M_Yamin RICE FARMERS FACING CLIMATE CHANGE BY OPTIMIZING TECHNOLOGY

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RICE FARMERS FACING CLIMATE CHANGE BY OPTIMIZING TECHNOLOGY ADOPTION BASE ON DIFFERENT LAND TYPOLOGIES

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ABSTRACT

Climate change, such as flooding, is indeed a major challenge for the agricultural sector. However, farmers continue to try to overcome this impact by increasing the use of agricultural technology.The objectives of this research are (1) analyzing farmers' perceptions and levels of adoption of rice productivity in three land typologies, namely lowland swamp, tidal and rainfed land in South Sumatra, (2) analyzing the influence of socio-economic characteristics on the level of technology adoption, (3) rational behavior of farmers in dealing with floods as an impact of climate change (4) adaptation strategies for facing climate change. The sampling method used was a simple random sampling. The population of rice farmers is 854 farmers. By using the slovin method (α=0.1), 90 sample farmers were obtained. Data was collected through deep interviews in three regency in South Sumatera. Data processing uses are simultaneous multiple correlation test with SPSS software for the influence of socio-economic, KMO (Kaiser-Meyer-Olkin) method and Bartlett's test for testing rational behavior of farmers, and SWOT analysis for adaptation strategies. The research results show that farmers have adopted technology in the form of tractors, organic fertilizer, inorganic fertilizer, pesticides, combine harvesters, superior variety seeds, and rice threshing machines. The adoption rate in three regency of South Sumatra is in the high category, there is a relationship between perception and adoption level on productivity. On land with a lowland swamps and tidal lowland typology, farmers are more likely to pay attention to the technology used during irrigation and harvesting. Meanwhile, the typology of rainfed swamps includes planting methods and superior variety seeds. Tthe success of farming on three different technology is very dependent on proper irrigation using a system of opening and closing sluice gates. Therefore, for rainfed land, a water management system must be implemented to deal with the impacts of climate change.

Keywords: *adaptation, floods, rice farmers, strategy, water management*

BACKGROUND

Climate is a very dynamic and complex factor, so what can be done to adapt it to the local climate. Apart from its dynamic and complex nature (Ferrianta and Hamdani, 2023; Rocha-Meneses et al., 2023). Climate change is a change in temperature conditions and weather patterns over a long period of time (Ahmed et al., 2021; Magruder, 2018; Saefudin et al., 2021). Climate change is caused by natural events and various human activities. One of the agricultural commodities most affected by climate change is rice (Onyeneke, Amadi, and Njoku, 2022;

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Rosyadi and Wijaya, 2023). The impact of climate change is affecting agricultural productivity and food security. According to CSAAC research, current trends in population growth, changes in diet, crop yields and climate change, if not controlled, will put the global community outside the safe zone by 2050 (Beddington et al., 2012; Waldman et al., 2020). Therefore, it is necessary to prepare succeed rice farmers as the main actors in food security in Indonesia. The need to overcome this challenge, farmers are required to adopt more sophisticated and innovative agricultural technology. Addressing climate change requires an integrated approach, including the adoption of technologies tailored to land typology. By optimizing the use of technology, the agricultural sector can be more resilient to climate change, increase productivity, and support global food security (Arbuckle et al., 2017; Gobin & Van Herzele, 2023; Maru et al., 2021; Long et al., 2016; Nahar et al., 2018).

Rice productivity in Indonesia faces serious challenges due to the low adoption of agricultural technology and the sensitivity of the land to climate change. These conditions cause vulnerability to extreme floods and droughts, as well as difficulties in determining the right planting time. Tidal lands also face the problem of salt water intrusion, while dry lands are vulnerable to drought. The absence of an accurate planting calendar, coupled with the influence of rainfall and extreme drought on fertilization and pest control, further complicates efforts to increase productivity. To overcome this, a comprehensive strategy is needed that includes increasing the adoption of modern agricultural technology, developing an efficient water management system, improving the planting calendar, implementing integrated nutrient management and pest control, and developing rice varieties that are adaptive to specific land conditions. With this integrated approach, it is hoped that rice productivity in Indonesia can be significantly increased, despite the challenges of complex land conditions and climate change. Rice productivity is still relatively low, namely around 2.7-3 ton/ha, when compared with the potential yield of several new superior rice varieties, namely 6-8 ton/ha (Suparwoto, 2019). This low production must be given a solution by identifying one of the impacts of climate change and technology adoption. This research is different from research by dos Santos et al. (2023) and Zizinga et al. (2017) because this research prioritizes identifying climate change and then identifying appropriate steps to deal with climate change in several different land typologies. Previous research tends to analyze the causes of climate change without explaining specifically what kind of climate change is occurring based on different typology (El-Nashar and Elyamany, 2023; Magruder, 2018; Nagothu, 2018).

Measuring the level of technical risk is one effort that can be made to make decisions by looking at how big or small the risk faced by farmers. Droughts, floods, pest attacks and plant diseases in Mita et al. (2020) opinion causing production costs incurred by rice farmers to be quite high. This results in mitigation that farmers must carry out to anticipate crop failure. The socio-economic aspects of farmers also need to be examined because these factors will show how these aspects influence farmers' decisions in adopting new and sustainable technologies. In accordance with the existing land typology in South Sumatra. This condition causes the production and productivity of rice plants and farmers' income to decrease, not according to farmers' expectations (Balogun et al., 2020; Saraswat, Kumar, and Mishra, 2016; Tuomala and Grant ,2021). There has not been much research conducted to deal with various climate threats with the use of technology that is differentiated based on differences in land typology. The novelty of this research is to analyze what climate problems are experienced and the comparison of technology application on

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different land typologies. So that we can find out the differences in technology adoption, differences in productivity and income. The objectives of this research are 1) analyze farmers' perceptions and levels of adoption of rice productivity in three land typologies, namely lowland swamp, tidal and rainfed land in South Sumatra, (2) analyze the influence of socio-economic characteristics on the level of technology adoption, (3) rational behavior of farmers in dealing with floods as a result of climate change (4) adaptation strategies for facing climate change. This article aims to explore how farmers in South Sumatra adopt various technologies to optimize their rice production according to different land conditions. It is hoped that the results of this article can provide valuable information for other farmers, policy makers and stakeholders in the agricultural sector to formulate effective climate change adaptation and mitigation strategies.

RESEARCH METHODS

The research method used is a survey method. The sample districts were selected because the typology of each land character represents the widest typology, Tidal typology in Banyuasin District, swamp typology in Ogan Ilir District and rainfed typology in Ogan Komering Ilir District, South Sumatra Province. The rice production center is represented by each sub-district, namely SP Padang District with Ulak Jeremun Village, Lempuing Jaya District with Lubuk Seberuk Village. Muara Telang District is represented by Upang Karya Village and Upang Jaya Village, and Pemulutan District is represented by Tanjung Pasir Village and Pemulutan Ulu Village.

Sampling Method

The sampling method that will be used in this research is the simple random sampling method. Simple random sampling is a simple random sampling technique without paying attention to certain criteria. Simple random sampling aims to obtain representative data, the data can be estimated accurately (Astuti, Wijianto, and Rusdiana 2021; Pratiwi et al. 2021). The level of random error can be tolerated and applied by researchers to answer research objectives. The tidal typology fields in this research were carried out in Upang Karya Village and Upang Jaya Village, Muara Telang District, Banyuasin Regency. The lowland swamp typology land in this study was in Tanjung Pasir Village and Pemulutan Ulu Village, Pemulutan District.

Method of Collecting Data

In this research, data collection was conducted using a mixed-methods approach that encompassed both primary and secondary data. Primary data was gathered through semi-structured interviews and structured questionnaires administered to rice farming actors and key informants, allowing for the collection of firsthand insights into farming practices, challenges, and socio-economic factors. The interviews facilitated in-depth discussions, while the questionnaires provided quantitative data from a broader sample of farmers. Secondary data was sourced from existing literature, government reports, and academic journals to contextualize the findings and support the analysis. This comprehensive methodology ensured a rich and nuanced understanding of rice farming practices, integrating both qualitative and quantitative perspectives.

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Data Processing Methods

The data obtained during the research will be processed tabulatedly, then analyzed descriptively and quantitatively (Ayanlade, Radeny, and Akin-Onigbinde 2018; Triana, Hutabarat, and Hadi 2022). Descriptive data processing will be carried out by explaining and describing existing data so that it can complement and provide a way to solve problems well. Quantitative data processing will be carried out using Microsoft Excel software because the data obtained is in the form of numbers. To answer the second objective, quantitative analysis was carried out. The magnitude of the technical risk of rice farming was analyzed using production risk analysis. Data regarding production risk was first tested using the KMO test (Kaiser-Meyer-Olkin) and the Bartlett test. These two tests are used to measure the suitability of variables in factor analysis or cause-and-effect analysis. A KMO value greater than 0.50 indicates that these variables are suitable for use. Conversely, if the KMO value is less than 0.50 not suitable for use (Kaiser 1974). Apart from the KMO test, the Bartlett test is also used to test the suitability of variables in factor analysis or cause-and-effect analysis and tests the hypothesis. The correlation matrix between variables is an identity matrix, which means there is no relationship among variables. If the significance value of the Bartlett test is less than 0.05 (Bartlett 1950), then the hypothesis is rejected, and these variables are considered suitable for use in factor analysis or cause-and-effect analysis.

Thus, the KMO test and Bartlett's test are important steps in research regarding variable suitability. By using these two tests, researchers can ensure that the variables used in the analysis are suitable for advanced decision making. In factor analysis using statistical software such as SPSS 26, KMO and Bartlett's Test are used to ensure the suitability of the data before carrying out factor analysis. These steps are important to ensure that the results of the factor analysis are not affected by the quality of the data. In addition, the results of the KMO and Bartlett's Test will also be included in the factor analysis report to provide a better understanding of the suitability of the data and the validity of the analysis results (Hair et al., 2006). In practice, both methods are important steps in the factor analysis process. Checking data suitability with the KMO and Bartlett's Test can prevent errors in factor analysis and ensure accurate and reliable results. Therefore, a good understanding of these two methods and their use with SPSS or other statistical software is necessary in carrying out factor analysis.

RESULT AND DISCUSSION

Climate change has become a serious threat to earth, affecting the entire ecological system including different land typologies. Adoption of precision farming technologies, such as smart irrigation systems and weather sensors, can improve agricultural practices to make them more adaptive to climate change (Nciizah et al. 2021; Pessot et al. 2023; Ward 2022). At the research location, if there is a flood, the land will be very easily inundated. If there is a drought, the land will dry out easily. Farmers in rainfed and swampy areas cannot predict when flooding will occur. In addition, farmers must plant more seeds, resulting in increased production costs. The adaptation carried out by farmers is to shift the planting calendar. Tidal land that is not affected by climate change, to increase production using four-wheeled tractor technology. To identify differences in production costs (Table 1.) which include the cost of equipment and irrigation installations, while variable costs are related to maintenance and farming operations. This article will examine how

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technology can be optimally adopted in each land typology while still considering the balance between fixed costs and variable costs.

Table 1. Variable Costs of Rice Farming in Three Land Typologies

No	Type of Expenditure	Planting Season 1 (Rp)			Planting Season 2 (Rp)		
		Swamps	Rainfed	Tidal	Swamps	Rainfed	Tidal
1	Seeds/Seedlings	80,230	61,205	124,562	40,350	22,398	140,459
2	Pesticide	459,025	396,535	543.205	159,025	196,535	543,205
	Herbicide	289,670	64,523	350,289	189,670	24,523	450,289
	Insecticide	65,020	27,791	125,023	20,340	17,791	325,023
	Fungicide	20,980	35,020	-	10,980	10,020	-
	Organic	348,965	446,279	620,258	128,965	346,279	620,258
3	Fertilizer	100,280	65,067	120,354	20,280	65,067	120,354
4	BBM (transportation) (per month)	80,230	61,205	124,562	40,350	22,398	140,459
5	Labor Wages						
	Seeding	35,450	55,000	605,000	35,450	55,000	605,000
	Land processing	325,020	450,500	1,200,000	325,020	450,500	1,300,000
	Planting Wages	1,050,000	230,000	120,000	1,050,000	230,000	140,000
	Fertilization I	75,000	80,000	95,000	55,000	80,000	100,000
	Fertilization II	75,000	80,000	75,000	35,000	60,000	85,000
	Weeding/matun	65,000	65,000	65,000	45,000	35,000	65,000
	Embroidery	55,000	45,000	55,000	55,000	45,000	55,000
	Spraying	85,000	85,000	85,000	55,000	55,000	85,000
	Harvest	1,600,000	3,500,000	2,500,000	1,000,000	2,500,000	2,500,000
	Post-harvest	45,000	55,000	85,000	20,000	30,000	95,000
6	Land Rental Costs (Rp/Ha)	150,000	200,000	100,000	50,000	40,000	120,000
7	Total Variable Costs	4,924,640	5,941,920	6,868,691	3,295,080	4,263,113	7,349,588
8	Average Variable Cost	273,591	330,107	381,594	183,060	236,840	408,310

Source: Primary Data (2023)

Variable costs in three different land typologies in South Sumatra vary in each land typology. The largest variable costs are in tidal land, due to the use of irrigation technology and production inputs. The highest costs are caused by the use of fertilizers, pesticides, manure, and locations far from the city center so that the purchase price of production inputs becomes more expensive. However, this is followed by higher productivity. The use of technology that is in accordance with land typology can increase productivity. Larger land can be cultivated with technology to shorten the time of rice farming. The application of modern production inputs in rice farming, such as hybrid seeds, four-wheel tractors, and blowers, can significantly increase productivity and efficiency. Hybrid seeds, which were introduced around 2009, have a faster ripening process and higher yields. This allows farmers in tidal land to increase their planting index to IP 200. Four-wheel tractors and combine harvesters accelerate land preparation and harvesting and improve rice quality and stabilize selling prices. However, technology adoption faces challenges such as higher investment. To realize the benefits of these modern inputs, government support through subsidies, training programs, and increased access to technology is needed to accelerate adoption and increase rice production.

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Table 2. Fixed Costs of Rice Farming in Three Land Typologies

No	Tool's Name	Costs Incurred (Rp)		
		Swamps	Rainfed	Tidal
1	Sprayer	120,000	205,000	380,000
2	Hoe	70,000	50,000	80,000
3	Machete	47,000	35,000	70,000
4	Sickle	35,000	30,000	65,000
5	Threshing tool	-	60,000	85,000
6	Motorcycle (transport)	80,000	50,000	35,000
7	Cart	15,000	20,000	14,000
8	Pump machine	32,000	23,000	12,000
9	Bucket	12,000	23,000	62,000
10	Combine	3,000	2,000	5,000
11	Other tools	25,000	7,000	8,000
	Amount	439,000	505,000	816,000

Source: Primary Data (2023)

In the long term, technology optimization not only has the potential to reduce variable and fixed costs in line with research from Fonseca, Lagdami, and Schröder-Hinrichs (2021), Şerban and Lytras (2020), Srivastava, Chauhan, and Patel (2021), but also increase environmental quality and socio-economic resilience in each land typology. In the dry season, tidal land becomes dry, so it requires a pump to channel water. In addition, mulch is needed to overcome rat pests. In the rainy season, pumps are still used to remove water. Meanwhile, in rainfed land, if there is a flood, farmers do not use pumps, they tend to let the water in so that they can reduce farming costs. In swampy areas, the distance between the rice fields and the production road is quite far so that transportation costs are quite large. This study proves that government policies and initiatives have supported technological improvements. The provision of assistance in the form of 4-wheel tractors, fertilizers and irrigation to achieve the goal of comprehensive and sustainable climate change adaptation is in line with the research of Rusliyadi et al. (2023) and Supanggih and Widodo (2023). So, that farmers can adopt technology to adapt to climate change.

Table 3. Rice Productivity of Farmers in Three Land Typologies

No	Description	Planting Season 1			Planting Season 2		
		Swamps	Rainfed	Tidal	Swamps	Rainfed	Tidal
1	Harvest area	1.25	1.75	2.00	0.75	1.00	1.88
2	Production (kg)	4,700	3,800	6,150	2,500	2,800	5,500
3	Sold (kg)	4,500	3,700	5,800	2,200	2,500	5,500
4	Price (Rp/kg)	5,400	5,500	5,800	5,600	5,700	6,000
5	Productivity (kg/ha)	4,500	3,700	6,000	2,500	2,800	5,500
6	Seedlings (kg)	20	25	10	-	-	-
7	Consumed	100	100	350	0	300	0

Source: Primary Data (2023)

Farmers' productivity is high due to the use of fertilizer with 6T treatment (right type, right amount, right price, right place, right time, right quality, right targe), good water management, regular cleaning of weeds (Djaja, Pratiwi, and Maruta, 2022; Pujiharti, 2017). In Banyuasin Regency (Tidal lowland) there is more productivity because farmers use fertilizer with the 6T principle. This is

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different from Lebak Swamp and Rainfed land which often experience flooding so that farmers assume that fertilization will be in vain if flooding occurs so farmers do not apply 6T.

Table 4. Technology Adoption Before Facing Floods

No	Technology Adoption	Swamps	Rainfed	Tidal
1.	Seeding (Dapog/Tray)	9.15	8.40	9.15
2.	Land Processing (Tractor)	14.15	12.62	20.15
3.	Planting (Superior Seeds, Planting Patterns, and Planting Methods)	25.61	40.74	27.61
4.	Fertilization (Methods and 5 Proper Fertilizers)	25.56	32.7	25.56
5.	Pest Control (6 Appropriate Pesticides)	20.25	23.09	21.25
6.	Irrigation (Water pump machines and Irrigation doors)	20.07	16.38	20.07
7.	Harvesting (Combine Harvester/Laser/Reaper/Binder)	20.59	18.50	22.59
8.	Post-Harvest (Drying oven and Rice milling machine)	15.92	18.13	15.92
	Total	159.56	128.16	162.30
	Categories	High	Medium	High

Source: Primary Data (2023)
Note: The categories of technology adoption levels after a flood occur
1.00 - 44.80 : Very low
44.81 - 89.60 : Low
89.61 - 134.40 : Medium
134.41 - 179.20 : High
179.21 - 224.00 : Very high

If the impact of the flood becomes more widespread and farmers need seeds in large quantities, extension workers in collaboration with Gapoktan will register farmer members and submit them to the center to request seed assistance so that planting area and production targets are not disturbed. However, farmers in Banyuasin Province have been registered as recipients of 7kg of seed aid for one farm. Even though there have been several floods and impacts in a number of areas, total rice production in South Sumatra remains in surplus. Land cultivation was initially carried out conventionally or traditionally, using livestock (cattle, buffalo and horses). As time goes by, conventional land processing is being replaced by modern processing using sophisticated technology. Simple tools which are generally used to cultivate the land, such as hoes, machetes, sickles and others, are now being replaced with plows and harrows which have been modified with tractors. the use of land processing using machine power is more efficient and effective. The use of combine harvesters in rice harvesting offers significant advantages over manual methods with sickles and power threshers, especially in reducing crop losses. Combine harvesters are able to reduce yield losses of around 3% of the total harvest by cutting, threshing, and separating rice grains from straw in one efficient operation. This not only reduces the risk of grain loss during the harvesting process but also increases time efficiency, reduces grain damage, and improves the quality of the harvested rice. Thus, the use of combine harvesters is an effective solution for farmers to increase the productivity and quality of their rice harvests.

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Table 5. Technology Adoption After Facing Floods

No	Technology Adoption	Swamp	Rainfed	Tidal
1.	Seeding (Dapog/Tray)	9.34	8.85	18.02
2.	Land Processing (Tractor)	23.15	18.62	22.66
3.	Planting (Superior Seeds, Planting Patterns, and Planting Methods)	47.61	50.74	53.70
4.	Fertilization (Methods and Six Proper Fertilizers)	36.28	32.71	37.43
5.	Pest Control (6 Appropriate Pesticides)	26.25	23.09	24.38
6.	Irrigation (Water Pump Machines and Irrigation Doors)	20.07	16.38	20.37
7.	Harvesting (Combaine Harvester/Laser/Reaper/Binder)	22.59	18.50	21.31
8.	Post-Harvest (Drying Oven and Rice Milling Machine)	15.92	18.13	18.02
	Total	202.41	191.78	216.98
	Categories	Very high	Very high	Very high

Source: Primary Data (2023)
Note: The categories of technology adoption levels after a flood occur
1.00 - 44.80 : Very low
44.81 - 89.60 : Low
89.61 - 134.40 : Medium
134.41 - 179.20 : High
179.21 - 224.00 : Very high

Low adoption has not used mechanization, medium adoption has used hand tractors, planting still uses human power, while high technology has used sophisticated technology, planting uses a blower machine so that it is fast and the seeds grow and spread, using water gates, and understanding the principles of fertilizer use. Based on the table above, it can be seen that the highest level of technology adoption of the three types of land typology is in the tidal lowland with an average technology adoption rate of 202.41. This is followed by swamp land with an average adoption rate of 216.98 and is included in the very high technology adoption category. This average is also included in the category of very high technology adoption. The lowest adoption rate is on rainfed land with an average of 191.78. Even though it is the lowest compared to the other two types of land typology, the level of technology adoption in rainfed land is also classified as very high.

Technology adoption is still low, namely adoption in water management systems. Respondent farmers carry out their farming in lowland swamp land which does not have water channels. This makes farmers vulnerable to crop failure. Apart from water management technology, technology for using superior varieties has been implemented by respondents. However, due to limited capital, the solution for some of them is to mix superior variety seeds with the previous planting season's harvest. According to key informants, technology for organic fertilizer, inorganic fertilizer, superior varieties, institutions, rice threshing machines and pesticides entered 1st place in 2013 or ten years ago. This means that farmers already know about the existence of this technology. In this technology, respondent farmers have reached the adoption stage. However, there are obstacles in the distribution of subsidy assistance, causing respondent farmers to only try and adopt inconsistently, especially in

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inorganic fertilizer technology, superior varieties and pesticides which are subsidized by the government.

The adoption of agricultural technology in South Sumatra on various different land typologies generally goes through several stages, namely introduction, awareness, attention, assessment, trial, and finally adoption. This process begins with farmers becoming aware of new technology, then growing awareness of its benefits. Furthermore, farmers begin to pay attention to and assess the suitability of the technology to their conditions. Tractors and harvesting machine technology entered the village in 2018 or five years ago. Respondent farmers have gone through stages of awareness and interest in this technology. These two technologies were brought by the Indralaya sub-district extension institution (Innovator) which brought innovation. This is supported by the help of tractor units and combine harvester machines. According to farmer respondents when interviewed, these two technologies are very helpful in the rice farming process, they are not complicated and it is easy to understand how these tools work. Tractor technology and harvesting machine technology have been adopted by 97.7 percent. This means that rice farmers have reached the adoption stage of these two technologies with a percentage of more than 50. The remaining respondents have not adopted it because of complexity or complexity, one of which is accessing tools to cultivated land. So there are respondents who do not meet the characteristics of adoption. The government is expected to increase the role of extension workers and institutional roles in farmer groups (Sirait, Rosnita, and Arifudin, 2015). Especially the farmer groups where the research was carried out. It is very unfortunate that farmers have adopted agricultural technology, but have not yet reached the stage of complete adoption. As well as equal distribution of subsidy assistance so that technology adoption continues and reaches the final stage, namely constant technology adoption.

Table 6. Proportion of Farmers Using Technology

Level of Adoption	Swamp	Tidal	Rainfed
Do not use	5.55	0	0
Low	51,11	0	35,00
Medium	43.33	32.22	47,28
High	0	67.78	17.22
Total	100.00	100.00	100.00

Source: Primary Data (2023)

Not all farmers have implemented technology in their agricultural activities. There are still farmers who carry out farming activities without using technology (category do not use). There are farmers who only adopt the use of hybrid seeds and the use of planting calendars (low category). Farmers who have used hybrid seeds, planting calendars, and hand tractors for land processing (medium category), as well as the use of all technologies including harvesting with a combination, irrigation, and mixing organic fertilizers (high category). Objectively the application of technology in the three districts is in the medium category. This is because more than 50% of the population adopted seven technologies from the eight adoption categories tested. The real proof is the implementation of harvesting machines (combine harvesters). According to the farmer respondents, using this tool helps in the harvesting process. The harvest process is faster compared to manual harvesting. Likewise with tractor engines, many of them have adopted tractor engines on a rental system. Respondent farmers think that tractor and combine harvester machines are not complicated.

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Even for tractors themselves, there are respondent farmers who have their own tractors and use it as a business outside of the rice farming business.

Technology adoption is still low, namely adoption in water management systems. Respondent farmers who carry out their farming in lowland swamp land and rainfed land do not have water channels. This makes farmers vulnerable to crop failure. Apart from water management technology, technology for using superior varieties has been implemented by respondents. However, due to limited capital, the solution for some of them is to mix superior variety seeds with the previous planting season's harvest. According to key informants, organic fertilizer technology, inorganic fertilizer, superior varieties, institutions, rice threshing machines and pesticides have entered the area around 2013 or ten years ago. This means that farmers already know about the existence of this technology. In this technology, respondent farmers have reached the adoption stage. However, there are obstacles in the distribution of subsidy assistance, causing respondent farmers to only try and adopt inconsistently, especially in inorganic fertilizer technology, superior varieties and pesticides which are subsidized by the government.

Tractor and harvesting machine technology entered the village in 2018 or five years ago. Respondent farmers have gone through stages of awareness and interest in this technology. These two technologies were brought by the Indralaya sub-district extension institution (innovator) which brought innovation. This is supported by the help of tractor units and combine harvester machines. According to farmer respondents when interviewed, these two technologies are very helpful in the rice farming process, they are not complicated and it is easy to understand how these tools work. The adoption rates of agricultural technologies, particularly tractors, can vary significantly due to differences in land typology and irrigation practices. These differences are influenced by several factors, including soil conditions, water availability, and the specific agricultural practices employed in various regions in line with research by Caunedo and Kala (2021), Mamkagh (2019), Ranjbarian, Askari, and Jannatkhah (2017), and Remelgado et al. (2020).

Table 7. Correlation of Perception and Adoption with Productivity Levels

Correlations		Application of Technology	Productivity
Application of Technology	Pearson Correlation	1	,520**
	Sig. (2-tailed)		,000
	N	180	180
Productivity	Pearson Correlation	,520**	1
	Sig. (2-tailed)	,000	
	N	180	180

Source: Primary Data (2023)
Note: **Correlation is significant at the 0.01 level (2-tailed)

There are socio-economic factors that influence technology adoption (Table 7). This research examines factors such as farmer age, education level, land area, income, interaction with extension workers, availability of facilities and infrastructure, and the role of institutions. From the results of the multiple linear regression test, results were obtained from respondents' answers regarding socio-economic factors that influence technology adoption. The results show that socio-economic factors that influence technology adoption are education, length of farming and availability of facilities and infrastructure. From the results of this analysis, it is hoped that farmers can improve their education

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factor so as to increase their willingness to adopt technology, and it is hoped that the government can facilitate irrigation schemes so that flooding and drought do not occur if water management has been carried out according to the scheme. The government is expected to increase the role of extension workers and institutional roles in farmer groups. Especially the farmer groups where the research was carried out. It is very unfortunate that farmers have adopted agricultural technology, but have not yet reached the stage of complete adoption. As well as equal distribution of subsidy assistance so that technology adoption continues and reaches the final stage, namely constant adoption of technology.

Rational Behavior of Farmers in Dealing with Flooding as an Impact of Climate Change

Farmers' rational behavior in dealing with flooding in lowland, rainfed, tidal and swamps can reflect responses based on knowledge, experience and economic logic. In this context, farmers often take actions they deem most reasonable to protect their farms and maintain agricultural yields, even when they are faced with extreme environmental challenges. Some of the rational behaviors commonly adopted by farmers in this situation are the use of superior varieties that are flood resistant, planned irrigation systems, monitoring and predicting floods with rainfall forecasting, financial risk management, preferential use of lowland swamps and tidal areas, group collaboration. farming, and the use of agricultural technology. The purpose of utilizing lowland and tidal swamps is that farmers in these two land typologies tend to have more in-depth knowledge of water flow patterns and plant adaptations that are suitable for these conditions. They can take advantage of tidal changes for pond or rice farming. So that during the rainy season with extreme rainfall, agricultural land can be converted into pond farming.

Table 8. KMO and Bartlett's Test

Land Typology	Swamps	Rainfed	Tidal
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.711	0.645	0.615
Bartlett's Test of Sphericity			
Approx. Chi-Square	355.22	197.68	192.60
df	45	45	45
Sig.	0.00	0,000	0,000

Source: Primary Data (2023)

The output results of the KMO and Bartlett's Test can be seen to determine the suitability of the variables. The KMO MSA value is greater than 0.50 for each land typology, meaning that the variables used are suitable for advanced level decision making.

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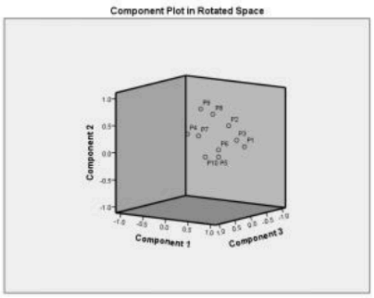
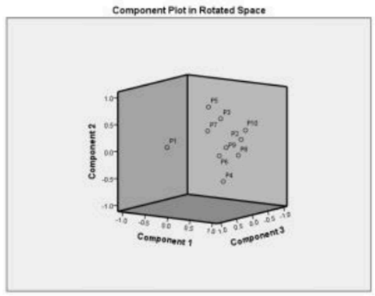
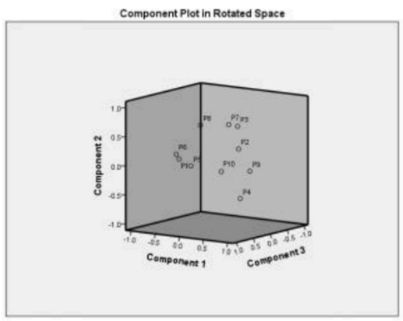


Rainfed Typology



Swamps Typology



Tidal Typology

Figure 1. Farmers' Rational Decision Model in the Lebak Swamp Land Typology
Source: Primary Data (2023)

Based on Figure 1. in the typology of rainfed land, it is known that farmers' rational decisions in adopting technology in order to deal with the impact of flooding are P8 and P9, namely decision making during the irrigation and harvesting process. This means that on land with a rainfed typology, farmers are more likely to pay attention to the technology used during water management and harvesting using a planting calendar based on local weather and climate patterns allows farmers to predict the best time to plant rice, thereby minimizing the risk of crop failure due to unpredictable weather conditions. For better plan their activities often look for side jobs or utilize the land around their homes to grow fruits such as oranges and langsat. Farmers also fish in rivers and rice fields in line with research by Budiyoko et al. (2023), Rejeki and Mardiansjah (2018), Suryandari and Rahayuningsih (2020). This is because floods usually come during the harvest month in the Ogan Komering Ilir area with a rainfed typology. Meanwhile, the typology of lowland swamps in Ogan Ilir. It can be seen that P5 and P3 are at the highest level, namely planting methods & population size, and superior variety seeds. This is a rational decision for farmers when choosing to plant rice in

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lowland swamp areas. Farming in swampy areas which are always flooded with water requires seed varieties that can withstand soaking longer than those on dry land. So that when facing flood condition the plants will withstand flood stress. In the tidal land typology, it can be seen that P8 and P7 are at the same level, namely irrigation and integrated pest control, then the second level is P3, namely superior variety seeds. These three rational decisions are what farmers choose when farming on tidal land. This is because the success of farming on tidal land is very dependent on proper irrigation using a system of opening and closing sluice gates. So, when high tide comes due to extreme rainfall, it will not affect the land and can prevent flooding in line with (Purba et al. 2021; Yamin et al. 2023). Apart from that, because the typology of tidal land is type A, the decision to use superior varieties of seeds that are resistant to flood stress is also a rational consideration for farmers in carrying out rice farming. The adaptation strategies to face climate change that farmers can carry out based on SWOT analysis. The value of this y coordinate point shows a positive result. The result of calculating the coordinate points (x ; y) is (0.59 ; 0.48). Point x is on the positive axis and point y is also on the positive axis. The coordinates of the x and y points can be depicted in a SWOT diagram to determine the quadrant position of South Sumatra Province in maintaining rice self-sufficiency. The results of the analysis in the form of a SWOT analysis diagram can be seen in Figure 2.

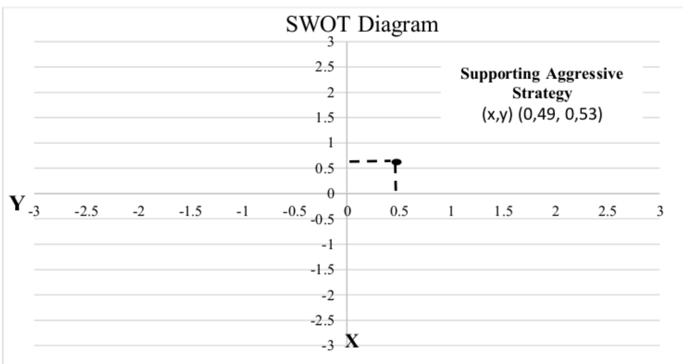

Figure 2. SWOT Diagram Analysis Results
Source: Primary Data (2023)

Based on the image above, the quadrant position of South Sumatra Province is in the upper right area and is included in quadrant I, namely supporting aggressive/progressive. In this quadrant, the strategy that can be implemented is to maximize the company's strengths and take advantage of the company's opportunities. Alternative strategies that can support aggressive/progressive strategies can be carried out through market development, product development, or a combination of both.

SWOT Matrix Analysis Results

Based on the results of the SWOT diagram, it shows the position of South Sumatra Province in quadrant I which is between strengths and opportunities. Results for the research he position in quadrant I supports efforts to implement aggressive/progressive strategies, so that an alternative

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strategy that suits the conditions of South Sumatra Province is the SO (Strengths-Opportunities) strategy. The formulation of alternative strategies to maintain rice self-sufficiency in South Sumatra Province can be seen in Table 9.

Table 9. SWOT Matrix Analysis Results

IFAS / EFAS	POWER(S)	WEAKNESSES (W)
	1. Provincial Land Productive South Sumatra 2. Land productivity continues to increase 3. Production increases every year 4. Good access to agricultural production and machinery 5. Structural institutions	1. The land area owned is small and scattered 2. Climate change 3. Land conversion often occurs 4. Farmers' motivation to adopt rice technology is decreasing 5. Lack of research and technological development
OPPORTUNITY (O) 1. Reduce food insecurity 2. Level of health and nutritional awareness with farmer income and optimal land use 3. Become a sustainable rice self-sufficient area 4. Sustainable agricultural land protection law	**SO STRATEGY** 1. Continuing the agricultural extensification and intensification area program 2. Providing targeted agricultural inputs/machinery assistance 3. Strengthening the use of technology starting from improving water channels, using organic fertilizer and utilizing waste	**WO STRATEGY** 1. Carry out repairs to water channels by providing assistance to accelerate repairs 2. Optimizing the role of extension workers and farmer group association in overcome the problems faced by farmers in planting rice 3. Using superior varieties
THREAT (T) 1. There is food insecurity 2. Climate change 3. There are rice imports 4. Rice inflation can reduce people's purchasing power 5. Substitute commodities for rice have not yet been developed	**STRATEGY ST** 1. Farming business development with an institutional concept 2. Diversifying food crops 3. Intensive socialization of the B2SA program (Diverse, Balanced Nutrition and Safe)	**WT STRATEGY** 1. Maintain food price stability 2. Bulog can absorb rice optimally 3. Reducing the level of rice consumption through substitute commodities (corn, soybeans, wheat etc.)

Source: Primary Data (2023)

The strategy that should be implemented based on the results of the SWOT analysis is to utilize the company's internal strengths to seize external opportunities. Be aggressive and take the initiative, with a focus on growth and expansion. And optimize all the strengths that are owned to seize and utilize the greatest opportunities. The strategy implemented is Continuing the agricultural

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extensification and intensification area program, providing targeted agricultural inputs/machinery assistance, strengthening the use of technology starting from improving water channels, using organic fertilizer and utilizing waste. Meanwhile, for tidal rice farmers, the socio-economic factors that influence technology adoption are the area of cultivated land owned by farmers, interactions with extension workers and institutions that farmers participate in. Maximum income and productivity, swamp land technology cannot be compared to tides, low technology, higher costs There are many possibilities that occur due to differences in land typology. There are several variations in the adoption of the technology used. The obstacles are why one farmer cannot adopt many technologies. Policies or technology provision can be adjusted based on the nature of the soil. The varieties planted use Ciera, and INPARI. small ditch irrigation systems and land processing, cleaning small ditches to clean the land. Tertiary channels that are communal property can be managed through mutual cooperation, without government assistance. Advanced technology for land processing, tractors, the water enters using irrigation. There are times when the water doesn't rise or arrives, there are times when the water doesn't rise even during high tide.

CONCLUSION AND SUGGESTION

The farming risk that occurs due to climate change is mostly experienced by farmers is flooding. This farming risk has an impact on production, income, and farmers' income. The minimum production that farmers must obtain so that farmers do not experience losses is 3,169.27 kg/ha/year. Farmers who apply the most technology have the largest average income with this income value being the largest income that can be obtained by using the six technologies. On land with a rainfed typology, farmers are more likely to pay attention to the technology used during irrigation and harvesting. Meanwhile, the typology of lowland swamps includes planting methods, population size and superior variety seeds. This is a rational decision for farmers when choosing to plant rice in lowland swamp areas. These three rational decisions are what farmers choose when farming on tidal land. This is because the success of farming on tidal land is very dependent on proper irrigation using a system of opening and closing sluice gates. So, when high tide comes due to extreme rainfall, it will not affect the land and can prevent flooding. Apart from that, because the typology of tidal land is type A, the decision to use superior varieties of seeds that are resistant to flood stress is also a rational consideration for farmers in carrying out rice farming. The adaptation strategy needed by farmers to face climate change is an aggressive strategy.

Comprehensive revitalization of water channels by the government, both in the city center and in the outskirts, is a crucial step in anticipating flooding and waterlogging, especially ahead of the rainy season. At the same time, farmers need to optimize the use of government assistance, such as agricultural machinery, and increase participation in agricultural institutions such as farmer groups and UPJA. Micro water management through mutual cooperation, such as irrigation channel maintenance, can increase the efficiency of water use for agriculture. Continuous innovation and research, including the development of drought-resistant plant varieties and modern water management technologies, are also needed to increase agricultural productivity. By integrating these efforts, it is hoped that a more effective and sustainable water management system can be created, which in turn will support food security and reduce the risk of hydrometeorological disasters.

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