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ADAPTATION AND ADAPTATION STRATEGY OF FARMERS TO CLIMATE CHANGE: A CASE IN BEJIHARJO VILLAGE, KARANGMOJO DISTRICT, GUNUNGKIDUL REGENCY

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ABSTRACT

In 2017, the village of Bejiharjo, Karangmojo District, Gunungkidul Regencywas flooded caused by one of the climate factors called La Nina. The farmland and a bridge that connecting the village had suffered damage. This study aims to determine perception, adaptation, and factors that influence farmers' adaptation to climate change in Bejiharjo Village. The sample used were 32 farmers taken by using purposive sampling method. Farmers' perception was measured by 2 indicators with Likert scale, namely perceived climate change variables and the impact of climate change on farming. Then, the farmers were grouped according to Strugers' formula and analyzed with proportion test. Adaptation strategies were measured by calculating the number of adaptation strategies carried out by farmers. The factors that influence the adaptation of farmers were analyzed by using multiple linear regression analysis. The result of research showed that farmers in Bejiharjo had strong perception on climate change. There were 12 adaptation strategies carried out by farmers. The most widely practiced adaptation strategy was adjustment the planting period, which is done by 90.62% respondents. Farmers' adaptation to climate change were positively influenced by the education of the household head, the number of productive household members, perception, and number of water irrigation sources. The factor that negatively affect the strategy was the contribution of farm income.

Keywords: perception, adaptation, climate change

INTRODUCTION

In November 2017, the first time in the last 10 years the Bejiharjo Village area, Karangmojo District, Gunungkidul Regency was flooded. This phenomenon is unique because the Gunungkidul region is generally known as a dry area and is located in a highland area. The floods damaged the bridges that were accessed by the community so that the village's economic activities had become sluggish.

The flood is one of the consequences of climate change. The rainy season coupled with La Nina results in rainfall that exceeds normal conditions (BMKG, 2018). One of the parties affected by the flood was farmers. However, the response given by farmers depends on farmers' perceptions of the phenomenon that occurs. Farmers' perceptions can be interpreted as the process of understanding the information received by the farmer's five senses (Harish & Masiming, 2008). Farmers can get information about climate change from agricultural extension agents and the mass media. In addition, farmers can also feel anomalies or abnormalities that occur in carrying out agricultural business, for example, the decline of the rainy season, prolonged dry season, explosion of certain plant pests and diseases, and so on which are related to climate change (Deressa et al., 2009).

Farmers will make various efforts to deal with conditions that have the potential to reduce their agricultural output. This effort can be called a farmer adaptation strategy (Deressa et al., 2009). Examples of farmers' adaptation to climate change are adjusting drainage techniques, increasing the dosage of pesticides, increasing irrigation, using drought / inundation resistant varieties, and adjusting the planting period (Li et al., 2012).

The adaptation of farmers to climate change is influenced by socio-economic, cultural, political, geographic, and institutional factors which then form interactions between individuals and the environment (Pouliotte et al., 2009). Based on research by McDowell & Hess (2012), access to water, human capital, social capital (including institutions, farmer groups, etc.), access to financial institutions, levels of stress due to decreasing quality

and quantity of land, and perceptions.

The Indonesian government is making efforts to increase farmers' knowledge and adaptability to climate change through the climate field school program or SLI (BMKG, 2019). This program is run by the Center for Education and Training (Pusdiklat) of the Meteorology, Climatology and Geophysics Agency (BMKG). SLI was held starting in 2011 and has been running until now. This program is implemented in stages with topics tailored to each region.

Based on this description, it is necessary to conduct research on:

1. How do farmers perceive climate change?
2. How are farmers adapting to climate change?
3. what factors influence farmers' adaptation strategies to climate change

The objectives of this research are:

1. Knowing farmers' perceptions of climate change
2. Knowing the adaptation of farmers to climate change
3. Knowing the factors that influence the adaptation strategy of farmers to climate change

METHOD

The research method used is a descriptive research method, beginning with collecting data, analyzing, and compiling research reports (Murniati, 2014).The location chosen was Bejiharjo Village, Karangmojo District, Gunungkidul Regency. The research sample was taken by purposive sampling method, namely the method of purposive sampling based on research objectives (Deressa et al, 2009). The criteria used in selecting samples were farmers in areas affected by natural disasters, particularly those related to climate change. The number of samples used was 32 respondents.

This study uses primary data and secondary data with some of the data used as part of the research grant. Jangkung Handoyo Mulyo, M.Ec. entitled"Farming Household Adaptation Strategies to Climate Change in the Framework of Strengthening Food Security and Food Supply Chains and Improving the Welfare of Agroecosystem-Based Farmers in the Special Region of Yogyakarta". Primary data was taken directly on November 2 and 4 2018 through interviews with a systematic questionnaire. Secondary data were obtained from local government website data and related sources. Before measuring farmers' perceptions of climate change, validity and reliability tests were conducted on the question items first. The software application used is the IBM SPSS Statistic 22 application . The validity test is used to show that the question items used are valid while the reliability test is carried out to show that the question items used are reliable or not. (Anggraini et al., 2010).

Farmers' perceptions of climate change are known by using the perceived climate change indicator approach and the impact of climate change on farming. The data was collected in the form of a score using a Likert scale (Anggraini et al., 2010). The next step is to determine the category of perception based on the total score obtained by the farmers. This categorization is used to determine the criteria for strong or weak perceptions of farmers. The determination of perceptual categories is carried out using the Struges formula (Dajan, 1996 in Murniati, 2014):

$$Z = \frac{X - Y}{K}$$

In which:
Z = class interval
X = the highest score
Y = the lowest value
K = many categories

Furthermore, further analysis was carried out on the strength or weakness of farmers' perceptions of climate change using the Z-test proportion test with α = 5%. This test aims to determine the level of perceptions of farmers statistically. (Sudjana, 1992 in Hadi & Ediyanto, 2016). The hypothesis used:

H_0: P ≤ 3, farmers have a weak perception of climate change

H_1: P > 3, farmers have a strong perception of climate change

The Z test can be done by comparing the Zvalue with the Zsig. If Zvalue is greater than Zsig then H_0 is rejected so H_1 is accepted. Zhitung can be found by the formula:

$$Z_{hitung} = \frac{x - Po}{\frac{\sigma}{\sqrt{n}}}$$

In Which:

X = average perception value of each sub-indicator per sample
P_O = the coefficient of the hypothesized value, namely 3
σ = standard deviation
n = number of samples

The adaptation strategy of farmers is known by the descriptive analysis method. The data is processed and presented in the form of a diagram, described and interpreted. The data used are all adaptation actions taken by farmers to climate change.

Regression analysis is used to analyze the relationship between the dependent variable and one or more independent variables (Hadi & Ediyanto, 2016). The factors that are thought to have an effect are the age of the head of the household (KRT), the education of the household head, the number of productive household members, the contribution of farm income, perceptions, sources of information, sources of irrigation water, and access to credit. After that, a classic assumption test is carried out to detect any data deviations. The classical assumption tests carried out are multicollinearity test, heteroscedasticity test, normality test, and autocorrelation test. Finally, the model accuracy test is carried out, namely the coefficient of determination test, the F test, and the t test.

RESULTS AND DISCUSSION

Validity test

Based on the validity test, it can be seen that the Corrected Item-Total Correlation (CITC) value of each question item is to measure farmer perceptions. All CITC values of the items are greater than R table (0.3494), so all question items used to measure farmer perceptions are valid.

Reliability Test

Cronbach's Alpha value shows the reliability value of all question items. The resulting value is 0.908 (> 0.7), so the question items used to measure farmers' perceptions are reliable or trustworthy. The Cronbach's Alpha value is getting closer to 1, the more reliable the question items used will be.

Changes in climate elements felt by farmers

The phenomenon of climate change can be explained through the variables of climate change that occur. The climate change variables can be felt by some farmers. The indicator of climate change felt by farmers is a measurement of climate change variables through several sub indicators that are asked to farmers in general.

Table 1. Indicators of Climate Change Indicators for Farmers

Sub indicators	Number of respond					Total score (max=160)	Percentage S & SS (%)
	SA (5)	A (4)	U (3)	D (2)	SD (1)		
The air temperature has increased	14	10	1	7	0	127	75,00
The frequency of retreating from planting increases	10	14	4	4	0	126	75,00
The land is getting drier	5	18	1	8	0	116	71,88
The frequency of climate extremes is increasing	4	16	7	5	0	115	62,50
Wind speed increases	9	8	6	9	0	113	53,13
Rainfall increases	5	11	9	6	1	109	50,00

SA = Strongly Agree, A= Agree, U= Unsure, D= Disagree, SD = Strongly Disagree

Source: Primary Data Analyzed in 2019

The sub-indicator that had the highest score was the increasing air temperature with a total score of 127 and was felt by 75% of farmers. These results are in accordance with the statement of Wheeler & Braun (2013) where global warming results in an increase in the average temperature of the earth. Rainfall increases to become the sub indicator with the lowest total score, namely 109 and is felt by 50% of farmers. This shows that some farmers in Bejiharjo Village do not feel an increase in rainfall even though the Yogyakarta area in 2018 experienced an increase in the volume of rainfall (BMKG, 2017).

The Impact of Climate Change on Farming Felt by Farmers

The impact of climate change on farming that is felt by farmers focuses on the phenomena experienced when running the farm.

Table 2. Indicators of the Impact of Climate Change on Farming Felt by Farmers

Sub indicators	Number of respond					Total score (max=160)	Percentage S & SS (%)
	SA (5)	A (4)	U (3)	D (2)	SD (1)		
It is difficult to predict the planting period	7	20	1	4	0	126	84,38
The risk of farm losses increases	6	17	5	4	0	121	75,00
Reduced water availability	5	19	2	6	0	119	71,88
The risk of crop failure increases	6	15	5	6	0	117	65,63
There was a decrease in production	7	11	5	9	0	112	65,63
The cropping pattern is erratic	4	17	1	10	0	111	62,50
The quality of the results decreases	5	14	4	9	0	111	59,38
Failed production	4	16	1	11	0	109	59,38
Increase in pests and diseases	5	14	0	13	0	107	56,25

SA = Strongly Agree, A= Agree, U= Unsure, D= Disagree, SD = Strongly Disagree

Source: Primary Data Analyzed in 2019

The sub-indicator with the highest score was difficult to predict the planting period with a total score of 126 and was felt by 83% of farmers. The prediction of the growing season is related to the rainy season. In general, farmers in Bejiharjo Village wait for the rainy season to start planting, especially for the rice commodity. Predictions or forecasts are increasingly difficult to do because the rainy season is increasingly erratic (Wheeler & Braun, 2013).

The increase in plant pests was the sub indicator with the lowest total score, namely 107. Some farmers did not feel an increase in plant pests and diseases because they had applied pesticides. In addition, these pests and diseases are pests and diseases of the same type as usual, not new ones. Pests and diseases that attack are predominantly types that adapt to dry conditions, namely urets, leafworms, and brown spots.

Farmers' Perceptions of Climate Change

Perception is measured in the form of a score. The perception score is a combination of the different scores of climate elements felt by farmers and the impact of climate change on farming that is felt by farmers. Then, the scores are grouped according to the Strugers formula.

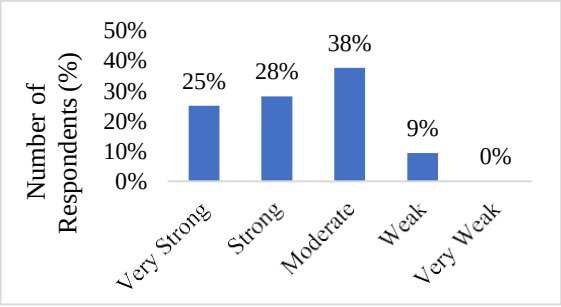

Figure 1. The category of farmers' perceptions of climate change is based on the Strugers formula

As many as 25.00% of farmers have very strong perceptions and as many as 28.13% have strong perceptions. These two categories can indicate that 53.13% (from 25.00% + 28.13%) farmers in Bejiharjo Village have really felt the effects of climate change.

As many as 37.50% of farmers had a moderate level of perception, 9.38% had a weak level of perception and none had a very weak level of perception. So as many as 46.88% (from 37.50% + 9.38%) farmers feel doubtful or unsure about the effects of climate change both in farming and in their daily activities.

Proportion Test

The Z-test proportion test was conducted to determine the level of farmers' perceptions of climate change statistically. The hypothesis used is:

H_0: P ≤ 3, farmers have a weak perception of climate change

H_1: P > 3, farmers have a strong perception of climate change

The calculation of the proportion test is as follows:

$$Z_{hitung} = \frac{x - Po}{\frac{\sigma}{\sqrt{n}}}$$

$$Z_{hitung} = \frac{3{,}341272 - 3}{\frac{1{,}054613}{\sqrt{32}}}$$

$$Z_{hitung} = 3{,}341$$

The results of the proportion test showed that the Zvalue was 3.341. This value is greater than Zsig, which is 1.645, then H0 is rejected. Farmers have a strong perception of climate change.

Strategy for Adaptation of Farmers to Climate Change

All the adaptation actions that farmers take to climate change. Adaptation measures allegedly carried out by farmers are the use of drought / inundation resistant varieties, adjustment of planting time, adjustment of harvest time, adjustment of pesticide application (5T), adjustment of organic matter dosage, use of mulch, increased watering, water saving, adjustment of irrigation and drainage techniques, diversification of crop types, expansion of arable land, and diversification of sources of income.

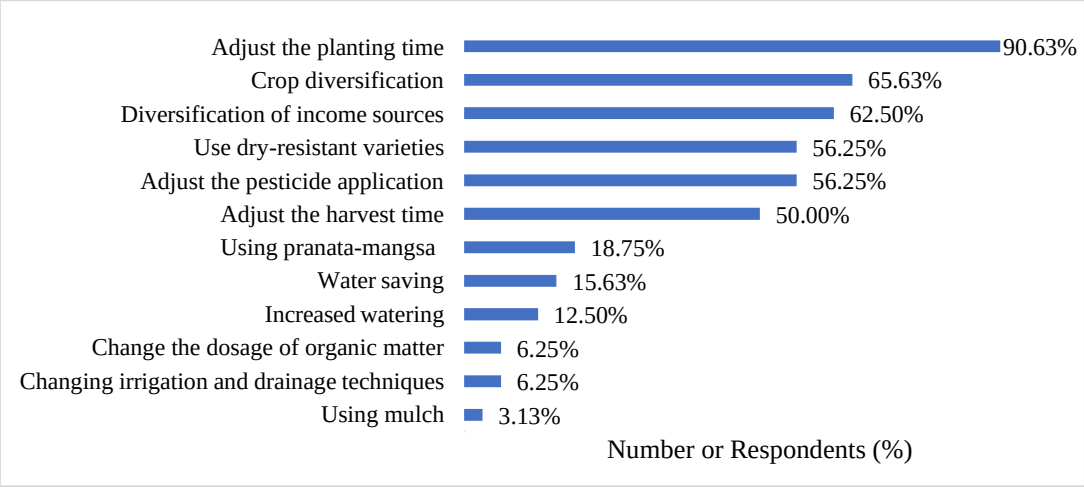

Figure 2. Farmers' adaptation strategy to climate change in Bejiharjo Village

The adaptation strategy that is mostly carried out by farmers is to adjust the planting period, which is as much as 90.63%. Adjustment of the planting period is done by aligning the planting time with the rainy season. When the rainy season arrives, water that can be used to meet the needs of the plants will be available so that the planting process can be carried out. On the other hand, the majority of land used for farming is upland, relying on water from rain.

Factors Affecting Farmers' Adaptation to Climate Change

Classic assumption test

a) Normality Test

The results of the normality test show the Jarque-Bera probability value of 0.5575. This value is greater than $\alpha = 10\%$ so that H_1 is rejected. The data used to determine the factors that affect the adaptation of farmers to climate change is data whose residuals are normally distributed.

b) Mulitkoleniaritas Test

The multicollinearity test results show that all correlation coefficients between independent variables have a value of less than 0.8. Thus, there is no correlation between variables used to determine the factors that affect the adaptation of farmers to climate change.

c) Heteroscedasticity Test

The chi-square probability value of the Obs* R-square Breusch-Godfrey test shows a value of 0.3719. This value is greater than $\alpha = 10\%$, then H1 is rejected. The data used to determine the factors that affect the adaptation of farmers to climate change is homoscedasticity data.

Table 3. Factors that affect the adaptation of farmers to climate change in Bejiharjo Village in 2018

Variable	*Expected sign*	Coefficient	Probability
Constant	+/-	-1.26	0,4256
log (head of household age)	+	-0,15	0,5218
log (head of household education)	+	0,04*	0.0633
log (productive family members)	+	0,25*	0.0532
log (farm contribution)	+	-0,23***	0.0087
log (perception)	+	0,60**	0.0241
log (number of sources of information)	+	-0,02	0.1514

log (number of irrigation sources)	-	0,56***	0.0004
dummy credit access	+	0,36	0.1810
R-squared		0.7400	
Adjusted R-squared		0.6496	
F-statistic		8.1853***	

*** = significant at α=1%, ** = significant at α=5%, * = significant at α=10%

Source: Primary Data Analyzed in 2019

a) F test

The probability value of F-statistic is 0.0000. This value is smaller than α = 1%, so H0 is rejected. The age of the head of the household, the education of the head of the household, the number of productive household members, the contribution of farm income, perceptions, information sources, water sources, and access to credit all have a significant effect on the amount of adaptation of farmers.

b) t test

1) Education of the head of household

The head of the household has a vital role in the household, including in decision making. The longer the education of the head of the household can be an indicator of the more information, knowledge and development of reasoning they have, including those related to climate change (Deressa et al., 2009).

2) Number of productive household members

The number of productive household members can be related to the availability of labor in the family. There is an increasing number of available family workers, more and more adaptation strategies that can be worked on will also be available (Deressa et al., 2009).

3) Contribution of farm income. Contribution of farm income

Farming shows the percentage of farm income to total household income. The regression test results show the opposite of some research results and sources regarding farm income with adaptation to climate change (Audirac, 1997; Wani et al., 2013; Abid et al., 2016). However, these results can be caused by Bejiharjo Village farmers who are subsistence farmers so that the adaptation action taken is more influenced by social factors (Acosta-Michlik & Espaldon, 2008).

4) Perception

Farmers 'perceptions can be linked to farmers' knowledge of the risks and negative impacts of climate change, especially in farming. That way, farmers who have strong perceptions can take various actions. These actions can be in the form of prevention and control of farm losses, especially due to the impact of climate change (Li et al., 2012; McDowell et al., 2012).

5) Irrigation water sources

The more irrigation water sources, the less adaptation that farmers should do (Deressa et al., 2009; McDowell et al., 2012). However, in the case of rainfed land such as the majority of land in Bejiharjo Village, increased watering is a very vital adaptation to overcome drought, especially during the dry season. The available irrigation sources if it is increasing can also increase certain adaptation measures, namely increased watering (Niles et al., 2015; Ahmadaali et al., 2018; Trbic et al., 2018).

DISCUSSION

This research focuses on perceptions and adaptation as well as the factors that influence the adaptation of farmers to climate change. The results of farmers' perceptions of climate change have some similarities with research on farmers in the Nile Basin of Ethiopia, namely by feeling weather anomalies, erratic rainy season, prolonged dry season, explosion of pests and plant diseases (Deressa et al., 2009). In addition, in 2019 there was also La-Nina so that the perception of farmers in the research location showed that they had the highest perception of rising air temperatures and it was difficult to determine the planting period.

The adaptations carried out by farmers vary depending on the factors that influence it. In this study, adjusting planting time was the most widely practiced adaptation for farmers. These results are similar to the results of previous studies, except that our results indicate that the significant factors in determining the adaptation of farmers are the education of the head of the household, the number of family members, the percentage of farm income contribution, the perception, and the number of irrigation sources. These results are not much different from previous studies that were used as references (Pouliotte et al., 2009; McDowell & Hess 2012).

CONCLUSION

Farmers in Bejiharjo Village have a strong perception of climate change. Based on the indicators of climate change factors and the impact of climate change on farming, the increase in air temperature and difficulty in predicting the planting period are the sub indicators most felt by farmers.

All farmers in Bejiharjo Village make an adaptation. The most widely used adaptation strategy is adjusting the planting time, which is 90.63%. The factors that influence the number of farmers' adaptation strategies to climate change are the education of the head of the household, the number of productive household members, perceptions and sources of irrigation water with positive values. Another factor that has a negative effect is the contribution of farm income.

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