Performance of high yielding varieties of rice in two planting season in the irrigated lowlands of South Kalimantan

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Abstract. Lowlands in South Kalimantan are only about 54,455 ha (9.9%) of the total rice field area of 549,988 ha, most of them are irrigated paddy field that has been planted twice. The average productivity of rice in South Kalimantan is still low, which is around 4.46 t/ha milled dry grain. Rice productivity can be increased by the use of new high yielding varieties. In paddy fields, the use of new high yielding varieties with 2 seasons plantations is expected to increase rice production in the 2017 year in South Kalimantan which produces 2.25 million tons of rice. To find out the adaptation and yield of high-yielding rice, a study has just been carried out in rice fields in South Kalimantan. The activity was carried out in the village of Harapan Masa, Tapin Selatan sub-district, South Kalimantan district during the two planting seasons: Rainy season 2015/2016 and dry season 2016. Rice planted in rainy season 2015/2016 are varieties of Inpari-9, Inpari-20, inpari-21, and inpari-31, while in the dry season 2016 are varieties of Inpari-9, Inpari-30, inpari-31 and inpari-33. The results of the study showed that the average yield in the rainy season was higher (7.05 t/ha) compared to the results in the dry season 6.47 t/ha). In the rainy season, the highest yield was obtained in the Inpari-31 variety (7.95 t/ha), while in the dry season the highest grain yield was obtained by the Inpari-30 variety (6.99 t/ha). Inpari-9 and Inpari-31 varieties which were planted in the rainy season yielded higher yields of 7.30 t/ha and 7.95 t/ha respectively compared to those planted in the dry season of 6.29 t/ha and 6.19 t/ha.

1. Introduction
Food crop commodity is a strategic commodity and has an important role on national food security, the need for rice continues to increase every year in line with population growth so that this commodity is strived to continue to increase production both through increasing planting areas and increasing productivity. South Kalimantan with an area of 3.75 million ha consisting of various agroecosystems such as irrigated rice fields, rainfed, tidal swampland, swampland, dry land, with an area of agricultural cultivation area of 2,590,733 ha (69.05%) has great potential for agricultural development. Dryland agricultural cultivation area with a slope of land 0-8% for food crops and horticulture and plantations covering an area of 1,457,980 ha (38.86%), a wetland area of 759,776 ha (20.52%) [1]. Tapin Regency is one of the regencies in South Kalimantan with an area of 217,495 ha, has 79,190 ha of paddy fields with rice productivity of 5.27 t/ha [2].

Irrigated lowland rice are fields that have the potential as a source of rice production because water is generally available for 2-3 planting times, however, it this land is not always planted with rice twice let alone 3 times planting rice in one year. Irrigated paddy fields in South Kalimantan 55,116 ha
planted with rice twice a year are only around 16,348 ha (29.7%) [3]. The small number of paddy
planted in the second season (dry season) may be due to inadequate irrigation infrastructure for
irrigating paddy fields in the dry season, so that often in the second crop there are problems with water
shortages so that not all farmers in the irrigated area are planting rice twice. In addition to the problem
of water for rice, usually more pests and diseases attack rice plantations so that some farmers do not
plant their land for rice.

The difference in planting time in the rainy season and dry season, in addition to differences in the
climate such as rainfall, temperature, solar radiation, also differences in pest attacks that cause
differences in rice yields in different seasons even though the availability of water in the irrigated
paddy fields is the same in different seasons. Research results showed that in various locations of
paddy fields, both inbred and hybrid rice showed a tendency for differences in rice yields in different
seasons [4]. Although the results of other studies showed that high sun intensity in the tropics
throughout the year, both the rainy season and the dry season, rice productivity is not limited by
differences in the rainy season or the dry season [5].

This research aims to examine the productivity of several inbred rice varieties that have high
yielding potential in two growing seasons in irrigated lowland in the Tapin district, South Kalimantan.

2. Methods
The study was conducted from 2015 to 2016 on irrigated lowlands in Harapan Masa village, Tapin
Selatan sub-district, Tapin District. New high yielding rice in the 2015/2016 rainy season include
Inpari-9, Inpari-20, Inpari-21 and Inpari-31, while in the dry season 2016 varieties planted include
Inpari-9, Inpari-30, Inpari-31, and Inpari-33 involving farmers as many as 6 people with an area of 1
ha each.

Rice seeds before sowing are treated with Agrimeth biofertilizers at a dose of 50 g/5 kg of seed at
the time they are sown. Age of rice seeds 20-25 days after the seedlings are planted with 2:1
jajar legowo system (40x20x10 cm). The recommended dosage of fertilizer is Urea 250 kg, SP-36 100kg
and KCl 100 kg/ha, pest control is controlled according to recommended. Observations were made on
the number of productive tillers per plant, the number of filled grains per panicle and grain yield. Data
analysis was done using analysis of variance, and the Least Significant Difference (LSD) at 95%.

| Characteristics | Inpari-9 | Inpari-20 | Inpari-21 | Inpari-30 | Inpari-31 | Inpari-33 |
|-----------------|---------|---------|---------|---------|---------|---------|
| Maturity (day)  | 125     | 104     | 120     | 111     | 119     | 107     |
| Plant height (cm)| 113     | 102     | 96      | 101     | 104     | 93      |
| Grain shape     | Long-slim | Slim    | Moderate | Long-slim | Long    | Long-slim |
| Grain loss      | Moderate | Easy    | Moderate | Moderate | Moderate | Moderate |
| Plant collapse  | -       | Tolerant | Tolerant | Tolerant | Slightly | Tolerant |
| Rice texture    | Sticky  | Moderate | Moderate | Moderate | Moderate | Moderate |
| Amylose content (%) | 20.46   | 21.1    | 26      | 22.4    | 21.1    | 23.4    |
| Yield potential (t/ha) | 9.3     | 8.8     | 8.2     | 9.5     | 8.5     | 9.8     |

3. Results and Discussion
The research locations in Harapan Masa village in South Tapin sub-district some are irrigated rice
fields and some are not exposed to irrigation networks and are categorized as rainfed. Rice fields in the
study site in Tapin District consist of irrigated paddy fields (4,542 ha), rainfed (25,218 ha), tidal
swampland (17,265 ha) and freshwater swamp (19,139 ha) [3].

3.1. Climate Characteristic
Climatic conditions in Tapin district on average the last 5 years have a total rainfall of 1,942.7 mm,
with a wet month (rainfall> 200 mm) for five months (December, January, February, March, April)
and dry months (rainfall <100 mm) for 3 months (June, August, September). Rainfall peaks occur in
December (326 mm) and dry peaks occur in September (20 mm). The average temperature in the range of 25.40°C (January) to 26.70°C (June) (Figure 1).

3.2. Rice Yield
The results showed that in wet season planting, Inpari-31 rice yields gave the highest yield (an average of 7.95 t/ha) with a range of yields at the farm level of 6.72-9.44 t/ha, the average number of panicles 18.70/tiller with a range of panicles number 18.40-19.00, the average number of grain filling/panicle 134.35 seeds with a range of grain filling/panicle 124.5-144.2 seeds (Table 2).

Table 2. Yield and yield component of rice, Harapan Masa village, Tapin district, Rainy Season 2015/2016

| Varieties | Grain Yield (t/ha) | Panicle number/tiller | Grain filling/panicle |
|-----------|--------------------|-----------------------|-----------------------|
|           | Average | Range | Average | Range | Average | Range |
| Inpari-9  | 7.30 a   | 7.04-7.56 | 17.28 b | 15.90-18.70 | 123.18 b | 104.96-145.96 |
| Inpari-20 | 6.40 b   | 5.76-6.88 | 20.17 a | 17.30-23.0 | 109.30 c | 108.00-110.60 |
| Inpari-21 | 6.61 b   | 6.40-6.88 | 16.60 b | 14.80-18.40 | 126.59 ab | 115.67-137.50 |
| Inpari-31 | 7.95 a   | 6.72-9.44 | 18.70 ab | 18.40-19.00 | 134.35 a | 124.50-144.20 |

Means with the same letter are not significantly different (P < 0.05) using LSD test.

Rice yields in dry season showed that Inpari-30 variety gave the highest grain yield, with an average production of 6.99 t/ha) with a yield range of 6.56-7.84 t/ha, compared to other varieties Inpari-33 (6.40 t/ha), Inpari-9 (6.29 t/ha) and Inpari-31 (6.19 t/ha) (Table 3). The results of the assessment conducted during the 2 planting seasons in irrigated paddy fields in Harapan Masa village showed that the average yield of rice in the Rainy Season (RS) gave higher yields (7.05 t/ha) compared to the results in the Dry Season (DS) 6.47 t/ha. Different planting seasons give different responses to rice varieties, namely Inpari-9 and Inpari-31 varieties planted in the rainy season give higher yields of 7.30 t/ha and 7.95 t/ha compared to planting in the dry season respectively 6.29 t/ha and 6.19 t/ha.
Table 3. Yield and yield component of rice, Harapan Masa village, Tapin district, Dry Season 2016

| Varieties | Grain Yield (t/ha) | Panicle number/tiller | Filled grain/panicle |
|-----------|-------------------|-----------------------|----------------------|
|           | Average           | Range                 | Average              | Range               | Average | Range |
| Inpari-9  | 6.29 a            | 5.76-7.20             | 15.1 b               | 13.5-17.4           | 119.3 a | 96.8-132.6 |
| Inpari-30 | 6.99 a            | 6.56-7.84             | 16.9 ab              | 14.6-19.5           | 122.8 a | 107.4-140.6 |
| Inpari-31 | 6.19 a            | 5.28-7.36             | 14.5 b               | 12.6-16.5           | 116.5 a | 98.6-130.6 |
| Inpari-33 | 6.40 a            | 5.12-7.52             | 17.9 a               | 15.7-21.7           | 117.1 a | 110.2-130.5 |

Means with the same letter are not significantly different (P < 0.05) using LSD test.

Inpari-20 variety although the yield is not higher than other varieties, this variety is the shortest harvest age so that the earliest harvest is one of the early-age varieties for lands whose water is insufficient for irrigation in the dry season crop. Inpari-9 variety is a variety that has been commonly planted by farmers before which also gives quite high yields, which is an average of 7.30 t/ha. Inpari-9 is widely planted by farmers because of the slender form of grain and is somewhat smaller than Ciherang varieties which are also widely planted by farmers around the location of the activity. According to farmers' preference for the varieties planted, Inpari-31 although the yield is high, according to them, during the processing of grain yields it is difficult to break down, the use of a combine harvester tool is also a lot of grain that is scattered along with panicle stalks in the field. Inpari-20 rice is short-lived, according to farmers, the plant is a bit too short, and because it is short-lived, so transplanting to land should not be too late. The use of improved varieties that are adaptive to land conditions and in accordance with farmers preferences are very important in increasing rice production. High yielding varieties are one of the technological components that have a real role in increasing the production and quality of agricultural commodities.

The most common pest problems found in the field during the rainy season are golden snails at planting time, leaf folder pests (*Cnaphalocrocis medinalis*) at maximum tillers, stem borer and rice bug pest when filling grain. In addition to pests and diseases, the obstacle of rice cultivation around the location of the activity is the presence of iron toxicity symptoms in rice plants which are shown in brownish-red color on old rice leaves. Iron toxicity is caused by iron levels in the soil which are quite high and is also caused by sandy soil textures which are generally K deficiency, also triggered by land that is always flooded (poor drainage system) and sensitivity of varieties to iron toxicity. The results show that iron toxicity in lowland rice can reduce yields up to 12-100% [6, 7]. Based on the results of research, iron toxicity in severely affected rice plants results in very poor growth, tillers do not grow so that the results obtained are very low and can even lead to crop failure [8].

Based on farmers' references, Inpari-30 is many liked by farmers, both in the appearance of plants in the field and in the form of grain and rice taste similar to Ciherang varieties. Inpari-33 is based on the number of tillers much preferred by farmers, although according to farmers the length of panicle is shorter than Inpari-9. The main constraints faced by farmers in dry season crop is rat and bird pests, this is because not all farmers plant twice in the dry season, then some farmers do not plant simultaneously. Rice damage caused by rat pests in the dry season is around 25-60%, depending on the controls carried out such as installing a plastic fence, protecting the land from rats at night. Other pests that attack rice plantations but do not reduce yield too much like rats are leafhopper, leaf folder, stem borer and rice bug. These pests can still be controlled by farmers by spraying the appropriate insecticide.

The planting method that has been carried out in the assessment for two planting seasons in the irrigated fields of Harapan Masa village applies the legowo row system. The results of the study showed how jajar legowo can be used as an effort to increase plant population per hectare so that productivity increases. In jajar legowo planting, all plant tiller becomes side crops, the effect of side plants is to get more sunlight and better air circulation and facilitate plant maintenance [9]. Some other research results also show that the 2:1 jajar legowo planting system is beneficial both in increasing productivity and incomes of farmers. Application of jajar legowo 2:1 planting system technology can increase plant population by 33.33% [10], increase production 16.44 % in irrigated lowland [11] and...
gave 19.7% higher milled dry grain yield compared to the tiled planting system [12]. The study results showed that the number of productive tillers was more in jajar legowo than in the way of planting tiles (the way of farmers) [13].

The study results in the Sidondo experimental garden, legowo row planting system and different planting distances gave different grain yields. Legowo row 3:1 gives the highest grain yield of 7.29 t/ha compared to jajar legowo 2:1 (6.26 t/ha) and jajar legowo 4:1 is 6.72 t/ha [14].

The results of the dem-area in the Jajar Legowo Super in Indramayu, rice productivity of Inpari 30 variety is 13.9 t/ha; Inpari 32 HDB is 14.4 t/ha; and Inpari 33 is 12.4 t/ha, while the average crop productivity of farmers outside the dem-area with Ciberang varieties is 7.0 t/ha [15]. Planting jajar legowo system can increase farmers income compared to non-legowo row regular planting. The magnitude of the difference between the results of the 2:1 jajar legowo planting system model and the non-jajar legowo system is 1,483 kg/ha, with the difference in profits with the non-jajar legowo system as much as Rp. 6,463,750/ha [16].

Irrigation techniques in irrigated lowland can also give different results to rice yields in different seasons, giving intermittent irrigation water yields higher yields (4.36 t/ha) compared to land that is always flooded during the rainy season (4.12 t/ha). The irrigation technique shows no difference in the dry season, intermittent irrigation yields 4.07 t/ha and is always flooded 4.07 t/ha [17].

The results of research conducted on irrigated lowland in Harapan Masa village show that the average yield of rice in the rainy season is higher than the dry season, this shows the yield gap and unstable grain yields in different seasons. Lower rice yields in the dry season are expected due to changes in climatic conditions such as rainfall, temperature, and solar radiation. According to The results of research showed that an increase in temperature of 1°C can reduce grain by 10% [18], an increase in temperature also increases the rate of transpiration and respiration which can affect the speed of seed intake and grain yield becomes low [19], changes in CO₂ concentration can affect plant growth [20], solar radiation can affect grain filling [21].

Efforts to maintain yield stability between seasons require season-specific rice varieties and locations that have resistance to pests/diseases that are at risk of appearing in each season at each location [4]. Increasing rice production and maintaining national food security can be done with the application of appropriate specific technologies so that it will reduce inter-seasonal yield gaps [22]. One model for implementing technology is the adoption of Integrated Crop Management (ICM) technology which has been known to have the potential to increase rice productivity in Indonesia [23].

4. Conclusions
The results of the study showed that the average yield in the rainy season yielded higher yields (7.05 t/ha) compared to the results in the dry season 6.47 t/ha). In the rainy season, the highest yield was obtained in the Inpari-31 variety (7.95 t/ha Harvest Dry Gain), while in the dry season the highest grain yield was obtained by the Inpari-30 variety (6.99 t/ha). Inpari-9 and Inpari-31 varieties which were planted in the rainy season given grain yield higher 7.30 t/ha and 7.95 t/ha respectively compared to those planted in the dry season 6.29 t/ha and 6.19 t/ha.

References
[1] Mulyani A, Yasin M, Noor A, and Amalia L. 2013. Peta zona agroekologi provinsi Kalimantan Selatan skala 1:250.000. Edisi 2013. Badan Penelitian dan Pengembangan Pertanian. Kementerian Pertanian.
[2] CBS Tapin. 2018. Tapin District in Figure 2018. Central Bureau of Statistic. District of Tapin.
[3] CBS South Kalimantan. 2016. Agriculture Survey: Land Area According to Its Use in South Kalimantan Province in. Central Bureau of Statistic. Province of South Kalimantan.
[4] Satoto, Widyastuti Y, Susanto U, dan Mejaya MJ. 2013. Rice Yield Gap between Planting Seasons in the Irrigated Wet Land. Iptek Tanaman Pangan. 8 (2) 55-61.
[5] Laza R C, Peng S, Akita S, Saka H. 2003. Contribution of biomass partitioning and translocation of grain yield under sub-optimum growing conditions in irrigated rice. *Plant Prod. Sci.* 6:28-35.

[6] Sahrawat K L. 2004. Iron to xicity in wetland rice and the role of other nutrient. *J. Plant Nutrition* 27 (8):1471-1504.

[7] Sahrawat K L. 2010. Reducing iron toxicity in lowland rice with tolerant genotypes and plant nutrition. *Plant Stress* 4:70-75.

[8] Audebert A and Sahrawat K L. 2000. Mechanisms for iron toxicity tolerance in lowland rice. *J. Plant Nutr.* 23:1877-1885.

[9] Mujisihono R and Santosa T. 2001. Sistem budidaya teknologi tanam benih langsung (TABELA) dan Tanam jajar Legowo (TAJARWO). Makalah Seminar Perekayasaan Sistem Produksi Komoditas Padi dan Palawija. Diperta Prp. DIY. Yoyakarta

[10] Erythrina and Zaini Z. 2014. Budidaya Padi Sawah Sistem Tanam Jajar Legowo : Tinjauan Metodologi untuk Mendapatkan Hasil Optimal. *J. Litbang Pertanian* 3 (2):79-86.

[11] Witjaksono J. 2018. Kajian Sistem Tanam Jajar Legowo untuk Peningkatan Produktivitas Tanaman Padi di Sulawesi Tenggara. *J. Pangan* 27 (1):1-8.

[12] Donggulo C V, Lapanjang I M, and Made U. 2017. Growth and yield of rice (*Oryza sativa L.*) in various patterns of legowo row and planting space. *J. Agroland.* 24 (1):27-35.

[13] Sutardi, 2017. Pengaruh model sistem tanam jarwo terhadap pertumbuhan dan hasil padi pada pola tanam padi+padi+kedelai. Dalam Prosiding Seminar Nasional 2016: Inovasi Teknologi Padi Mendukung Pertanian Bioindustri. Badan Besar Penelitian Tanaman Pertanian, Badan Penelitian dan Pengembangan Pertanian. Sukamandi p.181

[14] Elmer B D and Amplayo I P. 2016. Performance of irrigated lowland rice (*Oryza sativa*) production under different irrigation techniques in Sto. Tomas, Davao del Norte, Philippines. Univ. of Min. *Intl. Multi. Res. Jour.* 2016, 1(2):164-171.

[15] Sumarno, Kartasasmita U G, Zaini Z, and Hakim L. 2009 Senjangan adopsi teknologi dan senjangan hasil padi sawah. *Iptek Tanaman Pangan* 4 (2):116-130.
[23] Sembiring H, Hakim L, Widiarta IN, dan Zaini Z. 2012. Evaluasi adopsi pengelolaan tanaman terpadu dalam sekolah lapang (SL) pada program nasional peningkatan produksi tanaman pangan. Prosiding Seminar Nasional Inovasi Teknologi Pertanian Spesifik Lokasi. p.1–14.