Analysis of rice farming using new superior varieties in swamp lands in Mesuji District, Lampung

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Abstract. This study aims to analyze rice farming using several superior varieties of rice in the swamps of Mesuji District, Lampung Province. The study was conducted on PT-1/MH December 2020/January 2021 in Tanjung Mas Jaya Village, Mesuji Timur District, Mesuji District, Lampung Province. The superior varieties of rice grown by Cilamaya Muncul, Inpara-2, Inpara-8, Inpari IR Nutrizinc, Mapan, Supadi and Kebo. Each variety is planted by one farmer with an area of about 1 ha. The analysis was carried out descriptively comparing the revenues and costs used. The results of the study show that rice production ranges from 7,573-10,400 t/ha, with an average rice productivity of 9,243 t/ha. Contribution to the cost of using production facilities occupies 28.77% - 45.52% of the total production cost, while the cost of using labor is 54.48% -71.23% of the total production cost. Rice farming in the swamps of Mesuji area with the use of six superior varieties of rice is still profitable with R/C ratio ranging from 3.48 to 4.63. In the future, for efficient farming, the implementation of technological innovations, especially the choice of suitable (adaptive) improved varieties of rice, is very important to consider.

1. Introduction
In the era of economic globalization, the agricultural sector still plays an important role and rice is a food commodity to meet the needs of the Indonesian people. As the population increases, the need for staple food (rice) increases, so rice production also needs to increase. The science-based innovation production strategy of new rice cultivars is stress-resistant [1]. In Lampung, land area for agriculture both annual crops and food crops is estimated at 2.7 million ha out of 3.4 million ha in Lampung's total area [2]. For technically irrigated rice fields covering an area of about 445,173 ha and rain-fed areas of 191,343 ha [3]. The rainfed land area occupies 27% of Lampung's total rice fields [4]. This land can be classified as sub-optimal land due to limited soil fertility and depending on the availability of rainwater, as well as the cropping index (CI) once a year, productivity tends to be not optimal at 3-7 tons/ha [5].

Tidal swamp agroecosystem is an alternative option for rice field expansion. Tidal land has four different land typologies, namely (1) potential land, (2) acid sulfate land, (3) peat land, and (4) saline land [4]. The limitations of labor and capital as well as the extent of cultivated rice fields per farmer household are often also a barrier to farmers' efforts to increase the intensity of planting (CI) of swamp rice from one to two [6].
The Agricultural Research and Development Agency continues to innovate to produce agricultural technology. Innovation is something that is considered new or can encourage renewal in certain social systems of society [7, 8]. New innovation has a meaning that it is not only known but also new in the sense that the community has not accepted it in the sense of attitude, and is also new in the sense that it has not been implemented by the community in its social system [9]. The Agricultural Research and Development Agency introduced the application of the latest technological innovations, better known as Jajar Legowo Super or Jarwo Super. The technological innovation is based on the innovation component of integrated crop management (ICM) of rice [10], ratoon technology [11], new superior varieties [12], increase farmers’ resilience to climate change [13], using low costs [14]. The advantages of applying ratoon rice technology in swamps include (1) lower production costs because there is no need for tillage and replanting, (2) lower fertilizer required (½ than the dose given to the first plant), (3) shorter harvest life, (4) yields obtained can reach 66% of the main crop [15], and (5) plants in the ratoon system use 60% less water than the main crop [16]. Able to contribute yields of more than 60% of the main crop yields [17, 18]. Tidal rice yields in Indonesia range from 3.2–4.2 tons/ha with a harvest age of 5–6 months, with the innovation of ratoon rice yielding at least 2 tons/ha within 2 months.

The choice of technological innovation in the form of using superior rice varieties that can increase rice productivity is very urgent. Seed breeders such as “BBU/BBI” and “UPBS” are only able to provide about 28% of rice seeds [19] and the rest are available with uncontrolled quality. For that we still need a good rice seed supply chain. The Agricultural Research and Development Agency has produced superior rice seeds for specific agroecosystem varieties, such as Inpara 2, Inpara 8, Cilamaya Muncul for swamp agroecosystems and nutrient-rich varieties such as Inpari IR Nutrizinc. In addition to local varieties specific to certain regions.

Mesuji District is one of the areas in Lampung Province which has very potential tidal swamp land. The area of swamp land in Lampung is 544,305 hectares, of which 410,177 hectares are potential for rice field [20, 21]. The tidal swamp land is the foundation of future food security because it is quite large. One way is in the form of rice farming with the application of appropriate innovations for specific locations. Rice farming with the application of specific technological innovations includes the use of new, adaptive superior rice varieties in the tidal swamp land of the Mesuji area. For this reason, this study aims to analyze rice farming using several superior varieties of rice grown in swampy agro-ecosystems in the Mesuji District, Lampung.

2. Materials and methods

The study was conducted on the rice field in tidal swampland agro-ecosystem in Mesuji District in 2021. Planting was carried out on first planting time (PT-1) from December 2020 through January 2021 and harvesting in April 2021. The study began with coordination, socialization, and technical guidance as well as the introduction of new superior varieties of rice. Mesuji’s population is 230,373 people spread over 7 subdistricts. Mesuji Timur District has a population of 36,352 people spread over 20 villages. One of them is Tanjung Mas Jaya Village with a population of 1,210 people. Tanjung Mas Jaya Village is the location of research activities. The research location was chosen purposively with the consideration that the location is a swamp agro-ecosystem and a center for lowland rice production. The participatory approach involved 7 farmers.

The planting location is in Tanjung Mas Jaya Village, East Mesuji District, Mesuji District, Lampung Province. The rice varieties planted are superior rice varieties from the Agricultural Research and Development Agency (Cilamaya Muncul, Inpara-2, Inpara-8, Inpari IR Nutrizinc), and multinational varieties (Mapan, Supadi), as well as existing local varieties (Kebo). Each variety is planted on an area of about 1 hectare by one farmer.

Technological innovations that are implemented locally are in accordance with local knowledge that has been introduced through technical guidance training and farmer habits. The applied
technological innovation is in accordance with the understanding of farmers. The analysis was carried out descriptively comparing the revenues and costs used (R/C ratio). Data are presented using descriptive statistics: \( \text{RC ratio} = \frac{\text{TR}}{\text{TC}} \), which TR: Total revenue; TC: Total Cost. If RC ratio >1, Farming is feasible; RC ratio = 1, Farming is break event; RC ratio <1: farming is not feasible.

3. Results and discussion

3.1. Conditions of application of technology in rice farming in swamp land in Mesuji, Lampung

The results of observations in the area at the research location show an overview of the conditions of using technology in rice farming in tidal swamp land (Table 1). Tillage technology is carried out using a tillage machine by turning the soil over and harrowing and leveling using a hand tractor. Planting using a jarwo transplanter with a 2:1 “legowo” planting system. The management of rice plants is carried out conventionally according to the methods and experiences of each farmer. However, it refers to the standard of integrated crop management (ICM) which is taught by field officers.

| No. | Components          | Range of use | Price (IDR/unit) |
|-----|---------------------|--------------|------------------|
| A.  | Production inputs:  |              |                  |
| 1   | Rice seed (kg/ha)   | 4-15         | 9,000-15,000     |
| 2   | Urea (kg/ha)        | 100-200      | 2,500            |
| 3   | SP-36 (kg/ha)       | 100-150      | 3,000            |
| 4   | KCl (kg/ha)         | 50-100       | 6,500            |
| 5   | NPK Phonska (kg/ha) | 100-400      | 3,200            |
| 6   | Lime (kg/ha)        | 0-950        | 1,375            |
| 7   | Foliar fertilizer (bottles/ha) | 0-24 | 5,000-10,000 |
| 8   | Compost/manure (tonnes/ha) | 0-2 | 500-1,000 |
| 9   | Herbicides (bottles/ha) | 1-10 | 20,000-120,000 |
| 10  | Insecticides (bottles/ha) | 2-8 | 50,000-200,000 |
| 11  | Fungicides (bottles/ha) | 1-6 | 100,000-140,000 |
| B.  | Labor               |              |                  |
| 1   | Tillage             | Plows machine 1 time and rakes, piece rate | 1,000,000 |
| 2   | Planting            | Machines transplanter and human labor, piece rate | 1,000,000 |
| 3   | Weeding (HOK)       | 10-20        | 70,000           |
| 4   | Fertilization (HOK) | 3-5          | 70,000           |
| 5   | Spraying (HOK)      | 2-5          | 70,000           |
| 6   | Harvesting          | Combine harvester or power thresher machine, piece rate | 1,500,000-2,000,000 |

By observing the implementation of technological innovations, which tend to be limited in nature, actually efforts to increase the productivity of lowland rice in swamps are still open to be carried out. Such as the application of the innovation component of integrated crop management (ICM) for lowland rice. As a comparison, the results of the Lampung AIAT study, which implemented the innovation component of ICM rice, proved to be successful in increasing rice productivity by 11.59-33.5% [22,23]. The application of ICM for lowland rice also has a positive impact on changes in farmers' income [24]. In addition to increasing production, the use of ICM also increases the Net Present Value (NPV). The Net Present Value (NPV) of rice production in the biochar system, based on production costs and income, resulted in a 12% increase in NPV, compared to rice production under conventional management [25].

Acceleration and delivery of ICM innovation through the Field School of Integrated Crop Management (FS-ICM) approach for lowland rice. Although the acceleration and adoption rate tend to
be slow [26,27], the innovation of ICM rice significantly increases production. Increased adoption of improved varieties resulted in greater rice yields and labor productivity in the Philippines’ Central Luzon and contributed to the gradual transition from subsistence farming systems to commercial farming systems [28]. Acceleration of innovation adoption by rural farmers can use new strategies, namely cultural and religious strategies to promote new innovations [29] and depend on the performance of the innovation characteristics and the specific conditions of the region, including swampland [30].

3.2. Analysis of superior rice farming on swamp land in Mesuji, Lampung

Based on the results of the analysis, it is known that rice farming using superior varieties on swampy land is carried out per hectare of farmland area in Tanjung Mas Jaya Village, East Mesuji District, Mesuji District, Lampung Province is quite optimal. On the character of swampy land using the implementation of innovation according to the understanding of farmers, it is able to produce an average production of 9,243 kg per ha of harvested dry grain (HDG). The highest rice productivity was 10,400 kg per ha HDG, while the lowest productivity was 7,573 kg per ha HDG (Table 2).

Table 2. Analysis of rice farming using several superior varieties on swamp land in the Mesuji District, Lampung, MT-1, 2021.

| No | Component | Inpari IR Nutrizinc\(^a\) | Cilamaya Muncul\(^b\) | New Superior Variety | Inpara-8\(^b\) | Inpara-2\(^b\) | Mapan\(^b\) | Supadi\(^b\) | Kebo\(^b\) |
|----|-----------|--------------------------|----------------------|---------------------|------------|------------|------------|------------|----------|
|    | Cost:     |                          |                      |                     |            |            |            |            |          |
| A. | Production Inputs |                  |                      |                     |            |            |            |            |          |
|    | Seeds     | 408,000                  | 400,000              | 224,000             | 408,000    | 540,000    | 900,000    | 360,000    |          |
|    | Urea      | 250,000                  | 540,000              | 540,000             | 250,000    | 250,000    | 405,000    | 250,000    |          |
|    | SP-36     |                          |                      |                     |            |            |            |            | 450,000  |
|    | KCl       |                          |                      |                     |            |            |            |            | 325,000  |
|    | NPK Phonska | 360,000                 | 1,400,000            | 700,000             | 360,000    | 800,000    | 660,000    | 380,000    |          |
|    | Chalk     |                          |                      |                     |            |            |            |            | 1,450,000 |
|    | Foliar Fertilizer |                |                      |                     |            |            |            |            |          |
|    | Compost/Manure |                 |                      |                     |            |            |            |            |          |
|    | Herbicide | 120,000                  | 265,000              | 270,000             | 120,000    | 120,000    | 120,000    | 120,000    |          |
|    | Insecticide | 460,000                 | 350,000              | 700,000             | 460,000    | 300,000    | 400,000    | 280,000    |          |
|    | Fungicide | 280,000                  | 250,000              | 500,000             | 280,000    | 100,000    | 480,000    | 700,000    |          |
|    | Sub quantity: | 1,878,000             | 3,205,000            | 2,934,000           | 1,878,000  | 3,855,000  | 3,563,000  | 2,090,000  |          |

B. Labor:

|       | Tillage                  | 1,000,000              | 1,000,000            | 1,000,000            | 1,000,000  | 1,000,000  | 1,000,000  | 1,000,000  |          |
|-------|--------------------------|------------------------|----------------------|---------------------|------------|------------|------------|------------|          |
|       | Investments              | 1,000,000              | 1,000,000            | 1,000,000            | 1,000,000  | 1,000,000  | 1,000,000  | 1,000,000  |          |
|       | Weeding                  | 700,000                | 700,000              | 700,000              | 700,000    | 700,000    | 700,000    | 700,000    |          |
|       | Fertilization            | 210,000                | 210,000              | 210,000              | 210,000    | 210,000    | 210,000    | 210,000    |          |
|       | Spraying                 | 140,000                | 140,000              | 140,000              | 140,000    | 140,000    | 140,000    | 140,000    |          |
|       | Harvesting               | 1,600,000              | 1,600,000            | 1,600,000            | 1,600,000  | 1,600,000  | 1,600,000  | 1,600,000  |          |
|       | Sub quantity:            | 4,650,000              | 4,650,000            | 4,650,000            | 4,650,000  | 4,650,000  | 4,650,000  | 4,650,000  |          |
|       | Total costs (A+B)        | 6,528,000              | 7,855,000            | 7,584,000            | 6,528,000  | 8,535,000  | 8,213,000  | 6,740,000  |          |

Revenue:

|       | Production               | 8,093                  | 9,472                | 9,435                | 7,573      | 10,184     | 9,547      | 10,400     |          |
|-------|--------------------------|------------------------|----------------------|---------------------|------------|------------|------------|------------|          |
|       | The Selling Price        | 3,200                  | 3,000                | 3,000                | 3,000      | 3,200      | 3,200      | 3,000      |          |
|       | Sub quantity:            | 25,897,600             | 28,416,000           | 28,305,000           | 22,719,000 | 32,588,800 | 30,550,400 | 31,200,000 |          |
|       | Profit                   | 19,369,600             | 20,561,000           | 20,721,000           | 16,191,000 | 24,053,800 | 22,337,400 | 24,458,000 |          |
|       | R/C                      | 3.97                   | 3.62                 | 3.73                 | 3.48       | 3.82       | 3.72       | 4.63       |          |

Note: The selling price of grain based on the type of rice size group: * type of long rice = IDR 3,200/kg; * type of sissy rice = IDR 3,000/kg; * type of round rice = IDR 3,000/kg

The highest yield was obtained from superior rice farming using the Kebo variety, because already adaptive to swamp land in Mesuji. This variety is tolerant of environmental stresses. Farmers have
been planting for generations. It’s just that the grain looks dull. The new superior rice varieties spread at the farmer level received various responses. As a new innovation, the distribution of the use of the new seed varieties is closely related to the preferences of farmers, especially with regard to the production capacity of the seed type itself. The adoption of new varieties of rice is closely related to the introduction process of various seed-producing producers. This condition is still relevant theoretically as stated by Rogers and Shoemaker [31] where the process of diffusion and adoption of technology takes time. Rogers and Shoemaker [31] identified important variables that determine the rate of adoption of an innovation. There are five kinds of innovation characteristics that affect the speed of innovation adoption based on recipient observations, namely (1) relative advantage; (2) compatibility; (3) complexity; (4) triability; and (5) observability. Even according to Van den Ban and Hawkins [32], the farmers will accept or adopt new varieties of seeds as new innovations for them according to the conditions faced by farmers.

The selling price of paddy rice varies greatly depending on the water content when farmers sell their crops. At the same condition of water content, the shape of the size of the rice is also able to distinguish the selling price. There are three types of rice size groups in the Mesuji area, namely long rice types, sisy rice types and round rice types. The long rice type usually has a higher selling price than the round rice type. The selling price range of grain per kg of grain is IDR 3,000-3,300. At the level of rice production of 7,573-10,400 kg/ha, according to the selling price of rice, the superior rice farming in swamp land provides revenues ranging IDR 22,719,000-32,588,800 per ha. The results of the analysis of superior rice farming on swampy land show an R/C ratio of 3.48 to 4.63, so it can be concluded that superior rice farming in tidal swamp land is feasible.

4. Conclusions
Rice farming using superior varieties planted in tidal swamp rice fields in the Mesuji District area provides benefits. In general, the value of the profit is highly dependent on the use of superior varieties of rice planted. The planting of superior rice varieties Inpara-2 provides a minimum profit of IDR 16,191,000. The highest profit was obtained from superior rice farming using the Kebo variety with a profit of IDR 24,458,000. The results of the analysis of superior rice farming on swamp land show the R/C ratio value of 3.48 to 4.63, so that superior rice farming in tidal swamp land is feasible. Innovation is one of the keys to increasing income, so in order for innovation in swamp rice cultivation to spread quickly, it is necessary to introduce innovation in bulk, besides that innovation-producing institutions should create innovations that have characteristics of swampy rice fields that are profitable, uncomplicated, as needed, can tried, easily observed and communicated by farmers so that farmers will quickly adopt the innovation.

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