Technology Innovation of Rice Mechanical Transplanting in China

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Abstract

Development of social economic accelerated agricultural modernization progress in China. Saving and simple cultivation method was the basic way to realize high efficiency and large scaled of rice production. Due to differences in rice varieties and regional climates, multiple planting patterns were coexist, in which mechanical transplanting is the important planting method to keep rice yield stable. Rice seedling nursing was the key link of the mechanical transplanting, with the improving of technology, seedling-nursing methods gradually turned from flat seedling, pot seedling to pot-flat seedling, and the cost of nursery matrix was cut down. In the northern of China, scientists invented the technologies like precision drilling sowing, pot-flat tray seedling breeding, big pot seedling breeding, and narrow-row mechanical transplanting. Which overcome the problems of weak quality in rice seedling nursing, high leakage rate of seedling in transplanting, and deficiency of panicles in rice population. In the future, rice mechanical transplanting should develop the social service to realize large-scaled factory seedling breeding, and apply novel technology like stack-plate dark seedling to promote rice production in large scale.

Keywords: Rice; Machine transplanting; Pot-mat seedling; Mechanization

Introduction

Rice is a staple food in China. Rice planting area and production stands for 27.4% and 36.1% of national planting area and production of grain crops. About half of the Chinese people live on rice. In China, rice is widely grown in large area from tropic to cold zone. Types of rice varieties also are diversified with Japonica and Indica, Inbred and hybrid.

In recent decades, the agricultural labors are shifting from agriculture to other sectors with social and economic development. Old workers and women are taking most work in field for rice production, meanwhile, the labor cost also is increasing faster [1]. Due to lack and limitation of labor force, rice production in China is being transferred from hand operation to mechanization [2,3].

Since the middle and later periods of the 60s of the 20th century. Hand and animal power in land preparing of rice production had been gradually replaced by different type of plough machine. In addition, from the 80s of the 20th century, machines were taking the place of hand harvesting. Nowadays, rice field preparation and harvest is operated by machine in the most area of China. However, percentage of rice planting operated by machine still is low due to different rice variety and planting types, rice seasons, and small production scale [4-5].

Chinese rice ecosystem is different from other rice growing country in Asia. Irrigated rice is the main type in China. In different regions, various planting types, hand transplanting, direct seeding, seedling throwing and machine transplanting for rice production is practiced. Machine rice transplanting is main planting types in near future according to rice production environment and management type. This paper analyzed the transformation of rice planting method in China and the innovation and application of mechanical transplanting technology.

Transition of rice transplanting method in China

In recently years, traditional artificial transplanting does not meet the need for modern technology innovation of rice production in the phase of economic booming. Therefore, it is urgent to develop the laborsaving cultivation techniques for rice high-yield stability. In the late 1970s, China introduced the mechanized transplanting technology with plate seeding breeding from Japan. With the household contract responsibility
system implemented in 1980s, the mechanical transplanting was inhibited due to rice production was divided into small plots. From 1980s to 2010s, technology of rice throwing transplanting and direct seeding were developing fast, the area of throwing transplanting achieved 24% in 2007 [6]. With the fast developing of rice mechanical transplanting technology from 2010s, 38.53% of the total area in china applied the technology of mechanical transplanting in 2014. However, due to geographic variation and climate difference in southern and northern of China, different rice planting patterns including artificial transplanting, direct seeding, ratooning rice, and mechanical transplanting are coexist. Some region liked Hubei and Sichuan province at Yangtze River region formed the model of “Middle-season rice – Ratooning rice", and achieved a high level yield [7]. Due to the increase of the rice stock and the maturation of the direct seeding technology, the area of direct seeding planting area increased gradually, and achieved the effect of laborsaving and high efficiency.

**Table1**: Percentage (%) of rice machine transplanting in different region of China.

<table>
<thead>
<tr>
<th>Rice season</th>
<th>Zone</th>
<th>Year</th>
<th>2010</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-season</td>
<td>Middle and lower Yangtze River</td>
<td>28.79</td>
<td>51.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>South-west</td>
<td>11.28</td>
<td>28.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Northern</td>
<td>62.01</td>
<td>79.24</td>
<td></td>
</tr>
<tr>
<td>Double-season</td>
<td>Yangtze valley</td>
<td>5.66</td>
<td>17.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Southern</td>
<td>4.53</td>
<td>16.23</td>
<td></td>
</tr>
</tbody>
</table>

In different rice planting region, machine-transplanting level existed difference (Table 1). In northern plain region of rice production, it was suitable for promotion of mechanical transplanting due to japonica rice planting. At 2014, the area of rice mechanical transplanting achieved 79.24% in northern rice production region. In southern rice production region, because above 50% was planting hybrid rice and much more hills in the region. In 2014, only 34.54% of rice planting area in the middle and lower Yangtze River applied the mechanical transplanting technology, and the single-rice planting area achieved 51.57%. Take the Jiangxi province as example (Figure 1): throwing transplanting and artificial transplanting were the main pattern for rice planting, mechanical transplanting need to be further developed.

**Technology developing of rice machine transplanting in China**

Early technology of machine transplanting with matseedling was introduced from Japan, which was developed on the base of japonica rice planting, and it is fit for applying in the region of planting japonica rice, because of short plant height of japonica rice seedling. However, mat seedling raising adopted with much more seeding rate broadcasting, resulting in poor seedling quality, low elasticity of seedling ages, and poor effect of machine transplanting. In addition, mat seedling increased leakage of seedling transplanting, and made it difficult to regulate field population. In order to increase the machine transplanting rice yield, pot-transplanting technology developed to strengthen the single seedling and rice population quality [8]. And now, the group of high yield cultivation in China national rice research institute(CNRI) invented technology to raising seedling of pot-grown flat seedling combined the advantage of mat seedling and pot seedling, which adopted precision drilling technology, formed the strong seedling population on the surface and pot down the surface (Figure 2), and transplanted by locating and quantifying. By means of the technology, some problem in traditional mat seedling transplanting were solved efficiently, degree of root injury decreased, seedlings evenly divided, and seedling turn green speeded up [9]. The technology is popularizing 4.5×108 hm² per year in northeast China. However, above three technologies need lot of plastic and soil from the progress of manufacturing the tray to seedling breeding every year. Therefore, we improved the technology of long carpet soilless seedling breeding based on applying in japan, and invented the tray with biodegradable materials [10].

The soil of rice seedling breeding for machine transplanting developed from paddy slurry soil, dry land soil to matrix soil [11]. In addition, in present, inorganic material and biologic material applied in order to reduce soil wasting. With the social economic development, rice seedling breeding model was turning from small shed and greenhouse to industrialized rice seedling breeding in factory.
Machine transplanting technology of double-season rice

In southern region of rice planting, the soil and climate fit to double-season rice planting, with the rice breed improvement and planting technology, yield of double-season rice planting increase 57% than single season rice planting. The transplanting technology of double season rice planting included three main points.

Varieties selecting: Due to tight scheduled season for later season production, it is necessary to form the collocation mode of proper varieties of early and later season in different region.

Seeding quality improvement: Precision sowing and concentrated seedling breeding were conducted to improve seedling quality. The important point is to prolong seedling later rice seedling age from 10~15d to 25~30d, paclobutrazol was largely applied in practice [12].

Planting density increasing: Row spacing of 25cm machine transplanter application improve the quality of machine-transplanted. Traditional transplanter is 30cm wide-row, which need to equip with rice rare-planting technique and not benefit to early rice production. Narrow row transplanting increase the density of rice seedling population, which overcome the problem of basic seedlings deficiency.

Machine transplanting technology of hybrid rice

In practice, yield of hybrid rice was 20% more than inbred rice, hybrid planting area in China was more than 55 % [13]. With the improvement of hybrid breeding, hybrid rice planting area has the tendency of further expanding.

However, low yield and high price of hybrid seed, including higher seeding rate in seedling breeding increased the cost of hybrid rice transplanting seedling breeding [14]. In addition, transplanting seedling of each hole was overmuch and uneven, which lead it is difficult to regulate the rice population in the later of rice growth duration. The key innovation of hybrid rice machine transplanting technology is including two points:

1. Reducing the sowing rate
   Proper seeding rate was explored to fit for transplanting of different varieties in different region.

2. Increasing machine transplanting quality
   Technology of big pot-growing flat seedling with precision drilling was invented to reduce sowing rate, and keep the each hole with two seedling, which also reduced the leakage of seedling and degree of root injure in the transplanting progress.

Research prospects of rice machine transplanting

In future, it is important to develop the model and equipment of rice seedling breeding and transplanting in double-season and hybrid rice transplanting progress. Especially improve the technology of precision sowing, seedling grasping, and seedling transplanting. In addition, it is necessary to improve the machine technology of fertilization, spraying, and weeding, and it is efficiently for rice production to combine the transplanting and fertilization.

With the development of large-scale rice planting, it is important to invent the factory seedling progress, and socialized service system. In southern china, stack-plate dark seedling technology was applied, it is useful for double season, and single season rice seedling breeding, but it is small scaled nowadays. Scaled seedling breeding technology for social service is further developing for rice production intensification and modernization.

References
