The implementation of jarwosuper technology to increase rice productivity and supports food self-sufficiency in Riau Province

Anis Fahri¹, Rathif F. Zona¹, Ida NurIstina¹ and Rachmiwati Yusuf¹
¹Assessment Institute For Agriculture Technology Riau.
Indonesian Agency for Agricultural Research and Development, Indonesia

E-mail: anisfahri@gmail.com

Abstract. The availability of agricultural land, especially rice fields, which covers an area of 8.08 million hectares has not been able to meet Indonesia's food needs. The low rice productivity (around 3.5 - 4.5 tonnes / ha) in Riau Province are strategic issues today and in the future. Indonesian Agency for Agricultural Research and Development (IAARD) has produced various technological innovations that able to increase rice productivity, one of them is Jarwo Super technology. This study aimed to examine the application of jarwo super technology to increase rice productivity and support food self-sufficiency in Riau Province. This research was conducted through literature studies and field surveys. The method of planting legowo row has the opportunity to increase grain yield, because in addition to the higher population than the tile planting method, the orientation of the crop is also better in the use of solar radiation. In addition, the increase in grain yield will be more significant by choosing adaptive varieties. The application of super jarwo technology innovation, the productivity of rice plants reached 5.73 tonnes / ha higher than the tile method of 5.25 tonnes / ha of harvested dry grain.

1. Introductions
The availability of agricultural land, especially rice fields, which covers an area of 8.08 million ha [1], has not been able to meet Indonesia's food needs, especially rice, maize and soybeans, so it needs to be added with imports which are increasing in number. Meanwhile, population growth from year to year is increasing with a growth of around 1.5% per year, thus encouraging food demand to continue to increase.

Other problems are a) decreasing productive agricultural land, b) decreasing quality of land resources due to poor management, and c) competency in land use and fragmentation. In terms of potential, Riau Province has 69,948 ha of rice fields and around 3,676,348.31 ha of dry land, Riau Province's rice productivity is around 3.5 - 4.5 tons / ha and an average cropping index (IP) of 100, generally planting only once a year [1].

The planting system that is widely used by farmers is direct seed planting and transplanting. In the transplanting system, namely legowo rows and tiles. The direct spread cropping system has advantages and disadvantages. The advantages include earlier harvest age, less labor required. While the drawbacks are that more seeds are needed, low production yields and difficulty maintaining.
Besides that, it is difficult to control weeds and the soil surface must be flat and the water is easy to manage, so that not all land is cultivable.

Based on this, the developed planting with the system moving (transplanting) which was originally developed is a system of tiles with the planting of 25 cm x 25 cm or 20 cm x 20 cm. This planting system can save seeds, is easy to maintain, the production can be increased to 6–7 tonnes/ha, when compared to the direct seed planting system (tablea) which ranges from 4–5 tones/ha. Along with technological developments, the Agency for Agricultural Research and Development has produced technology with a legowo row planting system. This system is believed to increase the production of 1–1.5 tonnes/ha from the tile system. This is because the plant population can be increased up to 30 percent.

Along with technological advances, the Agency for Agricultural Research and Development in 2016 developed the Jarwo Super Technological Innovation. Jarwo super rice cultivation is an improvement from the Jarwo rice cultivation technology itself, which only relies on setting the spacing of rice, so that all plants become marginal crops. In addition, the application of jarwo increases the plant population. The results of the study by the Agency for Agricultural Research and Development were produced with a super-productivity legowo row system that could reach 8-9 tonnes/ha yields dry harvest.

Legowo row planting is a technological engineering aimed at improving the productivity of rice plantations. This technique is a change from symmetrical spacing to legowo planting row. So between groups of rice rows there is a wide and extending alley along the row. A cropping row can consist of 2 rows, 3 rows, 4 rows, 5 rows and 6 rows. In the row group, the spacing is 25 x 12.5 cm (compaction occurs). The distance between groups of rows (aisles) can be 50 cm or 60 cm. The different number of rows in a row group is followed by the difference in the number of clumps and the percentage of open space. The more rows, the greater the number of clumps. The legowo row planting system can increase the yield of dry unhulled rice by around 19.90-22% [2]. Jarwo super rice cultivation is the result of technology development as a result of the development of integrated rice cultivation technology from the Agricultural Research and Development Agency (IAARD) based on the legowo row planting method (jarwo). Super jarwo rice cultivation is an improvement of the jarwo rice cultivation technology. Jarwo itself only relies on the spacing of the rice plants, so that all plants become marginal crops. In addition, the application of jarwo increases the plant population, which in has the effect of increasing production by about 30%. The components of super jarwo rice cultivation technology that are introduced and developed include New Superior Varieties with high yield potential, straw decomposers, biological fertilizers, balanced fertilization based on the Paddy Field Test Tool (PUTS), and control of plant pests with vegetable pesticides and chemistry based on control threshold, as well as agricultural machine tools (transplanter and combine harvester).

With the legowo system, rice plants will produce higher because of the more "border effect" due to the large number of side or alley plants in the rice fields. The number of alleys provides more space for plants to get light, as well as makes it easier for farmers to do weeding and fertilizing [10]. This paper aims to examine the application of jarwo super technology to support increased productivity and food self-sufficiency in Riau Province.

2. Research and Methods
This research was carried out through literature study and field surveys. Secondary data were extracted from the Riau Provincial Agriculture Office, Riau Province BPS, and other related agencies. Meanwhile, primary data was obtained through interview survey with farmers and field observation. To measure the increase in production and productivity of the introduced technology, observations are made on the production. The data analysis was done by tabulation and descriptive method.
3. Result and Discussion

3.1. Regional Characteristics

Riau Province has an area of 8,915,016 hectares. Its existence stretches from the slopes of Bukit Barisan to the Strait of Malacca, located between 01° 05' 00" South Latitude to 02° 25' 00" North Latitude or between 100° 00' 00" East Longitude - 105° 05' 00" Longitude East. The land area is composed of two types of land, namely wet and dry land with a total area of 8,887,162.46 ha or 80.92 percent of the total area of Riau Province, which is dominated by wetlands covering 8,707,412.90 ha (79.28 percent) , while the dry land was only 179,749.56 ha (1.64 percent) . Harvested area 63,142.04 ha with a productivity of 3.66 tonnes / ha dry harvest [1]. This productivity is still low, because the results of using the superior variety Inpari 35 produce 6.5 tons / ha dry harvest [12].

In general, the farming pattern takes the form of rice once a year based on the availability of water resources and rainfall patterns. [6] stated that the impact of changing rain patterns affects three things, namely: 1) Agricultural resources and infrastructure, especially changes in hydrological systems and water resources, land damage and degradation, changes in irrigation capacity, 2) Planting (farming systems) due to seasonal shifts and changes in rainy patterns that affect planting time and season, cropping patterns, crop damage and productivity, planting and harvesting areas and 3) Changes in habitat and damage to biodiversity.

3.2 Physiological Aspects

Effect of cropping systems of rice as one of the components of the mind power that influence on the results and revenues, it turns out complex [7]. Spacing and orientation of plants in the field affect six important processes as follows: (1) capture of solar radiation by plants for photosynthesis, (2) absorption of nutrients by roots, (3) plant water requirements, (4) circulation of CO2 and O2 from photosynthesis. (5) availability of space which determine the populations of weeds, and (6) a climate micro under the canopy, which affects the development of plant pests.

The results of [12] reported that the distance of planting width give opportunity varieties of plants expressing the growth. The denser population of plants, the fewer the number of tillers and total length of panicle per clump. In low populations (wide spacing), the diversity of rice clumps is large, but the yield area and yield components are lower than the spacing which is tighter.

A wide spacing will increase the capture of solar radiation by the plant canopy, thereby increasing plant growth such as the number of productive tillers, volume and total root length, increasing plant dry weight and grain weight per hill, but it has no effect on yield per unit area [4] and [2]. Conversely, at a distance of planting dense number of panicles per hill decreased, but the number of panicles per m² real increase [9].

The weakness of tight planting, including legowo row, is phenolic compounds which are allelopathic in straw and plant roots.[13] reported that of the 10 rice varieties tested had phenolic acid in plants ranging from 260 ppm (on the IR64 variety) to 777 ppm (in the Merning variety) which had the potential to inhibit plant growth at tight spacing, as well as residues for subsequent crops. [3] add that kind of rice Javanica and paddy rice red has a compound alelo high chemical so it is not suitable for planting meetings.

In the dense cropping system, including the legowo row planting system, competition for plant roots to absorb water and nutrients takes place intensively. By Therefore, varieties of rice that is tolerant of drought or adaptive in soil with low fertility rates has the potential to produce grain that is high on the way Legowo row planting compared to the way the tiles. Varieties of rice are relatively tolerant of drought can be known to be rapidly based test power penetrating roots into a layer of wax. [15] the spacing of the optimum would give the top growth of plants and growing part of the root that good so it can make more use of sunlight and utilize over many elements of nutrients. Conversely, a spacing that is too tight will result in the competition between the plants that are very great in terms of light the sun, water, and nutrients. As a result, plant growth is stunted and crop yields are low.
3.3. Agronomic Aspects
The legowo row planting system makes all plants or more of them become marginal plants. Periphery plants will get better sunlight, air circulation and nutrients [10]. The population that is high in the system of planting rows of legowo gives an opportunity to obtain a high yield. The performance of varieties of the plant the distance of planting the meeting primarily on the number of panicle [16].

The existence of an empty hallway in the legowo system makes plant maintenance easier, such as controlling weeds and fertilizing more easily. According to [14] spacing affects panicle length, number of grains per panicle, and yield per ha of rice plants. Besides having several benefits, the legowo row planting system also has several drawbacks:
1. Requires more labor and planting time
2. Requires more seeds with an increasing population.
3. Normally the section of land that is vacant in between the rows of plants will be much overgrown with grass.

3.4. Socio-Economic Aspects
When using human labor, the legowo row planting method takes longer than tile planting, at least 1.5 times. This is due to more seeds that must be planted or spots that must be planted in the legowo row.
The amount of seed that is used is also more lots around 1.5 times. If the price of seed Rp 25.000 / kg then the way Legowo row who use the seeds 30 kg / ha need for seed capital of Rp. 750.000, whereas by way of planting tiles 20 kg x Rp 25.000/kg = Rp 500.000. Thus, the legowo row method requires capital for seeds of IDR 250.000 more. Excess wages in Legowo row planting method compared tiles is 1.5 x 7 working people's day / ha x Rp 80.000 / ha = Rp 840.000 / ha, so that the total input of planting ways row legowo more Rp 1.090.000. This means that the results of the grain of how planting row legowo minimum should be large Rp 1.090.000 devided Rp 5.000/kg or 218 kg of grain is higher than the tiles planting method, assuming a price of selling grain Rp 5.000 / kg.

In areas where labor is lacking or the speed of work of farmers / farm laborers is low, planting legowo rows is more difficult for farmers to adopt. In areas such as these need to be introduced planting machines, either planting the seed directly or transplanting moved (seed). In case this should be considered satisfaction of farmers adopters of how planting Legowo row, so that the next will enjoy the ease of operation and maintenance of plants, such as fertilizing, weeding, spraying pests diseases and weeds that can do it more quickly and effectively.

3.5 Jarwo Super Technology for Increasing Rice Productivity
Population and productivity of rice clumps from the method of planting tiles versus legowo row that the population for a tile planting of 25 cm x 25 cm is 160,000 clumps / ha, while for legowo row 2:1 (25-50) cm x 12.5 cm = 4/3 x 160,000 = 213,333 clumps, or 1.33 times more much compared to planting tiles 25 cm x 25 cm. However, populations of plants / ha which is higher (1.33 times) has not necessarily resulted in productivity (kg / ha) were higher. Many studies show that the more dense spacing of planting or growing a lot of populations of plants per unit area decreases the quality of clumps of plants, such as the decrease in the number of tillers and number of panicles per clump. It is due to competition among clumps of rice in the capture of solar radiation, the absorption of nutrients and water, as well as the more optimal the environment under the canopy for the proliferation of the disease. In certain rice varieties, the decrease in the number of tillers or the number of panicles due to clumps that were too dense was significantly greater.

If the number of panicles per clump or grain yield decreased by 1.33 due to tight spacing, for example from 20 panicles / clump to 15 panicles / clump, then the productivity of the plant by planting legowo rows would be the same or lower than the tile method. On the other hand, if the number of panicles per hill was more than 1.33 times, then the rice yield by planting legowo rows was higher than the tile planting method. It is assumed that panicle quality is the same. Therefore,
planting legowo rows the yield will be higher than the tile planting method if the ratio of grain yield per hill between legowo rows is higher than tiles.

The results of the research in Kuala Cenaku village showed that there were variations in the response of swamp rice varieties (Inpara) to spacing (tile and legowo row), as presented in Table 1. More about this source text Rice yield in row planting system legowo much higher compared with the manner of planting tiles on varieties Inpara1, Inpara 3 and Inpara 9.

Table 1: Jarwo planting system and use of new superior varieties of rice yields (tonnes / ha) of tidal land, Kuala Cenaku 2018.

| No. | Variety   | Jarwo 2:1 | Tile (25x25 cm) | Average |
|-----|-----------|-----------|-----------------|---------|
| 1   | Inpara -1 | 5.92      | 5.42            | 5.67    |
| 2   | Inpara -3 | 5.45      | 5.02            | 5.24    |
| 3   | Inpara -9 | 6.17      | 5.67            | 5.91    |
| 4   | Ciherang  | 5.38      | 4.88            | 5.13    |
|     | Average   | 5.73      | 5.25            | 5.49    |

Age seedlings affect the response results of crop paddy. [3] reported the use of the Inpari 13 variety on planting systems of legowo and tile rows. At the age of 7 and 21 day after seedling, the tile system produced 1.1 ton/ha higher grain compared to the legowo row planting method. Conversely, when the age of the seeds at the time of planting 14 and 28 day after seedling, the system of planting legowo row larger increase yield of 0.2 ton grain / ha and 0.8 ton grain / ha compared to the way of planting tiles This is probably caused by the use seeds by younger 7 day after seedling, the number of tillers was more so that it was not suitable for the legowo row planting system. Planting seedlings were older age 28 day after seedling where the number of tillers less than the seedlings of young. This matter lead the way legowo row planting is more appropriate than the way of planting tiles. [4] Reported that the use of seedlings were younger at the time flowering and age of harvest, but does not affect the roots or grain yield per hill and per hectare.

4. Conclusion
Jarwo super technology has a higher chance of producing grain compared to the tile planting method. Clumps that have fewer tillers, either due to the use of older seedlings, or more lots of seeds per hole, tend to be more appropriate for the way the planting row legowo than tiles. Legowo row planting system as socially economy less favored by farmer because of using capital seed and personnel work more, but bring ease of care of plants next. Jarwo super technology is an attamp to achieve increased production and food self - sufficiency in Riau Province.

References
[1] Badan Pusat Statistik (BPS) 2020 Provinsi Riau Dalam Angka. Badan Pusat Statistik Provinsi Riau.
[2] Hatta M 2012 Jurnal Agrista 16: 87-93
[3] Ikhwan GR, Pratiwi E Paturohman, and AK Makarim 2013 Iptek Tanaman Pangan 8 2
[4] Kurniasih BA, S Fatimah, DA Purnawati 2008 Jurnal Ilmu Pertanian 15 15-25
[5] Las I, A Unadi, H Syahbuddin, and E Runtunuwu 2007 Atlas Kalender Tanam Pulau Jawa. Skala 1:1.000.000 dan 1:250.000 Balai Penelitian Agroklimat dan Hidrologi
[6] Makarim AK, D Pasaribu, Z Zaini, dan I Las 2005 Analisis dan sintesis pengembangan model pengelolaan tanaman terpadu padi sawah (Balai Penelitian Tanaman Padi) pp 18
[7] Makarim AK and Ikhwani 2012 Teknik ubinan pendugaan produktivitas padi menurut jarak tanam (Puslitbangtan) pp 44
[8] Misran 2014 *Jurnal Penelitian Pertanian Terapan* **14** 106 - 110
[9] Mobasser HR, R Yadi, M Azizi, AM Ghanbari, and Samdalari 2009 *J. Agric. and Environ. Sci.* **5** 745-754
[10] Mujisihono R and T Santosa 2001 *Sistem Budidaya Teknologi Tanam Benih Langsung (TABELA) dan Tanam Jajar Legowo (TAJARWO)*. Makalah Seminar Perekayasaan Sistem Produksi Komoditas Padi dan Palawija. (Yogyakarta: Diperta Provinsi D.I. Yogyakarta)
[11] PH Sinaga, E Ritonga and M Jahari 2017 *Adaptasi Genotipe di Lahan Salin Kabupaten Kepulauan Meranti* (Palembang: Dalam Siti Erlinda et al. (eds) Prosiding Seminar Nasional Lahan Sub Optimal) pp 584 - 593
[12] Pratiwi GR, E Suhartatik, and AK Makarim 2010 *Produktivitas dan komponen hasil tanaman padi sebagai fungsi dari populasi tanaman*. In : S. Abdulrahman, H.M. Toha, dan A. Gani (Eds.). Inovasi Teknologi Padi untuk Mempertahankan Swasembada dan Mendorong Ekspor Beras. Prosiding Seminar nasional Hasil Penelitian Padi 2009 (Subang: Balai Besar Penelitian Tanaman Padi) pp 443-450
[13] Rauf AW, Tohari, P Yudono, and S Kabirun 2005 *J. Pen. Pert. Tan. Pangan* **24** 76-84.
[14] Salahuddin KM, SH Chowhdury, S Munira, MM Islam, and S Parvin 2009 *J. Agric. Res.* **34** 279-285
[15] Sohel MAT, MAB Siddique, M Asaduzzaman, M Alam, and MM Karim 2009 *Bangladesh J. Agric. Res.* **34**: 33-39.
[16] Suhartatik E, AK Makarim, and Ikhwanii 2011 *Respon lima varietas unggul baru terhadap perubahan jarak tanam. Inovasi Teknologi Padi Mengantisipasi Cekaman Lingkungan Biotik dan Abiotik*. Prosiding seminar Nasional hasil penelitian Padi 2011 pp1259-1273.