Review of rice transplanter and direct seeder to be applied in Indonesia paddy field

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Abstract. The challenge to plant one seed or plant per hill by rice ordinary rice transplanter (RT) is still difficult to be achieved due to random in sowing seed by on rice nursery tray. But due to the vigor of seed after sowing in the field and also the unfavorable condition, the more number of seed are still needed and the yield lower compare transplanter method. Recently, the use of rice direct seeding has been increasing rapidly owing to rural labor shortages and continuous increases in agricultural production costs. This article reviews the research and application progress of mechanized rice direct seeding including direct seeding technologies, precision rice seeding, precision rice seed-metering devices. The other important component on succession direct seeding method is also discussed i.e. calcium gypsum coating and iron powder coating. Operating direct seeding machine also need consider about land and water management. Paddy field need to be managed since the seed drooped in order give favor condition of seed and facility the seed with optimum growing condition. In this approach, pre-germinated seeds are uniformly hill-dropped in the expected positions in puddled soil. The both technology PNRT and RDS have prospect and great potential for promoting the development of precession on rice cultivation in Asia.

1. Introduction
Planting is important part on rice cultivation which consume around 25% of total labor of cultivation. Most of manual worker has been come to non productive period, and also there is a reluctance and reducing enthusiastic on young generation in engage on farm activities more ever by traditional system of agriculture [1]. Those condition effected on achievement of food security national program. Due to the lack of labor for planting rice get effect on delay planting and also difficult on make planting on the same time on several areas then later on will reducing the rice index crop yearly. Another negative impact on crop disease and insect then will reducing final yield of rice [2].

Base on the evaluation condition of lack number of agriculture labor in village where mostly rice field is existed could be concluded that farm machineries become main factor in agriculture sector. Through farm machinery not only solve problem of lack of labor but also possible to increase labor productivity, increasing efficiency of crop cultivation, production time, reducing lost of harvest and increasing quality of agriculture product [3]. The number labor requested for manual planted by hand in wet field condition in Indonesia around 2975 man-days/ha. While the total labor to conduct rice cultivation start from land preparation until harvest by manual around 145,75  man-days/ha [4].
Another option instead use rice planting method their direct seeding method on growing rice. Rice direct seeding has been a less labour-intensive, high-efficiency, and simple method to cultivate rice. The commonly there are three main rice direct seeding methods rice dry direct seeding (RDDS) in which dry seeds are sown in dry soil to depths of 1-3 cm before irrigation; rice water direct seeding in which seeds are sown into standing water on ploughed dry land; and rice wet direct seeding (RWDS), in which pre-germinated seeds are sown in wet puddled-precipitated-drained soils [5,6].

Comparing with transplanting, rice direct seeding saves water and reduces greenhouse gas (GHG) emissions. Therefore, rice direct seeding mechanization is one of the most simple, effective, and sustainable ways to cope with labour shortages and high production costs. South China Agricultural University developed a precision rice hill-drop drilling (PRHDD) technology with synchronous furrowing and ridging for wet paddy. In this approach, pre-germinated seeds are uniformly hill-dropped in the expected positions in puddled soil [7,8]. It significantly improves the crop growth population and effectively solves the problems of high frequency of disease and pests caused by the irregular distribution. This paper has the purpose to increase the visibility and knowledge about the research and development on direct seeder and rice transplanter through precision of seed application.

2. Rice transplanter and direct seeder

2.1. Status of mechanized rice direct seeding

USA is biggest rice production among Euro-American, USA has the largest rice planting area among Euro-American countries with 1253 thousand hm² and the yield of 8 t/hm² in 2016. The main rice planting areas are in the Mississippi River, Arkansas, and California, with Arkansas alone accounting for around half of the total planting area in USA. The two main rice planting methods used in USA are aerial seed planting (20%) and mechanical drilling (80%) [6,9].

In Japan direct seeder cover 1.7% of all acreage of rice planting in Japan. Among of them direct seeding on wet submerged field occupies 65%. By the end of the 20th century, with increasing labor shortages and production costs, the direct seeding area increased from 8.9 thousand hm² in 2000 to 27 thousand hm² in 2014. There are several method of direct seeding method practiced by farmer in Japan as in Table 1. In India, the rice planting area was 43 million hm² in 2016, being around 1.3 times as much as that in China and the highest in the world [10,11]. However, its total grain yield was 160 million tons, being around three-fourths of that of China.

Table 1. Method of direct seeding in Japan (Ishikawa 2018).

| Seeding method                        | Seeder machine                          |
|---------------------------------------|-----------------------------------------|
| Submerge direct seeding (on submerge field) | Special seeder - with calper coating |
|                                       |                                        |
|                                       | - with iron coating                     |
| Broadcast seeding                     | Power spreader                          |
|                                       | - with calper coating                   |
|                                       | - with iron coating                     |
| V-furrow direct seeding (on dry field) | V-furrow no-till                       |
|                                       | No-coating                              |

It is one of the major rice-producing countries with the largest total rice yield (27%) in the world. In 2014, 2015, and 2016, its rice yields were 207, 208, and 210 million t, accounting for 37.0%, 36.4%, and 36.0% of China’s total grain crop yield and 27.8%, 28.1%, and 28.2% of the world’s total rice yield, respectively. China’s rice planting mechanization level currently exceeds 40%. China’s “Thirteenth Five-Year Plan” has proposed to increase rice-planting mechanization level to 60% [9].

The reason why these developed Euro-American countries can produce high yield of rice, is not only relating to rice varieties and soil climatic conditions, but also high precision direct seeding technology.
The mechanization of rice production level of most Asian countries is far behind the developed countries. The mechanization of rice production level of most Asian countries is far behind the developed countries as shown in Figure 1. Meanwhile, they produce less rice. Obviously, rice yield is positively correlated with mechanization level. Therefore, it is urgent to improve the mechanization level of rice production.

Figure 1. The principle of furrowing and ridging system on the hill dropping of seed on wet direct seeding

On the direct seeding have disadvantages which one of the are easy lodging and also bird attack after sow the seed. The deal with those problem, Japan has applied seed coating technology. By coating the seed will not only avoid bird attack but also possible to make heavier the seed and bit submerged the seed onto muddy soil [12,13]. One common coating material is Calper (CaO₂) which agricultural material as presented in Figure 2 and Figure 3. It contained calciul peroxxide 16% when reacts with water will form oxygen.

Figure 2. The material coating seed

Figure 3. Rice direct seeding machine wet hill dropping system on metering device
2.2. Status of mechanical rice transplanted

Rice transplanter was developed in Japan since 1965, which at the beginning use root wash nursery. Then on 1970 was rapidly changed to the mat type young nursery and have self propelled walking type with 2-6 row. Further a riding-type transplanter was also developed in around 1975. Then for high speed riding transplanter require a rotary type planting arm replace previous crank type planting arm.

The seedling with soil are generally classified into mat-type, band–type and pot-type according to their form, however most of transplanted being used today are for mat-type seedling.

In the Case of mat-type seedling, seed are broadcasted on the bed soil of nursery box then cover with pulverized dry soil. The roots of grown seedling interwind with each other in bed soil and from a mat. There are two rising method as for mat-type seedling, one is for young seedling and the other is for medium seedling as above-mentioned. The former is high sowing density and restrains the root in nursery box and the roots can’t come out of the box [5,14]. So it is difficult to obtain the large seedlings.

On the other hand, for sparse sowing density the nursery boxes used in this method have many small holes on the bottom and they are placed on nursery bed, so that roots penetrate into the soil through the hole and uptake nutrients from nursery bed. Therefore, larger seedling can be obtained but the quantities of mats required in same planted area become many.

Although precise hand placement would qualify, precision seeding usually refers to a mechanical process. A wide range of hand-push and powered precision seeders are available for small- to large-scale jobs. Using a variety of actions, they all open the soil, place the seed, then cover it, to create rows.

The depth and spacing vary depending on the type of crop and the desired plant density. In commercial production, precision seeding is an alternative to placing larger quantities of seed in a row, by dribbling seed or setting several seeds in each position [15,16]. Depending on the device, precision seeders may place only one, or a very few seeds per position. This is an advantage, in that it saves seed and it avoids crowding, or the need for thinning, allowing plants the space to grow efficiently. On the downside, by placing fewer seeds, a very high germination rate is required to make full use of the seeded area.

2.3. Pot-type nursery mechanical rice transplanter

The ordinary rice transplanter machine has planting finger to cut and bring the cutting portion area of mat nursery and remain it into the muddy soil around 5 cm from the surface. But on the pot-type nursery rice transplanter has different mechanism to take the nursery and planted it into the muddy soil. The ready rice nursery is placed on the tray compartment of machine together with the plastic pot as shown in Figure 4. Then, there is the pushing root device of machine which will push the pot-nursery from the pot and then placed on the moving belt conveyor. Since the individual pot nursery come to the end the planting finger will pushing it into the muddy soil.

The rice seed are sow in specific amount 2-4 into every hole of plastic pot use special seeder machine. By this machine it can sow the seed exact amount and precise. Therefore, the total number of sowing seed will much efficient in less number.

![Figure 4. The pot-nursery for rice transplanter](image_url)
opportunities to conduct research and modification related it. Korea, China Taiwan and many countries in Asia adapted technology rice transplanting machine since several years ago. Mostly is due to the labor shortage reason for conduct transplanting by hand. Using rice transplanter give many advantages especially on reducing man or women power. But in another case, use a rice transplanter machine should be accompany by several considerations. There are many considerations should pay attention such as preparing field condition or muddy soil, the hard pan condition, water depth. And the most critical consideration is nursery preparation [17].

The era of precision is come for agriculture, one of the is about precise in number planted seed. Therefore, the sowing seed method on nursery preparation need to evaluated [2,18,19]. In order to make more efficient of number sowed seed the pot-type nursery preparation for rice transplanter is introduced as shown in Figure 5. In agriculture, precision seeding is a method of seeding that involves placing seed at a precise spacing and depth. This is in contrast to broadcast seeding, where seed is scattered over an area.

![Figure 5. The pot-nursery rice transplanter work in the field](image)

The preparation of nursery will have effected on the filed performance and planting quality of rice transplanter. Rice seed are sowed by seed sowing machine or by hand sowing which both of them are look like random dropping. It has target, all area on the nursery box should be sowed as dense as possible. The basic mechanism of planting finger of planting arm will take area from nursery box around 1,5 mm and 0,8–1,5 in width and length respectively in every time planting mechanism. Therefore, on those certain area of nursery box should have sowed with grain seed of rice 3 – 5 grain. By practicing those sowing method on preparing nursery for rice transplanter will affect on the number of consumed seed and also field performance and planting quality of rice transplanter machine.

3. Conclusions

The precision technology on rice cultivation is still important in order to make more efficient and effective on rice cultivation. Precise number of seed through direct seeder and special pot-nursery rice transplanter are option can choose. The technology direct seeding on rice cultivation has merit on save labor but has unmerit on maintainance after sowing, otherwise rice transplanter slightly opposite than direct seeding method.

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