Agribusiness Journal
http://usnsj.id/index.php/AJ
journalagribusiness@gmail.com
e-ISSN : 2548-2211, p-ISSN : 2548379X

DOI : https://doi.org/10.31327/aj.v7i2.2259

Adaptation Patterns of Corn Farmers to Climate Change

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Abstract

The extreme climate change on the earth's surface in recent years is a serious issue. The agricultural sector has been affected by climate change because it causes crop failure and decreases crop productivity, especially food crops, namely corn. The climatic conditions of the Takalar Regency are generally characterized by high rainfall and drought, particularly at dry times. The purpose of this study is to: (1) Analyze the opinions of corn farmers; (2) Analyze the adaptation pattern of corn farmers; and (3) Analyze the factors that influence the adaptation pattern of corn farmers. The first and second objectives were analyzed quantitatively, and the third objective was analyzed using ordinal logistic regression. The results on 39 farmers being interviewed showed that (1) Corn farmers' opinions regarding changes in temperature, rain intensity, drought have increased in recent years; (2) Adaptation patterns carried out by corn farmers in facing climate change are improving water management, soil management technology, integrated pest control, changing cropping patterns, and adjusting planting time; (3) Factors that affect the pattern of adaptation of corn farmers to climate change are land area, number of dependents of the household head, income, and access to information on climate change.
Keywords: climate change, adaptation patterns, corn farmers, logistic regression.

A. Introduction

Climate change is a global problem that has become an issue in many places in recent years. On the other hand, agriculture must meet the increasing global demand for food (Roy, et al., 2023). People's understanding of changes in natural conditions is quite varied, ranging from a very simple understanding of climate change that is felt every day to a very detailed understanding using various scientific references. Climate change is caused by characteristic forms of internal and external forces, especially human-centred activities that continuously exploit natural resources which then change land use and atmospheric composition (Herminingsih, 2014).

Examples of serious climate change on the planet today, especially in Indonesia, include changes in rainfall, increasingly extreme climates, rising air temperatures, and rising sea levels. Because agriculture is very dependent on nature, farmers must be able to adapt well (Maponya & Mpandeli, 2021). Farmers can mitigate these impacts through knowledge, understanding and adaptable actions (Rasmikayati, et al., 2017). The factor that will make farmers better prepared to face the pressures and risks posed by climate change is adaptability, which will encourage farmers to adapt individually and collectively. Farmers can adjust and adapt to several conditions, which can be done by themselves or collectively to reduce the negative impacts of climate change.

South Sulawesi, especially Takalar Regency, is one of the corn producers in Indonesia. However, climate change is greatly affecting corn productivity. The rainy season has a significant

impact on the climate of Takalar Regency, generally consisting of a relatively high number of days and rainfall. These conditions influence the wind cycle, which can change at any time, especially during dry periods (Maponya & Mpandeli, 2021). This weather causes farmers to be unable to carry out their farming activities smoothly. Research on how farmers adapt to climate change in Indonesia, especially concerning food crops, is still rarely conducted. Although this issue requires regular review, the limited and incomplete research on climate change conducted by several research institutions means that the results cannot provide suggestions for policy formulation by relevant stakeholders.

B. Methodology

1. Farmers' Opinions Regarding Climate Change

The first objective was analyzed quantitatively and descriptively. Descriptive analysis is carried out to describe and measure the characteristics of a social phenomenon and simply aims to describe the variables to be measured (Lail & Suryanto, 2020).

Farmers were asked their opinion regarding climate variables that have changed over the last 5 (five) years, such as temperature, rain intensity, drought/prolonged drought, and flooding, where there were responses in the form of increasing, decreasing or not changing. After that, the percentage was recorded and calculated.

2. Farmers' Adaptation Patterns

The second objective is to analyze farmers' adaptation patterns to climate change and quantitative descriptive analysis is also used. Here we see farmers' efforts to deal with climate change and the negative impacts on their corn farming. Adopted from research results by Turasih, et al. (2016), the forms of farmers' adaptation in facing climate change are creating irrigation and drainage channels, changing planting patterns, adjusting planting times, changing techniques for controlling plant pest organisms, and changing land processing techniques.

3. Factors that Influence Farmers' Adaptation Patterns

The ordinal logistic regression method was applied to determine the factors that influence the adaptation patterns of corn farmers in facing climate change. Predicting at least two independent variables from one ordinal scale dependent variable can be checked using this relationship analysis method (Lail & Suryanto, 2020). The independent variables measured in this research are education, age, number of dependents of the head of the family, area of farming land, and farming experience. Apart from that, there are also economic aspects in the form of income, access to credit, social aspects in the form of access to climate change information, frequency of counselling related to climate change, as well as institutional aspects in the form of involvement in farmer groups, and frequency of discussions about climate change. The ordinal logistic regression formula is presented as follows:

$$Logit(\mathrm{Y}_1) = \log\left(\begin{matrix}\mathrm{Y}1\\ 1-Y1\end{matrix}\right)$$

C. Findings and Discussion

1. Respondents' Characteristics

The characteristics of a respondent can provide information regarding the condition of their farming business, especially in terms of production. The different characteristics show the diversity of the respondent farmers. The distribution of sociodemographic characteristics is summarized in Table 1.

Table 1. Distribution Respondent Characteristics in Sanrobone Village, Sanrobone District, Takalar Regency, 2022.

Variable	Number of Respondents	
	(n=39)	(%)
Education level		
Elementary	26	66.67
Junior High School	8	20.51
Senior High School	5	12.82
Age (years)		
36-43	11	28.2
44-51	24	61.53
52-59	4	10.25
Farming experience (years)		
15-19	13	33.33
20-24	25	64.10
25-28	1	256
Farmland area (ha)		
0.25-1	34	87.18
>1-1.75	3	7.70
>1.75-2.5	2	5.12
Household head's family dependents (person)		
1-2	8	20.51
3-4	15	38.46
5-7	16	41.02

Source: Primary data analysis (2022)

Table 1 provides information regarding the characteristics of the farmer respondents. Most of the respondent's educational level is Elementary. Furthermore, the average age was 44-51 years old, and they were experienced in farming for about 20-24 years. Several studies have found that age is directly related to measurements of adaptation to climate change. Older farmers have experienced much and are expected to adapt better to climate change compared to younger farmers. On the other hand, younger farmers have more mature and long-term planning abilities to respond to the climate (Zama et. al., 2021).

The average land area owned by farmers is between 0.25 to 1 hectare. The land area has a positive and significant relationship with most adaptation strategies. This means that as the size of agricultural land increases, the possibility of carrying out integrated planting such as intercropping and polyculture also increases (Belay, et al., 2017). The number of family dependents was 5-7 people. Adaptation to climate change is higher in larger households compared to smaller households. Households with a larger number of members have greater income contributions so their tendency to survive climate change is better (Ndamani & Watanabe, 2016).

2. Farmers' Opinions on Climate Change

Climate change has recently been felt by corn farmers throughout Sanrobone Village. This can be seen from the impact of climate change, such as a decrease in corn production both quantity and quality, as well as drought during the dry season in Sanrobone Village. The majority of

problems in dry land are water supply and soil fertility (Barokah, et al., 2015). Below are the opinions of respondent farmers regarding climate change in recent years.

Table 2. Farmers' Opinions on Climate Change

No	Statement	Total Score	Category
1.	Temperature changes	113	Increase
2.	Rain intensity	117	Increase
3.	Drought	98	Increase
4.	Flood potential	67	Not changed
	Jumlah	395	Increased

Source: Primary data analysis (2022)

Table 2 presents data recapitulating farmers' opinions regarding climate change. Variables measured related to climate change are changes in temperature, rain intensity, drought/prolonged drought and potential for flooding. All in all, farmers said that the changes in the climate seen by four variables were increasing. Different farmers' opinions regarding the changes that occur in each climate component are based on the experiences felt by each individual or in other words referred to as empirical experience (Sugihardjo, 2016).

3. Adaptation Patterns of Corn Farmers to Climate Change

Farmers cannot accurately predict cropping patterns as a result of climate change. Because if farmers make wrong predictions, production will decrease or even crop failure will occur. Until now, farmers have always relied on previous knowledge or experience. In Sanrobone Village, many corn farmers have implemented several adaptation patterns in dealing with climate change.

Table 3. Adaptation Patterns of Corn Farmers to Climate Change

No	Variable	Total Score	Kategori
1.	Improvement of water management	345	Currently doing
2.	Development of soil processing technology	107	Currently doing
3.	Integrated pest management	202	Ever done
4.	Changing planting patterns	317	Currently doing Currently
5.	Adjusting planting time	106	doing

Source: Primary data analysis (2022)

a) The first pattern of adaptation of corn farmers to climate change is by improving water management. The indicators measured here are optimizing irrigation channels, conserving water by harvesting/storing rainwater, and utilizing groundwater using water pump technology. Rainfall patterns have changed as a result of climate change which has reduced surface water availability and decreased water quality. Corn fields in Sanrobone Village rely on irrigation from rainwater during the rainy season which is collected in water reservoirs and farmers also have drilled wells to water their plants. Farmers can no longer rely on rain-fed irrigation systems due to climate change, in fact, more than 80%, of this phenomenon often results in water scarcity (Belay, et al., 2017). Ways to face climate change is by improving irrigation and increasing the possibility of using alternative water sources utilizing water pump technology (Rasmikayanti, et al., 2017).

b) The majority of farmers still cultivate the land using traditional systems. Some farmers burned crop residues during the corn planting season to add soil nutrients. Efforts to improve soil nutrients using organic materials have been demonstrated by farmer respondents with a total score of 107, meaning farmers are making changes to the way they cultivate the land. The addition of organic matter provides improvements in organic C, CEC (Cation Exchange Capacity) and soil pH (Wirawan, 2018). Furthermore, mulching techniques can reduce labour use in land processing, especially during the dry season (Zama, et al., 2021).

c) Corn production has decreased due to increasing pest attacks. The majority of farmers claimed that armyworms were to blame for most of the attacks. Therefore, this must be anticipated as soon as possible to prevent severe damage. Surya and Rubiah (2016) state that natural enemies or predators can help control pests without damaging the environment compared to using pesticides. Seed treatment is one change that many farmers have made to control armyworms. There are chemical and non-chemical approaches to this. Before planting, the seeds are chemically mixed with the pesticide fenite, while the non-chemical method uses soapy water. Currently, farmers are reducing the suitability of the pest ecosystem by carrying out sanitation. Living plant remains, plant parts affected by pests, dead plant remains, other plants that can become hosts, and leaves that have fallen to the ground are the targets of sanitation procedures (Inayati & Marwoto, 2015; Kabeakan, et al., 2022).

d) One effort that can be made to increase corn production is through diversification, especially on dry land, which can be done through intercropping, rotation, or alley planting methods. The majority of farmers in Sanrobone Village apply an intercropping (*tumpangsari*) planting pattern. Farmers usually plant chillies or beans next to corn. On dry land, intercropping can maintain soil moisture and constant water content, reduce erosion, and increase nutrients in the soil (Syafi'i, et al., 2017).

e) Farmers also use crop rotation consisting of planting rice-corn or rice-corn-corn every one to two years. Other than that, farmers also switch from a single cropping pattern to a *legowo* planting system as a response to climate change. It is said that the row spacing of *jajar jegowo* can overcome climate change. This planting pattern produces twice the production of regular planting distances, and can also be used to adapt to climate change (Amran & Husain, 2020).

f) The phenomenon of climate change has a significant impact on both the rainy and dry seasons, including on corn fields. The farmers' strategy for anticipating climate change is to use a planting calendar. If there is a decline from normal conditions, it has the potential to cause drought. Utilizing drought-tolerant varieties is one strategy to prevent a decline in corn productivity. Other than that, increased rainfall has the potential to cause flooding. Corn is a type of plant that does not like flooding because it makes it more difficult for plants to aerate and breathe (Herlina & Prasetyorini, 2019).

4. *Factors that Influence Corn Farmers' Adaptation Patterns to Climate Change*

Regression Model

The results of parameter estimation for the ordinal logistic regression model on the influence of several factors on the adaptation patterns of corn farmers in facing climate change are shown in the following table.

Table 4. Parameter Estimate

							95% Confidence Interval	
		Estimate	**Std. Error**	**Wald**	**df**	**Sig.**	**Lower Bound**	**Upper Bound**
Threshold	[Y = 1]	12.975	8.993	2.081	1	.149	-4.652	30.601
	[Y = 2]	4.887	12.067	.164	1	.685	-18.763	28.537
Location	X1	-.042	.147	.080	1	.778	-.330	.247
	X2	2.627	1.795	2.143	1	.143	-.891	6.144
	X3	.256	.320	.638	1	.424	-.372	.883
	X4	11.216	5.071	4.893	1	.027	1.278	21.155
	X5	.944	.480	3.864	1	.049	.003	1.885
	X6	1.252	5.448	5.282	1	.022	1.562	4.984
	X7	-5.285	9.614	.302	1	.583	-24.128	13.558
	X8	2.337	1.580	2.188	1	.013	-5.434	.760
	X9	.673	1.533	.193	1	.661	-2.332	3.679
	X10	-1.870	1.617	1.337	1	.248	-5.039	1.299
	X11	1.362	1.142	1.424	1	.233	-.876	3.601

Based on the output above, the ordinal logistic regression model is as follows.

Logit (Y_1) $= \log (Y_1/(1-Y_1))$

$= 12.975 - 0.042X_1 + 2.627X_2 + 0.256X_3 + 11.216X_4 + 0.944X_5 + 1.252X_6 - 5.285X_7 + 2.337X_8 + 0.673X_9 - 1.870X_{10} + 1.362X_{11}$

Logit (Y_2) $= \log (Y_2/(1-Y_2))$

$= 4.887 - 0.042X_1 + 2.627X_2 + 0.256X_3 + 11.216X_4 + 0.944X_5 + 1.252X_6 - 5.285X_7 + 2.337X_8 + 0.673X_9 - 1.870X_{10} + 1.362X_{11}$

Statistical t-test

The t-test results in this research are presented in Table 4 and can be explained as follows. Four variables significantly affect the adaptation patterns of corn farmers in facing climate change, namely land area (X4), number of family dependents (X5), income (X6), and access to information regarding climate change (X8).

a. The regression coefficient value is 11.216 for land area meaning that farmers who have wider agricultural land are 11.216 times more likely to be able to adapt to climate change. This is by (Lail & Suryanto, 2020) that land area influences farmers' decisions to adapt to climate change positively and significantly.
b. The results of the ordinal logistic regression estimation show that the variable number of dependents of the head of the family has a significant effect with a significance value of 0.049. This means that the greater the number of dependents, the more likely the farmers to adapt to climate change by 0.944 times. The research results show that the possibility of adaptation to climate change is higher with large household sizes compared to small households. Likewise, the observed tendency of larger households to adapt to climate change may be due to their higher labour contribution (Ndamani & Watanabe, 2016).
c. The regression coefficient value of income is 1.252 meaning that the greater the income of corn farmers, the greater their tendency to increase their adaptation patterns to climate change by 1.252 times. Previous research by Ndamani & Watanabe (2016) found that farmers with higher incomes are more likely to use adaptation practices in response to climate change than farmers with lower incomes.
d. The regression coefficient value about access to information about climate change is 2.337 means that the better access corn farmers have to information about climate change, the greater their probability of adapting patterns to face climate change by 2.337 times. Research by Mabe, et al. (2014) suggests that access to climate information is one of the factors that influences farmers in adopting patterns of adapting to climate change. Farmers can obtain similar information from their involvement in a farmer group (Raya, et al., 2017).

D. Conclusion

Corn farmers' opinions regarding changes in temperature, rain intensity, prolonged drought/drought, and potential for flooding in Sanrobone Village have increased in the last few years. Regarding climate change, farmers are implementing adaptation patterns by implementing improved water management, developing soil processing technology, integrated pest control, changing planting patterns, and adjusting planting times. Factors that influence corn farmers' adaptation patterns to climate change are land area, number of family dependents, income, and access to information.

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