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Strategies for Optimising Rice Management in New Rice Expansion Areas in West Sumatra Province, Indonesia

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ABSTRACT

The West Sumatra provincial government from 2016 to 2018 implemented a new paddy field expansion programme. Currently, 73.33% of paddy fields are not managed by farmers. The paddy fields have been converted into plantations, buildings, and many are abandoned. The purpose of this study is to formulate strategies that can optimize the management of rice paddy farming in the location of new rice field expansion in the province of West Sumatra. This research uses mixed methods, combining quantitative methods with qualitative methods. The type of research used is survey research. The research location was determined by purposive technique, namely 8 districts where the implementation of new rice field expansion in West Sumatera Province. Respondents and research informants were selected using a purposive technique. The number of respondents was 48 paddy rice farmers and 22 informants from agricultural extension workers and Nagari government officials. The questionnaire data collection technique was used to obtain: a) data and information on the current condition of paddy rice farmland in the location of new rice field expansion; b) supporting and inhibiting factors in the management of paddy rice farming. In addition, interview techniques were used in conjunction with direct observation activities at the research site. Secondary data were obtained through documentation techniques, which were analyzed using the content analysis method. Qualitative data were analyzed using descriptive interpretative techniques, while quantitative data were analyzed using multivariate analysis techniques in Structural Equation Modeling - Partial Least Square (SEM-PLS). The results of this study are that only 26.67% of the new rice fields are managed by farmers. Strategies that can be used to optimize rice wetland management in new wet rice-expansion areas include optimizing agricultural extension to empower farmers' institutions and competencies, improving irrigation infrastructure, and utilizing wet rice farming technology. The strategy can be an input for the government in formulating policies to optimize the management of paddy farming in the location of new rice field expansion. The strategies formulated set this research apart from previous studies.

1. INTRODUCTION

In an agrarian country like Indonesia, the agricultural sector is one of the foundations of economic development. The agricultural sector can deliver food security and poverty reduction if properly managed [1]. The Indonesian government has made the agricultural sector a priority in its development policy [2] aiming to make Indonesia the world's food supply centre by 2045 [3].

Policies for the development of agriculture need to strike a balance between improving the quality and quantity of human resources in agriculture and agricultural land [4]. As policy functions to provide direction for government action in addressing agricultural development issues [5]. This is why the Indonesian government has put in place a policy in the form of an expansion programme for rice fields.

Rice is a strategic crop for meeting the food needs of the Indonesian people. Rice is the third crop grown in the world as a people's food [6]. Rice is a very important crop for the nation's food security [7]. For this reason, the Indonesian government annually sets policies to ensure the sustainability of wet rice farming [8].

A major issue for the sustainability of rice cultivation in Indonesia is the conversion of paddy fields [8]. The conversion of paddy fields is caused by the high economic value of paddy fields, the strategic position of paddy fields and population growth [9]. Other causes include the small size of farmers' rice farms, geographical conditions, low soil fertility, low income of rice farmers, changes in farmers' economic structure, national economic conditions and the development of tourist attractions around rice farms [10].

The conversion of paddy fields has led to a reduction in the national paddy area. This has had an impact on the decline in national rice productivity. To address the problem of the

conversion of rice paddy land, the Indonesian government launched a rice paddy expansion programme to increase the national rice paddy area. Land that is used as a new rice field area in the form of various soil typologies and has never been used for rice paddy farming activities [11]. The location of rice fields must be supported by the availability of irrigation, availability of tenant farmers, fertiliser technology and the availability of farm capital [12].

There are several land requirements that can be used for the expansion of new rice fields, including a) clarity of land ownership; b) not dispute land; c) the land has never been managed into rice fields; d) the slope of small land from 8%; e) a stretch of at least 5 Ha; f) close to settlement and accessibility; g) the land is suitable for cultivation of rice fields; h) the land is intended for cultivation; i) the field fields that have been made incorporated into Sustainable Food Agriculture (LP2B); and j) the availability of water for irrigation and farmers. All of these criteria must be met so that the future does not cause problems.

The above requirements are guidelines for every executor's activity throughout Indonesia. The new rice field land expansion program was implemented in Indonesia from 2016-2018. One of the provinces that implements this new rice field land expansion program is West Sumatra province. Realization of the program in West Sumatra began in 2016, which is located in 8 districts; in 2017, it was implemented in 4 districts; and in 2018, it was implemented in 2 districts. The total area of rice fields made in West Sumatra from 2016 to 2018 is 1,073,42 ha [13].

Currently, the rice fields are not all well managed by farmers. Based on the evaluation results conducted by the Food Plantation and Horticulture Agency in 2022, the field fields are still managed by farmers, which is 286.32 ha, or only 26.67% of the total rice fields. The rest, rice fields, have become a bush of 499,54 ha, or 46.53%. There are also those who have switched functions to folk gardens of 70.26 Ha (6.54%), mixed gardens of 102.26 Ha (9.52%), horticultural farmland of 37.01 Ha (3.44%), and some turn into buildings of 0.27 Ha (0.02%).

The above conditions certainly do not fit the purpose of the new rice field expansion programme. Where the policy aims to address the problem of reduced raw area in rice fields. Even the rice fields cannot be maintained in LP2B. This condition proves that the implementation process of policy is much more difficult when compared to policymaking.

Failure to implement policies and development programmes can cause government financial losses and eliminate the opportunity for people to get other government programmes such as subsidies and grants [14]. Failure to implement government policies is caused by several factors, including aspects of authority, resources, communication, and disposition. Policy implementation depends not only on the behaviour of administrative institutions responsible for implementing the programme but also on the participation of society, political, economic, and social forces, and various parties [15].

The cause of the poorly managed rice fields by farmers is due to the limitations of farmers' competence in running rice fields. This can be overcome by doing farmer-empowering activities that benefit new rice fields [16]. Other solutions that can be done are the preparation of careful programme planning, the presence of irrigation management or irrigation systems, and the presence of training and technical assistance for farmers. To realise sustainability in the management of rice fields in the area of expansion of new rice fields, social aspects, ecological aspects, institutional aspects, and aspects of agricultural infrastructure need to be optimised [17].

The availability of water for rice fields is an important input in ensuring the sustainability of rice field farms; therefore, sustainable irrigation management needs to be established [18]. Rice field planting systems, such as rainy season planting systems, rainfall, and irrigated rainy season planting systems, also become important considerations to ensure the sustainability of the management of rice field farming businesses [19]. The sustainability of the management of rice field farm businesses also depends on a good institutional system between its levels so that sociotechnical rice field businesses can run in balance [20]. The availability of data, technology, and integrated use can create smarter rice field farm business development [21].

Based on the previous research above, the differences in this study can be seen in:

(1) This research focuses on the location of the implementation of the new paddy field expansion programme in West Sumatra Province.

(2) The research method used in this study is different from previous researchers, namely using mixed research methods, namely combining quantitative methods with qualitative methods.

(3) This research produces strategies to optimise wetland rice farming that can be used by the government in making policies.

Referring to the research gap above, the novelty offered in this study falls into the improvement type. This is because the novelty of the research is an increase or improvement of principles or practices in optimising the management of farming management of wet-rice farming in the location of the paddy field expansion program.

The novelty in this research contributes to the strengthening of the theory of agricultural development, especially in the theory of farm management of paddy rice farming. To be able to produce the novelty of this research, the general objective of the research is to formulate strategies for optimising the management of rice farming in the implementation location of the new rice field expansion programme. While the specific objectives of this research are:

(1) Describe the current condition of rice field expansion.

(2) Analyse the supporting factors and inhibiting factors to optimise the management of rice paddy farming.

(3) Formulate strategies to optimise the management of rice paddy farming management.

Based on the description of the novelty and purpose of this research, it can be emphasised that this research is important. This is so that the problem of the sustainability of rice field management in the location of the new rice field expansion programme can be resolved properly. In addition, it can also help in achieving the objectives of the rice field expansion programme in West Sumatra Province.

2. RESEARCH METHOD

This research uses the research method of mixed-methods research with a sequential explanatory design. In this case, the research begins using quantitative methods and is strengthened by qualitative methods [22]. The type of research used is survey research. The research site was selected using a purposive method. The considerations used to determine the

research site are:

(1) Districts in West Sumatra Province that implemented the new paddy expansion programme from 2016 to 2018.

(2) The availability of respondents and informants who are willing to take the time to provide data and information related to the research topic.

(3) The research location is the result of recommendations from the West Sumatra Provincial Government.

Based on the above considerations, this research was conducted in 8 districts, namely Mentawai Islands, Agam, Lima Puluh Kota, South Solok, Solok, West Pasaman, Dharmasraya and Sijunjung.

The time used for this study is 4 months, starting from September to December 2022. The research data focus is: a) a description of the current land conditions of the rice farm at the programme's location; b) Supporting and constraining factors for the optimisation of the management of wet rice cultivation in the new areas of rice field expansion; and c) strategies for optimizing rice farming management in new field expansions. The data used are secondary and primary data.

Respondents and research informants were identified using purposive techniques. The considerations used to select the respondents are:

(1) Individual farmers as owners of rice fields at the site of new rice field expansion.

(2) Farmers who are members of farmer groups that are beneficiaries of the new paddy expansion programme.

(3) Farmers who cultivate paddy fields at the location of the new paddy field expansion.

The considerations used to select research informants are:

(1) Individuals assigned by the government to assist farmers in managing wet rice cultivation in the area of new rice field expansion.

(2) Nagari government officials with authority in the agricultural development sector.

(3) Individuals who understand the conditions for implementing the new paddy expansion programme.

Based on the above considerations, 48 research respondents were obtained from farmers, while 22 research informants were obtained from the Nagari government apparatus and agricultural extension workers.

The data collection techniques used in this study are:

(1) Questionnaire technique.

In its implementation, the researcher uses an instrument in the form of a questionnaire or list of questions. The questionnaire used contains closed questions, namely questions for which a list of answer choices has been provided. This technique was used to obtain data on a) existing conditions of paddy fields; b) management of paddy rice farming in the location of new paddy field expansion; c) supporting and inhibiting factors in running the farm; and d) clarification of the location of paddy fields.

(2) Interview

The interview technique used was a semi-structured interview. This aims to allow the interviewees to disclose information, ideas and opinions more freely. The data collected through the interview technique are a) problems faced by farmers in managing wet rice cultivation; b) supporting factors and barriers faced by farmers in managing wet rice cultivation; and c) strategies or tips to be able to optimise the management of wet rice cultivation in the location of expansion of new paddy fields.

(3) Documentation Method

This technique is used to collect secondary data. The secondary data in this study are in the form of paddy field maps, documents on the implementation of the new paddy field expansion programme and previous research relevant to the topic of this study. The instrument used in the documentation technique is a documentation guide which contains the data required in this research.

(4) Observation

The observation technique was used to corroborate the results of the questionnaires and interviews. The observation used in this research is non-participant observation. The instrument used for observation is an observation sheet. The observation sheet contains notes about the observed objects. The focus of field observations is a) the condition of paddy fields; b) the availability of facilities and infrastructure of paddy farming; and c) problems faced by farmers in managing paddy farming.

The data analysis techniques used in this study are:

(1) In order to describe the existing conditions of new paddy field expansion, analytical descriptive data analysis techniques were used. The results of data analysis are presented in the form of narrative, tabulation. To map the condition of paddy field expansion, satellite image interpretation techniques were used using GIS (Geographic Information System) software.

(2) To analyse the supporting and inhibiting factors in optimising the management of paddy rice farming using Structural Equation Modeling-Partial Least Square (SEM-PLS) software.

The SEM_PLS used is the measurement model. This model allows only a unidirectional model of the relationship between variables. The principle is the same as in multiple linear regression. In this case, it relates all the manifest variables (x) to their latent variables (y). The manifest variables (x) used are:

- Supporting factors: soil quality, availability of sustainable irrigation for rice fields, availability of production facilities, availability of farm capital, quality of farmers, support for farm facilities and infrastructure, farm management, strong farm institutions and availability of strong social capital.
- Inhibiting factors: lack of farmer commitment, climate, soil fertility, limited irrigation, high attractiveness of other farms, high economic needs of farming families, low productivity, lack of government support, farmers have no background in paddy farming.

To measure reliability, Cronbach's Alpha was used with a minimum value of 0,7 and an ideal value of 0,9. The absolute correlation between the latent variables and their indicators must be > 0,7 (absolute value of the raw external loadings). Reflective indicators should be removed from the measurement model if they have an external raw loading value below 0.4.

(3) The data analysis techniques used to formulate strategies used qualitative descriptive techniques through the interpretation method. The analysis thought pattern is the reason x (strategy) is the reason for doing y (optimising the management of rice farming management).

3. RESULTS AND DISCUSSION

The development of new rice fields by the West Sumatra provincial government requires strategic action to optimise the function of rice fields. Therefore, the findings and discussion

chapter begins with an overview of the existing conditions of new paddy fields. It also identifies factors that support and inhibit the optimisation of rice field management. Based on the data and information, strategies are formulated to optimise the management of new paddy fields. More details are given in the following discussion.

3.1 Overview of existing conditions for new rice field expansion in West Sumatra Province

The West Sumatra provincial government organised activities to expand new paddy fields from 2016 to 2018. This activity aims to overcome the problem of paddy conversion, which results in reduced productivity of paddy rice. This will have an impact on the region's ability to meet its rice needs.

The location of the new rice field expansion in 2016 was in Mentawai Islands, Solok, West Pasaman, South Solok, Sijunjung, Agam, Lima Puluh Kota and Dharmasraya. The total area of new rice fields in 2016 was 597.09 hectares. In 2017, the expansion of rice fields was implemented in the districts of Dharmasraya, South Solok, West Pasaman and Agam with a total area of 331 hectares. The latest implementation was in 2018 in West Pasaman and Dharmasraya districts with a total area of 145 hectares of new paddy fields.

The development of new rice fields is funded by the national budget (APBN). The implementation of this activity is carried out with a self-management pattern, which is carried out by government agencies so that the results are more efficient. In this case, it is carried out by the West Sumatra Provincial Agricultural Office in collaboration with universities and the Indonesian National Army. For more details, the data in Table 1 can illustrate the state of new rice field expansion in West Sumatra Province.

Table 1. Overview of existing conditions for the implementation of new rice field expansion in West Sumatra Province

Implementation Year	Location of Implementation				Target for Paddy Field Expansion (Hectare)	Realisation of New Paddy Land Expansion (Hectare)
	District	Number of Subdistricts	Number of Villages	Number of Farmers' Groups		
2016	Kepulauan Mentawai	1	1	1	25	25
	Solok	2	2	2	18	13
	Pasaman Barat	2	2	2	42	38.80
	Solok Selatan	3	3	5	117.4	117.14
	Sijunjung	3	5	5	100	100
	Agam	2	2	2	59	59
	Lima Puluh Kota	5	7	13	172.15	172.15
	Dharmasraya	1	3	4	72	72
	Total:	**19**	**25**	**34**	**605.55**	**597.09**
2017	Dharmasraya	6	7	7	149.99	115
	Solok Selatan	2	2	2	92	65
	Pasaman Barat	2	2	2	137	80
	Agam	1	1	1	71	71
	Total:	**11**	**12**	**12**	**449.99**	**331**
2018	Pasaman Barat	1	2	2	95.33	95.33
	Dharmasraya	1	1	1	50	50
	Total:	**2**	**3**	**3**	**148**	**145**

Source: Processed from secondary data expansion of new field fields of Provincial & Regency Agriculture Office in West Sumatra, 2022.

The government targeted 605.55 hectares of new rice fields in 2016, while 597.09 hectares were realised and 8.46 hectares of land could not be converted into new rice fields. This is because some potential areas do not meet the standards set by the government. The regions with the most new rice fields are Solok Selatan with an area of 117.14 hectares and Lima Puluh Kota with a total area of 172.15 hectares.

The expansion of new rice fields continued in 2017. The total land area targeted by the government was 449.99 hectares, while the new rice field expansion that could be implemented was 331 hectares. This is due to the unsuitability of potential rice fields in Dharmasraya, Solok Selatan and Pasaman Barat. The total area that cannot be used as rice fields is 118.99 hectares.

The target for the implementation of the expansion of new rice fields in 2018 was 148 hectares, and the realised area was 145 hectares. There were 3 hectares of land that could not be used as new rice fields. The reason is the same as the previous year, namely that the candidate land does not meet the indicators set by the government.

The location of the expansion of new rice field farmland in 2016 is spread across 8 districts, 19 sub-districts, and 25 villages or nagari. The land is implemented on farmland belonging to the farm group, which has 34 farm groups. For 2017, the location of the expansion of new rice field farmland spread across 4 districts, 11 sub-districts, and 12 villages or nagari implemented on farm group land by as many as 12 peasant groups. Furthermore, in 2018, it was implemented in 2 districts, 3 subdistricts, 3 villages (nagari), and applied to as many as 3 peasant groups.

To describe the location of the new rice field expansion in West Sumatra Province, it can be seen in the map in Figure 1. Based on the literature review, there are three methods of mapping: a) the optical mapping method based on remote sensing; b) The mapping method based on microwave remote sensing; and c) The mapping method based on optical remote sensing integration and microwave [23]. There are also those who use phenological-based approaches through the introduction of sensing away from the main growth phase. Mapping can also be done using Sentinel-1 SAR data and conventional decision tree methods [24]. Another method that can be used is to utilise the Google Earth Engine cloud

computing platform (GEE) and the Landsat 8 image to extract rice fields. Referring to the various methods of map making, the map in Figure 1 was made using satellite image interpretation techniques that were used using GIS (Geographic Information System) software.

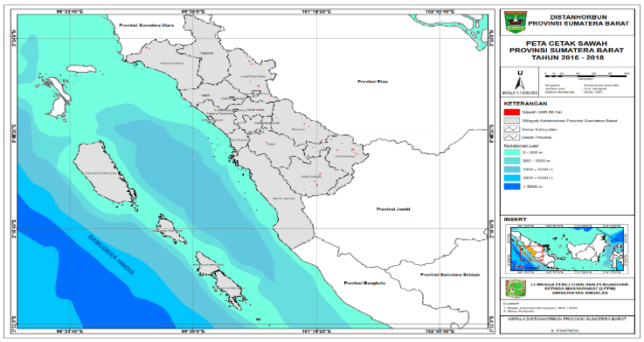

Figure 1. Map of the expansion of new rice fields in West Sumatra Province, 2016-2018
Processed from data: Food Plantation Service and Horticulture Unit Working Unit Food Plant Agriculture Service West Sumatra Province, 2022

The red colour in the map above shows the location of new rice field expansions in the administrative area of West Sumatra Province.

The evaluation results in 2022 showed that not all of the paddy fields resulting from the expansion of new paddy fields were managed by farmers. The total area of paddy fields still under cultivation is 286.32 hectares or only 26.67% of the new paddy fields developed by the government. Most paddy fields have become shrubs, converted to smallholder plantations, horticultural farms, mixed gardens and built-up areas. For more details, see Table 2.

Most farmers are not planting new rice fields. This can be seen from the condition of 499.54 hectares of new paddy fields that have become bushes. This means that 46.53% of the new paddy fields have been abandoned by the farmers.

The abandonment of new rice fields is due to the lack of sustainable irrigation. Another reason is the limited competence of farmers in managing wet rice farms. The unavailability of agricultural production facilities for paddy rice constrains farmers from running their farms. Climate mismatch in some new paddy expansion sites makes paddy production sub-optimal. It is also caused by the limited farm capital of the farmers.

The condition of abandoned new rice fields has an impact on the performance of government policies that fail to increase rice productivity. In addition, the hope of increasing farmers' income and welfare cannot be properly achieved. Ultimately, the goal of food security and self-reliance cannot be achieved.

The abandonment of new paddy fields results in losses to government finances. The considerable cost of developing new paddy fields does not have the expected impact. Obviously, this situation needs to be addressed by the government. In order to optimise the achievement of the objectives of new rice field expansion activities.

Some farmers have converted their rice fields into other farms, such as community gardens covering an area of 70.26 hectares, horticultural farms covering an area of 37.01 hectares and mixed farms covering an area of 102.26 hectares. This situation is found in the districts of Solok, Sijunjung, Agam, Lima Puluh Kota, Solok Selatan, Dharmasraya, Pasaman Barat.

According to the farmers, the new rice fields they have received have not been able to produce rice as expected. In addition, the sale value of other agricultural commodities, which is higher than the sale value of rice, makes farmers redirect the function of their rice fields. In order to prevent their farmland from being abandoned, the farmers took the initiative to grow plantation products and horticultural crops.

The condition of the new paddy fields, which does not correspond to their allocation, indicates that the objectives of the programme are not being achieved. The government needs to make this condition a strategic issue in formulating agricultural development policies for food crops. An effective strategy is needed to overcome the problems encountered in the location of new rice field expansion.

Table 2. Condition of existing use of rice paddy farmlands at the expansion location of new paddy rice farmlands in 2022 in West Sumatra Province

Num.	District	Land Cover Conditions (hectares)					
		Rice Fields	Shrubs	Folk Plantations	Horticultural Farmland	Mixed Plantations	the Area Awakens
1.	Kepulauan Mentawai	0	24.24	0	0	0	0
2.	Solok	6.47	4.01	0	1	1.43	0.03
3.	Sijunjung	53.31	64.51	1.5	0.43	0	0
4.	Agam	9.21	93.37	15.19	11.67	0	0
5.	Lima Puluh Kota	18.67	76.72	30.48	11.26	0	0.18
6.	Solok Selatan	48.74	86.42	1.43	0.43	43.88	0
7.	Dharmasraya	120.82	36.49	2.32	0	52.5	0.06
8.	Pasaman Barat	47.1	113.78	19.34	12.22	4.45	0
Total (hectares)		**286.32**	**499.54**	**70.26**	**37.01**	**102.26**	**0.27**
Scentage (%)		**26.67**	**46.53**	**6.54**	**3.44**	**9.52**	**0.02**

Source: Processed from various data and satetlit imagery, 2022.

3.2 Factors affecting the optimisation of rice cultivation management

Optimising the management of wet rice cultivation in new paddy expansion areas is a key research issue. Optimisation can be achieved through several strategic formulations that can be used as input to the government. In order to formulate the strategy, supporting and inhibiting factors need to be identified.

The first stage in identifying supporting and inhibiting factors was conducted using a qualitative approach. These factors were captured through interviews with research informants. According to the research informants, the

supporting factors to optimise the management of paddy rice farming are:

(a) Soil quality of paddy fields;
(b) Availability of sustainable irrigation of paddy fields;
(c) Availability of input support (seeds, fertilisers, plant medicines and equipment);
(d) Availability of farm capital;
(e) Quality of human resources of farmers;
(f) Support of agricultural facilities and infrastructure;
(g) Management of paddy rice farming;
(h) Strong farmer institutions;
(j) The strength of social capital.

The number of supporting factors expressed by informants in this study is 9. All these supporting factors are the result of a summary of important statements made by research informants.

The research informants identified several factors that hinder the optimisation of rice management in new rice expansion sites. The inhibiting factors are:

(a) Lack of farmers' commitment;
(b) Climate;
(c) Soil fertility;
(d) Limited availability of water for paddy irrigation;
(e) The high profit of other farms compared to the results of paddy farming;
(f) The economic needs of the farmer's family;
(g) Low production and productivity;
(h) Lack of government support;
(i) The characteristics of sharecroppers who were not previously wet rice farmers.

All of these inhibiting factors were expressed by the informants based on their observations and experiences during the new rice field expansion activities carried out in their areas.

There are differences between the results of this research and previous research in terms of supporting and inhibiting factors for optimising wetland rice management. Previous research has shown that the sustainability of wetland management is closely related to the productivity of wetland rice production. Paddy production can be influenced by land area, seed, phoska and labour [25]. Experience, education, and capital can also affect the production and productivity of rice fields as an indicator of the sustainability of the management of rice fields [26]. The findings are similar to those produced by Ashar & Balkis [27] which reveal that the area of land, labour, and capital is a factor that affects the production of rice fields. The difference between the findings of this study and previous studies is due to the fact that previous studies did not consider climatic conditions, irrigation support, the quality of farmer institutions, the commitment of programme beneficiary farmers, the attractiveness of other farm profits and the strength of social capital as factors that can influence the optimisation of farm management.

A quantitative analysis was carried out to find out which variables have a significant impact on optimising the management of wet rice production. The method of analysis is SEM-PLS with T-value calculation. Any variable that has a value > 1.98 means that it has a significant effect on optimising farm management. An overview of the variables of supporting and inhibiting factors that can influence the optimisation of rice farm management activities can be seen in Figure 2.

Based on the results of the SEM-PLS analysis, the supporting factors that have a significant effect are:

(a) Strong farmer institutions (a8) with a value of 2.684;
(b) Quality of farmers' resources (a5) with a value of 2.112;
(c) Sustainable irrigation (a2) with a value of 2.251.

While the other 6 variables become intermediate variables that are supporting elements to be able to realise the optimisation of the management of the rice paddy.

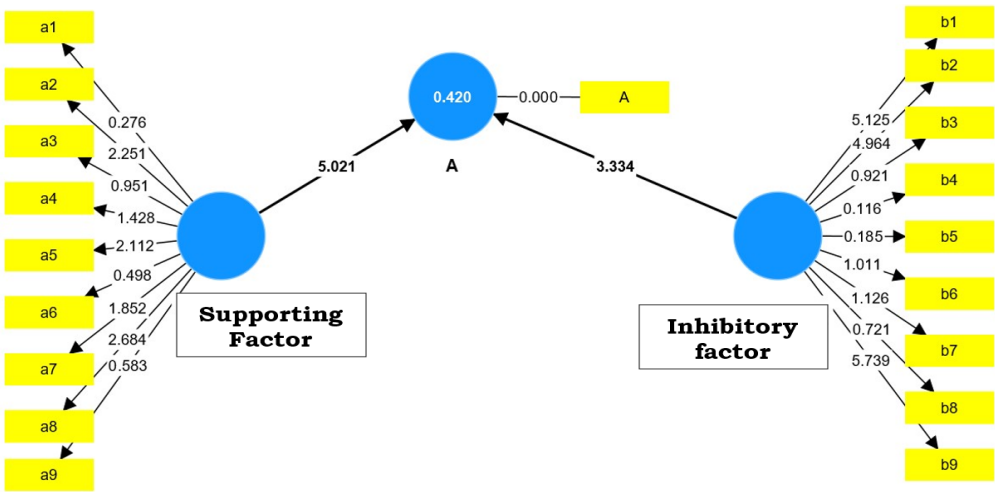

Figure 2. PLS SEM analysis chart about supporting factors and inhibitors optimizing rice paddy optimization management at the new rice field land expansion location

The six variables are a1. soil quality of paddy fields, a3. availability of input support (seeds, fertiliser, pesticides and equipment), a4. availability of farm capital, a6. support for farm facilities and infrastructure, a7. management of paddy farming and a9. strength of social capital.

When farmer institutions function well, they can be a collective force among group members. Problems that farmers face in running their farms can be overcome through mutual help between group members. Motivation and commitment to running a rice farm can also be achieved.

The quality of farmers' resources is a key factor in optimising wetland rice management. Farmers with a high level of knowledge, skills and willingness are needed for sustainable rice farming. Qualified farmers will be able to carry out farming activities optimally.

Another supporting factor that has a significant impact is continuous irrigation. Rice paddy cultivation is highly dependent on the availability of irrigation. Rice is a plant that

requires a lot of water, especially during its growth. Rice plants need 2-3 cm of water from the age of 15-50 days. In the period from planting to harvest at 100 days of age, 520-1,620 mm of water is required. In order to support the availability of water for rice production, continuous water management is required in terms of both quantity and quality.

In addition to facilitating factors, there are also inhibiting factors in optimising paddy management. There are three inhibiting factors that significantly influence the optimisation of rice farm management in the location of new rice field expansion. The inhibiting factors are:

(a) Farmers' characteristics (b9) of the beneficiaries of the paddy expansion programme with a value of 5.739;

(b) climatic conditions (b2) with a value of 4.964;

(c) low commitment of farmers (b3) to their responsibilities with a value of 5.125.

While the other six variables become intermediate variables that hinder the optimisation of the management of new land expansion.

In addition to the above inhibitory and supportive factors, in principle, rice field entrepreneurs need a considerable amount of water. To overcome the need for water, it can be done by utilising rainwater [28]. Those accommodated with various methods include bloating. In addition, the influence of soil temperature and humidity [29] can also affect the sustainability of rice fields. Management of weed control and pests of rice paddy crop disease [30] has become one of the factors in creating sustainability in field management. The use of production factors by farmers has a significant influence on the sustainability of the management of rice fields [31]. The findings in this study are in line with the findings of [32] namely that education, farming experience, irrigation, the active peasant group, seedlings, and intensity of intensity have a positive and significant effect on rice productivity.

Based on the findings of this study, to optimise the management of rice field business at the site of the expansion of new rice fields carried out by the West Sumatra government, it is necessary to utilise some supporting factors such as strong farmer institutions, the quality of farmer resources, and the availability of sustainable rice fields. In addition, it needs to be minimised the inhibitory factors, namely the characteristics of farmers who were once not farmers, the climate, and the curricula of farmers' commitment. These factors become decisive in optimising the management of rice fields with the expansion of new rice fields created by the government of West Sumatra.

3.3 Strategies for optimizing rice farming management in new field expansions

The basic meaning of optimisation is to make something better. In this case, optimisation means the actions or strategies used to improve the management of rice farming at the site of new rice field expansion in West Sumatra Province. This is because optimisation is an action to achieve goals [33].

To optimize the management of rice fields, we can learn lessons from developed countries like Japan. Rice field farming in Japan can be sustainable because its government issued a policy on intelligent agriculture [34]. That means utilizing rice field production technology as a solution to address the problems faced in managing rice field farmland. In addition, strategies to optimize the management of rice fields can be done by using water-saving irrigation systems and optimizing nitrogen fertilization [35]. Irrigation management for rice fields needs to also be improved so that water availability can always meet the needs of farmers' rice fields. Last Need to also optimize supply chain management [36] in order to solve the marketing problems of rice produced by farmers.

For this reason, it is necessary to develop a strategy that will be implemented for the beneficiaries of the new rice field expansion programme in West Sumatra Province. To formulate a strategy, we used a qualitative approach with interpretation and analysis tools that used the pattern that reason X is the reason for doing Y. That is, every strategy offered in this study is a reason to realise the optimisation of the management of rice fields in the area of the expansion of new rice fields. For more details, you can see Table 3 below.

Table 3. Framework formulation strategy optimization strategy management of rice fields at the expansion location of new rice fields

No.	Supporting Factor	Inhibiting Factors	Strategy Formulation
1.	Strong farmers institutional	Characteristics of farmers who were once not rice field farmers	1. Sustainable empowerment of farmer institutions. 2. Increased capacity of rice farmers through innovation and technology. 3. Construction of alternative water sources for rice field farmland. 4. Utilization of technology to address climate threats and land mismatch.
2.	Quality of farmers resources	climate	
3.	Sustainable rice field water availability	The Farmers Commitment	

There are four main strategies to optimise rice farming management in new rice field expansion sites, namely:

(1) Continuous empowerment of farmer institutions. This strategy can be done through agricultural extension activities, mentoring and training. This strategy can increase the ability and independence of farmers in running rice farms.

(2) Increasing the competence of farmers based on innovation and technology. This strategy can overcome the problem of low knowledge and skills of farmers in running rice farming. Increasing farmers' competence will improve their quality in managing rice farming.

(3) Construction of alternative water sources for rice field farmland. This strategy is proposed to address the problem of rice field irrigation. Many of the rice fields do not have proper irrigation supply. As a result, rice farming activities are disrupted. In order to solve this problem, alternative water sources can be created, such as creating retention basins, making water pumps, and building boreholes.

(4) Utilisation of technology to address climate threats and land mismatch. This strategy is to overcome climate and soil fertility problems in the location of new rice field expansion. Climate problems can be addressed by using weather modification technology or making artificial rain. To overcome soil fertility problems can be done by applying chemical fertilisers and organic fertilisers in accordance with their needs.

In order for the above strategy formula to be applicable, it can be described through the work plan matrices, as seen in Table 4 below.

To realise the optimisation of new field management, synergy between institutions was needed. The programme and activities are not only leaning towards the government; there must be collaboration in the optimisation efforts. In this case, private companies and NGOs are asked to be actively involved to realise the optimisation of the management of the rice fields. Therefore, the variable collaboration between related stakeholders strongly determines the success of this activity. The synergy between the related parties strongly determines the success of the achievement of increased production and irrigation in rice fields [37, 38].

Table 4. Work plan optimization of rice paddy optimization on rice paddy rice expansion land new rice fields in West Sumatra Province

Num.	Strategy	Program	Activities	Engaged Stakeholders
1.	Sustainable empowerment of peasant groups	Empowerment Program of rice field farmers	Leadership Training Organizational management training. Capital training and marketing of engagement results	Agricultural Service Province and County, College, NGO
2.	Strengthening competence of rice field farmers based on innovation and technology	The strengthening and improving competence program of rice field farmers.	School Field management field rice fields Pest Management Training and Weed Rice Paddy Plant Weeds Training of irrigation management of rice fields	Agricultural Service Province and County, College, NGO
3.	Construction of alternative water sources for rice field farmland	Procurement program of irrigation means and infrastructure	Primary irrigation development Tertiary irrigation development Construction of the bloating	Provincial and district agricultural services, Provincial and district Public Works Service, colleges, NGOs
4.	Utilization of technology to address climate threats and land mismatch	Environmentally friendly technology application program for rice fields	Technology Procurement Rock to address weather disruption Help of field field processing technology	Ministry of Agriculture, Provincial and district agricultural services, colleges, Private, NGO

4. CONCLUSIONS

The West Sumatra provincial government from 2016 to 2018 has implemented a new paddy field expansion programme with a total area of 1,073.42 hectares. The expansion of new paddy fields is carried out in stages. In 2016 the location of paddy field expansion was carried out in the districts of Mentawai Islands, Solok, West Pasaman, South Solok, Sijunjung, Agam, Lima Puluh Kota and Dharmasraya with a total area of 597.09 hectares of new paddy fields. In 2017, it was implemented in Dharmasraya, South Solok, West Pasaman and Agam districts with a total expansion of 331 hectares of new paddy fields. In 2018, it was implemented in West Pasaman and Dharmasraya districts with a total area of 145 hectares.

Based on the findings of this study, the expansion of rice fields in 2022 is not entirely well managed. Only 286.32 hectares or 26.67% of the total new paddy fields are still being used as rice fields. The worst condition is found in Mentawai Islands Regency, where there is no more paddy fields managed by farmers. All land in this area has been turned into shrubs. However, there are also areas where new paddy fields are still being managed, such as in Dharmasraya District with an area of 120.82 hectares. Likewise, there are also other areas where the management of paddy fields resulting from the expansion of paddy rice farming is still found, although the area is not as much as before.

The condition of new paddy fields in West Sumatra has changed into shrubs covering an area of 499.54 hectares or about 46.53% of the total area of new paddy fields. Some have been converted into smallholder plantations covering an area of 70.26 hectares. Other forms of conversion are into horticultural agricultural land covering an area of 37.01 ha, into mixed plantation land covering an area of 102.26 hectares and into buildings covering an area of 0.27 hectares.

The reason for not managing paddy fields properly is due to the poor condition of paddy field irrigation. Problems with land suitability and soil fertility are also reasons why farmers do not want to manage new paddy fields. In some locations, weather conditions are not favourable for wet-rice farming activities. Another cause is the lack of availability of production facilities for wet-rice farming, such as superior seeds, fertilisers and wet-rice farming equipment. There are also some farmers who complain about problems with their farming capital.

To overcome the above problems, it is necessary to formulate a strategy to optimise the management of paddy rice. Of course, there are supporting and inhibiting factors. Based on the results of SEM-PLS analysis, there are supporting factors that have a significant effect on optimising the management of paddy rice farming, namely: a) strong farmer institutions with a value of 2,684; b) quality of farmer resources with a value of 2,112; c) sustainable irrigation with a value of 2,251. These three factors can work by taking into account the quality of paddy land, the availability of support for production facilities, the availability of farm capital, the support for agricultural facilities and infrastructure, the management of paddy farming and the strength of social

capital. Some inhibiting factors that have a significant effect on optimising the management of wet rice farming, namely: a) characteristics of farmers receiving the paddy field expansion programme with a value of 5,739; b) climatic conditions with a value of 4,964; c) low commitment of farmers to carry out their responsibilities with a value of 5,125.

Through the use of all supporting factors and minimising inhibiting factors, several strategies can be formulated to optimise the management of rice paddy farming management, namely:

(a) Institutional empowerment of farmers or farmer groups receiving sustainable new paddy field expansion programme. This strategy can be done through agricultural extension activities. The impact of this strategy can organise and strengthen farmers in managing wet-rice farming collectively.

(b) Increasing the competence of wet-rice farmers based on innovation and technology. This strategy can increase the knowledge and skills of farmers in managing quality wetland rice farming. Increasing the competence of farmers can be done through agricultural extension activities, field schools, and internships.

(c) Development of alternative water sources for paddy fields. This strategy is needed to overcome irrigation problems in the expansion of paddy fields.

(d) Utilisation of technology to overcome climate threats and land unsuitability. Agricultural land that is less suitable for wet-rice farming can be engineered for soil fertility using technology. Likewise, climatic conditions can be engineered by utilising technology.

The strategies resulting from this research enrich the conception of optimising farm management at the location of the new paddy field expansion programme. Where previous research has not focused on the locus conducted in this study.

The strategies formulated from this research provide input to the government in formulating policies to optimise new rice fields in West Sumatra Province. The government policy can help to realise the increase in the area of paddy fields. In the end, the goal of increasing the productivity of rice fields and improving the welfare of farmers can be well achieved.

The results of this research have only reached the conceptual level. All strategies formulated still need to be continued to the level of applied research. The suggested form of applied research is quasi experimental. Research themes that can be continued such as trials of farmer institutional empowerment models, trials of farmer competency improvement models, trials of weather engineering technology and soil fertility engineering. All of these themes are expected to make the strategies formulated in this research be implemented in the location of new paddy fields in West Sumatra Province.

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