JAMBURA AGRIBUSINESS JOURNAL
VOLUME 5 ISSUE 2 JANUARY 2024
E-ISSN: 2685-5771 | **P-ISSN:** 2685-5860
Publisher: Agribusiness Department
Agriculture Faculty State University of Gorontalo
DOI: 10.37046/jaj.v0i0.24946

CONTRACT FARMING'S IMPACT ON COFFEE FARMERS' ADAPTATION STRATEGIES TO CLIMATE CHANGE IN EAST JAVA

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(Received: April 19, 2024 | Accepted: May 20, 2024 | Published: May 23, 2024)

ABSTRACT

Contract Farming is considered to be able to increase farmers' yields and income. In addition, another factor that influences is socio-demographic factors, so this research contributes as a reference in coffee farmers' decision-making in choosing adaptation strategies. This research also supports the long-term sustainability of farming to address climate change by supporting the thirteenth Sustainable Development Goals (SDGs) related to climate change mitigation by increasing effective planning and management capacities related to climate change, especially in the agricultural sector in Indonesia. This research was conducted in August 2022 in Pasuruan and Malang, East Java Province. Respondents were determined by Multistage Random Sample Procedure with a total of 100 coffee farmers. From the interview data of 100 coffee farmers in East Java, it was found that the majority of farmers had an understanding of climate change from three indicators: changes in rainfall, temperature, and length of the rainy season. The analysis results showed that Contract Farming influenced farmers' decision to adapt to climate change. In addition, socio-demographic factors that influenced the decision to adapt were the age of the farmer, but its effect was negative, meaning that the younger the age of the farmer, the higher the chance of implementing adaptation strategies. The findings indicate that both Contract Farming and socio-demographic factors are crucial in shaping the adaptation strategies of coffee farmers in response to climate change. This research highlights the importance of promoting Contract Farming as a means to enhance farmers' resilience to climate impacts.

Keywords: Adaptation strategies; Climate change; Contract farming; Socio-demographic

INTRODUCTION

Climate change is an evolving issue from year to year. Climate change has become one of the major threats to the agricultural sector in developing countries (Rondhi *et al*., 2019). Climate change is a long-term alteration in weather patterns from tropical to polar regions. This global threat has begun to exert pressure on various sectors (Abbass *et al*., 2022). Agriculture and food security are predicted to be significantly impacted by climate change (Anderson *et al*., 2020). The occurrence of this phenomenon results in changes in the climate system that affect natural changes and human life, such as changes in plant lifespans and the emergence of more serious plant diseases and pests. Climate change is also evidenced by extreme weather phenomena, unpredictable temperatures, and fluctuating rainfall. The adverse impacts

associated with climate change indicate the need for agricultural production to adapt to changing climate patterns or seasons, with the aim of minimizing potential negative impacts, such as low food production and low income (Makate, 2019).

One of the sectors affected by climate change is the agricultural sector. High rainfall variability and temperature changes resulting from climate change pose climate risks and affect agricultural production (Kogo *et al*., 2021). The occurrence of these phenomena requires farmers to start adapting to climate change. Therefore, farmers need to know the right strategies to face climate change to maintain agricultural production levels in the future. According to Intergovernmental Panel on Climate Change [IPCC] (2014), adaptation is the process of adjusting to planned climate change effects. In human life, the goal of adaptation is to avoid losses or take advantage of beneficial opportunities. Strategies are future plans that can be adjusted to interact with the competitive environment to achieve specific goals. Strategies reflect awareness of how, when, and where to compete. Adaptation strategies are plans developed to respond to or anticipate climate condition changes so that farmers can reduce the adverse impacts caused by climate change (Saptutyningsih *et al*., 2020).

Some commodities find it difficult to adapt to climate change, especially concerning rainfall levels. Some commodities require specific rainfall levels. One commodity affected by changes in rainfall is coffee. Excessive rainfall also causes damage and reduces coffee production. The impact of rainfall on coffee plants can decrease the quality of coffee beans. According to Kath *et al*. (2021), higher rainfall during harvesting can lead to increased defects in coffee beans, resulting in decreased selling prices.

Coffee plants are categorized as perennial plants with an economic lifespan of up to 30 years. In Indonesia, the two most commonly grown varieties are arabica and robusta. Indonesia is one of the largest coffee-producing countries globally. However, Indonesia still has low coffee production quality. type of Indonesian coffee is still less competitive than the products of Vietnam, Brazil, or Colombia (Purwawangsa *et al*., 2024). Robusta coffee plants grown on Java Island thrive best at elevations between 300 and 900 meters above sea level (MASL) (Herdiani, 2018).

Coffee commodities are a backbone for communities in East Java. Thus, this encourages farmers to maintain their coffee fields. However, many farmers still do not understand the meaning of adaptation, especially to climate change. Adaptation in agriculture is crucial. Climate change negatively impacts plant growth worldwide, resulting in reduced crop yields and increased difficulty in maintaining food security, particularly in regions heavily reliant on agriculture for livelihoods and economies (Kabir *et al*., 2023). Therefore, adjustments are needed at the household level for farmers and communities in East Java to implement adaptation strategies to climate change. Adaptation is a key response for humans to withstand the effects of climate change.

Farmers' adaptation actions to climate change are also influenced by several factors such as participation in contract farming, farming experience, age, income, education, and land area. According to Makate (2019), effective strategies at the policy and institutional levels can enhance the adoption of CSA (Climate-Smart Agriculture) technologies. This supports policy and institutional focus, one of the success factors and sustainability factors that need to be considered in the effective improvement of CSA. One institution that has supportive policies for enhancing adaptation is Contract Farming. Some previous researchers have studied adaptation strategies to climate change and the influencing factors (Biswas *et al*., 2020). Adaptation to climate change is also influenced by farmers' participation in Contract Farming. The most common form of contract farming for small farmers is providing production inputs to farmers, paid through goods at the end of the production season. Such arrangements are expected to provide new and better technologies to farmers. Biswas *et al*. (2020) found that farmers in India prefer to work outside agriculture and cope with climate change by reducing household consumption.

Previous research indicates that institutional factors such as farmer groups are determinants of farmers' adaptation. Besides farmer groups, other institutional factors like Contract Farming also play a role. However, there have been few studies involving Contract Farming in farmers' adaptation to climate change. This study used an instrumental variable probit approach to understand the influence of Contract Farming on farmers' adaptation to climate change. The study provides evidence that Contract Farming enhances the resilience of small farmers to the impacts of climate change through increased climate change coping and adaptation strategies (CAS). Thus, it can be concluded from this study that Contract Farming influences farmers' adaptation, and the largest CAS impact is felt by farmers in terms of crop yields. Farmers' opportunities to implement adaptation strategies will increase with increased participation in farmer groups (Priyanto *et al*., 2021). By joining farmer groups, farmers will find it easier to access information about climate change. Therefore, access to information is one of the determinants of farmers' adaptation.

This study will attempt to fill the gap from previous research by measuring the level of adaptation strategies of coffee farmers in East Java using an interval scale with the analytical tool of tobit regression to determine the level of farmers' adaptation to climate change. This study contributes as a reference for coffee farmers in decision-making regarding adaptation strategies. It also supports long-term farming sustainability to cope with climate change. Additionally, this research is expected to support Sustainable Development Goal (SDG) thirteen concerning climate change mitigation by enhancing effective planning and management capacities related to climate change, especially in the agricultural sector in Indonesia. This study also aims to fill gaps in previous findings by investigating the relationship between Contract Farming and adaptation strategies at the level of coffee farmers and the influencing factors in the research location.

The objectives of this study are threefold. First, the study aims to analyze coffee farmers' perceptions of climate change, focusing on how they understand and interpret changes in climate patterns, such as variations in rainfall, temperature, and the duration of the rainy season. Second, the research seeks to examine the impact of Contract Farming on adaptation strategies employed by coffee farmers. This involves investigating how contractual agreements with buyers or processors influence farmers' decisions and actions to mitigate or adapt to the adverse effects of climate change. Finally, the study aims to analyze the socio-demographic factors that influence climate change adaptation strategies in coffee farming. This includes exploring how factors such as age, education, gender, and household composition affect the likelihood of adopting various adaptation measures. By addressing these objectives, the study aims to provide a comprehensive understanding of the factors driving adaptation strategies among coffee farmers in the face of climate change.

METHOD

Data Collection

The research was conducted in August 2022 in East Java, specifically in Malang and Pasuruan districts, with an average rainfall of 248 mm3. The area has a maximum temperature of 34°C and a minimum temperature of 22°C. The sampling technique used in this study was the Multistage Random Sample Procedure (Ma *et al*., 2018). The following steps were taken: first, selecting the research location, which was East Java because it has coffee farmers. Second, choosing two locations, Malang and Pasuruan, with relatively high coffee production and contract farming. The designated locations were one village in Dampit Sub-district, Malang Regency, and two villages in Prigen Sub-district, Pasuruan Regency, with high coffee production and farmers participating in contract farming.

This research was based on primary data collected by the researchers in the field. The total number of farmers who were respondents was 100 farmers. Three data

collection techniques were used: interviews, observations, and documentation. Observation was used to support data collection activities to assist the research. Second, structured interviews were conducted by asking farmers questions according to a questionnaire created by the researchers to obtain the required data. The questions asked by the researchers to the research informants related to farmers' knowledge of climate change, information obtained by farmers regarding climate change, farmers' awareness of climate change, perceived effects of climate change, and what adaptation strategies have been implemented by farmers. Third, documentation was used to record all activities and results of the data collection process conducted by the researchers.

Measuring Climate Change Adaptation Strategies

This research uses a structured questionnaire designed for face-to-face interviews, with three different sections. In the first section, the researcher asks about household characteristics such as the number of family members, age, education, annual household income, and farming experience. The second section relates to farmers' participation in Contract Farming. The researcher asks, "Are you involved in coffee partnership/Contract Farming?" and farmers can answer "yes or no". Then, in the third section, the researcher asks about climate change. The question asked is "Have you ever heard of the term climate change?", and farmers only need to answer "yes or no".

The next question is related to farmers' perceptions of climate change in the last 10-20 years. The researcher asks, "Have you experienced changes in rainfall/temperature in the last 10-20 years?" Farmers can answer with a score of 1 indicating no change, 2 indicating slight change, 3 indicating significant change, and 4 indicating very significant change. For the final question, it is related to the strategies that farmers implement in dealing with climate change. The researcher asks, "What strategies have you implemented to cope with climate change?" Farmers can answer from the five strategies asked by the researcher, including changes in cropping patterns, changes in plant varieties, changes in crop types, planting of boundary trees, and changes in fertilizer use. Farmers can answer more than one or not answer at all.

Empirical Framework

This study uses Tobit regression analysis. Tobit Regression Analysis was first introduced by Tobin (1958). Tobit regression is a regression analysis used to measure the dependent variable with censored data, where it allows for values of 0. The purpose of using this model is to measure the influence of Contract Farming and socio-demographic factors on farmers' adaptation strategies to climate change. The formula obtained is as follows:

$$A = \alpha + CF\alpha_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \alpha_5 x_5 + \alpha_6 x_6 + \alpha_7 x_7 + \alpha_8 x_8 + \alpha_9 x_9 + e \ldots (1)$$

Where A value represents censored data that represents the total adaptation of farmers to climate change with a ratio value of 0 to 6. α is a vector of variables to be assessed. CF vector represents the Contract Farming participation variable and e is a random error. Furthermore, vectors x_2 to x_9 represent socio-demographic factors consisting of level of education, farmer age, farming experience, total land area owned by farmers, number of farmer family members, non-farming jobs performed by farmers, total farmer income from farming and non-farming jobs, and farmers' access to climate change information.

RESULTS AND DISCUSSION

Descriptive Statistics

Based on the data provided, it can be seen that the implementation of climate change adaptation among coffee farmers in East Java is influenced by various factors, including participation in contract farming, socio-demographic factors, and access to information about climate change. Participation in contract farming is one of the factors that affect climate change adaptation. Out of 100 respondents, 46 farmers have participated in contract farming, while 54 farmers have not. Contract farming may provide farmers with access to information, technology, and markets that can help them to adapt to climate change.

Table 1. Characteristics of Respondents

Variable	Definition	Mean	Std. dev.
Climate Change Adaptation Intensity	Farmers' awareness of climate change is in the form of changes in rainfall, changes in temperature and the length of the rainy season in the last 10 years with range (0-3) unchanged, slightly changed, significantly changed, drastically changed)	0.4	0.619
Contract Farming Participation	The number of many adaptation strategies carried out by farmers with a range (0-5) 1. Changes in planting patterns 2. Changes in plant varieties 3. Changes in plant type 4. Planting of hedges 5. Changes in fertilizers used	0.46	0.500
Education Level (year)	The length of time coffee farmers take formal education	7.28	2.474
Age (year)	The age of the coffee farmer who was the respondent	50.34	11.857
Contract Farming Experience (year)	The length of time coffee farmers work in agriculture	21.05	11.621
Land (m^2)	The area of cultivation owned by coffee farmers for agricultural cultivation	10,431.2	26,709.38
Number of Family Members	The number of family members of coffee farmers according to the Family Card data	3.36	1.132
Off Farm Jobs	obs unrelated to the agricultural sector or farmer's side hustle	0.67	0.472
Access to Climate Change Information	Obtaining information related to climate change through various parties such as agricultural extension workers, the internet and newspapers	0.67	0.472
Total Revenue (IDR)	The amount of money received by farmers from the deduction of total receipts and total costs incurred as well as the addition of non-agricultural income	3,892,802	4,713,281

Source: Primary data processed, 2024

Socio-demographic factors such as education level, age, farming experience, land size, family members, and off-farm work also play a role in climate change adaptation. Education level is an important factor, as the majority of coffee farmers in

East Java have only completed primary school. This may limit their access to information and knowledge about climate change adaptation strategies. Age and farming experience also affect farmers' ability to adapt to climate change, as older farmers with more experience may be more resistant to change. Land size is another important factor, as the majority of farmers in Indonesia own small plots of land. This limits their ability to implement climate change adaptation strategies that require larger investments. Family size and off-farm work may also affect farmers' ability to adapt to climate change, as these factors may impact their time and resources. Access to information about climate change is also crucial for farmers to adapt. While 67% of the respondents have received information about climate change, there are still some farmers who have not received this information. Improving access to information about climate change and adaptation strategies is important to help farmers adapt to the changing climate.

Farmer Perceptions of Climate Change

This study categorizes farmers' perceptions of climate change into three indicators: average rainfall changes, temperature changes, and length of rainy season over the past 10 years.

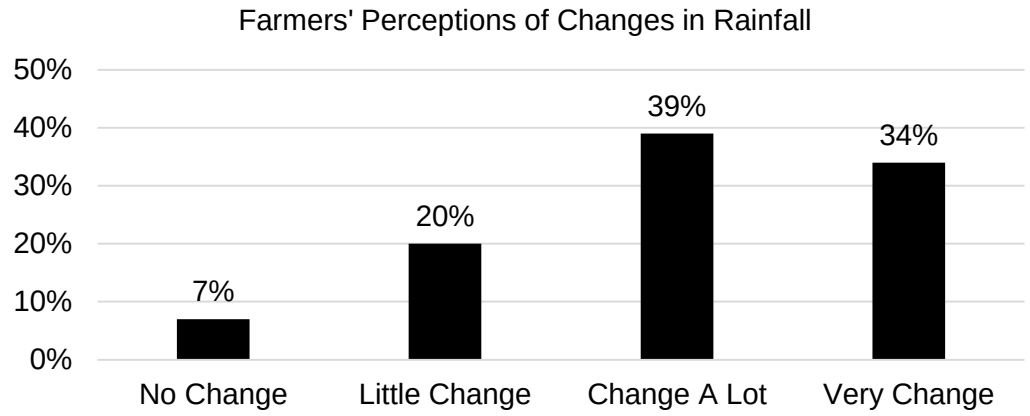

Figure 1. Farmers' Perceptions of Changes in Rainfall
Source: Primary data processed, 2024

From Figure 1, it can be seen that 34 farmers, or 34% of the total respondents, strongly experienced changes in rainfall over the past 10 years. 39 farmers, or 39% of the total respondents, perceived a significant change in rainfall over the same period. Furthermore, 20 farmers reported a slight change, while 7 farmers did not perceive any changes in rainfall.

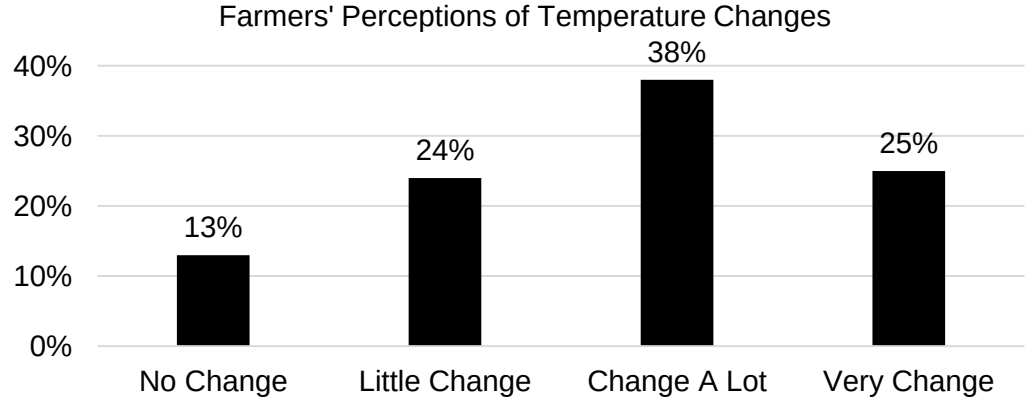

Figure 2. Farmers' Perceptions of Temperature Changes
Source: Primary data processed, 2024

Figure 2 shows that approximately 25 farmers', or 25% of the total respondents, strongly felt changes in temperature over the past 10 years, and 38% or 38 farmers indicated significant temperature changes over the same period. 24 farmers reported a slight change, while 13 farmers did not perceive any temperature changes. Meanwhile,

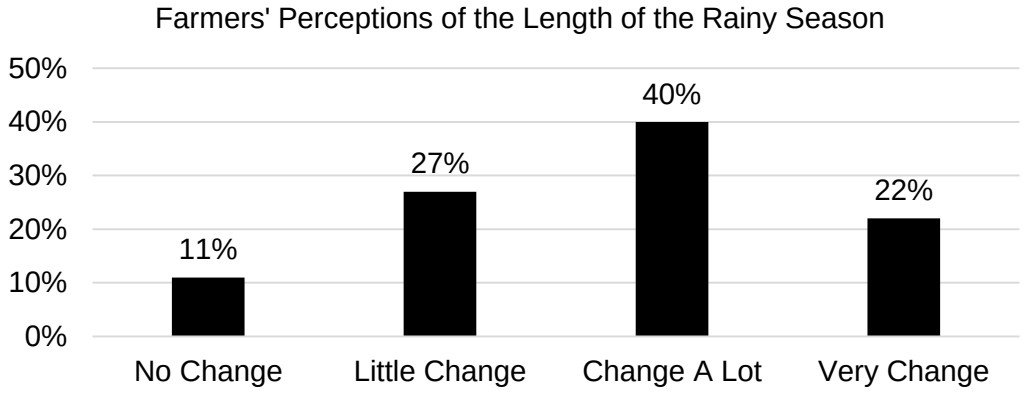

Figure 3. Farmers' Perceptions of the Length of the Rainy Season
Source: Primary data processed, 2024

Figure 3 indicates that around 22 farmers, or 22% of the total respondents, strongly felt changes in the length of the rainy season over the past 10 years, and 40% or 40 farmers perceived significant changes in the length of the rainy season. 27 farmers reported a slight change, while 11 farmers did not perceive any changes in the length of the rainy season.

The Effect of Contract Farming and Socio-demographic Factors on Climate Change Adaptation Strategies of Coffee Farmers in East Java

The influence of Contract Farming and Socio-demographic Factors is shown in Table 2 of the tobit regression analysis results. The data from the analysis of the influence of Contract Farming participation on the intensity of adaptation conducted by farmers indicates a significant effect. According to the processed data in Table 2, the p-value for the influence of Contract Farming participation on climate change strategies is 0.098, which is less than 10%. Education level has a negative coefficient value of 0.044 with a p-value of 0.638, indicating a positive but insignificant influence. Age has a negative coefficient value of 0.044 with a p-value of 0.046, indicating a significant negative influence on adaptation strategies. Farming experience towards adaptation strategies has a positive coefficient value of 0.021 with a p-value of 0.392, indicating a positive but non-significant result. Land size towards adaptation strategies has a negative coefficient value of 0.000 with a p-value of 0.583, indicating a positive but non-significant result. The number of family members towards adaptation strategies has a positive coefficient value of 0.031 with a p-value of 0.872, indicating a positive but non-significant result at the 10% level. Non-agricultural occupation towards adaptation strategies has a coefficient value of 0.451 with a p-value of 0.348, indicating a positive but non-significant result at the 10% level. Total income towards adaptation strategies has a coefficient value of 2.08 with a p-value of 0.978, indicating a positive but non-significant result. The influence of climate change information access on adaptation strategies has a coefficient value of 0.038 with a p-value of 0.936, indicating a negative influence and showing an insignificant result.

Table 2. Factors influencing climate change strategies

Adaptation Intensity	Coefficient	Std. err.	t	P>|t|	95% conf.
Contract Farming Participation	0,828	0,495	1.67	0.098*	-0,156
Education Level	-0,044	0,093	-0.47	0.638	-0,231
Age	0,046	0,025	-1.83	0.071*	-0,096
Farming Experience	0,021	0,024	0.86	0.392	-0,027
Land	-0.000	0.000	-0.55	0.583	-0.000
Number of Family Members	0,031	0,194	0.16	0.872	-0,355
Jobs Outside Of Agriculturen	0,451	0,478	0.94	0.348	-0,499
Access to Climate Change Information	-0,038	0,484	-0.08	0.936	-1.001
Total Revenue	2.080	7.380	0.03	0.978	-1.45
Changes in Rainfall	2.351	1.278	1.84	0.069*	-0,190
Temperature Changes	0,577	0,810	0.71	0.478	-1.032
Length of the Rainy Season	-2.362	0,927	-2.55	0.013*	-4.204
Doble	0,243	1.962	0.12	0.901	-3.657
Where (e.intensity adaptation)	2.610	0,889			1.326
Number of obs	= 100				
LR $chi^2(12)$	= 22,50				
Prob > chi^2	= 0,032				
Username R^2	= 0,114				

Source: Primary data processed, 2024
Note: *,**,*** denote significance on 10%, 5%, and 1% respectively

Discussion

The perception of climate change adaptation among coffee farmers in East Java shows that the majority of farmers are aware of climate change, including changes in rainfall, temperature, and the length of the rainy season in the past 10 years. This is also marked by the occurrence of the La Nina phenomenon in Indonesia, which has happened for the past three years. According to Agency for Meteorology, Climatology, and Geophysics [BMKG] (2022), La Nina is a cooling of the sea surface temperature in the central and eastern Pacific Ocean. In addition, La Nina causes the land surface of the Maritime Continent to warm up faster than the Pacific Ocean (Zhong *et al*., 2024). La Nina causes a longer rainy season than normal conditions. A longer rainy season increases moisture in the land, resulting in decreased agricultural production (Li *et al*., 2020). This is very important in determining future agricultural policies and increasing agricultural resilience in Indonesia.

Farmers' adaptation to climate change is influenced by several factors, including Contract Farming and socio-demographic factors. There is a link between the adoption of adaptation strategies and farmers participating in Contract Farming. Farmers who participate in Contract Farming are potentially able to apply adaptation strategies that make them more resilient to potential crop losses due to the impacts of climate change (Megersa & Assefa, 2019).

The socio-demographic factor analysis shows that age has a significant but negative impact. This means that the younger the farmer, the greater the chance of adapting to climate change. This is consistent with several previous studies, such as research, which stated that Young farmers are more likely to adopt CSA practices

because they are more interested in the latest practices and technologies. Additionally, they find it easier to learn how to use these technologies and to find solutions that fit their production systems (Gemtou *et al*., 2024).

CONCLUSIONS

Research related to adaptation strategies to climate change among coffee farmers in East Java aimed to understand the farmers' perceptions, the relationship between contract farming and the implementation of climate change adaptation, as well as the socio-demographic factors that influence it. The study was analyzed using the tobit regression method to determine the intensity or level of adaptation strategies undertaken by farmers in facing climate change. From the analysis of 100 respondents from coffee farmers in East Java, several conclusions can be drawn. Firstly, farmers have experienced climate change in the past 10 years, marked by changes in rainfall, temperature, and the length of the rainy season. Secondly, it was found that contract farming significantly influenced the implementation of adaptation strategies to climate change. Thirdly, socio-demographic factors that significantly influence the intensity of farmers' adaptation strategies to climate change are age, but its effect is negative, where younger farmers are more likely to choose to adapt than older farmers. Meanwhile, other socio-demographic factors such as education level, farming experience, total land area, number of family members, non-farming occupation, total income, and access to climate change information do not significantly influence the intensity of farmers' adaptation to climate change.

The researchers suggest that the government needs to disseminate information related to contract farming by collaborating with extension workers, farmer groups, cooperatives, and other agricultural institutions. The government and agricultural institutions in the villages play an important role in helping to improve climate change adaptation. Things that can be done include helping farmers in developing farming businesses according to strategies in facing climate change, such as changing fertilizer use, planting boundary plants, and changing types and varieties of plants. In addition, capacity development and knowledge dissemination through extension services are needed to ensure that farmers know the right strategies in facing climate change. Regular extension services related to information about the steps that farmers should take are very much needed in implementing adaptation strategies. In addition, supporting the implementation of appropriate adaptation strategies requires the role of young farmers. Therefore, training for young farmers in understanding the importance of implementing climate change adaptation strategies for the sustainability of farming is needed. Furthermore, investment in agriculture is also needed to support household capacity to make long-term strategic decisions so that providing agricultural loans and agricultural insurance can support farmer adaptation and reduce farmers' concerns about crop failure.

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