Improving rice productivity through the new superior varieties of rice in the irrigation land, Jambi Province

J Bobihoe, Jumakir and Endrizal
Balai Pengkajian Teknologi Pertanian (BPTP) Jambi, Jl. Samarinda, Paal V, Kec. Kota Baru, Kota Jambi, Jambi, 36128, Indonesia
E-mail: julistial17@gmail.com

Abstract. New superior varieties of rice have a very important role in improving rice productivity. In Jambi Province, the use of VUB in irrigation land has begun to be in demand by farmers and dominated by Inpari varieties. This activity aims to find out the appearance of several new superior varieties (VUB) of rice and rice productivity on irrigated rice fields. The assessment activity was conducted in Sri Agung Village, Batang Asam District, Tanjung Jabung Barat, Jambi Province from March to July 2019. New superior varieties of rice paddy planted consist of Inpari 12, Inpari 13, Inpari 30, Inpari 32, Inpari 33, Baroma, Inpari Nutri Zinc, and Ciherang on an area of 2 ha. This assessment is carried out through an integrated crop management approach (IPM) with technology components including new superior varieties, legowo jajar planting system, fertilization, disease pest control, harvesting, and post-harvest. The results showed that the highest production is found in the Inpari 30 variety which is 7.30 t/ha because it has more tillers, more grain content, fewer quantities of hollow grain and weighs 1000 seeds heavier than other Inpari varieties.

1. Introduction
In Jambi Province rice crops are an important food crop commodity so this commodity becomes a priority in supporting agricultural programs. In Jambi Province the rice paddy planting area is 133,868 ha, the harvest area is 63,536.06 ha, the productivity is 4.45 tons/ha with a total production of 309,923 tons [1]. The productivity level is still low compared to the potential yield of several new superior varieties of rice that exist today [2].

One of the causes of the low productivity of rice paddy is the use of the same varieties in an area for a long period, so it is no longer able to produce higher because of its limited genetic ability [3]. Therefore, there needs to be a new superior variety, in lieu of old superior varieties that have experienced a decrease in productivity. Efforts to increase rice production in Jambi Province need to plant new superior varieties to production centers.

New superior varieties are one of the breakthrough technological innovations that can increase rice productivity and farmers’ income. VUB is also the most easily adopted technological innovation of farmers because it is cheap and its use is very practical. Superior varieties are one of the components of technology that has a real role in improving the production and quality of agricultural commodities [4]. Furthermore, according to [5] that VUB rice paddy needs to be developed in Indonesia because 1) rice paddy is the main supplier of national rice production so that the planting of VUB will increase the productivity, production, and income of farmers, 2) VUB is rice inhibrida, so seed production is easier and cheaper and quality seed prices are affordable to farmers. The increase in rice production is due to
the use of superior varieties accompanied by better cultivation techniques compared to previous times. New superior varieties are obtained through plant breeding, both conducted by government research institutes and by the seed industry that has an R&D division.

In the next development, seed not only serves as a material for crop purposes but also serves as a means of carrying technological innovation [6]. For example, the advantages of new varieties with new high yields will be felt by farmers if there are enough quality seeds to be planted. Therefore, the seed industry is indispensable to support resilient agriculture, especially to facilitate the spread of superior varieties to farmers and protect the quality produced during the production and distribution process so that the advantages of varieties assembled by breeders get into the hands of seed consumers.

One of the efforts to increase rice production is by planting new superior varieties (VUB) planting system of "jajar legowo" planting line, and balanced fertilization. “Jajar legowo” planting system is a way of planting intermittently 4 rows and 1 empty row. The advantages of the “jajar legowo” planting system are: 1) all rows of clumps of plants are on the edge that usually gives higher yields (side plant effect), 2) pest control, disease, and weeds are easier to implement 3) provide space for water arrangement, snail collecting channels mas or for mina rice and 4) the use of fertilizer is more effective [7]. Thus there will be a population of more marginal plants compared to the tile planting system. Marginal crop productivity is expected to be higher compared to plants in lanes 2 and 3 because edge plants receive more solar intensity and the photosynthesis process is higher and more efficient so that it will produce better. As for anticipating the shortage of artificial fertilizers, the utilization of organic fertilizer, using ruminant animal manure (cow) that is widely maintained by the community in Sari Agung Village, is expected to reduce the use of synthetic fertilizers.

The study aims to determine the growth and yield of rice as well as financial insecurity in the rice crop system of new superior varieties (VUB) with “jajar legowo” planting system in irihasi rice fields in Sri Agung Village, Batang Asam District, Tanjung Barat Regency, Jambi Province.

2. Methods
The assessment was conducted in Sri Agung Village, Batang Asam District, Tanjung Jabung Barat, Jambi Province. The assessment site has a flat topography with a height of 10-15 m above sea level. Rainfall patterns in Sri Agung Village are almost evenly distributed throughout the year with an average rainfall of 2,600 mm year⁻¹. The highest monthly rainfall generally occurs on December or January, the lowest rainfall on August. Usually, the rainy season in Sri Agung Village starts in September or October and the dry season in April or May. In general, the farming system that develops in Sri Agung Village is a food crop-based farming system with planting patterns: rice-rice-Palawija and rice-rice-bare land. Rice is usually planted in the rainy season, the planting time is at the beginning of the rainy season which is on September or October and the harvest is done on January or February. Rice planting time after the first rainy season rice harvest on February or March and harvest on May or June. After the rice harvest, continued with the crops that are soybeans on July or August and the harvest is done on October or November.

Assessment activities were conducted in the dry season from March to July 2016. The new superior varieties of rice fields used to consist of 9 varieties of Inpari consisting of Inpari 12, Inpari 13, Inpari 30, Inpari 32, Inpari 33, Baroma, Inpari Nutrizing, and Ciherang, obtained from Balai Besar Penelitian Tanaman Padi (BB Padi) in Sukamandi, West Java. The assessment was conducted by applying integrated crop management (IPM) technology and farmer methods. Components of rice PTT technology applied at the testing site and farmer technology are listed in Table 1. Soil processing is carried out using tractors. After the first hijacking of the rice fields was flooded for 7 days, then carried out a rake that aims to flatten and soften the soil. The planting system used is the jajar legowo 4:1 pattern which is 4 rows of rice plants interspersed with one empty row. Provision of organic fertilizer in the form of compost with a dose of 1.0 t ha⁻¹ given at the time of processing of the second soil. Inorganic fertilizer administration that is Nitrogen given 46 kg ha⁻¹, P₂O₅ fertilizer, and K₂O given at a dose of 36 kg ha⁻¹ and 22.5 kg ha⁻¹. For pest and plant disease control is carried out with the application of integrated pest management (IPM).
Table 1. Components of rice integrated crop management (IPM) technology and farmer technology in the irrigation paddy fields of Sri Agung Village, Tanjung Jabung Barat Regency - Jambi.

| Components of Technology | Integrated Crop Management (IPM) | Farmer |
|--------------------------|----------------------------------|--------|
| Soil Processing          | Tractor                          | Tractor|
|                          | 1 x plow, 1 x rake               | 1 x plow, 1 x rake |
| Seed                     | Labeled/Quality                  | Labeled/Quality |
| Nursery                  | Wet Nursery                      | Wet Nursery |
| Planting System          | Legowo 4:1                       | Tiles/irregular |
| Age seedlings            | 15-21 days                       | 21 days |
| Varieties                | Inpari 12, Inpari 13, Inpari 30, Inpari 32, Inpari 33, Baroma, Inpari Nutrizinc | Ciherrang |
| Organic fertilizer       | 1 t ha\(^{-1}\)                  | 0      |
| Inorganic fertilizer (kg ha\(^{-1}\)) | 67.5 | 46 |
|                         | P\(_2\)O\(_5\)                    | 36     | 27   |
|                         | K\(_2\)O                          | 22.5   | 11.5 |
| Irrigation (Intermittent) | Intermittent water settings      | Intermittent water settings |
| Pest and disease control | Application of Integrated Pest Management | Application of Integrated Pest Management |

The parameters observed in this test include the agronomic aspect consisting of vegetative and generative phase plant growth. The vegetative phase consists of vigor plant: very sturdy (score 1), sturdy (score 3), medium (score 5) and weak (score 7), the height of plants, and a number of productive saplings. The generative phase consists of the length of the panicle, the amount of grain content, the amount of empty grain, the weight of 1000 grains, and the yield (t ha\(^{-1}\)). Vegetative and generative data of rice plants is tabulated by displaying the average of the observed parameters.

3. Results and discussion

3.1. Performance of plant growth

The diversity of several varieties of rice is quite diverse according to the genetic properties of each variety and environmental conditions (table 2). The aggression of rice crop varieties in the vegetative phase and generative phase shows very sturdy growth to sturdy (score 1-3), unless the Ciherrang variety shows sturdy to moderate growth (score 3-5). The results of the study [8] shows that the diversity of properties of rice plants determined the diversity of the environment and the diversity of genotypes as well as the interaction of both. Furthermore [9] says that the ability of plant adaptation to the environment is influenced by metabolic activity that varies depending on the variety.

There is a variety of plant height of each variety tested which is between 77.87 to 92.47 cm. There is a variation in the height of each plant varieties tested which is between 77.87 to 92.47 cm, the height of this plant is not by the description of new superior varieties of rice where the average height of plants between 93 to 115 cm [2]. The highest plant height is found in the Inpari 30 variety which is 103.2 cm and the lowest is found in the Inpari 12 variety which is 77.87 cm. The occurrence of high variations of
plants is caused because each variety has genetic factors and characters that are different from other words, due to the presence of genes that control the nature of the variety [10]. Plant height is one of the parameters that can see if the plant grows normally or grows in a stressful condition. Normal plant height growth indicates such superior varieties are quite adaptive [10]. Plant height is also one of the selection criteria in rice plants, but high growth has not guaranteed its production level [11].

Table 2. Plant performance, average plant height, and number of productive tillers of several varieties in irrigated land.

| Variety         | Vigor (score) | Plant height (cm) | Number of productive tillers/clumps |
|-----------------|---------------|-------------------|-------------------------------------|
| Inpari 12       | 3             | 77.87             | 18.00                               |
| Inpari 13       | 3             | 89.17             | 19.6                                |
| Inpari 30       | 1-3           | 103.2             | 22.33                               |
| Inpari 32       | 1-3           | 92.6              | 17.8                                |
| Inpari 33       | 1-3           | 94.8              | 18.8                                |
| BAROMA          | 1-3           | 110               | 16.00                               |
| Inpari Nutri Zinc | 1-3         | 90                | 17.00                               |
| Ciherang        | 3-5           | 83.05             | 12.23                               |

Score: 1 = very sturdy, 3 = sturdy, 5 = weak.

The number of productive tillers between varieties also varies from 12.23 – 22.33 tillers, varieties that have the highest number of productive tillers are found in the Inpari 30 variety of 22.33 stems and at least 12.23 Ciherang varieties. The difference in the number of productive tillers is also influenced by the genetic and environmental properties of growing plants, if plants have good genetic properties coupled with favorable environmental conditions or following the growth and development of plants, then rice plants will produce a high number of productive tillers [10]. During the growth of plants, it is expected that all productive tillers will produce panicle because productive tillers affect the high yield of grain. The maximum number of tillers is also determined by the planting distance because the planting distance determines solar radiation, mineral nutrients, and cultivation of the plant itself [12].

3.2. Performance components of rice yields and yields

There is a variation in the length of malai among the varieties tested, the longest malai is found in the Inpari 30 variety which is 25.70 cm, and the shortest inpari 12 variety which is 20.77 cm. The longer the malai of rice plants the more branches each malai, each branch there is a grain of rice. The number of grains of rice in each branch of malai depends on the varieties of rice planted and cultivated plants. The amount of grain content of superior varieties tested there is a variation between 49.06 to 119.00 grains. The highest amount of grain content is found in the Inpari 30 variety which is 119.00 grains and the lowest in ciherang varieties which is 49.06 grains. The highest amount of empty grain found in ciherang varieties is 31.00 grains and the lowest is found in the Inpari 30 variety which is 21.2 grains.

The amount of grain contents and empty grain is one component of the results that will affect rice yields, the higher the percentage of empty grain, the greater the influence on rice yields, where the higher the hollow seed results in low rice crop production. The amount of grain content per malai has a real correlation with the result, so the amount of grain content per malai is one of the reference selection criteria to get a high result [12].

The weight of 1000 grains is highest in the Inpari 30 variety which is 29.6 g and the lowest in Ciherang varieties which is 24 g. The weight of 1000 grains indicates that the variety contributes to the increase in rice production which is one of the component factors that determine the yield of grain (table 3). The highest production is in the Inpari 30 variety which is 7.3 t ha\(^{-1}\) and the lowest production is found in the Ciherang variety which is 4.9 t ha\(^{-1}\). Ciherang varieties are varieties commonly grown by farmers. The highest production is in the Inpari 30 variety which is 7.3 t ha\(^{-1}\) because it has more tillers
(22.33 stems), more grain content (119 grains), fewer empty grain (21.2 grains) and weighs 1000 seeds heavier (29.6) compared to other varieties. Rice yield is determined by the resulting component such as the amount of grain content per malai and the weight of 1000 grains. The nature of the component results between each other has a close relationship, the imbalance between the components of the result will greatly affect the potential results obtained.

**Table 3.** The average length of panicles, number of filled grains, number of empty grains, the weight of 1000 grains, and yields of several new high yielding varieties in irrigated land.

| Variety           | Long of Panicle (cm) | Number of filled grain/panicles (grain) | Number of empty grain/panicle (grain) | Weight of 1000 seeds (g) | Yield (t ha\(^{-1}\)) |
|-------------------|----------------------|----------------------------------------|--------------------------------------|--------------------------|----------------------|
| Inpari 12         | 20.77                | 50.66                                  | 22.67                                | 24.70                    | 5.08                 |
| Inpari 13         | 23.46                | 52.00                                  | 19.33                                | 24.05                    | 6.11                 |
| Inpari 30         | 25.70                | 119.00                                 | 21.20                                | 29.60                    | 7.30                 |
| Inpari 32         | 21.60                | 115.00                                 | 28.40                                | 28.80                    | 7.00                 |
| Inpari 33         | 24.00                | 95.20                                  | 45.10                                | 28.50                    | 6.70                 |
| BAROMA            | 25.67                | 105.00                                 | 30.40                                | 26.04                    | 6.80                 |
| Inpari Nutri Zinc | 25.45                | 99.90                                  | 21.40                                | 25.56                    | 6.90                 |
| Ciherang          | 21.04                | 49.06                                  | 31.00                                | 24.00                    | 4.90                 |

The new superior varieties of Baroma and Inpari Nutri Zinc are new varieties and have the potential to be developed in the irrigation paddy fields of Jambi Province. Baroma variety is a premium rice substitute variety, especially Basmati, Basmati type rice that has been available can only be grown in the northern part of India and Pakistan, so for the fulfillment of rice is still to be imported and the price is relatively expensive. Baroma has an average yield of 6.01 t ha\(^{-1}\) of dry milled grain and yield potential of 9.18 t ha\(^{-1}\) that higher than Basmati varieties. This variety has a shorter appearance than Basmati with larger plant stems. Baroma varieties have a plant height of approximately 112 cm with a productive number of tillers approximately 17 stems. The harvest age of Baroma varieties is about 113 days after the spread. Amylose variety is 25.55% with the texture of rice “pura” and rice lengthening after the cooking process by 1.5 times. The resistance of this variety to pests and diseases is better when compared to Basmati. Baroma is suitable to be cultivated on irrigated rice fields at an altitude of 0 to 600 m above sea level. Baroma is premium rice that must be maintained the integrity of the rice grain, it needs special post-harvest handling especially when grinding because the shape of the grain is small and long, so the possibility of large fractures [2].

Inpari IR Nutri Zinc has many advantages over several other varieties in terms of Zn content. Based on the description data issued through the Decree of the Minister of Agriculture in 2019, that the content of Zn in the variety is 34.51 ppm while other varieties such as Ciherang have content of 24.06 ppm. The excellence is expected to contribute to the success of government programs in addressing zinc malnutrition and minimizing stunting in Indonesia. Zn deficiency in the body in addition to the result of decreased endurance, productivity, and quality of human life, Zn malnutrition is also one of the factors of stunting. This variety has an amylose content of 16.6%. In addition to being rich in nutrients, this variety also has high productivity, resistant to WBC, Blas, and Tungro, as well as good rice flavor. A healthy lifestyle that continues to grow encourages the increasing needs of the community for healthy food.

**4. Conclusions**

New superior varieties by planting legowo jajar planting system, obtaining high yields namely Inpari 30 (7.30 t ha\(^{-1}\)), Inpari 32 (7.00 t ha\(^{-1}\)). This production is influenced by the longest malai, the least amount
of empty grain, and the weight of the highest 1000 grains. New superior varieties of Baroma and Inpari Nutri Zinc have the potential to be developed in irrigated rice fields. The advantages of Baroma varieties are substitutes for Basmati rice and Inpari Nutri Zinc with a Zinc content of 34.51 ppm is expected to contribute to the success of government programs in addressing malnutrition and minimizing stunting in Indonesia.

Acknowledgment
The author would like to thank the Head of the Tanjung Jabung Barat District Agriculture Office, Batang Asam Sub-District Head, Rahmat and Syaefullah (Farmers), Batang Asai District Field Extension Officers, who have helped in the implementation of the activities in Batang Asam Sub District, Tanjung Jabung Barat District Jambi Province.

References
[1] BPS 2020 *Jambi Province in Figures* (Jambi: Central Statistics Agency (BPS) Jambi Province)
[2] Priyatna S, Satoto, Rahmani, Nurwulan A, Dody D H, Surihanto, Agus G and Suhana 2019 *Description of New Superior Varieties of Rice. Agricultural Research and Development Agency* (Jakarta: Indonesian Agency of Agricultural Research and Development, Ministry of Agriculture)
[3] Makarim A K, Irsal L, Fagi A M, Widiarta I N and Pasaribu D 2004 *Padi Tipe Baru, Budidaya dengan Pendekatan Pengelolaan Tanaman Terpadu* (Sukamandi: Balai Penelitian Tanaman Padi) p 48
[4] Daradjat A A 2001 *Participatory breeding programs in rice*: Concepts and Realizations. Workshop and Alignment of Superior Varieties of Horticultural Commodities through the Implementation of the Shuttle Breeding Program Jakarta
[5] Abdullah B, Tjokrowidjojo S and Sularjo 2008 Perkembangan dan prospek perakitan padi tipe baru di Indonesia *Jurnal Litbang Pertanian* 27 (1) 1-9
[6] Nugraha U S 2004 Legislasi, kebijakan, dan kelembagaan pembangunan perbenihan *Perkembangan Teknologi TRO* XVI (1) 61
[7] Zaini Z, Diah W S and Syam M 2004 *Petunjuk Lapang Pengelolaan Tanaman Terpadu (PTT) Padi Sawah. Meningkatkan Hasil dan Pendapatan, Menjaga Kelestarian Lingkungan* (Jakarta: Center for the Study and Development of Agricultural Technology) p 57
[8] Satoto and Suprihatno B 1998 Heterosis dan stabilitas hasil hibrida-hibrida padi turunan galur mandul jantan IR62829A dan IR58025A *Jurnal Penelitian Pertanian Tanaman Pangan* 17 (1) 3-37
[9] Vegara B S 1982 *Low-temperature problems in growing rice* (Los Banos Philippines: Lecture Notes gev Training at IRRI)
[10] Irmadamayanti A, Risna, Purnarahardjo Y and Syafruddin 2019 The appearance of VUB Inpari 30 and Inpari 36 rice on irrigated super “jajar legowo” system planting in Sigi Regency, Central Sulawesi *Proceedings of the National Seminar on Indonesian Biodiversity* 5 (2) 267-271
[11] Rubiyo, Suprapto and Dradjat A 2005 Evaluasi beberapa galur harapan padi sawah di Bali *Buletin Plasma Nutfah* 11 (1) 6-10
[12] Simanulang Z A 2001 *Kriteria Seleksi untuk Sifat Agronomis dan Mutu* Pelatihan dan Koordinasi Program Pemuliaan Partisipatif (Shuttle Breeding) dan Uji Multilokasi. Sukamandi 9-14 April 2001 (Sukamandi Subang: Balitpa)