Assessment of the success factors influencing of rice-fish farming innovation village to support food security

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Abstract. In the current condition in the village, the community is faced with limited agricultural land and the unpromising sustainability of conventional rice businesses, so that agricultural business is less attractive to the community. The solution that can be done by the community is to build a rice-fish farming innovation village. This study aims to analyze rice-fish farming in terms of social and economic aspects and to analyze the factors that influence the success of the rice-fish farming innovation village for food security and community welfare. This research was conducted from October to December 2020 in Samberembe, Candibinangun Village, Sleman District, Special Region of Yogyakarta. The research approach used a mixed-method, with data analysis using business analysis, descriptive analysis, and prospective analysis. The results showed that an integrated rice-farming program can increase farmers' income up to IDR 35 million per 1,000 m² per year and changing the socio-technical at every phase of cultivation. The success of the rice-fish farming innovation village can be realized with the following key factors (1) a good technical irrigation system, (2) a continuous supply of superior fish seeds, (3) strengthening of rice-fish farming innovation technology, and (4) strengthening of pest eradication technology (beaver). This key factor can be considered as a national scale reference for the development of the rice-fish farming innovation village. The implication of the study is to create a superior and sustainable village that can improve community food security and local economy growth.

1. Introduction
The phenomenon of the rural and urban development gap in Indonesia has been studied [1,2]. Indonesians living in cities are larger than those in villages by 56%, but the poverty rate in rural areas is still quite high, even double the poverty rate in cities [3]. The innovation village studies [4] show the importance of the village as the center of the socio-economic and cultural life of the community and the center of production. The village which is seen as the center of socio-economic life has inspired several institutions to innovate rural development through innovation villages [5,6].

The agricultural sector has a strategic role in realizing food security at the national, regional, and household levels. The role of agriculture in the national economy includes providing employment and increasing the national Gross Domestic Product (GDP). The role of the agricultural sector in the economy of a country can be seen from the large percentage of GDP from the agricultural sector [7]. Based on data [8], the agricultural sector is one of the third-largest contributors to GDP after the manufacturing and trade sectors, hotels, and restaurants with a value of IDR 1,209,687.2 billion. But as economy develop contribution of agriculture will steadily decline followed by the increase on the contribution of industry and services. Until now, rice is still the main staple food for most Indonesian people. The demand for rice commodities is increasing, but the sustainability of agricultural businesses
is increasingly unpromising, the narrowness of agricultural land due to the conversion of agricultural land into residential land is increasingly happening. This causes agricultural activities to be less attractive to the community, especially the younger generation [9], so people are looking for innovations to increase agricultural land productivity, one of which is the rice-fish farming system.

Rice-fish farming is an appropriate technology to optimize the productivity of paddy fields through the integration of fish farming with rice. The rice-fish farming system can be applied to the cultivation of carp, tilapia, ornamental fish, catfish, and giant prawns. Rice-fish farming technology can be applied to technical or semi-technical irrigated rice fields. Based on data [10], the total potential of rice-fish farming land in Indonesia is 8,118,233 ha consisting of irrigated land covering an area of 3,170,996 ha (39.06%) and non-irrigated land covering an area of 4,497,237 ha (60.94%). Rice-fish farming can suppress land conversion and urbanization [11]. The same thing was also true in Southern Thailand, where rice-fish farming business activities have a positive impact on farmers in maximizing their paddy field resources [12]. Furthermore, the rice-fish farming system has several advantages and economic benefits that can be felt by farmers and the community [13]. The farmers will get acceptance even though they are faced with rice crop failure. Integrated rice-fish production can optimize resource utilization through the complementary use of land and water, can improve diversification, intensification, productivity, and sustainability [14–16]. Integrated rice-fish farming is also being regarded as an important element of integrated pest management in rice crops [17,18]. This certainly makes rice-fish farming more profitable when compared to rice-mono cropping [19].

The development of rice-fish farming innovation has become a potential attraction for ecotourism. This innovation is carried out by the village community, as a form of effort to create new methods, processes, and products that provide added value to the life and welfare of the village community [20]. Currently, the factors that influence and determine the success of the rice-fish farming innovation village have not been carried out by the Indonesian government. Based on the description above, this study aims to analyze rice-fish farming in terms of social, and economic aspects and identify the factors that determine the success of rice-fish farming innovation village.

2. Materials and methods
This research was carried out from October to December 2020 on Samberembe, located on the Candibinangun Village, Sleman District, Special Region of Yogyakarta Province. Samberembe has implemented the rice-fish farming system since 2012, and in 2017 implemented the rice-fish farming ‘jajar legowo’ innovation which was able to increase business productivity by 50% compared to conventional rice businesses [21].

2.1. Materials
Primary and secondary data use in this study. The primary data collected from 20 respondents consist of farmers involved in integrated rice-fish farming and are members of the ‘Mina Muda Samberembe’ group and rice-mono cropping farmers. The secondary data obtained from National Statistik Bureau and Food Security and Fisheries Agency in Sleman District.

Primary data collection was carried out using a survey method. Interviews were conducted with rice-fish farming system farmers using structured questionnaires and data topics. In-depth interviews were also conducted with key informants from extension workers, heads of ‘poktani’ (farmer’s group), heads of ‘pokdakan’ (fish cultivators group), community leaders, and other stakeholders from the government. In addition, focus group discussions were also conducted to enrich information.

2.2. Methods
The analytical methods used in this study include business analysis, descriptive analysis, and prospective analysis. Financial feasibility analysis is used to determine the level of business efficiency on the balance of revenues or costs (R/C ratio). Business feasibility is carried out to assess the possibility of profit or loss obtained from farming [22]. The prospective analysis aims to determine the position of the lever factors [23] so that the determining factors or driving variables in the rice-fish farming business activities
will be obtained. The results of the analysis will obtain four quadrants which are the positions of the leveraging factors seen from the dependence and influence of each selected variable.

3. Results and discussion

3.1. Comparative of rice-fish farming and rice monocropping business in innovation village

Rice-fish farming uses different inputs than mono-crop because in addition to inputs in the rice production process rice-fish farming also requires inputs in the fish production process. Farmers who implement rice-fish farming will obtain greater revenues compared to the ones of farmers who do mono-crop. However, rice-fish farmers have to spend more on production expenses [24,25]. The development of rice-fish farming is a technological innovation of rice farming in a monoculture system to increase farmers' income in using paddy fields, not only because the amount of income received by farmers is even greater, but farming is also more beneficial for farmers when faced with conditions of rice harvest failure because farmers still get profits from the production of fish in his rice fields [19,26,27]. Previous study showed that the factors that influence farmers’ decisions to adopt rice-fish farming are conditions of irrigated land, access to capital assistance, and knowledge and experience of rice and fish cultivation [28].

Rice-fish farming business in Samberembe consists of four cropping patterns in one year, namely paddy-paddy-paddy (planting pattern I), rice-fish farming-rice-fish farming-rice-fish farming (planting pattern II), rice-fish farming-rice-fish farming-paddy (planting pattern III), and rice-fish farming-rice-fish farming-horticulture-fish farming (cropping pattern IV), with three growing seasons in one year. A comparison of the economic analysis of the four cropping patterns in terms of costs and revenues obtained by cultivators in one year for a land area of 1,000 m² can be seen in Figure 1.

![Figure 1. Economic analysis of four cultivation variation in Samberembe innovation village.](image_url)

The rice-fish farming system has four variations of planting, the conventional rice cropping pattern obtains a higher value the smallest (IDR 7 million), while the rice-fish farming pattern in one year received the largest revenue, which was IDR 35 million, as well as in terms of costs that the rice-fish farming pattern required the largest cost, which was IDR 27 million. Although the profits of rice-fish farming and horticulture-fish farming businesses are very small, these businesses have advantages in terms of health and income when harvesting fails with a monocropping business. The cost and benefit ratio (R/C ratio) shows that cropping pattern 1 (1.73) has the highest R/C ratio compared to other
cropping patterns. R/C ratio of cropping patterns 2 and 4 are 1.33, and pattern 3 is 1.29. Rice-fish farming activities can provide greater benefits than costs. The results of the cost-benefit assessment in the Samberembe innovation village show that the business provides a higher cost-benefit value (IDR 48 billion) compared to the conventional rice business (IDR 34 billion). The rice-fish farming business can increase rice productivity by 5%. Farmers can benefit 54% (IDR 60 billion) of the total benefits received (IDR 116 billion). The rice-fish farming business also grows a new business, namely fish processing. The same thing was found in the previous studies [29,30].

3.2. Social and institutional characteristics of rice-fish farming innovation village
Creative and innovative institutions are the key to developing an innovative village for rice-fish farming. "Gapoktan" conducts business activities in the field of integrated fisheries that lead to an eco-techno agricultural system with the principle of cooperation through coordination with sub-organizations including cooperatives, marine, and fisheries training center, and association of water user farmer, as well as creating innovative agricultural entrepreneurs, media, and internal sources of innovation (farmers groups), and external (fishery extension, research institutes, government institutions, community institutions, input giving institutions) support and can transform innovation by adapting the carrying capacity of the land, the needs of farmers, as well as the level of effectiveness and efficiency. The village management institution for rice-fish farming innovation refers to the fishery agribusiness system which includes (1) the subsystem for providing production facilities (upstream), (2) the production subsystem (on-farm), (3) the product processing subsystem (downstream), (4) support subsystem and (5) marketing subsystem. The components in the innovation area/village are the rice-fish farmer's group and the tourism awareness group of rice-fish farming. The components inside and outside the cultivation area/innovation village are seed provider (horticulture plant and fish), an association of water user farmer, fishery extension, consumer, and fish processor. While the components that are outside the cultivation area are providers of fish production facilities, feed providers, medicines and vitamins providers, government, financial institutions, village-owned enterprises, eatery, and tourists (Figure 2). The role of stakeholders in the institutional management of the rice-fish farming innovation village is shown in Table 1.

![Figure 2. Samberembe innovation village institution.](image-url)
### Table 1. The role of stakeholders in the rice-fish farming institution in Samberembe.

| Category   | Stakeholders                                      | Role                                                                 |
|------------|---------------------------------------------------|----------------------------------------------------------------------|
| Government | • Central Gov                                    | Regulators, dynamists, facilitators, and catalysts in the implementation of rice-fish farming innovation village activities. |
|            | • Provincial Gov                                 |                                                                      |
|            | • District/City Gov                              |                                                                      |
|            | • Village Gov                                    |                                                                      |
| Private    | • Providers of production facilities and infrastructure (superior seeds, quality feed, medicines, and production equipment) | To provide quality production inputs                                  |
|            | • Providers of marketing services                 |                                                                      |
|            | • Fish processor products.                       |                                                                      |
| Academics  | • Gadjah Mada University                         | To develop technological innovation                                   |
|            | • University of National Development “Veteran” Yogyakarta |                                                                      |
| Community  | • Rice-Fish Farmer’s group                        | A group with members consist of farmers who manage the innovation village |
|            | • Tourism awareness group of Rice-Fish Farming    |                                                                      |
| Others     | • Marine and Fisheries Business Capital Management Institution | To support the provision of capital, assistant staff for management assistance and business management |
|            | • CoIDRorate Social Responsibility                |                                                                      |
|            | • Bank and nonbank                                |                                                                      |

3.3. **Criteria and key factors for the success of rice-fish farming innovation village**

The identification of the factors that influence the success of the rice-fish farming innovation village is carried out based on the opinions of experts and rice-fish farming business actors, which consists of 45 mutually correlated factors, then by using the main component analysis which is reduced to 18 factors that affect the current condition. Further studies by conducting a prospective analysis to see the direct influence and dependence between factors, to predict the possibility that will occur in the future based on the influencing factors. Further studies by conducting a prospective analysis to see the direct influence and dependence between factors, to predict the possibility that will occur in the future based on the influencing factors, can ensure that the key determinants of the success of the innovation village are (1) water availability, (2) mastery of rice-fish farming technology, (3) availability of superior seeds, and (4) pest disturbance (see quadrant I in Figure 3).

![Figure 3. Key factors for the success of the Samberembe innovation village.](image)
4. Conclusions
The rice-fish farming innovation village has social, economic, and institutional characteristics that can support the success of future development. The rice-fish farming system has four cropping variations, the conventional rice cropping pattern has the smallest revenue value (IDR 7 million), while the rice-fish farming pattern in one year receives the largest revenue of IDR 35 million. The rice-fish farming business provides a high paddy business (IDR 34 billion) and can increase rice productivity by 5%. The farmers get benefit 54% (IDR 60 billion) of the total benefits received (IDR 116 billion). The cost and benefit ratio (R/C ratio) shows that cropping pattern 1 (1.73) has the highest R/C ratio compared to other cropping patterns. R/C ratio of cropping patterns 2 and 4 are 1.33, and pattern 3 is 1.29.

The village management institution for rice-fish farming innovation refers to the fishery agribusiness system. Institutional management of the rice-fish farming innovation village has interactions with several stakeholders who have a role in supporting the implementation of rice-fish farming innovation village activities, with the components inside and outside the cultivation area/innovation village. The stakeholder category is government, private, academics, community, and others.

The key factors determining the success of the dominant rice-fish farming innovation village are the mastery of rice-fish farming technology, water availability, availability of superior seeds, and pest disturbances. This key factor can be considered as a national scale reference for the development of the rice-fish farming innovation village.

For the success of the rice-fish farming innovation village to be optimal, the policy strategies that need to be considered for the development of the rice-fish farming innovation village program can be carried out: (1) stipulation of a Joint Decree on the management of water resources between the Ministry of Marine Affairs and Fisheries, the Ministry of Agriculture, and the Ministry of Public Works and Public Housing, (2) strengthening rice-fish farming business institutions from upstream to downstream, (3) increasing the capacity of extension workers in assisting the development of rice-fish farming innovation villages, and (4) developing partnerships in the management of ecotourism with.

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