Agro Bali : Agricultural Journal
Vol. 7 No. 3: 896-905, November 2024
e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

Farm Management and Factors Influencing Farmers' Adaptation Strategies in the Serayu Dam Area to Climate Change

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Article history: submitted: August 3, 2024; accepted: November 9, 2024; available online: November 27, 2024

Abstract. Unpredictable climate change impacts several sectors, one of which is the agricultural sector. Extreme climate change causes a decrease in farmer production. The Serayu movable dam area is an area that is prone to flooding, where farmers around this area own land. Farmers can make anticipatory efforts to overcome losses farmers suffer to adapt to the management system and farmer resilience. This study aims to analyze the farm management and factors influencing farmers' adaptation strategies to climate change in the Serayu Dam area. The research was conducted using a descriptive quantitative analytical method. This study used 30 rice farmers as respondents in the Serayu movable dam area. The data analysis method used farm business analysis and logistic regression. The results of the study also stated that the rice farming carried out by farmers earned a profit of IDR 7,639,324 with a total income received by farmers of IDR 10,726,000 and a total farmer expenditure of IDR 3,086,676. Farmers in the Serayu movable dam area have also experienced a decrease in crop production due to climate change. The adaptation strategy carried out by farmers is to postpone or advance planting based on the *pranoto mongso* used. The results of the study also stated that factors influence farmers' adaptation strategies, namely farmer education, farmer experience, farmer profession as the main job and farmer activity in farmer groups.

Keywords: adaptation; climate change; farmers; strategic

INTRODUCTION

The phenomenon of quite extreme climate change often occurs. Naturally, this change has also been influenced by human activities since the Industrial Revolution. The agricultural sector is one of the sectors that is directly affected, making it a sector that is vulnerable to climate variability. The multidimensional nature of extreme climate change will affect the agricultural sector, starting from the aspect of resources and production systems to touching on food security and the welfare of farmers in general (Marseva et al., 2016).

Climate change that cannot be predicted well is characterized by changes in air temperature or drought to flooding in several areas, which, in fact, have an impact on the agricultural sector (Shi-yan et al., 2018) (Sime, 2019) (Adeagbo *et al*., 2019). The decline or even loss of farmers' harvests is caused by real climate change that occurs in several areas (Bobojonov et al., 2016) (Obi, 2016) (Belay et al., 2017). The impact of climate change also causes the development of pests and diseases of food crops, resulting in a decrease in farmer production (Thi et al., 2015). In fact, this incident was experienced not only by Indonesian farmers but also by farmers in Europe and Tanzania. The decrease in farmer production due to climate change in Indonesia reached 11%, followed by Tanzania at 13% and parts of Europe reaching 22% (Moore, 2014) (Westengen, Ola T. & Brysting, 2014) (Yuliawan & Handoko, 2016).

The economic vulnerability of farmer households is certainly different from one another. Climate change will affect the sensitivity, exposure, and ability of the household to adapt to natural disasters (Bhowmick, 2018). Household recovery strategies for resilience will help implement mitigation steps. Behavioral adaptation is also needed in anticipating changes that occur, such as utilizing existing resources and social and physical capital (Tambo, 2016).

Farmers are the most vulnerable to climate change (Yastika et al., 2023). Farmers in developing countries must, of

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

course, start adapting to the pressures of climate change globally. Floods or storms will certainly increase the vulnerability of small farmers to social and environmental pressures. Damage to cultivated crops will also have its own impact on farmers, which will impact the economic resilience of their households. Resilience is the capacity to absorb disturbances or changes that occur. The level of farmer resilience will influence farmers' adaptation to changes in rainfall. Farmer adaptation results from learning by observing external and internal factors and then adopting technology to reduce climate risk. Resilience measurement indicators can be seen in buffer capacity, self-organizational control, and learning capacity/willingness. All three are divided into education level, long farming experience, income, savings, health conditions, expenses and community organization membership (Speranza et al., 2014). Resilience values must be interpreted through useful components in activating the sustainability process (Bonati, 2016). The ability to adapt to existing crises must be anticipated directly in the capital, as well as the completeness and readiness of farmers (Proag, 2014). Income diversification can help farmers deal with farmer losses, so appropriate policies are needed (Fang et al., 2014). The success of farmers must also be supported by optimal land ownership and crop cultivation that can be carried out as efficiently as possible (Mulyani et al., 2020) (Mulyani et al., 2022).

The Serayu movable dam area is located downstream and has a potential for flooding of up to 36%. This is what causes the heavy water discharge and causes agricultural land in the Serayu movable dam area to have the potential to be inundated when it rains heavily for days [16]. Anticipatory efforts against losses farmers suffer can be done by farmers carrying out collaborative management. This effort can be made by increasing farmers' incomes in the Serayu movable dam area. This study is novel compared to other studies that measure the extent of farmers' resilience in dealing with climate change. This study will also provide an overview of farmers' efforts to meet their household needs in dealing with unexpected climate change. The formulation of the research problem is illustrated bythe reflection of the efforts of farmers in the Serayu Movable Dam Area in maintaining the economic strength of their households or their resilience to climate change. Of course, in optimizing their farming production during climate change, good farming management is also needed. Based on the description above, this study aims to analyze the farm management and factors influencing farmers' adaptation strategies to climate change in the Serayu Dam area.

METHODS

The research was conducted using a descriptive quantitative analytical method. This research was conducted in the Serayu Movable Dam area of Banyumas Regency. The location was selected intentionally (purposively) by considering that this location is one of the locations prone to flooding due to climate change. Data collection was carried out from August to October 2024. The total number of farmers who own land around the Serayu Dam is 97 people. The samples analyzed follow a normal distribution, namely a minimum sample size of 30 or if the population size is around 100, the sample size is at least 30%. This study's respondents were 30 farmers who cultivate food crops as the main commodity around the Serayu Movable Dam area. The process of selecting samples or respondents using simple random sampling The data collection method was carried out by interviewing respondents using a questionnaire. Answering the objectives regarding farm management can be done by looking at farmers' income. The farmer's income can be calculated by subtracting the income of corn farmers from the costs incurred to cultivate their food crops. Mathematically, the calculation can be seen as **Equation 1** (Suratiyah, 2015).

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

$$\Pi = TR - TC \quad \text{.....(1)}$$

Description:
π = Income
TR= Total Revenue (Total Income)
TC= Total Cost (Total Cost)

To measure the level of efficiency of farming in the production process of cultivated commodities, R/C Ratio analysis is used with the formula:

$$R/C\ Ratio = TR / TC \quad \text{.....(2)}$$

Description:
TR = Total Revenue
TC = Total Cost
If the analysis results:

a. R/C ratio >1, then the business is efficient and profitable to run
b. R/C ratio = 1, then the business is neither loss nor profit (breakeven)
c. R/C ratio <1, then the business is inefficient and experiences losses

Farmers' adaptation strategies in climate management are compiled descriptively based on farmers' opinions during interviews. Various adaptation strategies carried out by all respondents were then summarized. Adaptation answers from all respondents were then mapped based on farmers who answered the same answer. The reasons for implementing the strategy are manifested in descriptive based on answers to farmers' experiences when experiencing losses or crop failures due to climate change.

The factors that influence farmers in the Serayu Movable Dam area in anticipating climate change are manifested in their adaptive system. In measuring these factors, logistic regression is used so that they are seen and described accurately (Priyanto et al., 2021). Logistic regression is a data analysis technique that uses mathematics to find the relationship between two data factors. The data variables used in this regression are farmer education, farmer experience, the presence or absence of family dependents, activeness in farmer groups and the main job as a farmer or not. The farmer's decision to carry out an adaptation strategy or not becomes a binomial variable that the independent variables will influence in the factors mentioned earlier. The following are the variables used and their construct values.

Table 1. Independent and dependent variables used in the research

Variable	Variable Construct Value
Strategy Adaptation	0 = not implementing adaptation strategies 1 = implementing adaptation strategies
Farmer Education	1 = less than 6 years of education 2 = 6-12 years of education 3 = more than 12 years of education
Farmer Experience	1 = less than 10 years of education 2 = 10-20 years of education 3 = more than 20 years of education
Family Dependencies	0 = no dependents 1 = there are dependents
Farmers Group	0 = not active in farmer group 1 = active in farmer group
Farmer's Main Occupation	0 = farmer is not the main profession 1 = farmer is the main profession
Harvest Orientation	0 = if the harvest is for other purposes 1 = if the harvest is for consumption

Table 1 explains the variables researchers use to measure the factors that influence the adaptation strategies of the Serayu farmer area. The dependent variable in this study is the adaptation strategy which is manifested in the number 1 for farmers who implement adaptation strategies and the number 0 for farmers who do not carry out any adaptation strategies. **Table 1** also explains that there are 6 independent variables used in this study covering farmer education, farmer experience, family dependence, farmer groups, farmer main occupation, and harvest orientation. The six

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

independent variables used are divided into several components of construct variable costs as shown in **Table 1**.

RESULTS AND DISCUSSION

The area of land owned by farmers is one of the parameters in measuring how high farmers produce the production. The wider the land farmers use to cultivate a commodity will be in line with the production produced. The land used by farmers in the Serayu Movable Dam Area is privately owned land or leased land. The following is the area of land cultivated by farmers in the research area.

Table 2. Area of farmers' cultivated land in the Serayu movable dam area

Land Area	Percentage
Farmers with Land Area < 0.1 Ha	36.67
Farmers with Land Area 0.1001 - 0.2 Ha	33.33
Farmers with Land Area 0.2001- 0.3 Ha	10.00
Farmers with Land Area 0.3001-0.4 Ha	3.33
Farmers with Land Area > 0.5 Ha	16.67

Based on **Table 2**, it can be seen that 16.67 farmers have a wider land area than other farmers. The average area of farmers' land cultivated in the Serayu Movable Dam area is 2,187 m2. This indicates that most of the land farmers own is below the average land of farmers in this study. This condition indicates that farmers in the Serayu Movable Dam area are included in small farmers. This indication can be seen that the average area of farmers' land cultivated is still small and less than 0.5 hectares.

Cost sacrifice is something that farmers do in cultivating their crops. Farmers in the Serayu Movable Dam area on average plant rice on several lands that are close to and directly border the Serayu River. To meet the harvest achievement, costs are needed for planting, maintenance and labor during the harvest phase. Fixed costs and variable costs are two components incurred by farmers in the Serayu Movable Dam area. Fixed costs are costs that tend to be constant and are not affected by the amount of output produced by farmers, while variable costs can change depending on the needs of farmers. The income between one farmer and another farmer is certainly not the same. The size of the farmer's income is in line with the area of land cultivated by the farmer. The influence of the selling price of rice received by farmers also affects the size of the income received by farmers.

Based on **Table 3**, the level of farmer income in the Serayu Movable Dam area depends on the rice production farmers produce. The average rice farming business in the Serayu Movable Dam Area produces a production of 1,730 kilograms. The selling price obtained by farmers also affects how much farmers receive. Farmers in the Serayu Movable Dam area receive a selling price of rice of Rp 6,200 per kilogram. Thus, the income of rice farmers in the Serayu Movable Dam Area gets an income of Rp 10,726,000. In addition to the income received by rice farmers in the Serayu Movable Dam Area, costs are also needed to obtain production.

The costs incurred by farmers are divided into fixed costs and variable costs. Fixed costs for rice farmers include taxes, rent, and depreciation. Irrigation costs that are usually included in the fixed costs of rice farmers generally do not apply to rice farmers in the Serayu Movable Dam Area who obtain irrigation from the Serayu River area. The total fixed costs incurred are IDR 500,500 with the largest component being depreciation costs. Depreciation costs are obtained from the depreciation of agricultural equipment owned by rice farmers in the Serayu Movable Dam Area. Variable costs incurred by rice farmers include the cost of seeds, fertilizers, pesticides, labor and other costs. The total variable costs incurred by rice farmers in the Serayu Movable Dam Area are

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

IDR 2,586,176. The largest cost composition is in labor from outside the family. The amount of labor spent by farmers is based on aspects of rice cultivation work such as in the land preparation, planting and harvesting phases. The fertilizers used by farmers consist of several types such as urea, phonska, KCl, Za, drums, and organic fertilizers. The cost of fertilizer needed by farmers is around Rp785,725. The proportion of seed costs also adjusts to the area of land planted by farmers. Farmers who have the largest land will certainly need higher seed costs. Pesticide costs are also incurred by farmers to handle pest and disease control. Farmers usually use several brands such as furadan, round up, virtako and regen.

Table 3. Average income, costs and revenue of rice farmers in the Serayu movable dam area

No	Item	Rice Farming
1	a. a. Production (Kg)	1,730
	b. b. Price (Rp/Kg)	6,200
2	Revenue	10,726,000
3	Fixed Costs	
	a. Taxes	90,200
	b. Rent	135,000
	c. Depreciation	275,300
4	Variable Costs	
	a. Seeds	453,400
	b. Fertilizers	785,725
	c. Pesticides	145,850
	d. Labor	1,045,551
	e. Others	155,650
5	Total Production Cost (3+4)	3,086,676
6	R/C Ratio	3.47
Profit		7,639,324

The average cost of pesticides used by farmers is around Rp145,850. Other costs are also used by farmers in the Serayu Gerak Dam Area such as holding ceremonies or slametan events that have become a tradition. This event is indeed a custom that has been passed down from generation to generation. The average cost of this kind incurred by farmers is Rp155,650. The total production costs incurred by farmers are at Rp3,086,676. The profit received by farmers is obtained by subtracting the total income of farmers from the costs incurred by farmers.

The profit of rice farmers in the Serayu Movable Dam Area is at Rp 7,639,324. This positive profit indicates that the rice farming business run by farmers is said to be feasible. This is in line with research conducted by Barokah et al (2014) which states that the higher the income owned by farmers, the more in line with the profits obtained. Optimizing farming profits can be done in various ways, including increasing production and reducing costs incurred. The R/C ratio value shows a value of 3.47, which indicates that the farming business run by farmers is said to be feasible.

In recent times, farmers in the Serayu Movable Dam area have experienced less than optimal harvests due to the effects of floods and droughts. Unpredictable changes in nature mean that farmers cannot harvest all of the land they plant. The amount of harvest production that farmers have due to climate change varies from one farmer to another depending on the actions or responses given by the farmers. The following is the amount of production that farmers have managed to secure when there are effects of climate change in the Serayu Dam area.

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

Table 4. Amount of farmers' production in the Serayu movable dam area that can be harvested due to the impact of environmental change

Farmer Production	Percentage
Farmers With Production <10%	16.67
Farmers With Production <20%	10.00
Farmers With Production <30%	3.33
Farmers With Production <40%	10.00
Farmers With Production <50%	3.33
Farmers With Production >50%	56.67

Based on **Table 4**, it can be seen that most farmers have felt the impact of changes in nature on their harvests. The average farmer's harvest reaches 70% of the results that can be saved due to climate change. However, some farmers cannot produce the crops they cultivate due to drought or flooding. This must be anticipated immediately by farmers in various ways. Farmers need adaptive capacity to be able to deal with the impacts of climate change. The capacity of individual farmers to anticipate change can be done by accessing other resources as an adaptation measure. Adaptive capacity must also be aligned with the objective capacity of farmers (Gardezi, M. & Arbuckle, 2017). Objective capacity can be done to use farmers' economic resources to meet needs and meet financial needs (Tripathi & Mishra, 2020)(Antwi-agyei et al., 2018). Low adaptive and objective capacity for farmers must be supported by good financial access for farmers such as subsidies, market access, and farming credit (Mehedi et al., 2017)(Jamshidi et al., 2019).One of the strategies farmers take in anticipating climate change is to advance or postpone the planting schedule. This is of course done based on the science of titen or the use of *pranoto mongso* which has been commonly done by old generation farmers. This science is intended to predict when the rain will fall and when the dry season will start from various natural signs. Farmers who experience crop failure must also be able to adapt in meeting their household food needs in various ways that can be done. Farming households usually reserve food from the previous harvest so that food needs can still be met when they experience an unwanted crop failure. The second step that farmers usually take in the Serayu Movable Dam Area to meet food needs due to crop failure is by looking for other side jobs besides being farmers and also being assisted by family members who are also looking for other jobs. Farmers' adaptation to climate change is also carried out through active farmer groups which hold regular meetings to discuss climate change and appropriate cultivation systems.

Table 5. Regression output

Variable	Coefficient	Std.Error	p-value
Farmer Education	2.793***	1.336	0.004
Farmer Experience	0.141**	0.065	0.023
Family Dependencies	-0.100	0.119	0.390
Farmers Group	0.001*	0.419	0.067
Farmers' Main Occupation	2.167**	1.276	0.029
Harvest Orientation	0.144	1.891	0.730
Constanta	5.279	4.441	0.176
Chi Squared Sig. (Hosmer and Lameshow Test)			0.404
Nagelke R Squared			0.517

Note * : Significant at 1% level if p-count < 0.1, ** : Significant at 5% level if p-count < 0.05, *** : Significant at 10% level if p-count < 0.01

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

Based on the table above, it can be seen that the chi squared significance value is 0.404 or greater than the alpha value of 5%. This means that the model formed in the regression output is good and suitable for use. The Nagelke R squared value of 0.517 indicates a coefficient of determination value of 51.7, meaning that the influence of the variables of farmer education, farmer experience, family responsibilities, farmer groups, farmer main jobs and harvest orientation on the dependent variable of farmer adaptation strategies. **Table 5** also states that farmer education has a positive effect on farmer adaptation strategies in dealing with climate change. This is in line with the research of Menike and Arachi (2016) which states that the higher the education, the higher the level of adaptation to various things. This statement is strongly supported by the conditions in the research area, although the farmers do not have a high level of education but are often present in various activities that provide new knowledge.

Farmers in the Serayu Dam area are indeed a concern for regional development not only as an agricultural sector but also for the tourism sector so that the local government often gathers farmers to discuss many things, especially regarding adaptation to climate change and what varieties are suitable for planting. Of course, this activity is also supported by the presence of field extension workers who often monitor farmer activities and provide advice to farmers regarding plant cultivation. This positive indication must also be supported by activities such as climate field schools. Of course, this will strengthen farmers' adaptation strategies. In line with the research of Zhang et al. (2015) which states that although rural farmers do not have higher education compared to urban areas, it should be noted that one of the characteristics of agricultural commodities is that they come from rural areas. Rural farmers have more experience than farmers in urban areas so that the strategies used to anticipate change are based on the experience they have. **Table 5** also indicates that experience has a positive effect on farmers' adaptation strategies. The longer the farmer's experience, the more appropriate adaptation strategies they will have. Usually farmers will use *pranoto mongso* to determine when the planting season will begin so that the planting calendar can be done earlier or later than usual depending on the prevailing natural conditions.

Table 5 also indicates that the activeness of farmers in farmer groups has a positive effect on climate change adaptation strategies. The activeness of farmers in groups has a positive impact because they meet other farmers and discuss many things. The discussion room also contains sharing experiences on what strategies each farmer has taken in dealing with climate change. Routine farmer group meetings also discuss many things such as rice farming, handling rice pests and diseases, various government assistance and the existence of new superior varieties that can be used in dealing with climate change. This is in line with the research of Erwandi & Ramainas (2016), the more active farmers in the group will form a positive network in terms of increasing farmers' abilities, especially in managing their farming businesses to deal with climate change.

The work of farmers as their main profession or not also affects the climate change adaptation strategy. Farmers who have side jobs are also not purely a mistake because they are an effort to meet food needs. Being a farmer has several weeks of time that can be used to do side jobs as laborers, carpenters, bricklayers or traders. However, farmers who focus on their farming efforts will usually get more abundant harvests than farmers who only make their profession a side job. The sacrifice of time to care for cultivated plants also has differences. Therefore, management and adaptation strategies are needed by all farmers. This will better prepare the mentality of farmers who previously did not know or were less

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i3.2055

prepared to be fully prepared in facing the phenomenon of change. According to Tripathi and Mishra (2017), adaptation can also reduce the negative impacts given so that losses in quantity and quality of harvests can be minimized.

CONCLUSION

Based on the research results, it was found that farmers have an average land area of around 2,187 m2. This indicates that farmers in the Serayu movable dam area are small farmers who have a land area that is not too large. The results of the study also stated that the rice farming carried out by farmers earned a profit of Rp 7,639,324 with a total revenue (TR) received by farmers of Rp 10,726,000 and a total cost (TC) of Rp 3,086,676. The R/C ratio value shows a value of 3.47, which indicates that the farming business run by farmers is said to be feasible. Farmers in the Serayu movable dam area have also experienced a decrease in crop production due to climate change. The adaptation strategy carried out by farmers is to postpone or advance planting based on the *pranoto mongso* used. The results of the study also stated that there are factors that influence farmers' adaptation strategies, namely farmer education, farmer experience, farmer profession as the main job and farmer activity in farmer groups.

ACKNOWLEDGEMENTS

The author would like to thank all parties who participated in helping to carry out this community service activity, especially the Ministry of Education, Culture, Research, and Technology through the Directorate General of Higher Education, Research, and Technology (Ditjen Diktiristek) for providing fundamental research funding and and Jenderal Soedirman University for providing the opportunity to access research funding. The author would also like to thank LPPM Jenderal Soedirman University for permitting the research activity. Gratitude is also given to all parties who assisted in this research.

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