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# Technology Innovation of Rice Mechanical Transplanting in China



Wang Ya-Liang, Xiang Jing, Zhang Yu-Ping, Chen Hui-Zhe and Zhu De-Feng\*

China National Rice Research Institute, China

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\*Corresponding author: Zhu De-feng, China National Rice Research Institute, Hangzhou, Zhejiang, China, 310006, Tel: +86-571-63370373; Email: cnrice@qq.com

## 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 seeding 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:** China; Rice; Mechanical transplanting; Innovation

## Introduction

Rice is the basal ration for half of the population in China. With social economic developing, the rural lobar was transferring to city quickly, and speeded up the degree of population ageing. Due to lack of labor force, mechanization is an important way for rice production in present and future [1-2].

In present, rice production realized mechanization in ploughing, spraying, and harvesting, however, low level achieved on the rice transplanting mechanization. In America, Australia, and Italy, rice planting was take the method of direct seeding.

In Japan and Korea, where the rice industry was developed, mechanical transplanting was large scaled applied. In China, rice transplanting technology development draw on the model of Japan and Korea, and according to development progress of local rice production. In order to realize goal of rice production mechanization, it was important to break through the bottleneck of mechanical transplanting technology. This paper analyzed the transformation of rice planting method in China and the

innovation of mechanical transplanting technology to provide reference for the technology improving for rice scale production.

## 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 light-simplified cultivation techniques for rice high-yield stability. In the late 1970s, China introduced the mechanized transplanting technology with plate seedling 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 [3]. 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.

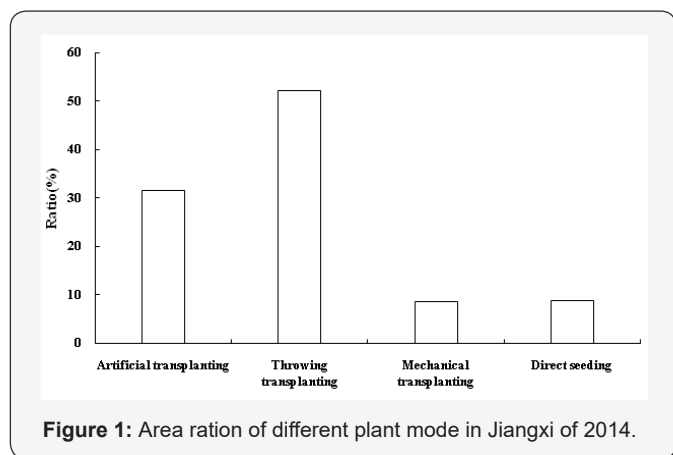
Some region liked Hubei and Sichuan province at Yangtze River region formed the model of "Middle-season rice-Ratooning rice", and achieved a high level yield. Due to the increase of the rice stock and the maturation of the direct seeding technology, the area of direct seeding planting area increased gradually, and achieved the effect of laborsaving and high efficiency.

In different rice planting region, mechanical 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.

**Table 1:** Rice mechanical transplanting level of different region in China (%).

Planting Season	Region	Year	
		2010	2014
Single-season	Middle and lower Yangtze River	28.79	51.57
	South-west	11.28	28.05
	Northern	62.01	79.24
Double-season	Yangtze valley	5.66	17.51
	Southern	4.53	16.23

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.

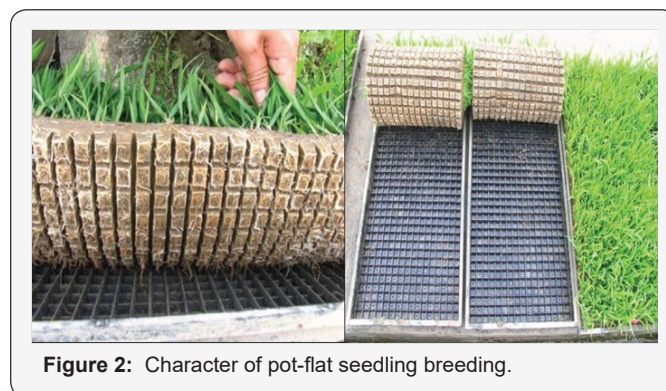


**Figure 1:** Area ration of different plant mode in Jiangxi of 2014.

### Technology developing of rice mechanical transplanting in china

Traditional technology of mechanical transplanting with flat seedling 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, flat seedling raising adopted with much more seeding rate broadcasting, resulting in poor seedling quality, low elasticity of seedling ages, and poor effect of mechanical transplanting. In addition, flat seedling increased leakage of seedling transplanting, and made it difficult to regulate field population.

In order to increase the mechanical transplanting rice yield, pot-transplanting technology developed to strengthen the single seedling and rice population quality [4]. And now, the group of high yield cultivation in China national rice research institute(CNRRRI) invented technology to raising seedling of pot-grown flat seedling combined the advantage of flat seedling and pot seedling. Which adopted precision drilling technology, formed the strong seedling population of flat on the surface and pot root below the surface (Figure 2), and transplanted by



**Figure 2:** Character of pot-flat seedling breeding.

By means of the technology, degree of root injury decreased, seedlings evenly divided, and seedling turn green speeded up, the problems of traditional flat seedling transplanting solved efficiently, the technology is popularizing 4.5×108hm2 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 [5].

The soil of rice seedling nursing for mechanical transplanting developed from paddy slurry soil, dry land soil to matrix soil [6]. In addition, in present, inorganic material and biologic material applied in order to reduce soil wasting. With the social economic development, the model of rice seedling nursery was turning from small shed and greenhouse to industrialized rice seedling breeding in factory.

## Mechanical 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.

**Seedling quality improvement:** The technology of precision sowing and concentrated seedling nursing 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.

**Planting density increasing:** Row spacing of 25cm mechanical 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.

## Mechanical 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%. 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. 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 mechanical transplanting technology are including two points:

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

**Increasing mechanical transplanting quality:** Technology of big pot-growing flat seedling with precision drilling was invented to reduce sowing rate by 30~50%, 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 mechanical transplanting

In future, it is important to develop the model and equipment of rice seedling nursery 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 mechanical 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 applied for rice seedling breeding in double season, and single season, but it is small scaled nowadays. Scaled seedling nursing technology for social service is further developing for rice production intensification and modernization.

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