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Optimization of Paddy Farming System in Shallow Swamp Land: Case Study of Sungai Dua Village

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Abstract: The conventional farming system used by farmers is planting paddy fields. Conditions for developing and optimizing the paddy field farming system on shallow swampy land with rainfed soil require various interrelated aspects. The objectives of the study include: 1) providing information on the characteristics, potential, and opportunities of shallow swampy land for agricultural development, analyzing the amount of income for farmers so that they can increase maximum profits for these farmers; 2) optimizing the paddy field farming system based on land, labor, and capital in implementing land and water management technology. Determination of respondents intentionally (*purposive*), the sample taken in this study was 100 rice and purple eggplant farmers. The analysis used income, feasibility, and optimization using linear programming. The results showed that the average value of rice farming income was IDR 3,641,966.5/Ha, and the average value of purple eggplant was IDR 3,865,939 in Sungai Dua Village. Farming with the optimization of the farming system is feasible to be cultivated with R/C values of 1.32 and 5.87. Optimization of the shallow swampy rice farming system per hectare is recommended only for purple eggplant farming activities so that the income obtained is more profitable. For labor, the remaining and unused labor is 119, and for the unused capital of IDR 10,979,640, the optimum income of farmers is IDR 3,865,939/Ha/MT.
Keywords: shallow wetlands, optimization, agricultural systems

1. Introduction

Agriculture in Indonesia generally uses a conventional farming system. Most farmers use the farming system for several food crops and plantation commodities [1]. The food problem for the Indonesian nation is considered very strategic because food is the largest household expenditure [2]. Banyuasin Regency is one of the central areas for rice production, which has part of its area in the form of tidal swamps influenced by river water and swamps, most of which are wetlands such as rice fields, tidal swamps, and swamps [3]. Rambutan District as one of the central areas for rice fields where the location is located on the border of Palembang City. The harvested area and production of rice fields are 7,769.1 hectares and 38,258.2 tons, with a productivity of 4.92 tons per hectare [4]. Sungai Dua Village is located in Rambutan District, where the average population earns a living from rice farming, so that this commodity has a market price and high selling value [5].

Swampy land is used for agricultural purposes as an alternative to meet the increasing need for food. Given that the demand for food continues to increase in line with population growth, there is a shift in the function of fertile land used for food crops and farming [6]. The role of swamp land in food security is currently not influential, but the potential and opportunities can increase national food production through the utilization and optimization of the management of very large and prospective swamp land [7]. The potential of swamp land in the agricultural sector can be developed through food crops which are always faced with various obstacles such as suboptimal land with low fertility levels, diverse land typologies, farming efforts in land development are always faced with various risks of uncertainty because they are highly dependent on climate conditions and rainfall [8].

Increasing the IP of rice also supports food security and contributes to increasing regional rice production. IP of rice can also open up opportunities for farmers to meet family food needs, and their income can increase. IP of rice can be increased in rainfed rice fields through efforts such as the application of technology (pumping, making drilled wells), certified early-maturing seeds, and providing fertilizer assistance, as well as assistance in renting modern agricultural equipment such as tractors and combine harvesters so that land processing time and harvest time can be done faster and more efficiently [9]. One of the activities in increasing rice production is the use of more optimal land through increasing the Planting Index (PI) and planting area, and harvest supported by land optimization policies such as the use of agricultural machinery, increasing seed capacity, improving water management facilities, and building extension workers' capabilities [10].

Conditions for developing and optimizing the lowland rice farming system in shallow rain-fed lowland land require various interrelated aspects, both in terms of technology and external support, such as the supply of inputs in sufficient quantities and on time, based on land expansion. Rainfed land usually experiences several problems, including low rainfall, soil fertility and drought so that it is overgrown with grass resulting in low yields [11]. Rainfed land where rice productivity is generally still low, limited water needs for plants and the planting system is only once a year [12]. On rainfed land, there is a fairly high risk in rice cultivation, the main problem is lack of water supply, no balance of nutrients. The solution developed is planting with tolerant varieties and balanced fertilization to improve nutrient balance [13].

Optimization of lowland swamp land refers to Permenta number 40.1 / Permentan / *RC*.010 / 10/2018 concerning increasing the Cropping Index or productivity through water and land system management activities that have been utilized by the community/farmers [14]. Optimization activities for shallow lowland swamp land are focused on activities that include a) rehabilitation or improvement of irrigation water gates, construction of embankments/dikes, drainage, making farm roads (JUT) to make it easier for farmers to sell their produce, use of pumping when it rains, b) rehabilitation and arrangement of infrastructure for shallow rain-fed lowland swamp land, c) improvement of swamp land fertility, d) application of rice cultivation technology on shallow rain-fed lowland swamp land. Based on the problems in developing swamp land for farming, consisting of pyrite, thick peat, poor parent soil material, anaerobic atmosphere, and if used in other ways, it can release toxic compounds.

Until now, swamp land has not been fully utilized in farming activities because of various problems, including suboptimal water management networks, land typology related to water management conditions/height and duration of inundation, and the relationship with water management in agricultural land. One of them is shallow rain-fed swamp land, so the technology applied in developing it is location-specific and looks at the biology and physical properties of the land, which are determined by the socio-economic conditions of farmers. Herliana et al. [15] and Chidiebere-Mark, et al [16] show the importance of strategies and efforts to achieve sustainable rice production through technological innovation and better practices. Innovations such as new superior rice varieties, sophisticated planting systems, and technologies such as harvesting machines. Alfayanti et al. [17] explains that innovation plays a very important role in increasing productivity and economic benefits in swamp land.

Efforts to optimize swamp land for rice cultivation involve various aspects. Mulyani and Widjayanthi [18] mentions the importance of intensification through technological innovation and improvement of irrigation systems to increase rice production. In addition, Afriyanto and Slameto [19] emphasized the selection of superior adaptive rice varieties as important to maximize yields in swamp agroecosystems. In addition, the economic aspect of optimizing rice farming systems in swamps is very important. Berliana et al. [20] showed that rice farming in swamps can be economically profitable, as indicated by a revenue-to-cost ratio exceeding 1.00. In addition, highlighted the importance of risk management strategies such as agricultural insurance to ensure the sustainability of rice farming practices. Land use for rice plants where purple eggplant plants are planted on the stilts or farm roads (JUT) in increasing efficient agriculture.

The objectives of this study include 1) providing information on the characteristics, potential, andincluding analyzing diversification opportunities into high-value commodities such as eggplant to increase income and economic resilience of farming households, as well as analyzing the amount of income for farmers; opportunities for shallow swamp land for agricultural development, analyzing the amount of income for farmers, 2) optimizing the rice farming system in rain-fed shallow swamp land based on land and water,by considering the integration of cropping patterns that can maximize income and reduce the risk of crop failure.

2. Materials and Methods

2.1. Materials

The research location was in Sungai Dua Village, Rambutan District, Banyuasin Regency, South Sumatra Province. This location was chosen deliberately (purposively) because the land used to optimize the rice farming system is in shallow, swampy areas. The total land area in Sungai Dua Village is 913 hectares, of which 615.4 hectares of shallow swampy land are optimized in 17 farmer groups. The research will be conducted for 8 months, from May to December 2023.

2.2. Methods

This study uses primary and secondary data. Primary data were obtained directly from the field through direct interviews using a questionnaire (questionnaire). Data were obtained from respondents who were rice farmers in shallow swampy areas and parties involved in optimizing agricultural systems in Village. Secondary data were used to supplement the information in this study, such as data from relevant government agency documents, such as village data, BPS, agricultural extension workers, and literature in the form of journal articles or research results, proceedings, magazines, and other relevant documents. The research instrument used was a questionnaire (questionnaire) through a survey.

2.3. Experimental variable and analytical procedures

Research using the method of simple random sampling (simple random sampling) to select farmers to be interviewed, where every rice farmer in the location has an equal chance and opportunity to be selected as a respondent through a random process (such as a lottery). The purpose of using this method is to obtain a representative sample so that the research findings can describe the actual conditions and can be generalized to the entire farmer population in Sungai Dua Village. Based on field data, Sungai Dua Village has 17 farmer groups where each group consists of 15-50 farmers whose land is paddy rice with a total of 755 people while the land optimized between paddy rice and purple eggplant was sampled as many as 100 farmers because the land owned is one stretch

2.4. Data Analysis

Data obtained from the field were first grouped, then tabulated, and analyzed mathematically using quantitative methods. To calculate the income of shallow, rain-fed lowland rice farmers using the fixed cost (depreciation) and variable cost formulas, the following is used:

$$Pd = TR - TC$$
$$TR = Y.Py$$
$$TC = FC + VC$$

Where

Pd	=	Farm income (IDR/Ha/MT)
TR	=	Total revenue (IDR /Ha/MT)
TC	=	Total cost (IDR /Ha/MT)
FC	=	Fixed cost (IDR /Ha/MT)
VC	=	Variable cost (IDR /Ha/MT)
Y	=	Output amount (Kg/ Ha/MT)
PY	=	Output price (IDR /Ha/MT)

Calculate the variable costs and depreciation of the equipment as follows:

$$BV = JI \times HI$$

with

JI	=	Input amount (Kg)
HI	=	Input price (IDR)

$$PA = \frac{HB - NS}{LP}$$

where

PA	=	Depreciation of equipment (IDR)
HB	=	Purchase price (IDR)
NS	=	Residual value (IDR)
LP	=	Duration of use (IDR)

Analyzing the feasibility of Farming in Farming business analysis is as follows:

$$R/C_{ratio} = \frac{TR}{TC}$$

where

R/C ratio	=	Return cost ratio
TR	=	Total Revenue (IDR)
TC	=	Total Cost (IDR)

Criteria:

R/C >1	=	Farming business is worth pursuing
R/C < 1	=	Is not worth pursuing
R/C = 1	=	The farm is at a break event point

Calculating the optimization of the rice farming system on shallow rain-fed swamp land, the data obtained from the field is processed in a tabulated manner and then analyzed systematically, so the optimization calculation is as follows.

1. Objective Function

$$Z = C_1X_1 + C_2X_2$$

2. Constraint Function

The land constraint function:

$$a_{11}X_1 + a_{12}X_2 < a_i$$

The labor Constraint Function:

$$b_{11}X_1 + b_{12}X_2 < b_i$$

The capital constraint function:

$$c_{11}X_1 + c_{12}X_2 < c_1$$

where

z	:	Total Maximum Profit to be achieved during the analysis period (Rp/Ha/MT)
C_1	:	Income obtained from paddy farming during the analysis period (Rp/Ha)
C_2	:	Income obtained from eggplant farming during the analysis period (Rp/Ha).
X_1	:	Land area used for rice farming (Ha)
X_2	:	Land area used for eggplant farming (Ha)
ai	:	The amount of land available that can be planted for the commodities available during the analysis period (Ha)
bi	:	Number of family labor availability during the analysis period (HKSP/MT)
ci	:	Amount of capital available during the analysis period (Rp/Ha).

3. Results and Discussion

3.1. Respondent Characteristics

The characteristics of respondent farmers include respondent age, education level, length of farming experience, and land area.

3.1.1. Age of Respondent

Age is the length of time a person has been in existence in years. Age is related to the respondent's internal factors and their level of productivity in carrying out farming activities [21]. Productive farmers typically work better and more optimally than unproductive farmers [22]. A determining factor in increasing productivity in business development is the relatively young age of those who are more resilient, agile, and receptive to new innovations, while older workers often reject innovation. The respondents in this study were lowland rice farmers whose land was optimized with purple eggplant plants. The number of respondent farmers in this study was 100 people, consisting of two farmer groups: Selat Kandis 2 and Suka Ratu, each with 50 farmers. Further details can be seen in Figure 1 and Table 1.

Table 1. Number and Percentage of Respondents Based on Age in 2023

No	Age (Years)	Number (of Souls)	Percentage (%)
1	≤ 30	4	4
2	31 - 59	56	56
3	≥ 60	40	40
Total		100	100

Source: Primary data Processed, 2023

3.1.2. Respondents' Education Level

The activity of increasing one's knowledge is called education. The final level of formal education consists of elementary school, middle school, high school, and university. A person's mindset is determined by education. A higher educational background can provide farmers with more advanced thinking compared to those with less education [22]. The implications of this limitation are evident in technical efficiency. For more details, see Table 2.

Table 2. Number and Percentage of Respondents Based on Education Level 2023

No	Education	Number (of Souls)	Percentage (%)
1	Elementary School	58	58
2	Junior High School	11	11
3	≥ Senior High School	31	31
Total		100	100

Source: Primary data Processed, 2023

Table 2 shows that the educational level of respondents who have completed elementary school is 58 respondents, or 58 percent. Farmers who have completed junior high school education are 11 respondents or 11 percent, while farmers who have completed high school to undergraduate education are 31 respondents or 31 percent. Based on these data, the education level of the most respondent farmers is in the low-level group, namely elementary school, amounting to 58 percent. According to Junaidi and Zamzami [23], low education is one of the + obstacles that can affect mindsets, which affect the results obtained. Conversely, farmers who have a low level of education generally have a more open mindset, are more likely to accept new innovations, and are easy to apply new technologies so that they can bring results and agricultural development in a better direction [22]. In line with the opinion of Listiana et al. [24], education levels can influence an individual's knowledge and ability in carrying out business activities.

3.1.3. Long Experience of Farming

The length of time farmers have spent pursuing their farming endeavors is determined by their farming experience. Farmers who have been involved in farming for a long time typically have a better understanding and knowledge of land conditions than those new to the world of agriculture. Farmers who have been involved in farming for a long time tend to be more adept at analyzing and selecting farming methods to increase production and profitability. The number and percentage of respondents from the Selat Kandis 2 and Suka Ratu Farmer Groups in Sungai Dua Village, based on their length of farming experience, can be seen in Table 3.

Table 3. Number and Percentage of Respondents Based on Years of Farming 2023

No	Experience (Years)	Number (of Souls)	Percentage (%)
1	≤ 10	4	4
2	10 - 20	20	20
3	≥ 20	76	76
Total		100	100

Source: Primary data processed, 2023

Table 3 shows that the largest number of respondents have been farming for 76 percent, or more than 20 years, while the smallest number of respondents is 4 people, with a value of 10 years. Long farming experience will help farmers deal with various problems encountered in the farming business they manage. A farmer farming for a longer period is expected to have a better understanding and knowledge related to farming, and be able to overcome problems experienced in their farming activities [24]. This is supported by the opinion of Agatha and Wulandari [25] who stated that farmers who have been involved in farming activities for a long time will be more selective and appropriate in choosing the type of innovation to be implemented, and more vigilant in the decision-making process for implementing their farming activities. Conversely, farmers with less experience usually tend to make decisions more quickly because they will bear more risks, resulting in frequent failures in producing output.

3.1.4. Shallow Lebak Swamp Land

The lowland swamp farming system is considered a potential and prospective land for future development [26]. Non-tidal swampland that forms depressions is called lowland swampland. Its topography experiences both periodic and permanent inundation. The use of this land is strongly influenced by water and seasonal conditions; this land can be reserved for agricultural development, especially during the dry season. Shallow lowland swampland has a water depth of less than 50 cm for less than 3 months. Shallow lowland swampland often experiences drought, while deep lowland swampland often experiences flooding [27]. The primary production factor in agriculture is land, as it is the place where plants grow and develop. Plants will grow and develop if the conditions of the land and surrounding resources, consisting of biological (plants and animals) and non-biological (soil, climate, weather), are favorable. The area of land used in the rice paddy farming system can be optimized by planting other crops, such as eggplant planted in rice fields or rice ridges. The area of land used in optimizing the rice paddy farming system in shallow swampy areas can be seen more clearly in Table 4.

Table 4 shows that the area of land to be optimized in the rice paddy farming system in shallow swamps for the 2 farmer groups that are cultivated has the highest value, with a total of 55 or 56.65 percent, with a range of 0.5 - 1 Ha, while the lower amount is 14 or 14 percent in the range of > 1 Ha. The land can be optimized by planting purple eggplant plants planted along the Farm Road (JUT) or on the edge of the rice field. Around 80 purple eggplant plant seedlings are used to increase production and as food security for the family. The land that is the location of the research can be seen in Figure 1.

Table 4. Number and Percentage of Respondents Based on 2023

No	Experience (Years)	Number (of Souls)	Percentage (%)
1	≤ 10	4	4
2	10 - 20	20	20
3	≥ 20	76	76
	Total	100	100

Source: Primary data processed, 2023

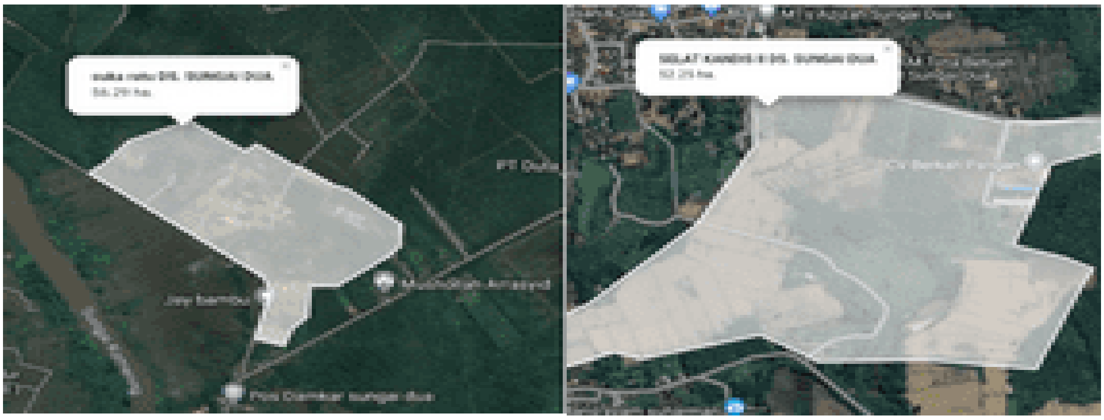

Figure 1. Land of the Suka Ratu and Selat Kandis 2 farmer groups
(Source: Gapoktan Data, 2023)

3.2. Optimization of the rice farming system on shallow swamp land in Sungai Dua Village

3.2.1. Land Preparation

The first step in farming is land preparation. Land preparation involves tilling the land from previous cultivation to loosen it and make it ready for planting. Land cultivation in shallow, rain-fed swamps use a tractor. The procurement system for farmer groups is still a rental system. The tractor is rented twice, at a price of IDR 1,200,000 per tractor. After the land is tilled, 100 kg of manure is added per hectare to loosen the soil. After the manure is applied, the land is left for one week. Farmers obtain manure by purchasing it from livestock breeders. The price of manure is IRD 7,000/kg. The time required to cultivate 1 hectare of land is over 7 hours with a plowing depth of 15–20 cm.

3.2.2. Sowing and Planting

Rice seeds must be soaked for one to two nights before planting to allow them to absorb water, thus promoting optimal germination. Most farmers in this village use floating seedbeds. Floating seedlings function to suppress pest and disease attacks on plants. Nurseries can be used 3-4 times. Floating seedlings are used for 15-20 days, depending on the condition of the land, ready for planting [5]. Rice planting is carried out in a 4: 1 row (Jarwo). Rice farmers in shallow swampy areas use superior Inpara 2 seeds. In particular, one of the supporting factors for efforts to increase productivity in shallow swampy areas, which are classified as suboptimal land, is the use of superior quality seeds [28]. Meanwhile, purple eggplant plants need to be nursed before being planted on farm roads.

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3.2.4. Fertilization

Fertilization is carried out periodically. Basic fertilization is done during land preparation by adding manure and leaving it for one week. The second fertilization is done when the rice is 7-10 days old. The third fertilization is when the rice plants are 20-25 days old. The fourth fertilization is when the rice plants are 30-35 days old. The types of chemical fertilizers used by respondents in Sungai Dua Village, Rambutan Regency, tend to be the same. The types of fertilizers used are urea and NPK. The use of urea fertilizer is still below the recommended level, while Ponska is sufficient. Meanwhile, the fertilizer used on purple eggplant plants remains the same type. Purple eggplant plants are used for 2 weeks using urea, followed by 2 months of NPK fertilizer.

3.2.5. Plant Care

Plant care is carried out at any time. Pest, disease, and weed control can be carried out mechanically or chemically. Chemical pest control involves administering medications such as pesticides and herbicides. The most common pests are snails, rats, ladybugs, grasshoppers, and leafhoppers, as well as weather conditions such as drought during the dry season and flooding during the rainy season. Medications should be used according to the recommended dosage. Respondents used medications such as Matarin, Dunke, Serendi, Nomin, and others. Purple eggplant is easier to care for.

3.2.6. Harvesting

Characteristics of rice that is ready for harvest When 95% of the grain has turned yellow, the flag has turned yellow, the optimal age of the rice panicle is 30-35 days from the day before flowering (HSB), contains a water content ranging from 21-26% where if the panicle is squeezed, the grain will fall around 16-30% [29]. How to harvest rice in shallow swampy land using a machine combine harvester with the same rental system as a tractor. Combine harvester. Its use has a positive impact on rice farmers, in addition to reducing labor use, lowering production costs, and ensuring even distribution of results. This is in line with the research of Maksudi et al. [30] that the use of a combine harvester provides an effectiveness of 128.57%, and its use also impacts farmers' income by 36.04%. Furthermore, research by Riasa et al. [31] found that farmers who have used the machine combine harvester have harvesting results in increased income. In swampy areas, using superior rice seeds, harvest time is faster, at 70–90 days after planting.

3.2.7. Analysis of Income and Feasibility of Farming Business

The income analysis in this study aims to determine the amount of income of respondent farmers in rice and purple eggplant farming in Sungai Dua Village, Rambutan District, Banyuasin Regency, during one planting season, by calculating the difference between total income and total costs used in carrying out farming, while *R/C* looks at whether it is feasible, not feasible, or break-even.

Table 5. Average Cost Structure of Farming Business Paddy Rice and Purple Eggplant on Shallow Lebak Swamp Land Year 2023

No	Cost Components	Paddy Fields		Purple Eggplant	
		Value (IDR)	%	Value (IDR)	%
Fixed Costs		4,814,536	43.85	179,136	22.56
1	Tractor rental	1,092,900	9.95	0	0
2	Combine harvester rental	2,422,900	22.07	0	0
3	Hoe	99,600	0.91	0	0
4	Stable	1,020,000	9.29	0	0
5	Equipment Depreciation	179,136	1.63	179,136	22.56
Variable Costs		6,165,100	56.15	614,775	77.44
6	Seeds	294,400	2.68	66,750	8.40
7	Manure	644,000	5.88	31,031.50	3.92
8	Urea	826,500	7.64	6,873.60	0.86
9	NPK	610,300	5.67	13,320	1.68
10	Pesticide	644,000	5.87	0	0
11	Herbicide	241,200	1.95	0	0
12	Labor Costs	2,905,100	26.46	496,800	62.58
Total Costs		10,979,636	100	793,911	100

Source: Primary data Processed, 2023

Table 5 shows that the highest cost of rice and purple eggplant farming in shallow swampy areas is labor, with percentages of 26.46% and 62.58%, respectively. This aligns with the research of Septian [32], the labor is the highest cost in rice farming activities. This is in line with the research of Wang et al. [33] which states that a higher proportion of labor in total labor costs improves farm performance and reduces production risks.

3.2.8. Revenue, Income, and Feasibility of Rice and Purple Eggplant Farming

The average value of production, price, income, production costs, and income in 1 hectare of converted land of respondents from the research results in Sungai DuaVillage, Rambutan District, Banyuasin Regency can be seen in Tables 6 and 7. Based on Table 6, the average production value of respondents' rice farming was 2,468.65 kg/ha at a price of IDR 5,850.00/kg/ha. The income obtained was IDR 14,441,602.5 and the average total cost incurred by respondents during the production process was IDR 10,979,636/ha/MT. The income received was IDR 3,641,966,5/ha/MT.

Based on Table 7, the average value of production in respondents' purple eggplant farming per hectare is 716.9 kg with a price of IDR 6,500/kg. The income obtained is IDR 4,659,850, and the total costs incurred by respondents during the production process are IDR 793,911/Ha/MT. The average value of income received is IDR 3,865,939/Ha/MT. Rice plants are able to produce an average production value of 2,468.65 kilograms. The income obtained by respondents in this rice farming is IDR 14,441,602.5/Ha/MT.

Table 6. Average Production, Revenue, Production Cost, and Feasibility of rice farming on the shallow swamp land in Lebak Sungai Dua Village, Subdistrict Rambutan, 2023

No	Description	Mark IDR /Ha/MT
1	Productivity (Kg)	2,468.65
2	Price (IDR)	5,850
3	Revenue (IDR)	14,441,602.5
4	Total Cost (IDR)	10,979,636
5	Income (IDR)	3,641,966.5
6	R/C ratio	1.32

Source: Primary data Processed, 2023

Table 7. Average Production, Revenue, Production Cost, and Feasibility of Purple Eggplant Farming Rice Fields in the Lebak Swamp Land Shallow in Sungai Dua Village, Rambutan District, 2023

No	Description	Mark IDR/Ha/MT
1	Productivity (Kg)	716.9
2	Price (IDR)	6,500
3	Revenue (IDR)	4,659,850
4	Total Cost (IDR)	793,911
5	Income (IDR)	3,865,939
6	*R/C ratio*	5.87

Source: Primary data Processed, 2023

The income obtained by respondents from rice farming is smaller than the average income from purple eggplant farming, which is IDR 4,659,850/Ha/MT. The income obtained by respondents from rice farming is smaller than the income from purple eggplant farming. Respondents' rice farming business experienced a decline, but this decline was supported by purple eggplant farming, which can be said to be profitable and successful (optimal), as can be seen from the average income obtained by respondents, which was IDR 3,865,939/Ha/MT. This purple eggplant plant can be harvested repeatedly up to 8 times in 2 months, with harvesting carried out every week. The decline in rice farming production results from production levels due to changes in weather, climate, the spread of pests and plant diseases, and the use of fertilizers that do not comply with government recommendations, as well as low-income respondents and low prices offered. High productivity in shallow swampy land can also be caused by the high use of outside labor and the use of fertilizers that do not comply with dosages, causing increased costs, as Vukey et al. [34] showed that Rice farming in Ghana shows that high labor allocation and fertilizer use have a positive effect on land productivity.

Furthermore, the data is used as a mathematical model to analyze the optimization of the rice farming system on shallow swamp land in the use of conventional farming systems by utilizing rice fields where the farming roads for rice plants are planted with purple eggplants as an increase in income for respondents in Sungai Dua Village Rambutan District Banyuasin Regency, the mathematical model in the Linear Program is as follows:

Objective Function,

$$\text{Max } Z = 3{,}641{,}966.5X_1 + 3{,}865{,}939X_2$$

Subject to

- Land: $X_1 + X_2 \leq 1$
- Workforce: $99.8X_1 + 47X_2 \leq 166$
- Modal:
  $10{,}979{,}636X_1 + 793{,}911 \leq 11{,}773{,}547$

The considerations obtained from the objective function and constraints determined for more clarity can be seen in Table 8.

Table 8. Land Allocation Recommendations: Shallow Rice Fields in Lebak Sungai Dua Village, Rambutan District, 2023

No	Observed variables	Mark IDR/Kg/MT
1	Maximum goal achievement	IDR 3,864,939
2	Rice (X_1)	0
3	Area of purple eggplant farming land (X_2)	1
4	Residual Value	
	- Labor force	119
	- Capital	IDR 10,979,640
5	*R/C ratio*	2.40

Source: Primary data Processed, 2023

Based on Table 8, it shows that the optimum income results or the achievement of maximization goals is IDR 3.864.939 per hectare, where X_1 is the area of land used for rice farming which has a value of 0, and X_2 is the area of land used for purple eggplant farming has a value of 1, meaning that all the land used is only for purple eggplant farming activities, so that Linear Programming takes all values objective function optimally using the QM program for windows. The workforce used for farming activities is 47, and the remaining and unused workforce is 119. The limit of the workforce used is 166 people obtained from the sum of Man-Days (HOK) in rice and purple eggplant farming activities, while the capital used for farming activities is IDR 793.911 and the remaining and unused capital is IDR 10.979.640.

The limit of the capital used is IDR 11.773.547 obtained from the sum of the total costs incurred in the production process of rice and purple eggplant farming activities. This study uses land for farming activities, which is not optimal, because during the dry season, with a long drought, rice plants lack water where the production location is higher than the river land, so pumping is needed so that water can reach the entire land area; ultimately, rice production can decrease. Respondent farmers are not optimal in utilizing available resources; as a result, many are left with unused available resources. Therefore, remaining labor and capital should be used for other purposes, such as household needs. Respondents should also use labor and capital only as needed in farming activities, ensuring that resources are not wasted and optimally utilized.

4. Conclusion

This study shows that the comparison of rice and purple eggplant farming activities on suboptimal land, namely shallow swamp land, is significant, both in the cultivation process, production levels, and productivity. Suboptimal land, namely, swamp rice fields, is only able to produce rice and purple eggplant with optimal production capacity. The cultivation of rice and purple eggplant farming that is developed includes the use of superior seed types between fields, and the dosage of chemical fertilizers, namely urea, NPK, has met the recommended standards. Shallow swamp land plant care only uses herbicides and pesticides. The age of rice plants until harvesting in suboptimal land, shallow swamp land that uses superior seeds, can be harvested when the rice is 90-110 HSS. While the harvest is still in the form of Harvested Dry Grain (GKP), purple eggplant in the form of fruit is directly sold to collectors or middlemen. Based on the analysis of farming profits, from the value of rice production levels, it is clear that shallow swamp land provides the highest profit for rice plants. The highest cost in rice farming in shallow swamp land is labor wages.

The results of the analysis show the use of inputs such as the number of workers. The R/C_{ratios} of rice and purple eggplant farming are 1.32 and 5.87, respectively. The average income of respondents who run rice farming in Sungai Dua Village, Rambutan District is IDR 3.641.966,5/Ha/MT. This rice farming income shows that the income obtained from running rice farming is greater than the total costs incurred in the rice farming production process, while the average income of farmers who run purple eggplant farming in Sungai Dua Village, Rambutan District is IDR 3.865.939/Ha/MT. This purple eggplant farming income shows that the income obtained from purple eggplant farming is greater than the total costs incurred in the farming production process. Farming activities in shallow swampy land in Sungai Dua Village, Rambutan District, Banyuasin Regency, are not optimal, as seen from the suboptimal use of the land. Optimizing the use of shallow swamp land rice farming systems per hectare is recommended only for purple eggplant farming activities, so that income is obtained more profitably, while for labor, the remaining and unused labor is 119, and for unused capital is IDR 10.979.640. If respondents add labor and capital, then the changes will not affect the objective function value. The optimum income obtained by farmers in the research was IDR 3.865.939/Ha/MT.

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