

# Indigenous Knowledge Cultivation of Local Rice Varieties “Siam Mutiara” and “Siam Saba” at Tidal Swampland

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**Abstract.** Tidal swampland at present and in the future is very strategic as one of the national food barns considering sloping of productive land. In South Kalimantan, for example, tidal swamp paddy fields are available which is quite large, but the most are still planted with local varieties. More than 70% of rice cultivation in the tidal swampland is planted with various local varieties. The existence of local rice varieties is inseparable from its adaptability and acceptability factors. Among local varieties that are popular and widely planted by farmers are Siam Saba and Siam Mutiara varieties. Siam Saba and Siam Mutiara were released as local-improved varieties. Both of these varieties have their respective advantages, both from the distribution of plant adaptation and the potential benefits of yield. Siam Saba variety is widespread in tidal swampland of acid sulfate soil types and soils that are seawater intrusion in the dry season (near the coast) with A/B overflow type, while Siam Mutiara in acid sulfate tidal paddy fields with B / C overflow type. Some of the advantages of Siam Saba compared to other local varieties are high yield potential of 4.70 t / ha, a large number of tillers, small and slender grain shape, white rice color, and amylose content of 81.69%. Whereas improved of Siam Mutiara is high yield potential of 4.80 t / ha, the color of clean yellow grain, the color of clear and translucent rice such as pearl, and amylose content of 48.88%. Both varieties showed uniform in growth, flowering time, and ripening simultaneously, in mature panicles with almost no green grains, and a high percentage of unfertile grains. Local rice cultivation technology (Siam Saba and Siam Mutiara) indigenous knowledge here includes seedbed, transplanting, land preparation, fertilizing, pest disease control, harvest, and post-harvest processing or yields carried out by indigenous farmers. This indigenous cultivation technology until now in tidal swamp paddy fields of South Kalimantan is still widely practiced by farmers, especially for ownership of narrow or limited rice fields. There were advantages and disadvantages of each in the practice of indigenous cultivation technology.

## 1 Introduction

Tidal swamplands play an important role now and in the future as a source of growth in rice production. Tidal swamplands have enormous potential with an area of around 20.14 million hectares, including those suitable for agriculture 9.53 million ha. Tidal swamplands that have been opened or reclaimed by the government are around 2.27 million ha and not yet reclaimed are about 7.26 million ha. While it has been utilized for agriculture, in general, it is estimated only around 1.43 million ha or 53% of the area that has been cleared by the government. Besides, there are tidal swamplands that are opened independently by local farmers around 3.0 million ha [1,2,3].

Agricultural development in tidal swamplands faces major agrophysical land constraints that affect rice productivity, such as high soil acidity, the solubility of toxic elements, low fertility, high salinity, shallow pyrite layers, thick and raw peat, and floods and drought problems [4]. Various research results showed that with proper land management and technological innovation, tidal swamplands can be developed into productive land for agriculture, especially for rice [5,6].

Rice cultivation in tidal swamplands has been known for hundreds of years and conducted traditionally or indigenous knowledge of farmers using local varieties. For example, in South Kalimantan, it was reported that between 1920-1967 there were

around 65,000 hectares of tidal paddy fields which were managed independently by the local community [7]. This tidal swampland paddy field is called Bayar rice. This variety has a late maturity between 10-11 months and is photoperiod sensitive that flowering during the short day (in Indonesia that is in June) and has a low yield between 2-3 t/ha [8,9].

Local varieties of tidal swamp rice are relatively more adaptive to such land conditions. Hundreds of local varieties are still planted in swamplands offering the opportunity to researchers to gain more information. Therefore, local varieties still dominate paddy fields in tidal swamplands, for example, in South Kalimantan, about 96% of the land is planted with local varieties [10]. The largest percentage of local rice varieties planted is probably due to high adaptability, besides, to ease of cultivation at the farm level. According to Wiggin [11], local varieties have several advantages seen from the interests of farmers, which are easily obtained in almost all places, only require very minimal maintenance, and high trunk so that farmers do not need to bend in harvesting with ‘ani-ani’ tools.

Local rice varieties, in general, are the long duration (9-10 months), low yield potential (2-3 t/ha), requires low inputs of fertilizers and pesticides, adaptive to environmental problems, grain prices are more expensive, its cultivation is easier, and for farmers considered more efficient. Besides, local varieties are relatively tolerant of iron toxicity and their

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rice contains high levels of Fe and Zn [12,13]. Cultivation of indigenous local varieties such as by returning organic matter to the soil means that it can maintain soil fertility (environmental safety) in the framework of agricultural sustainability [14].

Various local rice varieties have long been planted by farmers in tidal swamplands of South Kalimantan. Siam, Bayar, Pandak, and Lemo varieties groups are well-known local varieties. The Bayar variety group has been cultivated by tidal farmers since 1920, while Lemo variety around 1956 [7]. The Siam variety group is currently the most common with a variety of names depending on the shape of the grain, a taste of rice, the name of the farmer, or other characteristics received by local farmers [12,15]. Siam Mutiara and Siam Saba are two popular local varieties and are widely grown by farmers in tidal swamplands of South Kalimantan. Siam Mutiara is widespread in potential acid sulfate soils B/C overflow type in Barito Kuala District. Siam Saba is widespread in potential acid sulfate soils that subject to seawater intrusion in the dry season (near the coast) with A / B overflow type in Banjar and Tanah Laut District. These varieties are favored because of the color of brownish-yellow grain, the shape of small, slender grain and brown rice is translucent. Also, the growth and appearance of the plant are good, flowering time is uniform, panicles are perfectly ripe, fertile, percentage of fertile grain per panicle is high. Likewise, economic value is high because it has a taste of rice that matches the tastes of people, especially in South and Central Kalimantan.

### 1.1 Indigenous Cultivation Technology of Local Rice varieties

The technology of local rice varieties cultivation includes seedbed, transplanting, land preparation, fertilizing, maintenance, and control of pests, harvesting, and post-harvest conducted indigenously. Indigenous cultivation technology is still widely practiced by farmers, especially for ownership of narrow or limited paddy fields. By adopting the cultivation scheme to existing hydrological conditions, farmers grow rice in swamplands (Fig. 1). Most farmers still grow the traditional single crop of local rice varieties in the tidal swamplands. There is 9-10 month, photoperiod sensitive varieties, seeded in October/November, and harvested around August/September the following years. The seedbed period may require 120 days.

The high water level in the field requires that seedlings be transplanted up to three times, the final transplanting being done in March/April. At each transplanting, tillers are removed and replanted over a progressively larger area from the shallow to the deeper portion of the fields. By the third transplanting, the entire area is covered by rice plants. Nursery of local varieties is done by transplanting up to three times. Seedlings are carried out in a 'tugal' or 'taradak' (dry seedlings) and this method is most

commonly practiced by farmers in tidal swamplands, besides 'palai' (wet seedlings). Dry nursery (*tugal*) starts in October / November. Approximately 5 kg of seed is enough for an area of 150 m<sup>2</sup> and is sufficient for 1 ha of rice fields. Usually, farmers provide kitchen ash or husk ash over the holes. Seedlings age around 30-40 days after sowing to be ready for transplanting [16].

The first seedling transplanting was called 'ampak' planted in a small area of paddy fields (20% of the paddy field area) which was carried out in December-January. One hill of the seedling is divided into 4-5 parts which are then planted in 'ampakan'. The seedlings are used for around 40 days to be transplanted again. The second transplanting was called 'lacak' that carried out in January-February. About one-third of the paddy field area is needed for this 'lacakan', it is located in the middle of a paddy field. The age of seedlings is 'lacakan' to be ready planted in paddy fields between 55-60 days.

The third transplanting was conducted in April-May at the paddy field. Nursery by this transplanting takes up to four months. This is, of course, inefficient, considering that this period can be planted with a season of planting improved varieties. But in another hand, the condition of the paddy field is naturally still flooded deep enough to not allow seedlings to be planted directly in lands. Transplanting of seedling three times indirectly aims to enlarge, strengthen, and multiply seedlings. Another plus is the number of seeds used is less, which is about one-sixth of the amount compared to a seed that is planted directly. To overcome this long nursery time, appropriate water management is needed by utilizing spring tide, so that water in the fields can be regulated.

Land preparation is carried out approximately one month after seedling in 'lacakan' (second transplanting) in February. Weeds in paddy fields are cleaned using a cutting tool 'tajak' and these weeds are left in water surface for 10-15 days. The weeds are then shaped like small rounded supports. The spun is periodically reversed to accelerate decomposition. The mix is spread evenly on the surface of paddy fields while waiting for the water to recede. Sometimes in this waiting period, new weeds grow so that is carried out cut again using a long, sharp machete ('penjajaban'). Land preparation using the 'tajak' tool does not cause oxidation pyrite, so it is quite safe for plants. Weeds that have been cut indirectly are used as organic matter that can enrich nutrients. Nevertheless, the process of decomposition of organic matter is considered quite a long time. Decomposer matters are needed that can accelerate the organic matter and are safe for the environment.

Planting is done in March-April when the water level has receded and is suitable for planting seedlings from 'lacakan'. Farmers are not organized in terms of space, but usually 5 hills for each 'depa' (1 'depa' = 1.70 m) or about 42.5 x 42.5 cm. Number of seedling per hill are 2-3 seedlings, where these seedlings are





already large and strong. Planting in March- April is more indirectly beneficial to plants, considering that at that period of iron solubility decreased so that seedlings planted could avoid the stress of iron toxicity (Fig. 2).

Initially, farmers did not apply inorganic fertilizers such as urea, TSP / SP36, or KCl. The product of decomposition of organic matter is considered sufficient for plant growth. Some farmers only give salt at a modest rate. But lately, some farmers do inorganic fertilization. This is related to the depletion of organic matter. Even so, the fertilizers applied are mostly only urea, and / or SP36 in uncertain quantities. It is very rare to find information that farmers do fertilization using KCl fertilizer. This is, of course, detrimental to plants. Some information obtained from farmers shows that fertilizing rice yields can increase. The provision of table salt in the short term may benefit farmers, but in the long run, it is detrimental because it will damage soil structure. To increase local rice yields, fertilizer can be applied for 45 kg N, 60 kg P<sub>2</sub>O<sub>5</sub>, and 60 kg K<sub>2</sub>O per ha.

Weeding grass/weeds are usually only done at the beginning of growth. Most farmers do not do weeding, this is because a form of long-dangling rice canopies can cover the soil surface. Thus the growth of weeds can be suppressed, due to lack of sunlight distribution at the bottom/surface of the soil. However, weeding is needed to increase crop yields. Pests and disease control of the plant are conducted minimal. Pests that often attack are rats, stem borer, stinking bugs, and brown planthopper. While the diseases that often attack are neck blasts, brown leaf spots, leaf midrib blight, and tungro. The most recommended control is integrated pest and disease control, such as cropping patterns, including rotation of varieties and use of natural enemies. Chemically, spraying is usually done against pests that attack. Depending on the type of pest, the pesticide applied must be recommended by the government.

Harvesting is carried out in July-August / September, depending on the type of varieties and time of planting. Traditionally, farmers harvest with a tool called *ani-ani*. Although slow this is considered to reduce yield losses. Harvesting with *ani-ani* is also quite beneficial if rice is not yellow grain simultaneously. Harvesting using sickles is faster, but often rice breaks when ground. Associated with the needs of labor, of course, the harvest with *ani-ani* requires more labor and longer time. Processing (yielding) at the farm level is mostly in the traditional way, which is threshed using feet. Usually done at night and this is often also considered as entertainment because it is done together. A lot of labor is needed and a long time for removing the rice panicles.

The grain yield of local varieties of tidal swamplands rice varies considerably, depending on variety, soil fertility, and method of cultivation. Most rice grain yields are between 2-3 t / ha. These yields are low compared to improved varieties and this is a major drawback for local varieties. This low yield can still be compensated with a higher grain selling price.

Price fluctuations depend on sales, where at the time of harvest grain price drops and will rise again after three months [17].

## 1.2 Characters of Siam Mutiara and Siam Saba

Initially, in 1990 farmers in Barito Kuala district planted local varieties of Siam Unus Kuning. In the paddy field, local varieties (a population of other varieties) appear, which were named Siam Palut. This variety had characteristics: yellow rice straw is clean, grain shape is slender with the tip of grain slightly bent, uniform in flowering, mature, plant height and panicle compact and lumpy, but its age is longer than Siam Unus Kuning varieties. Information on the superiority of Siam Palut was spread to surrounding farmers because its brown rice was white as clear as pearl (Mutiara) so that by farmers and rice traders/rice mills they were named Siam Mutiara.

Siam Saba variety in 2000 began to be planted by farmers in Banjar district, which is a mixed population of varieties selected of Siam Unus varieties. According to Khairullah [17], local varieties of tidal swamplands rice have several advantages both in terms of cultivation and genetic aspects. These advantages include the management of organic matter, minimally used in pesticides, inorganic fertilizers, weeding, and seeds. Local varieties of tidal rice can be used as a genetic source for improvement in new high yielding varieties. These characters, such as morphological characteristics (tillering ability, strong culms), agronomic characters (basal leaf fronds), yield quality (grain, brown rice, and mill rice), tolerance to environmental stress (tolerance to iron toxicity, salt injury, drought sensitivity), high Fe and Zn content of brown rice, and resistance to disease injury (blast, brown planthopper).

The characters of Siam Mutiara and Siam Saba morphologically and agronomically as well as the quality of the grain, brown rice, and mill rice are presented in Table 1. The potential grain yield of Siam Mutiara varieties (4.40-5.67 t/ha) is slightly higher than Siam Saba (4.50-5.50 t/ha). Siam Saba was 15 days faster than Siam Mutiara, as is the plant height of Siam Saba which is shorter than Siam Mutiara. Short duration varieties have implications for fast harvesting and this is quite beneficial for farmers. Judging from plant height, although Siam Mutiara is higher but relatively resistant to lodging than Siam Saba. This is because Siam Mutiara plant culm is bigger and stronger so that even though it is exposed to wind that relatively quite resistant to lodging.

The adoption of varieties in tidal swampland is grain shape and grain color [17]. Siam Saba showed the grain shape that was slender and small, while Siam Mutiara was only slender grain. The slender grain has relatively higher head rice than only slender ones (Table 2). The brownish-yellow brown rice color of Siam Saba makes it easier to distinguish from Siam Mutiara which is the color of clean yellow grain. The protein content of Siam Mutiara is slightly higher than Siam Saba, but the carbohydrate content of Siam Saba

is much higher compared to Siam Mutiara (Table 2). The lower carbohydrate content is suitable for people whose carbohydrate diets are mainly associated with diabetes.

Based on field observations, it showed that pests and disease, injuries of Siam Mutiara, and Siam Saba varieties are relatively insignificant. Nevertheless, based on results of tests at the Laboratory at the Indonesian Center for Rice Research showed that Siam Mutiara and Siam Saba are not resistant to brown leafhopper biotype 3, but rather resistant to Cercospora

(Table 1). Some appearance of Siam Mutiara and Siam Saba can be seen in Fig. 3 and Fig. 4. The characters showed were panicle, grain shape, and brown rice from Siam Mutiara and Siam Saba varieties. Other varieties were varieties that exist in tidal swamplands. In the Siam Saba paddy field, there were also Siam Unyil, Siam Babirik, and Siam 14. While in the Siam Mutiara rice field, there were also Siam Arjan, Siam Pontianak, and Siam Izhar. Siam Mutiara and Siam Saba were dominant varieties grown in each of the regions.

**Table 1.** Morphological and agronomical characteristics and grain quality of Siam Mutiara and Siam Saba varieties.

Characters	Siam Mutiara	Siam Saba
Origin	Anjir Seberang Pasar II village, Anjir Pasar subdistrict, Barito Kuala district	Sungai Musang village, Aluh-Aluh subdistrict, Banjar district
Group	Cere	Cere
Maturity (plant old)	255 days	240 days
Plant shape	Erect, compact	Erect, compact
Plant height	159.6 -160.9 cm	149.9 – 150.9 cm
Productive tillering	Medium (17 – 19 tillers)	Medium (18.1–18.8 tillers)
Basal internode color	Green	Green
Culm color	Green	Green
Leaf color	Green	Green
Auricle color	Light green	Light green
Ligule color	White	White
Culm node	Enclosed	Enclosed
Leaf-blade pubescence	Intermediate	Intermediate
Leaf angle	Intermediate (45 <sup>0</sup> )	Intermediate (45 <sup>0</sup> )
Flag leaf angle	droopy ( 30.13 <sup>0</sup> – 30.67 <sup>0</sup> )	droopy (20 – 35 <sup>0</sup> )
Grain shape	Slender	Slender small
Grain color	Yellow	Brownish-yellow
% fertile grain/panicle	97.8 – 97.8 %	96.4 % – 96.6 %
Grain number/panicle	214 – 215	221 – 246
Threshability	Medium	Medium
Panicle exertion	Well exerted	Well exerted
Lodging	Rather resistance	Less resistance
Milled rice texture	Rough	Rough
Milled rice taste	Good eating quality	Good eating quality
1.000 grain weight	17.6-17.7 gram	17.6-17.9 gram
Amilose content	28.28 %	29.75 %
Pest injury	Susceptible Bph-3	Susceptible Bph-3
Disease injury	Rather resistance Cercospora	Rather resistance Cercospora
Grain yield potential	4.80 – 5.67 t/ha	4.50-5.50 t/ha

**Tabel 2.** Brown rice quality of Siam Mutiara dan Siam Saba varieties.

Quality of Brown Rice/Mill Rice	Siam Mutiara	Siam Saba
Water content (%)	13.0	13.1
Broken rice skin (%)	75.0	76.0
Head rice (%)	84.0	87.0
Rendemen yield (%)	65.0	64.0
Brown rice length	Long	Long
Brown rice shape	Slender	Slender
Chalkiness	Medium	Medium
Protein content	8.12 %	7.36 %
Carbohidrat content	48.88 %	81.69 %



Figure 3. Planting, panicle shape, grain and brown rice of Siam Mutiara



Figure 4. Panicles shape and grain of Siam Saba and other local varieties

## 2 Conclusion

Tidal swamplands play an important role today and in the future as a source of growth in rice production, but most are still cropped with local varieties. The existence of local rice varieties is inseparable from its adaptability and acceptability factors. Various local rice varieties are cropped by farmers who belong to Siam, Bayar, Pandak, and Lemo varieties groups. Local rice cultivation technology includes seedbed, transplanting, land preparation, fertilizing, maintenance, and control of pests and diseases, harvesting and post-harvest processing, or yields carried out by indigenous farmers.

Indigenous cultivation of local tidal swamplands rice varieties has several advantages as well as shortcomings in terms of technical and economic aspects. Positive aspects such as organic matter

management, minimal use of pesticides, weeding, seeds. The drawbacks are the potential for low yields, longer duration, more labor, and without the use of fertilizers.

Among local varieties that are popular and widely planted by farmers on tidal swamplands, for example, in South Kalimantan, are Siam Mutiara and Siam Saba varieties. Siam Mutiara is widespread in potential B/C acid sulfate soils in Barito Kuala District. Siam Saba is widespread in potential acid sulfate soils and that seawater intrusion in the dry season (near the coast) with A/B overflow in Banjar District.

Characteristics of Siam Mutiara include a high yield of 4.80 t/ha, bright yellow grain color, clear and shiny rice color like a pearl, and carbohydrate content of 48.88%. Siam Mutiara variety is suitable for diabetes sufferers because of its low carbohydrate content. Siam Saba includes a high yield potential of



4.50 t / ha, a large number of tillers, small and slender grain shape, white rice color, and carbohydrate content of 81.69%. Both of these varieties have a uniform in growing, flowering, and maturity, and it had a high percentage of grain fertile. Besides the taste of the rice varieties was good eating quality, so that preferred by people in South and Central Kalimantan.

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