Agronomical performance and economic feasibility of new superior rice variety planted on the irrigated field in Jayapura, Papua

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Abstract. The study aims to evaluate the agronomical performance of new superior varieties of rice in irrigated fields cultivated through the Integrated Crop Management approach and the feasibility of the farming system. The research was carried out in Koya Barat, a region in District Muara Tami, Jayapura City, Papua Province in April - October 2019. The research used a single factor randomised block design with four new superior rice varieties as treatment at five replications. The varieties were Inpari 36, Inpari 37, Inpari 43, and Ciherang. The data were analysed using analysis of variance (ANOVA) and followed by DMRT to determine the differences between treatments. The R/C ratio, marginal B/C analysis and the break-even point (BEP) were analysed to determine the economic feasibility. The results showed that the performance of each variety varied following their genetic traits. The highest rice production was obtained from Inpari 37 variety (6.86 t/ha), while Ciherang produced the lowest yield (4.34 t/ha). Inpari 37 and Inpari 43 provided higher profit compared to Ciherang and Inpari 36 with R/C values of 3.43 and 3.42, respectively. The highest market acceptance of Inpari 37 was valued at IDR 29,498,000 followed by Inpari 43 at Rp 29,412,000, then Ciherang at IDR 18,662,000 and lastly, the Inpari 36 at IDR 25,542,000. Economically, rice farming is feasible to be developed because it has an R/C ratio of > 1. The irrigated rice farming in Jayapura City is profitable with a rate of around 2.42 % of the total cost spent.

1. Introduction
Closing or minimising the yield gap through the introduction of rice varieties is one of the efforts to increase rice production. The use of superior seeds plays a role in influencing the increase in rice production. Some of the benefits that can be obtained from the use of superior seeds include a reduction in the number of seeds used to avoid over-replanting and high germination rate. Strict early growth maintenance can reduce the problem of weeds and increase the ability of plants against pests/diseases. The combination of these factors can increase the results 5 - 20% [1]. The Indonesian Agency for Research and Development has released more than 100 varieties that have the advantage of high yield potential, early maturity, and resistance to abiotic stress [2].

The provision of superior varieties plays a prominent role among technological components produced through research, both in their contribution to increasing the yield per unit area and as a component in controlling pests and diseases [3]. Besides, superior varieties are considered easy to adopt
by farmers with additional costs that are relatively inexpensive and provide direct benefits to farmers [3]. With more superior varieties being released continuously, farmers have more choices of varieties that are under the need and specifics of their region. This will broaden the genetic diversity of plants in the field to reduce the risk of certain pests and disease outbreaks [4].

The Integrated Crop Management (ICM) is an innovative approach that prioritises the synergy of various technological components in a technology package which increase the efficiency of input use and yield at the same time. ICM itself is an innovative approach that considers harmony and synergy between the components of production (cultivation) and local environmental resources [4]. Thus, the technological package prepared is site-specific, which can produce synergism and high efficiency, as a tool for managing site-specific plants and resources [5].

Application of the ICM model of lowland rice can increase grain yield by 1.0 ton/ha compared to farmers (non-ICM) technology. The application of the ICM model of lowland rice using a variety of Membramo produced harvested dry grain (HDG) of 6.172 tons/ha [6]. The application of ICM using Ciherang varieties produced HDG results of 7.6 to 8.2 tons/ha while farmers’ technology was only around 4.3 tons/ha [7, 8], reported that the use of lowland rice new superior variety (VUB) with the application of ICM could increase MPD yield by 11.1% and increase profits by 23.1% compared to local varieties. Various efforts made to achieve this are through expanding the role of technological innovations in new superior rice varieties and implementing integrated crop management innovations [9, 10]. One of the superior-rice varieties that has a fluffier rice flavour and higher production than IR64 varieties is Mekongga [11].

Although in recent years, Indonesia has experienced a slow rate in increase lowland rice production as a result of the conversion of agricultural land to non-agricultural land, opportunities for increasing productivity and rice production are still wide open, among others through the application of technological innovations of new high yielding rice varieties with high productivity [4]. In addition, farmers have not used ICM basic technological innovations such as the provision of organic materials by returning straw to the rice fields, an optimum regulation of plant populations by applying legowo planting system, fertilising based on crop needs and soil nutrient status, and controlling plant pests with integrated pest management. In this regard, the increase in rice production faces increasingly severe challenges for years due to decreasing productive paddy fields, limited fertile land, and the threat of climate and disease pests that can arise at any time and the minimal use of new superior rice variety

The area of rice planting in Jayapura City is 1,140 ha, producing 4,119 tons of rice. The productivity of paddy rice was 3.68 tons/ha [12]. Based on these data, the average level of rice productivity is still low when compared to the yield potential, which can reach 8.0 tons/ha [13]. Some of the reasons of low rice production are limited genetic capabilities of existing superior varieties, the use of the same variety in an area over a long period which can lead to the rapid process of breaking the resistance of varieties to pests and attacks plant-disturbing organisms [14, 15]. Therefore, the introduction and adaptation of rice which has high productivity and has pest and disease resistance are required.

The study aims to evaluate the agronomic performance of new superior varieties of rice in irrigated paddy fields cultivated through the Integrated Crop Management (ICM) approach as well as the farming feasibility on an irrigated paddy field.

2. Material and Methods

2.1. Time and location of research
The research conducted at Sub-district Koya Barat, District Muara Tami, Jayapura City, from April to August 2019. The field used was 5 ha irrigated rice field.

2.2. Material and equipment
The rice seeds consisted of 4 varieties, namely Inpari 36, Inpari 37, Inpari 43, and Ciherang. The other materials are NPK phonska fertiliser (15:15:15), Urea, SP36, pesticides and herbicides. The equipment
included: hand tractor, hand sprayer, hoe, *Indo Jarwo Transplanter* 4; planting equipment, scales, ruler and combine harvester.

### 2.3. Method

The present study used a single factor randomised block design with four new superior rice varieties as treatments and five repetitions. The varieties used were *Inpari 36, Inpari 37, Inpari 43 and Ciherang*. A 25 kg each variety was used, making a total of 125 kg of seed for 5 ha. Before the seeds were planted, they were first exposed to air for 48 hours and subsequently were sown through the *Dapog* system of planting. *Dapog* size was 18 x 56 cm with around 100 -125 grams of seeds/dapog. After the seedlings were aged 18 HSS were planted using the *Indo Jarwo Transplanter* planting tool, planting system 4: 1 (spacing 20 x 10 x 40 cm). Table 1 shows the detail rice plantation technology package.

**Table 1.** The rice plantation technological package.

| Component               | Crop Management                      |
|-------------------------|--------------------------------------|
| Field management        | Complete                             |
| Varieties               | *Inpari 36, Inpari 37, Inpari 43, Ciherang* |
| Seeds                   | 25 kg/ha                             |
| Nurseries               | Wet nursery                          |
| Plants per hole         | 1 – 2                                |
| Planting system         | Legowo 4:1                           |
| Fertilisation           | Urea 100 kg/ha, NPK 200 kg/ha and SP-36 50 kg/ha |
| Weeding                 | Integrated control of weed           |
| Control of pests and diseases | Integrated pest management                  |
| Harvest and Postharvest | On-time, processing with tools and machine |

The fertiliser dosage was determined based on soil analysis using the soil test equipment (PUST calculation) [16]. The recommended dosage of fertiliser at the study site based on PUTS version 1.0 is shown in Table 2.

**Table 2.** Fertiliser dosage.

| Class of soil sample | Minerals nutrition | Single and Compound fertilisers (kg/ha) |
|----------------------|---------------------|-----------------------------------------|
|                       | N  | P  | K  | Ph | NPK | NPK | Additional single fertiliser | Dolomite |
|                       |    |    |    |    | Phonska (15-15-15) | Pelangi (20-10-10) |                                  | Urea | SP36 | KC |
| High                  | Moderate | High | Rather acidic | 350 | 240 | 200 | 50-75 | 50 | 250 |

Source: primary data, 2020 (processed)

Basic fertilisation was done by giving urea as much as 100 kg/ha together with NPK 200 kg/ha, SP-36 50 kg/ha, on 14 days after planting (HST). Additional urea fertilizer was given in the active tillers phase (28 HST) Urea 50 kg/ha, NPK 50 kg/ha, and when *primordia* (50-60 HST) Urea 50 kg/ha. Chemical control of weeds was done 21 days after planting (DAP) and repeated 30 of DAP with a 200 D clipper herbicide (3 cc/l of water). Pest control was done by giving Furadan 3G (30 kg/ha) together with basic fertilisation (14 DAP). Furthermore, pest control was carried out by monitoring, if there were pests and diseases attacked in the vegetative phase or generative phase, then spraying was carried out.

Weed control was done by using pre-emergence herbicides combined with manual weeding while controlling pests and diseases based on Integrated Pest Control (IPC).
2.4. Observation and data collection
Observations were made on ten plants that were diagonally randomised. Variables observed were crop performance (maximum plant height), yield components (number of productive tillers, number of panicles per clump/stem), the yield of unhusked rice harvested per plot weighed in a tile (2.5 x 2.5), as many as three samples per plot, then converted to hectares.

2.5. Data analysis
The collected data were analysed statistically using analysis of variance (ANOVA) and further tested with DMRT at 5% significant level to determine differences between treatments, whereas to find out the level of farm feasibility, the data were analysed using R / C ratio, and Marginal B / C and the break-even point (BEP) of production and price was calculated.

3. Result and Discussions

3.1. Performance of existing technology
One of the success factors in the management of rice farming is determined through the use of production inputs. The use of optimal production inputs will produce maximum production and ultimately provide relatively high farm profitability. The recommended dosage of the use of production inputs such as fertilisation is known to farmers. Still, in practice, not all farmers apply the recommended dosage due to different levels of understanding. Based on the results of discussions with farmers and agriculture instructor, lowland rice farming is carried out by farmers in a field of 0.50-1.0 ha (an average of 0.75 ha/farmer). Farmers use varieties that are available from their harvest, and the seeds came from local government and the varieties used have been used continuously for several years. More than 60% of the rice seeds used by the community came from the informal sector in the form of grain that was set aside from the previous season's harvests which were done repeatedly [17]. Farmers only use inorganic fertilisers (artificial fertilisers), and there are no farmers who use organic fertilisers for planting paddy fields. The use of fertiliser doses is believed to be far from recommendations.

3.2. Components of plant growth
Data on growth components, including plant height and number of productive tillers, are shown in Table 3. The results of the statistical analysis showed that the plant height of the four varieties studied had a significant effect (P <0.05). The average plant height at 30 DAP using Inpari 36 was 86.40 cm (highest) and the Inpari 43 with 44.20 cm (shortest). The plant height at harvest showed that Inpari 36 had the highest height of 132.40 cm followed by Inpari 37 (126.80 cm) and Inpari 43 (126.40 cm) while the shortest was Ciherang at 102.20 cm.

The difference in plant height of the four varieties tested may be due to the genetic traits of the varieties and the influence of environmental conditions. Plant height is also one of the selection criteria in rice plants, but high growth does not guarantee the level of production [18]. Growth is a process in plant life that results in changes in size, weight gain, volume and diameter of the stem over time. Growth factors control the success of a plant's growth. Two important factors influence the growth of a plant, genetic and environmental factors. Genetic factors are related to the inheritance of the nature or behaviour of the plant itself, while environmental factors are related to the environmental conditions in which the plant grows. Each plant variety has different abilities in terms of utilising growth facilities and the ability to adapt to the surrounding environment, thereby affecting the potential yield of plants.

The number of productive tillers has a direct effect on the number of panicles produced. The more productive tillers, the higher the grain will be obtained. The average number of productive tillers shows a real difference. The ability to form productive offspring is influenced by the interaction of the genetic traits of varieties and their growing environment [19]. The highest number of 30 HST tillers was obtained from Ciherang variety (25.00 bushes/stems) and the lowest was from Inpari 43 variety (19.60 bushes/stems) but was not significantly different from Inpari 36 and Inpari 37.
In comparison, the number of tillers at harvest showed that *Inpari 36* had a higher number of tillers (Table 3). This shows that *Inpari 33* and *32* were able to adapt to growing conditions and rainfed land. The number of productive tillers/clump or tillers/unit area is a determinant of the number of panicles, which is one component of the yield that directly affects the level of grain yield [11]. There is a correlation between the number of panicles with the results because the more the number of panicles the higher the yield of rice plants, [20] showed that the number of panicles had a significant positive correlation with crop yields. The number of tillers is also related to the phyllochron formation period. Phyllochron is the period in which one stem cell, leaf and root arise from the base of the plant and the subsequent germination. When older seedlings were moved to the field, the less the number of phyllochron produced. When the younger seedlings are transferred, the more the number of phyllochron produced so that the number of tillers can be produced [21]. The results of observations of yields for each rice varieties are shown in Table 4.

### Table 3. Average measurements of plant height (cm) and several productive tillers (tillers) of each treatment.

| Variety  | Plant Height (cm) | Number of Tillers |
|----------|------------------|------------------|
|          | 30 DAP | At harvest | 30 DAP | At harvest |
| *Inpari 36* | 86.40 a | 132.40 a | 20.40 a | 23.4 a |
| *Inpari 37* | 82.20 a | 126.80 a | 21.00 a | 13.2 b |
| *Inpari 43* | 44.20 b | 126.40 a | 19.60 a | 18.4 ab |
| *Ciherang* | 86.20 a | 102.20 b | 25.00 a | 13.6 b |

Note: The numbers followed by the same letter in the same column are not significantly different in the DMRT Test of 5% significant level.

### Table 4. The average yield of the four rice varieties.

| Variety  | Panicle length (cm) | Grains per panicle | Fertile grains (%) | Sterile grains (%) | Weight of 1,000 seed | Yield (ton h⁻¹) |
|----------|---------------------|--------------------|-------------------|-------------------|----------------------|----------------|
| *Inpari 36* | 24.30 a | 122.4 b | 67.93 a | 32.07 a | 24.14 c | 5.94 b |
| *Inpari 37* | 24.74 a | 138.0 b | 83.12 a | 16.88 a | 24.78 b | 6.86 a |
| *Inpari 43* | 24.32 a | 199.6 a | 82.48 a | 17.52 a | 26.18 a | 6.84 a |
| *Ciherang* | 24.16 a | 143.6 b | 89.28 a | 10.72 a | 25.00 b | 4.34 c |

Note: The numbers followed by the same letters in the same column are not significantly different in the DMRT Test of 5% significant level; * Transformation of arc-sin data

Statistical data showed that panicle lengths in the four varieties tested were not significantly different. The greater the number of tillers, the more chances to produce a large number of panicles. Likewise, with the length of panicle, the longer the panicle of the plant, the higher opportunity to produce more and more grains.

The results of the analysis of variance showed that the productivity was significantly different, where the highest yield was directed by *Inpari 37* variety (6.86 tons/ha) and *Inpari 43* (6.84 tons/ha) then followed by *Inpari 36* variety (5.94 tons/ha) and *Ciherang* variety (3.34 tons/ha). Sirappa *et al.* (2009) [26], stated that the introduction of VUB supported by technology could give results 21-54% higher. Rohana and Asnawi (2012) [24] stated that rice yield is determined by yield components that are influenced by environmental, genetic factors in which the variety is planted.
3.3. Farming financial analysis
The ratio of acceptance of the input costs used while farm income was calculated by finding the difference between the value of the results and the cost of production to measure the level of ability to return the cost of farming. Table 5 shows that farm acceptance from the four varieties that varies greatly. The highest estimation of Inpari 37 variety is IDR 29,498,000, followed by Inpari 43 variety which is IDR 29,412,000, followed by Inpari 36 variety and Ciherang variety. The ratio of total income to all costs incurred reached >1 while the R/C value of Inpari 37 and Inpari 43 varieties were 3.43 and 3.42, respectively. This shows that the Inpari 37 variety and Inpari 43 variety are feasible to be cultivated if the R/C was 2 [22].

| Description                | Unit       | Inpari 36 | Inpari 37 | Inpari 43 | Ciherang |
|----------------------------|------------|-----------|-----------|-----------|----------|
| Yield                      | (Kg/ha)    | 5,940     | 6,860     | 6,840     | 4,340    |
| Selling price harvested grain yield | (IDR/Kg)  | 4,300     | 4,300     | 4,300     | 4,300    |
| Variable cost              | (IDR)      | 6,960,000 | 6,960,000 | 6,960,000 | 6,960,000|
| Fixed cost                 | (IDR)      | 1,650,000 | 1,650,000 | 1,650,000 | 1,650,000|
| Total cost                 | (IDR)      | 8,610,000 | 8,610,000 | 8,610,000 | 8,610,000|
| Receipt                    | (IDR/ha)   | 25,542,000| 29,498,000| 29,412,000| 18,662,000|
| Income                     | (IDR)      | 16,932,000| 20,888,000| 20,802,000| 10,052,000|
| R/C                        |            | 2.97      | 3.43      | 3.42      | 2.17     |
| B/C                        |            | 1.97      | 2.43      | 2.42      | 1.17     |

Source: Primary data, 2019 (processed)

Based on the analysis, results showed that from the four rice varieties, the highest net profit obtained was from Inpari 37 with a total of IDR 29,498,000, then Inpari 43 variety with IDR 29,412,000, followed by Inpari 36 and Ciherang varieties accounted for IDR 25,542,000 and IDR 18,662,000, respectively. The income differs from the two varieties because the yield was limited at 6.84 and 4.34 t/ha, respectively. The highest B/C values are found in Inpari 37 variety (2.43) followed by Inpari 43 variety (2.42). According to [23]. If B/C was lower than 1, it means that the variety gives added value and farming Inpari 37 and Inpari 43 varieties can be profitable in agribusiness scale.

The economic feasibility analysis showed that the ICM method can increase the productivity of lowland rice. In line with the statement of [24], the application of the technology component of lowland rice with the ICM method can grow and produce yield. Hence, this can be used as a model for developing lowland rice to increase rice production. In comparison, the results of research conducted in South Sulawesi on the introduction of the ICM model showed better additional income (IDR 5,089,400/year) or an increase of around 512% [20].

3.4. Break-even points analysis
The break-even point analysis of production in lowland irrigated rice farming was carried out to determine the relationship between farming costs, revenue and production volume. The break-even point for production and price is mathematically the point of intersection between the revenue and total costs when the profit is zero. This intersection describes the level of production and the minimum price that must be accepted to regain the capital. In other words, the total value of revenue is the same as the total cost. The results of the break-even point analysis for production is presented Table 6. The superior varieties of rice appear to give more benefits where Inpari 37 rice variety obtained revenue of IDR 20,888,000, followed by Inpari 43 variety of IDR 29,412,000 per farming season producing 6,860 t/ha and 6,840 t/ha, respectively with a selling price of IDR 4,300/kg.
Table 6. Analysis of break-even points.

| Description                        | Inpari 36 | Inpari 37 | Inpari 43 | Ciherang |
|-----------------------------------|-----------|-----------|-----------|----------|
| Total cost (IDR)                  | 8,610,000 | 8,610,000 | 8,610,000 | 8,610,000 |
| Yield (kg)                        | 5,940     | 6,860     | 6,840     | 4,340    |
| Harvested dry grain cost (IDR/kg) | 4,300     | 4,300     | 4,300     | 4,300    |
| Break-even point of earnings (IDR)| 2,268,041 | 2,156,862 | 2,161,666 | 2,631,580 |
| Break-even point of yield (Kg/ha) | 345.9     | 285.2     | 283.3     | 603.9    |
| Break-even point of cost (IDR/kg) | 1,449.5   | 1,255.1   | 1,258.8   | 1,983.9  |

Source: Primary data, 2020 (processed)

4. Conclusions
The growth and production of Inpari 37, Inpari 43, Inpari 36 and Ciherang varied, according to its genetic traits. The highest yield was obtained from Inpari 37 (6.86 tons/ha) HDG, followed by Inpari 43 (6.84 tons/ha) HDG, and Inpari 36 (5.94 tons/ha) HDG while the lowest yield was obtained from Ciherang (4.34 t/ha) HDG. The Inpari 37 and Inpari 43 were superior varieties that provide a high economic return compared to that of Inpari 36 and Ciherang with R/C values of 3.43 and 3.42, respectively. Integrated crop and resource management can be used as a model for developing lowland rice to support the Jayapura City regional government program.

Contribution
Pertrus A Beding and Batseba M W Tiro are the main contributor, Frasiskus Palobo, Rohimah H. S Lestari and Merlin Rumbarar are a member contributor.

References
[1] Abidin Z 2011 Analisis struktur biaya, keuntungan dan titik impas usaha penangkaran benih padi di Kabupaten Konawe Sulawesi Tenggara (Analysis of the cost structure, profit and break-even point of rice seed breeding in Konawe District, Southeast Sulawesi) Pengkaj. dan Pengemb. Teknol. Pertan. 14 91–9 [In Indonesian]
[2] Krishmawati A, Arifin Z 2011 Stabilitas hasil beberapa varietas padi lahan sawah (Yield stability of several varieties of rice fields) Pengkaj. dan Pengemb. Teknol. Pertan. 14 2 84–92 [In Indonesian]
[3] Pusat Penelitian dan Pengembangan Tanaman Pangan2000 Deskripsi varietas unggul tanaman padi dan palawija 1999-2000 (Description of superior varieties of rice and secondary crops 1999-2000) (Jakarta: Badan Penelitian dan Pengembangan Pertanian) [In Indonesian]
[4] Badan Litbang Pertanian 2007 Pengelolaan tanaman terpadu (PTT) padi sawah irigasi: petunjuk teknis lapang (Integrated crop management (ICM) for irrigated lowland rice: field technical instructions) (Jakarta: Badan Litbang Pertanian) [In Indonesian]
[5] Hasanuddin A, Baihaki S E, Munarso S J, Noor S 2000 Teknologi unggulan peningkatan produksi padi menuju revolusi hijau generasi kedua (The superior technology of increasing rice production towards the second generation of green revolution). Simposium Peneliatan Tanaman Pangan IV, Puslitbang Tanaman Pangan Bogor pp 154-165 [In Indonesian]
[6] Rachman B, Saryoko A 2007 Analisis sensitivitas padi sawah di Lebak Banten (Lowland rice sensitivity analysis in Lebak Banten) Pengkaj. dan Pengemb. Teknol. Pertan. 14 2 91–9 [In Indonesian]
[7] Sirappa M P, Susanto A N, Toha Y 2006 Kajian usaha tani padi sawah varietas unggul tipe baru dengan pendekatan pengelolaan tanaman terpadu (Study of lowland rice cultivation of new types of superior varieties using an integrated crop management approach) Pengkaj. dan Pengemb. Teknol. Pertan. 9 1 18–28 [In Indonesian]
[8] Arafah 2011 Kajian pemanfaatan pupuk organik pada tanaman padi sawah di Pinrang Sulawesi
Selatan (Study on the utilization of organic fertilizer in Paddy Rice in Pinrang, South Sulawesi) 
Pengkaj. dan Pengemb. Teknol. Pertan. 14 1 11–8 [In Indonesian]

[9] Pikukuh B, Setyorini, Handoko, Purwoko M 2007 Inovasi varietas padi (Rice variety innovation) (Malang: Balai Pengkajian Teknologi Pertanian Jawa Timur) [In Indonesian]

[10] Suhendra T, Kushartanti E, Munarso S J 2008 Keragaan beberapa varietas unggul baru padi di lahan sawah irigasi desa Pulir, Kecamatan Mojolaban, Kabupaten Sukohardjo (The performance of several new superior varieties of rice in the irrigated rice fields of Pulir Village, Mojolaban District, Sukohardjo Regency). Prosiding Seminar Apresiasi Hasil Penelitian Pada Menunjang P2BN 2008 pp 245-264 [In Indonesian]

[11] Simanulang Z A 2001 Kriteria seksi untuk sifat agronomis dan mutu (Section criteria for agronomic properties and quality). Pelatihan dan Koordinasi Program Pemuliaan Partisipatif (Shuttle Breeding and Uji Multilokasi) 2001 Balita Sukamandi [In Indonesian]

[12] Badan Pusat Statistik 2018 Kota Jayapura dalam angka 2018 (Jayapuran city in figures) (Jayapura: Badan Pusat Statistik Kota Jayapura) [In Indonesian]

[13] Suprihatno B, Daradjat A A, Satoto, Baehaki S E, Widiarta I N, Setyono A, Indrasari S D, Lesmana O S, Sembiring H 2009 Deskripsi varietas padi (Description of rice varieties) (Subang: Balai Besar Penelitian Tanaman Padi, Departemen Pertanian) [In Indonesian]

[14] Abdullah B, Djokowidjoso S, Sularjo 2008 Perkembangan dan prospek perakitan padi tipe baru di Indonesia (The development and assembly of new plant type prospects in Indonesia) Penelit. dan Pengemb. Pertan. 27 1 1-9 [In Indonesian]

[15] Suprihatno B, Estria FP, Widiarto Y P, Poniman, Kustiono G, Mardjuki, Bastian A 2009 Keragaan galur-galur padi sawah generasi menengah pada berbagai agroekosistem. Inovasi Teknologi padi Menganitispasi Perubahan Iklim Global Mendukung Ketahanan Pangan, Buku 1 (Rice Technology Innovation to Anticipate Global Climate Change to Support Food Security, book 1) (Bogor: Badan Litbang Pertanian) pp 937-1329 [In Indonesian]

[16] Jamil A, Abdulrachman S, Syam M 2014 Dinamika anjuran dosis pemupukan N, P, dan K pada padi sawah (The dynamics of the recommended dosage of N, P, and K fertilization in lowland rice) Iiptek Tanaman Pangan 9 2 63-77 [In Indonesian]

[17] Daradjat A A, Setyoana, Makarim A K, Hasanuddin A 2008 Padi:Inovasi teknologi produksi, buku 2 (Rice: Production technology innovation, book 2) (Jakarta: LIPI Press) [In Indonesian]

[18] Rubiyo, Supraptio, Daradjat A A 2005 Evaluasi beberapa galur harapan padi sawah di Bali (Evaluation of several hope lines for lowland rice in Bali) Buletin Plasma Nutfah 11 1 6-10 [In Indonesian]

[19] Endrizal, Bobihoe J 2010 Pengujian beberapa galur unggul padi dataran tinggi di Kabupaten Kerinci Propinsi Jambi (Testing of several superior lines of upland rice in Kerinci Regency, Jambi Province) Pengkaj. dan Pengemb. Teknol. Pertan. 13 175–84 [In Indonesian]

[20] Muliai A, Pratama R H 2008 Korelasi antara komponen hasil dan hasil galur harapan padi sawah tahan tungro (Correlation between yield components and yields of tungro resistant lowland rice lines). Prosiding Seminar Nasional Padi: Inovasi teknologi padi mengantisipasi perubahan iklim global mendukung ketahanan pangan 1 165–71 [In Indonesian]

[21] Sunadi 2008 Modifikasi paket teknologi SRI (system or rice intensification) untuk meningkatkan hasil padi sawah (Oryza sativa L) (Modification of the SRI (system of rice intensification) technology package to increase lowland rice yields (Oryza sativa L)). Doctoral Thesis, Andalas University Padang [In Indonesian]

[22] Swastika D K S2004 Beberapa teknis analisis dalam penelitian dan pengkajian teknologi pertanian (Some technical analyses in research and assessment of agricultural technology) Publitbang Sos. Ekon. Pertan. 7 1 90-103 [In Indonesian]

[23] Horton D 1982 Partial budget analisisys for on-farm potato research Technical Information 16 Internarional Potato Center Lima Peru1-17

[24] Arafah 2005 Pengkajian intensifikasi padi sawah berdasarkan pengelolaan tanaman terpadu di
Kabupaten Pinrang Sulawesi Selatan (Paddy rice intensification study based on integrated crop management in Pinrang Regency, South Sulawesi) Penelit. dan Pengemb. Sos. Ekon. Pertan. Bogor 8 2 165-175 [In Indonesian]