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ANALYSIS OF CLIMATE CHANGE VULNERABILITY OF RICE FARMERS IN ACEH UTARA DISTRICT

Maulana Irham*, **Azhar**, **Romano**
Study Program of Agribusiness, Faculty of Agriculture, Syiah Kuala University, Aceh, Indonesia
*E-mail: irhammaulana.msi@gmail.com

ABSTRACT
Climate change's impact on Indonesia's agricultural sector is now increasingly felt. The potential danger of climate change for the agricultural sector is the decline in rice production. District Aceh Utara, the most extensive rice production center in Aceh Province, has a high hazard potential and is one of the criteria for Regional Vulnerability and a High District/City Disaster Risk Index (IRBI). This study aims to determine the level of vulnerability to climate change on the income of rice farmers in District Aceh Utara. This study involved 100 farmers in Baktiya and Lhoksukon sub-districts who were determined using the multi-stage Stratification Random Sampling Technique. The data analysis technique used is the vulnerability level analysis model. The results showed that rice farmers in Aceh Utara District tended to be at a low level of vulnerability. Rice farmers in District Aceh Utara could maintain and save their farms from the stress of climate change.

KEY WORDS
Adaptive capacity, climate change, exposure, rice farmers, sensitivity, vulnerability.

The impact of climate change on the agricultural sector in Indonesia is now increasingly felt. Prolonged dry seasons, changing rainfall patterns, rising temperatures, and widespread floods are indications that climate change is happening. The agricultural sector is a vital sector that supports the Indonesian economy, where there are more than 40 million Indonesians who depend on jobs in the agricultural sector will be affected by climate change. The existence of climate change is a challenge, and a severe threat, especially for residents who have livelihoods as rice farmers. The impact will then impact the threat to the food security of a (Government of Republic of Indonesia, 2007).

Climate change is a significant threat to rice farmers because there are still many rice farmers who rely only on rainfall in their rice farming. Rainfed agriculture is particularly vulnerable to climate change risks, where any shift in rain or increase in temperature can pose a significant risk to farmers through their impact on growth, development, and crop yields. In the past few years, the rainy season has shifted the planting season and harvest time for food commodities. Floods and droughts that have become more frequent have caused many food commodities to experience crop failure and resulting in nothing being produced (puso) (Ruminta et al., 2018).

Agricultural activities are constantly faced with situations where risk and uncertainty always accompany them. If farming methods do not change, climate change will cause vulnerability, especially rainfed agriculture. Limitations of farmers' mastery of the climate and the environment in farming often confront farmers with the problem of uncertainty about the results of their farming. Climatic problems, such as prolonged drought, erratic rainfall patterns, the difficulty of handling unexpected attacks of pests and diseases, and increasingly widespread natural disasters, are part of the risks and uncertainties faced by rice farmers today. Efforts to minimize the impact of climate change must be carried out to reduce the impact faced by rice farmers and maintain food stability. By assessing the impact of climate change on rice farmers by analyzing the level of potential hazards, vulnerabilities, and risks (Metternicht et al., 2014), farmers will be able to assist farmers in determining decisions to be taken to defend their farming from climate change.

(Bappenas, 2021) states that the potential danger of climate change in Indonesia for the agricultural sector is a decrease in the production of rice food crops. The impact of climate change in question is the potential for changes in plant growth due to rising temperatures and changes in rainfall (climate that is no longer suitable), which results in decreased production yields. In addition to changes in plant physiology, decreased production yields can also be caused by drought, floods, and disruption of plant pests (OPT). Rice production is projected to decrease by >25% in the Provinces of Gorontalo, Maluku, and North Maluku until 2045. In the climate resilience improvement activities compiled by (Bappenas, 2021), there are climate resilience action intervention locations categorized into three priority levels, namely super priority, top priority, and priority based on the level of hazard, vulnerability, and disaster risk that has the potential to occur. *Super priority locations* have a high hazard potential and one of the Regional Vulnerability criteria and a high Indonesian disaster risk index (IRBI). *Top priority locations* are locations that have high hazard potential and have one of the Regional Vulnerability criteria or high IRBI. Moreover, priority locations are locations that have a high hazard potential.

Aceh is one of the provinces that have the most districts/cities that fall into the super-priority category. A total of 12 districts are classified as the super-priority category, three districts are classified as the top priority category, and four districts/cities are classified as priority categories (Bappenas, 2021). Aceh Utara, Pidie, Bireun, and Aceh Besar, the four largest rice-producing districts in Aceh Province, are classified as super priority categories. The decline in rice production in several districts/cities was also seen in 2020, including Aceh Utara, the largest rice production center in Aceh Province. In 2020 the total rice production in Aceh Utara District reached 388.2 thousand tons, which decreased compared to 2019. With an average rice production reaching 5.23 tons per hectare and a productivity of 4.91 tons per hectare (BPS Kabupaten Aceh Utara, 2019).

In the agricultural system, vulnerability to climate change is described as the level of the powerlessness of the scope of farming in carrying out the defense and saving its productivity level as an effort to deal with the impacts of climate change. Vulnerability to climate change is described as a condition that limits the ability to adapt optimally. The vulnerability is dynamic and directly proportional to technological prowess, socio-economic conditions, natural resources, and the environment (Balitbangtan, 2011).

IPCC (2012) in (Surmaini et al., 2017) describes vulnerability to climate change as consisting of three interacting factors, namely the duration and extent of exposure to climate change (exposure), the sensitivity of the system to climate change (sensitivity), and the capacity of the system to survive or recover from exposure (adaptive capacity). Exposure level describes the level of ease of the system to be adversely affected by climate change. The sensitivity level shows the internal system's vulnerability in facing the impacts of climate change. Moreover, adaptive capacity shows the ability of the system to adapt to climate change so that it can minimize the destructive impacts and optimize the existing good impacts, or is the capacity to cope with the impacts of climate change that occur (Boer (2015) in (Estiningtyas et al., 2018).

METHODS OF RESEARCH

Aceh Utara District was chosen as the research location because of its role as the main rice producer in Aceh Province. Data were obtained through observation and interviews with rice farmers. This research involved 100 rice farmers in Aceh Utara District from two sub-districts selected through random weighting, with the requirements of the most significant number of rice planting areas and the highest rice productivity, namely Baktiya and Lhoksukon Districts. The sampling technique used to summarize farmer respondents was carried out using a purposive side method based on respondents who felt climate change was occurring. So, 60 farmers were from Baktiya District, and 40 other respondents were from Lhoksukon District. The sample was selected taking into account the rice farming households that will experience the impacts of climate change and those that are vulnerable to climate change.

The indicators used to measure the vulnerability of rice farmers to climate change are adapted from (Chen et al., 2010) with transformation. Each indicator has a scaled score, where there is a "bad" value scale to a "good" value scale. Table 1 below presents indicators of vulnerability and scores used as an assessment of farmers' vulnerability to climate change.

Table 1 – Indicators of vulnerability level

Vulnerability Dimension	Indicator	Score
Exposure	Types of rice varieties	0;1;2;3
	Origin of rice varieties	0;1;2;3
	Number of family dependents	0;1;2;3
	Intensity of pest and disease attacks	0;1;2;3
Sensitivity	Total labor costs in one growing season	0;1;2;3
	The total cost of agricultural inputs in one growing season	0;1;2;3
	Lost selling price	0;1;2;3
	Total income in one growing season	0;1;2;3
Adaptive capacity	Age	1;2;3
	Experience	1;2;3
	Working hours	1;2;3
	Land area	1;2;3
	Irrigation conditions	1;2;3
	Off-farm income	1;2;3

Calculations for the level of vulnerability of rice farmers in Aceh Utara District to climate change are carried out using the formula adapted and transformed by (IPCC, 2001) and (Ru Minta, 2007) as follows:

$$V_i = \frac{\bar{E}_i \times \bar{S}_i}{\overline{AC}_i};\ \overline{AC}_i \neq 0 \qquad (1)$$

Where V_i: level of vulnerability of farmers-i to climate change; $\bar{E}_i$: level of exposure (average exposure score) of farmers-i to climate change; $\bar{S}_i$: level of sensitivity (average sensitivity score) of farmers-i to climate change; $\overline{AC}_i$: level of adaptation capacity (average adaptive capacity score) of farmers-i to climate change.

The results of the calculation of the level of vulnerability will be classified based on the value obtained from the previous formula. The classification of vulnerability level to climate change is attached below:

Table 2 – Classification of vulnerability levels

Climate Change Vulnerability Level	Category
$0 \leq V_i \leq 1$	Low
$1 < V_i \leq 2$	Medium
$2 < V_i \leq 3$	High

Source: Saefudin et al., 2021.

RESULTS AND DISCUSSION

The level of vulnerability describes the degree of ability of rice farmers in Aceh Utara District to anticipate, overcome, maintain survival, and save themselves from the impacts caused by climate change on their rice farming. The level of vulnerability results from the interaction of three components of vulnerability: exposure, sensitivity, and adaptive capacity.

Exposure illustrates the level of exposure experienced by rice farmers due to climate change. Exposure can present as a long-term change. The exposure indicators in this study relate to the type and origin of the rice varieties used by farmers, the intensity of pest/disease attacks, and the number of dependents in the family. Table 3 shows the exposure level of rice farmers in Aceh Utara District, where it founds that the majority of rice farmers in Aceh

Utara District had a low level of exposure, namely 43% of farmers. However, 21% of farmers also had a high category, and 36% of rice farmers had a medium category.

The high level of exposure obtains due to the high intensity of pest and disease attacks on the rice plants of the farmers. The high intensity of pest and disease attacks is a severe problem due to the need for more knowledge among farmers regarding appropriate pest and disease control. The control that rice farmers in Aceh Utara District have carried out still relies on knowledge obtained from circulating general knowledge or in ways passed down from generation to generation. Climate change has pushed living things to continue to adapt, and improper control treatment will result in pests and diseases becoming resistant, making them increasingly difficult to handle. With the control method that farmers have carried out so far, it fears that rice farming in Aceh Utara Regency will become more vulnerable due to pests and diseases that are not controlled. Pests that are difficult to handle will be a big problem for rice farming. Uncontrolled attacks of pests and diseases will reduce yields for farmers so that the welfare of farmers becomes threatened.

The number of dependents of rice farming families in Aceh Utara District is, on average, 3-4 people. The more the farmer must bear the number of family members, the more vulnerable the farmer will be. With a decrease in the amount of income earned and with no other work outside of farming or other family members who support the farmer's household, climate change will undoubtedly impact the farmer's household.

Table 3 – Level of climate change exposure to farmers in Aceh Utara District

Climate Change Exposure Rate	Frequency	Percentage
$0 \leq E_i \leq 1$ (Low)	43	43%
$1 < E_i \leq 2$ (Medium)	36	36%
$2 < E_i \leq 3$ (High)	21	21%
Total (n)	100	100
Maximum	2.75	
Minimum	0,25	
Average	1,32	

To reduce the exposure that farmers will face due to climate change, matters related to handling pests and diseases in rice plants. It is necessary to pay attention to the use of rice varieties and their origin, as well as the number of dependents in the farmer's family. Optimizing the use of superior and certified seeds and being able to adapt to climate change to minimize the decrease in rice productivity (Firdaus et al., 2020) and suppressing the spread and attack of pests and diseases by applying appropriate and adaptive handling technologies to climate change (Widiarta, 2016). Moreover, maximizing the capacity of small farmers to increase family income to improve the family's standard of living (Aminah, 2015).

The level of sensitivity describes the level of sensitivity of the farming system in dealing with climate change. Sensitivity is an aspect of farming that is directly vulnerable to climate change. Indicators of the sensitivity of rice farmers to climate change are related to production factor costs, such as labor costs, input costs, lost selling prices, and rice farming income.

Table 4 shows that most of the sensitivity levels of rice farmers in Aceh Utara District to climate change are in the moderate category, namely 56% of rice farmers. While the remaining 31% of rice farmers have a moderate level of vulnerability, and 13% are in the high category.

The success of rice farmers in farming will undoubtedly be influenced by climate change which reflects in their income. The severity of the impacts caused by climate change is indicated by reduced productivity, decreased yield quality, and crop failure. The decline experienced undoubtedly has implications for the income of rice farmers. The level of sensitivity of rice farmers in Aceh Utara District to climate change in the medium and high categories indicates that there are still many farmers who face the problem of inefficient production costs for their rice farming and need better market access.

The level of adaptive capacity can be interpreted as the level of ability of rice farmers to adapt to climate change. Indicators of rice farmers' adaptive capacity to climate change

consist of farmer age, farmer education level, farming area, working hours, land irrigation conditions, and farmer income outside of rice farming. Table 5. shows the level of adaptive capacity of rice farmers in Aceh Utara District in the low and medium categories. In each vulnerability category, 77% of farmers are in a low category and 23% in the medium category.

Table 4 – Level of sensitivity to climate change among farmers in Aceh Utara District

Climate Change Sensitivity Level	Frequency	Percentage
$0 \leq S_i \leq 1$ (Low)	31	31%
$1 < S_i \leq 2$ (Medium)	56	56%
$2 < S_i \leq 3$ (High)	13	13%
Total (n)	100	100
Maximum	2.75	
Minimum	0.00	
Average	1,33	

The low adaptive capacity of rice farmers in Aceh Utara District is due to the need for paddy fields and irrigation that reaches the rice fields owned by farmers. The average area of paddy fields owned by rice farmers in Aceh Utara District is < 1 ha. A minor land area will affect the amount of rice production obtained by these farmers, which will also impact the income earned. Most of the rice farmers in Aceh Utara District have no income outside of the rice farming they run. Therefore, it will increase the level of exposure due to climate change. Most of Aceh Utara Regency's rice fields are still rainfed. Rainfed rice fields have a high level of exposure to climate change. Rainfed rice fields significantly depend on climatic factors; shifts in rainfall patterns and erratic seasonal changes will impact farming activities in rainfed rice fields. Paddy fields are vulnerable to drought, impacting the low productivity of rice plants in the Aceh Utara District.

Table 5 – Level of adaptation capacity to climate change in rice farmers in Aceh Utara District

Level of Climate Change Adaptation Capacity	Frequency	Percentage
$0 \leq AC_i \leq 1$ (High)	0	0%
$1 < AC_i \leq 2$ (Medium)	23	23%
$2 < AC_i \leq 3$ (Low)	77	77%
Total (n)	100	100
Maximum	2.67	
Minimum	1,50	
Average	2,22	

Referring to (Saefudin et al., 2021), if the level of adaptive capacity possessed by rice farmers is more significant, then the level of vulnerability due to climate change that rice farmers will face will decrease. The number of farmers who have a high level of adaptation will reduce the number of farmers who have a high level of risk of vulnerability to climate change. Actions that can be taken to increase the adaptive capacity of rice farmers in Aceh Utara District include: conducting farmer regeneration from farmers who are no longer productive to productive age farmers, conducting more farmer training to increase farmer knowledge, increasing productivity land, adding and improving existing irrigation networks, and increasing side jobs for farmers outside their rice business.

Table 6 shows that 70% of Aceh Utara District rice farmers have a low vulnerability to climate change. This indicates that the risk faced by rice farmers due to climate change will decrease. Although the majority of rice farmers in Aceh Utara District have a low level of vulnerability, it should also be noted that there are 29% of rice farmers have a moderate level of vulnerability, and 1% of rice farmers have a high level of vulnerability.

According to (Murniati & Mutolib, 2020), climate change will impact the availability and accessibility of food, which, if not handled properly, can disrupt food security and increase the vulnerability of farming households. Research conducted by (Harvey et al., 2014) shows that small farmers are very vulnerable to experiencing shocks to their farming system. This is

because farmers who make the agricultural sector their main job field depend significantly on the agricultural sector. Food insecurity and extreme weather events cause loss of yields and income, causing farmers to be apprehensive.

Table 6 – Level of vulnerability to climate change in rice farmers in Aceh Utara District

Climate Change Vulnerability Level	Frequency	Percentage
$0 \leq V_i \leq 1$ (Rendah)	70	70%
$1 < V_i \leq 2$ (Sedang)	29	29%
$2 < V_i \leq 3$ (Tinggi)	1	1%
Total (n)	100	100
Maximum	2.02	
Minimum	0,00	
Average	0,78	

Efforts need to be made to reduce the level of exposure of rice farmers in Aceh Utara District by optimizing the aspects that are indicators of this level of vulnerability. By optimizing all existing aspects, it hopes that farmers can avoid risks due to climate change so that rice farmers in Aceh Utara Regency can maintain their households and farming.

CONCLUSION

Rice farmers in Aceh Utara District tend to be at a low level of vulnerability to climate change. Rice farmers in Aceh Utara District can maintain and save their rice farming from the grips of climate change. Optimization of vulnerability indicators needs to be done to reduce the vulnerability of rice farmers in the Aceh Utara District due to climate change. The government and related institutions can provide knowledgeable guidance and disseminate information about climate change to farmers through agricultural counseling and farmer schools. So that farmers understand the conditions they will face and farmers can determine the steps they must take to maintain their farming business.

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