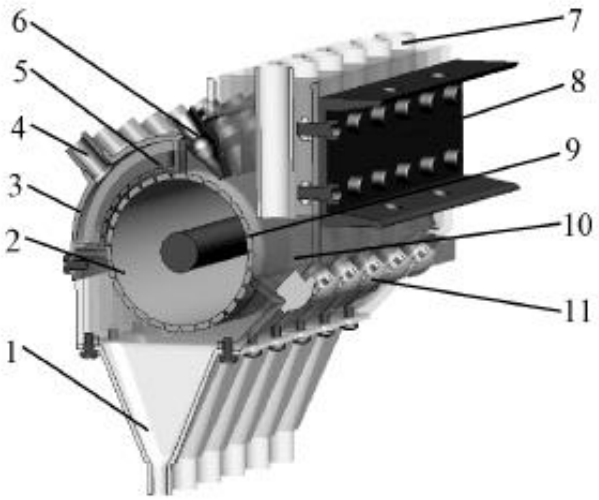


Fig .6 Schematic diagram of the structure of the fine pneumatic collector. 1. guide tube 2. seeding drum 3. protecting room plate 4. protecting seed air nozzle 5. protecting pad 6. cleaning seed air nozzle 7. feed branch pipe 8. Joining plate 9. 10. Filling chamber 11. Discharging plugs

At the same time, the seed feeding mechanism moves into the sorting V slot of the seed feeding mechanism under the action of the electromagnetic vibrator in the lower part of the seed box. Under the action of the electromagnetic vibrator, the seed feeding mechanism ensures that the seed is transported to the seed feeding area under the action of the synchronous seed protecting device. And under the action of seed gravity and scraping wheel, the seeding operation is realized.

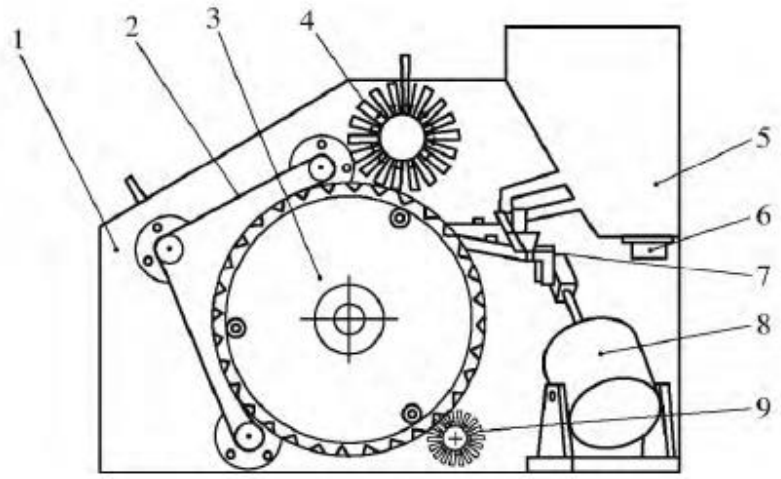


Fig .7 Schematic diagram of precise seed metering device with vibrating feeding type bore wheel and non-circular seed. 1. side plate 2. Synchronous seed protection device 3. Seed row wheel 4. brush type wheel 5. type box 6. electromagnetic vibration feeder 7. directional feeding mechanism 9. scraping device

The Problems and Suggestions of Rice Direct seeding Machine in China

1) due to the limitation of processing technology, processing conditions and the size difference between the same kinds of seeds, the rice direct seeding machine will inevitably produce partial wear and tear on the rice seeds, seriously or even damage the seeds, resulting in the seeds can not germinate and grow, the seeding quantity is not easy to adjust, it is difficult to achieve precision seeding, and all kinds of seeding machines have poor adaptability to different varieties of rice seeds.

2) the development of rice seeder should be combined with the discipline of rice seed agriculture, so that agricultural machinery and agronomy should be combined, agricultural machinery researchers fully understand the growth habits of rice seeds to meet their growth needs, agricultural researchers to study and cultivate good varieties suitable for seeder seeding.

3) government should increase investment in rice direct seeding machine, encourage enterprises and colleges to carry out scientific research, and develop more scientific rice seeding machine, so that rice direct seeding technology can be widely popularized and applied, so as to achieve the purpose of saving cost and improving production efficiency.

Conclusion

Although there are many kinds, complete functions and good seeding effect, the research on direct seeding technology of rice in China is still in the primary stage. Researchers need to combine the actual situation of our country, adhere to the combination of agronomy and agricultural machinery, to develop a more in line with the actual situation of our country, higher applicability, better reliability, faster work efficiency of high-quality rice direct seeding

machine.

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