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Research Article

Understanding Farmer Perception and Impact of Seasonal Climate Event on Rice Farming in Indonesia: Implication for Adaptation Policy in Local Level

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Abstract: The study aimed to understand how farmers perceive seasonal climate events (SCE) and assess the impact on farming and how farmers' attitudes and efforts to adapt in dealing with SCE. This study was conducted in Kuantan Singingi Regency, Riau Province, Indonesia, in August - December 2020. Total of 297 farmers was selected purposively to be interviewed. Descriptive statistics analysis was used to analyze socio-demographics, farm characteristics, the impact of SCE on rice production, and farmers' responses in adapting to SCE as an effect of climate change. Friedman's test was used to analyzed the importance of climate over other non-climate-related stressors. Ordinal regression analysis was performed for the determination of possible association of farmers' socio-demographics and farm characteristics to the perceived extent of SCE impact. Flood was the climatic factor that most often caused rice production failure. Farming experience, education, gender, farm size, cultivation period, rice varieties, land management, fertilization, rice field type, and farming purpose have a significant effect on farmers' perceptions of SCE impact. Adjusting the planting season, the use of chemical fertilizers, and controlling pests and diseases were the most dominant responses by farmers in dealing with SCE. Implications: The availability of weather information must be done massively, induction of flood-tolerant varieties needs to be carried out, female farmers with higher education and long experience in farming can be used as cadres as extension officers to farmer groups, planting twice a year was an option to increase rice production, the number of farmers get assistance from extension officers could be increased.

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1. Introduction

The earth's surface temperature has increased by 0.85°C over the last 100 years and is predicted to continue to increase by 1.5°C until the 21st century (IPCC, 2014). This condition causes climate change which has a negative impact on the agricultural sector, such as a decrease in cereal crops production and becoming more susceptible to disease and weeds (Asseng et al., 2011). This condition will certainly burden the agricultural sector in meeting global food needs, which are expected to double by 2050 compared to current needs (FAO, 2015). The agricultural sector, such as rice farming, is one of the sources of food and economy for people in developing countries in tropical climates. This condition causes many of these farmers to live in areas that are at high risk from the impact of climate change events, such as a change in seasonal climate events, which causes a decrease in rice yield. The condition of farmers in developing countries is also limited in facilities and knowledge, so that they have limited ability to respond to the impacts of climate change (Fierros-González and López-Feldman, 2021). Responding to these conditions, it is necessary to adapt efforts for rice farmers in the face of changes in seasonal climate events.

These adaptation efforts can be further realized in the line of policies. In making these policies, it is necessary to pay attention to farmers' perceptions of climate change as an effort to ensure that adaptation efforts can be implemented at the farmer level (Karki et al., 2020; Jha and Gupta, 2021). Many studies on rice farmers' perceptions of climate change have been carried out in developing countries in tropical climates (Mishra et al., 2018; Akhtar et al., 2019; Islam et al., 2020; Khan et al., 2021; Ojo et al., 2021). However, from the previous study that has been done, no one has examined the perception of rice farmers about climate change, such as seasonal climate events, to recommend as a basis for making policies on adaptation efforts for rice farmers at the local level. Mahfoud and Adjizian-Gerard (2021) state that there are several reasons why it is important to develop adaptation efforts in the agricultural sector based on local contexts, 1) climate change impacts are mostly manifested at the local level of a region, which affects activities and the economy, 2) vulnerability and capabilities adaptation systems in a given area are determined by local conditions which may be completely different from the national and regional levels, 3) adaptation activities are often better observed, measured and more effective at the local level. In addition, the perception of local farmers when combined with modern knowledge will strengthen farmers in facing climate change (Apraku et al., 2021). IPCC (2001), Sardar et al. (2019) and Singh, (2020) suggest that climate change management in the agricultural sector can run effectively if it is integrated at the local to national level.

Indonesia, like other developing countries in Southeast Asia, uses rice as a food crop and also as a source of income, where the agricultural sector accounts for 13% of the national gross domestic product (GDP). Of the 25 million farming households, 17 million are rice farmers with average land ownership of 0.6 ha (BPS, 2019). Indonesia, which is located in a tropical climate, is one area that is vulnerable to the negative impacts of climate change especially change in dry and wet season events. Yuliawan and Handoko (2016) report that in tropical countries such as Indonesia, every 1°C increase in temperature will reduce rice production by 11% on irrigated rice fields and 14% decrease in production on rainfed rice farms. Meanwhile, the Ministry of Agriculture (2018) reports that in Indonesia, there are approximately 8 million hectares of rice farming land, and only about 58.13% of the total land has irrigation infrastructure.

Responding to the threat of climate change, the Indonesian government created a National Action Plan (NAP) to mitigate risks and adapt to climate change as an effort to maintain rice production to fulfill national food needs. Policy recommendations for adaptation for rice farmers in Indonesia have been reported by Rondhi et al. (2019), but the policy recommendations given are for the national level, which still needs to be studied further to determine whether they can be adopted at the local level. In the NAP it was also stated that local governments need to plan and solve problems related to climate change problems at the local level (Ministry of Development and National Planning, 2019). Understanding farmers' perceptions at the local level can support the sustainability of a policy in the agricultural sector (Granco et al., 2022). In addition, a risk assessment of climate change at the local level will also facilitate the preparation of adaptation plans at the local level (Kirby, 2021; Sainz de Murieta et al., 2021). Based on the explanation above, this study aims to understand 1) how farmers perceive on seasonal climate events and assess the impact on farming, and 2) how farmers' attitudes and efforts to adapt in dealing with seasonal climate events. Then the perception and knowledge of farmers about seasonal climate events can be used as recommendations in making adaptation policies at the local level.

2. Material and Methods

2.1. Conceptual framework

The conceptual framework (Figure 1) was compiled from various literature sources to examine rice production systems in local contexts, namely small farmers at the individual or group level who are affected by climate change in the microenvironment of rice farmers (Mahfoud and Adjizian-Gerard, 2021). Climatic conditions that disrupt the agricultural environment will cause disruption of plant reproduction, physiological functions, and nutrient availability in the soil, which will then have an impact on production costs and production quantities (Li et al., 2015; Wang et al., 2018; Muehe et al., 2019; Mukamuhirwa et al., 2019). The framework refers to the idea that climate change impacts will be better determined from farmer perceptions of the events experienced related to the impact of the climate change on the rice farming system. In conveying the perceptions and events encountered, it is closely related to the conditions of socio-demographic and farm characteristics, cognitive factors, and experience processes (Xie et al., 2019). These farmer perceptions can be used as support for making policies related to climate change, behavioral intentions, and attitudes to address climate change (Sullivan and White, 2019).

Definition of perceptions referred to Wolf and Moser (2011) that perceptions were the views and interpretations of individuals on climate change issues based on beliefs, experiences, and understandings. In particular, we explore the experience of farmers to identify the impacts of climate change on rice production systems. Karki et al. (2020) suggest that the experience of farmers is important to be included in efforts to adapt to climate change; usually, farmers have different explanations and respond appropriately in dealing with climate change. Many researchers have shown that people attribute climate change to their personal experiences of an increased occurrence of extreme weather events and perceive this risk to be related to climate change (Carlton et al., 2016). Therefore, this study focuses on understanding possible adaptation responses to climate change through farmers' experiences of what they perceive about climate change and its associated impacts.

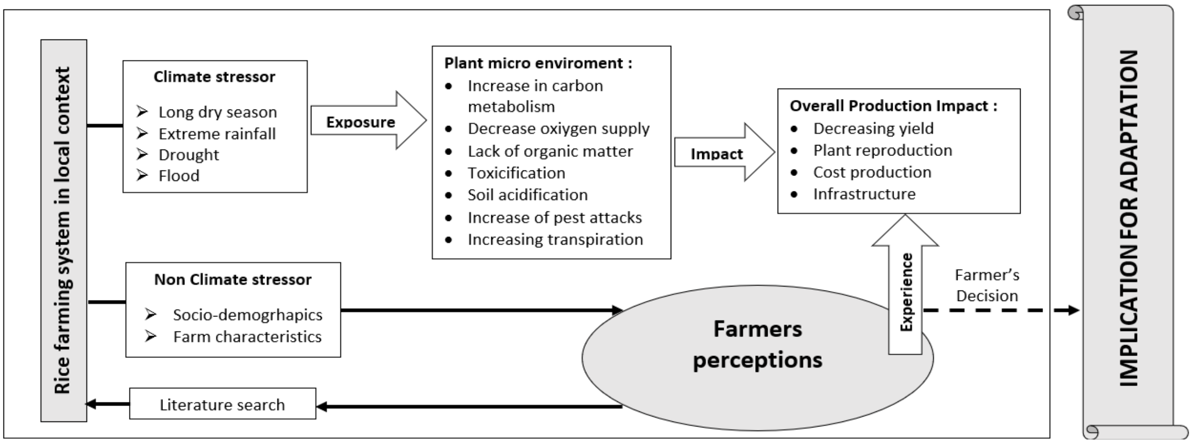

Figure 1. Conceptual framework linking farmers' perceptions on climate change risk, perceived impacts and adaptation behavior.

2.2. Study area and data collection procedure

This study was conducted during August - December 2020 at 22 villages spread over ten sub-districts along the Batang Kuantan river, which was located in Kuantan Singingi Regency, Riau Province, Region of Sumatra island, Indonesia. The ten sub-districts were Kuantan Mudik, Gunung Toar, Kuantan Tengah, Sentajo Raya, Benai, Pangean, Kuantan Hilir, Kuantan Hilir Seberang, Inuman, and Cerenti (Figure. 2). The reason for choosing this location as the study area was because, first, this area was an agricultural area that was dominated by rice farming because the soil conditions are quite fertile. The second reason, although this area has fertile soil, since 2011-2018 it has always experienced flooding during the peak of the wet season due to the overflowing of the Batang Kuantan river (BPS Riau, 2019), however during the dry season, the rice farms also experienced a drought. The third reason was that study on rice farmers' perceptions of climate change in Indonesia was mostly carried out on the Java island, which was dominant in rice farming (Rondhi et al., 2019), but in marginal areas such as on the Sumatra island, it was still rarely done, even though rice farming in the tropics was equally important in supplying food needs.

Collecting the data was used a structured questionnaire which was administered through face-to-face interviews with Farmers. Total 1245 farmers were registered in the village farmer group. From the list of farmer groups, a total of 297 farmers were selected purposively to be interviewed. Interviews were conducted on the farms when the farmers rested after working. The interviews were carried out by surveyors who had been trained beforehand. The survey was conducted in Indonesian and then translated into English.

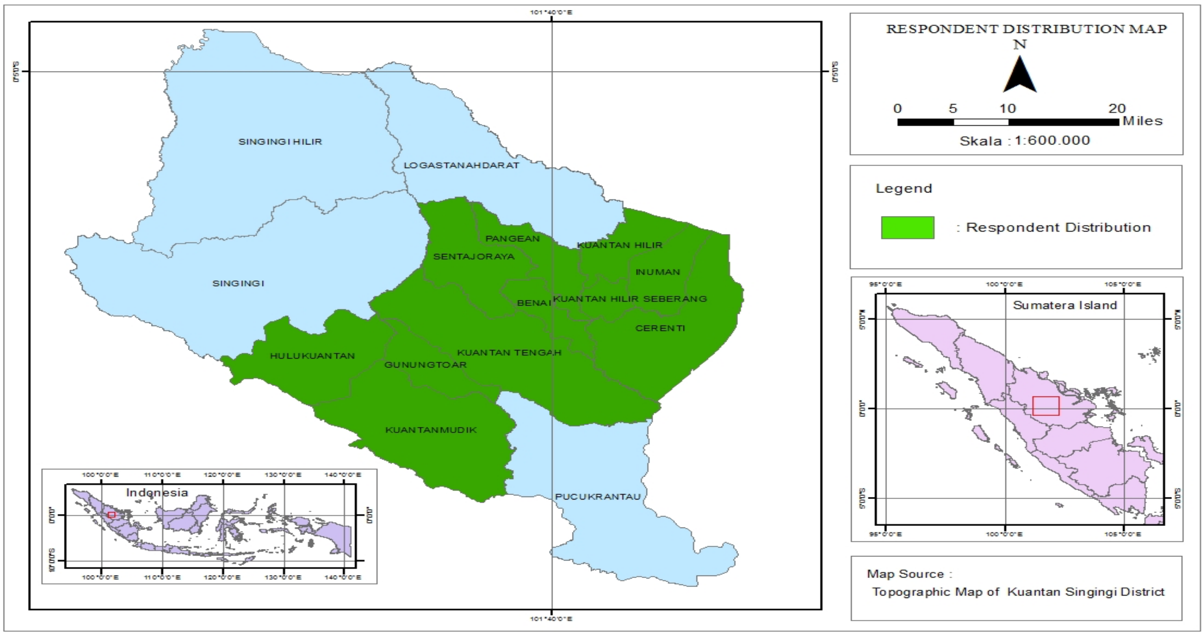

Figure 2. Map of the study area showing location and respondents distributions.

2.3. Questionnaire

The proposed questionnaire consists of 3 parts with closed questions: 1) socio-demographic characteristics and rice farming system, 2) perceptions about climate change in general, 3). Perceptions of the impact of floods and droughts due to climate change on rice production. Open questions for farmers' responses in mitigating and adapting to climate change. Perception data was collected by asking respondents whether they know about climate change and how the climate conditions are; they were asked about the perceived changes in seasonal climate events patterns in the last 5 years (2016-2020) with categorical answers ("no change", "changed"). The effects of seasonal climate events were compared with other stressors rated on a 5-point scale from 1 (no impact at all) to 5 (extremely strong impact).

2.4. Data analysis

Descriptive statistics analysis was used to analyze socio-demographics, farm characteristics, the impact of climate change on rice growth production, and farmers' responses in mitigating and adapting to climate change. To establish the importance of climate change over other non-climate related stressors to farmers' livelihoods, ratings were analyzed using Friedman's test (K-related-samples test) followed by Wilcoxon signed ranks test for pair-wise post hoc comparisons when appropriate. Ordinal regression analysis was performed to determine a possible association of farmers' socio-demographic conditions and farm characteristics to the perceived extent of climate change impact. The outcome variable captured responses on the perceived severity of seasonal climate events on overall production, an ordered variable coded as 0 (no impact), 1 (moderate impact), and 2 (strong impact). The dummy for socio-demographic variables for were: age (1 = 18-40 year ; 0 = other), farming experience (1 = <20 year; 2 = other), number of house-hold member (1 = <4; 2 = other), gender (1 = male; 0 = female); education (1 = junior high school; 0 = other), and land tenure (1 = private; 0 = other). The dummy for socio-demographic variables for were: Farm size (1 = less than 0.5 ha; 0 = other), Rice production (1 = less than 0.5 ton; 0 = others), cultivation period (1 = one a year; 0 = other), rice varieties (1 = hybrid; 0 = other), land management method (1 = traditional; 0 = other), fertilization (1 = chemical; 0 = other), farm type (1 = irrigation; 0 = other), farming purpose (1 = for sale; 0 = other), getting assistance from extension officer (1 = getting assistance; 0 = other)

3. Results

3.1. Socio-demographic and farm characteristics

A total of 297 data from farmers as respondents in this study were used to analyze socio-demographic conditions and farms' characteristics. The socio-demographic and the farms' characteristics in the study area are shown in Table 1.

Table 1. Summary of socio-demographic conditions (n = 297)

Variable	Mean/SD
Socio-demographic conditions	
Age (year)	49.7 ± 11.1
Max	70
Min	18
Farming experience (year)	18.4 ± 10.4
Gender	
Male	91 (30.6%)
Female	206 (69.4%)
Education	
Elementary school	129 (43.4%)
Junior High school	87 (29.3%)
Senior High school	81 (27.3%)
Land tenure	
Private	254 (85.5%)
Otherwise (rent, shared)	43 (14.5%)
Farm Charactersitics	
Farm size (ha)	0.5 ± 0.3
Rice production (ton/ha)	1.1 ± 0.2
Cultivation period	
One a year	211 (71.0%)
Twice a year	86 (29.0%)
Rice varieties	
Hybrid	66 (22.6%)
Indigenous	231 (77.4%)
Land management method	
Traditional method	101 (34.0%)
Machine mechanization	196 (66.0%)
Fertilization	
Chemical	122 (41.1%)
Organic	175 (59.9%)
Farm type	
Irrigated	42 (14.1%)
Rain-fed	255 (85.9%)
Farming purpose	
For sale	28 (9.4%)
Self-consumption	269 (90.6%)
Assistance from the extension officer	
Get assistance	116 (39.1%)
Not getting assistance	181 (60.9%)

Based on the data collected, it was known that the average age of farmers was 49.7 years, and the average experience of farming was 18.4 years. Respondents of female farmers were higher than male farmers. Farmers' education was dominated by farmers with elementary education followed by junior education and senior education. The land used for rice farming with private ownership was higher than land leased or profit-sharing.

With an average land area owned by farmers of 0.5 hectares, the farmers' were able to produce rice production of 1.1 tons per year. The cultivating period carried out by farmers was dominated by planting 1 time compared to 2 times in a year. Farmers were more interested in using indigenous varieties than in using hybrid varieties. The land management method was dominated by machine mechanization compared to using traditional methods by using tools such as plows with cattle or hoes. Organic fertilizers from livestock manure were used more by farmers than chemical fertilizers. The types of rice fields owned by farmers were almost dominated by rainfed, while the irrigated rice fields were only slightly. The rice yields obtained were generally used for own consumption compared to the purpose of selling. In general, more farmers did not receive assistance from extension officers than those who received assistance.

3.2. Farmers' perceived of seasonal climate events and impact on rice production

Several factors, which were climate, pests, diseases, and environmental damage as stressors in rice production, were asked to the farmers. From these factors, farmers consider that climate is the main factor as stressor that can cause failure in rice production, followed by factors of environmental damage, pests, and diseases. This was indicated by a significant difference in the median ranking ($p < 0.001$) among factor caused stressors. Furthermore, when we asked what climatic factors most influence rice production, 83% of the 297 respondents reported that flooding was the climatic factor that most often caused rice production failure (Figure 3.). More farmers stated that the wet season had not changed in the last 5 years, as well as in the dry season (Figure 4).

Table 2. Friedman's tests result showing rankings of the level of stressors on rice production

Stressors	Mean	SD	Mean rank[a]	Friedman test
Climate	3.4	0.45	3.3	$p < 0.001$
Pest	2.5	0.43	2.3	
Diseases	2.0	0.16	1.9	
Enviroment damages	2.6	0.45	2.4	

[a] The higher the mean rank of, the greater the level of concern as an a stressor.

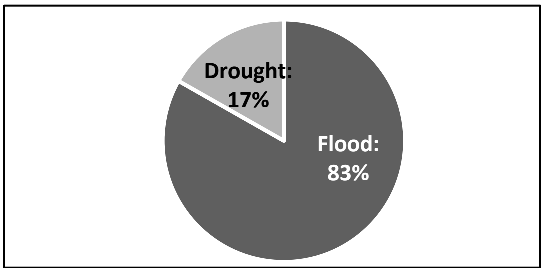

Figure 3. Climatic factors that cause rice production failure.

Figure 4. Farmers' perceptions of climatic conditions in the last five years.

Farmers were asked to share their perceptions related to flooding (Table 4) and drought (Table 5) impact on rice crops. Based on the farmer's perception, the most frequent flood events were for 3 days and caused the rice to wither and the possibility of rice to was low survival rate. Farmers reported that if the flood lasted for more than 3 days, the rice would rot and then perish. More farmers experienced less than 4 weeks of drought and a less severe impact on rice. Some farmers reported that they had experienced a drought of more than 4 weeks which had a negative impact on paddies, such as stunting, not bear, and yellowing leaves. Almost of farmers reported that the vegetative phase was a phase that is prone to failure due to flooding and drought compared to the seed phase and the generative phase (Figure 5).

Table 3. Farmer perceived of flood in rice production

Flood time (days)	Number of respondents	%	Impact
1	13	4.4	No impact
2	39	13.1	Low stress, high survival rate
3	124	41.8	Withers, low survival rate
4	49	16.5	Perish
5	27	9.1	Perish
6	6	2.0	Perish
7	17	5.7	Perish
>7	22	7.4	Perish

Table 4. Farmer perceived of drought in rice production

Drought time (weeks)	Number of respondents	%	Impact
1-2	135	45.5	No impact
3-4	125	42.1	Low stress, high survival rate
>4	37	12.4	Stunting, fail to grain

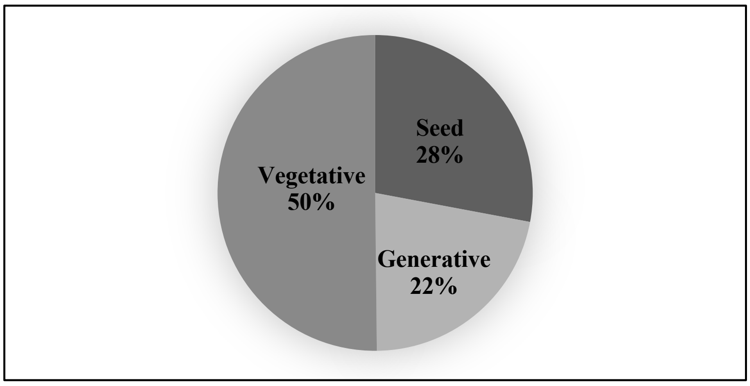

Figure 5. the most vulnerable rice growth stages due to flooding and drought based on farmers perceived.

3.3. Determinants factor of farmers' perceived seasonal climate events impacts

Of a total of 297 farmers, around 47.1% stated that the seasonal climate event had no impact on rice production, 32.3% of farmers stated it had a low impact, and 20.6% stated a strong impact. Logistic regression analysis of socio-demographic conditions on perceptions of seasonal climate events shows that farming experience (negative), education (negative), and gender (positive) have a significant effect on farmers' perceptions of climate change impact. Meanwhile, other factors such as age and land tenure did not affect farmers' perceptions of climate change impact (Table. 5). Farm characteristics in relation to perceptions of climate change show that farm size (negative), cultivation period (negative), rice varieties (positive), land management (positive), fertilization (positive), rice field type (positive) and farming purpose (negative) have a significant effect in determining farmers' perceptions in seasonal climate event. Meanwhile, rice production and assistance from extension officers did not affect farmers' perceptions of climate change (Table. 6).

Table 5. The relationship between socio-demographic and farmers' overall perceptions of seasonal climate event

Outcome variable	Estimate	SE	Wald	P Value
[Perceived of climate change = moderate impact]	-0.89	0.41	4.82	0.03**
[Perceived of climate change = strong impact]	-0.63	0.41	2.40	0.12
Location				
Gender (male)	0.42	0.24	3.10	0.07*
Age	0.08	0.40	0.04	0.83
Farming experience	-0.72	0.26	7.41	0.00***
Education				
Elementary school	-0.74	0.36	4.26	0.03**
Junior high school	-0.61	0.35	2.99	0.05**
Land tenure	-0.19	0.34	0.33	0.56
Overall model evaluation	$x^2 =$ 12.53	$p\ value$ 0.08*	R^2 Nagelkerke 4.7%	

***, **, and * denote significant at 1%, 5%, and 10% levels, respectively.

Table 6. The relationship between farm characteristics and farmers' overall perceptions of seasonal climate events

Outcome variable	Estimate	SE	Wald	P Value
[Perceived of climate change = moderate impact]	-2.99	0.89	11.20	0.00**
[Perceived of climate change = strong impact]	-1.22	0.88	1.94	0.16
Location				
Rice production				
Less than 0.5 ton	-0.10	0.75	0.01	0.89
More than 0.5 ton	-0.29	0.49	0.36	0.54
Farm size				
Less than 0.5 ha	-2.85	0.74	14.86	0.00***
More than 0.5 ha	-2.67	0.71	14.22	0.00***
Cultivation period	-0.72	0.26	7.73	0.00***
Rice varieties	0.92	2.87	10.43	0.00***
Land management method	0.75	0.26	7.79	0.00***
Fertilization	0.64	0.25	6.20	0.01**
Farm type	0.64	3.72	3.03	0.08*
Farming purpose	-1.43	0.49	8.54	0.00***
Assistance from extension officer	-0.23	0.27	0.75	0.38
Overall model evaluation	$x^2 =$ 68.51	$p\ value$ 0.00***	R^2 Nagelkerke 23.5%	

***, **, and * denote significant at 1%, 5%, and 10% levels, respectively.

3.4. Rice farmers' adaptive responses

Farmers were given open-ended questions about adaptative responses to minimize production failures due to climate change (Figure 5). Paying attention to the planting season, such as not planting in the rainy season, was the most common effort made by farmers to avoid flood events. Some other farmers increase the use of chemical fertilizers to fertilize crops and the use of pesticides to control pests and diseases. Some farmers repair irrigation canals to regulate the irrigation process. However, there were also many farmers who give up after a failure compared to farmers who replant if their rice fails to grow due to flooding or drought and irrigate with machines if there is a water source around the fields. A few farmers used local varieties that were more resistant to flood and drought conditions.

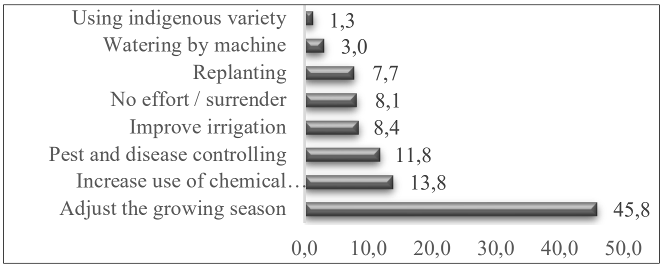

Figure 6. Rice farmers' adaptive responses.

4. Discussion

4.1. Socio-demographic and farm characteristics

In general, socio-demographic conditions and agricultural characteristics in the study were similar to some conditions in Indonesia (national level), as reported by Rondhi et al. (2019). The similar conditions were the average age of farmers being 49 years, the dominant type of rice fields being rainfed, the planting period being 1-2 times a year, land ownership being generally privately owned, and fewer farmers were receiving assistance from extension officers. However, there were a few points that differed at the national level in this field of study. Although the number of female farmers was low compared to the national level, the number of female farmers was higher in the current study area. In this study area, men usually acted as oil palm or rubber farmers, while women were rice farmers. Purpose of rice farming was used for family consumption, and oil palm and rubber farming as a source of economic income. The study area also has a higher proportion of farmers using organic fertilizers than farmers in Indonesia (at the national level), who predominantly use chemical fertilizers.

The average land area in the study of 0.5 ha is also almost similar to the data reported by BPS (2019). The average land area of rice farmers in Indonesia is 0.6 ha. Rice farmers in this study area were more interested in using local rice varieties than hybrid varieties. The reason being that farmers perceive local varieties were more resistant to flooding and drought than hybrid varieties ones. Rice production in the study area was low and only 1.1 tons/ha because, according to BPS (2021), in Indonesia, one hectare can produce rice of around 5.2 tons. In this study area, the farmers used the dominant local varieties and organic fertilization, and the irrigation system was not optimal because it used rainfed rice fields, which were thought to be some of the causes of the low rice production. The more dominant farmers' use of organic fertilizers was actually something positive for the sustainability of rice farming and climate change mitigation. Arunrat et al. (2021) reported that rice farming in Thailand using organic fertilizers contributed less negative impacts on climate change than rice farming using chemical fertilizers. The use of organic fertilizers does not always have a negative impact on rice production, Salam et al. (2021) reported in Bangladesh, rice farming which was dominantly using organic fertilizers intensively, results in higher rice production, with notes that the government provides sufficient access to organic fertilizers.

4.2. Farmers' perceived of seasonal climate events and impact on rice production

In general, farmers already know that climate has a big impact on rice farming. Farmers think that pests and diseases can be controlled with pesticides and the use of chemical fertilizers, but climate problems such as floods and droughts are difficult to overcome. However, although the climate was the main concern for farmers regarding the causes of failure of rice production, farmers consider that in the last five years, the rainy and dry seasons have not changed. To confirm the farmer's statement, we have collected rainfall data for the last five years from the Meteorology and Geophysics Agency station at the study site, and the results were known in the last five years the rainfall pattern was different every year (Figure 7).

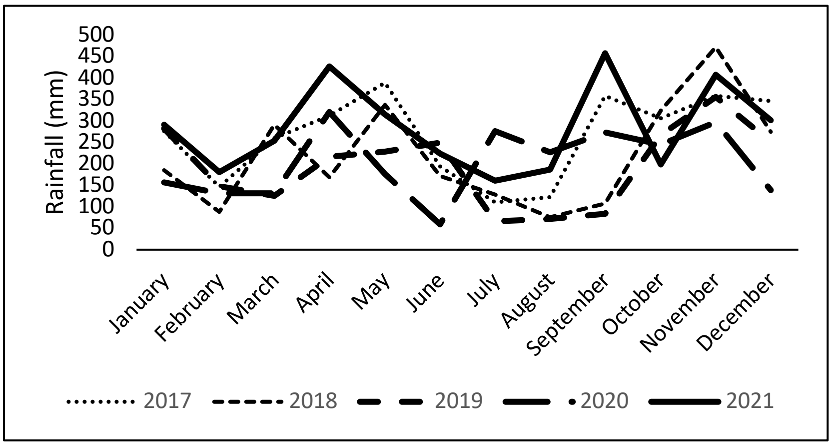

Figure 7. The rainfall trend in 2017-2021.

The climatic factor that was considered the biggest cause of rice production failure was flooding. This is also consistent with what was reported by Rondhi et al. (2019) that rice farmers in Indonesia consider climate factors such as floods to have the greatest impact on rice production failure compared to drought and other factors. According to farmers, if the flood recedes in two days, it is highly likely that the rice will continue to grow and bear, but if the flood does not subside within three days and the entire plant is submerged, then it is highly likely that the rice will fail to grow and perish. This condition is different from that reported by Manzanilla et al. (2011) that the average rice crop in Southeast Asia, such as in the Philippines, Laos, Indonesia, and Southern Vietnam, if flooding with a height of > 100 cm and more than 2 weeks can cause failure production by 40-77%. Floods cause many complex abiotic stresses on rice plants. Losses that may be caused to rice plants can vary depending on flood characteristics such as temperature, turbidity, water depth, oxygen and carbon dioxide concentration, and light intensity (Panda and Barik, 2021). The period of vegetative growth was a growth period that was prone to failure due to flooding and drought. This is also in accordance with what was conveyed by Hendrawan and Komori, (2021) that the vegetative to reproductive period is a growth phase that is prone to failure due to flooding.

4.3. Determinants factor of farmers' perceived seasonal climate events and farmers' adaptive responses

Farmers' perceptions of the impact of climate change, such as seasonal climate events on rice farming, were varying, and this was something natural because individual responses can vary (Grunblatt and Alessa, 2017). Based on socio-demographic conditions, factors that influence perceptions of the impact of climate change were gender, farming experience, and education. Female farmers believe that seasonal climate events can have a negative impact on rice farming. The longer the experience of farming and the higher the education of the farmer, the more likely he was to believe in the negative impacts of seasonal climate events on rice farming. The influence of gender on perceptions of climate change can be different in each region. Therefore, it was necessary to look at specific contexts and locations (Jamal et al., 2021). In several previous studies, such as in Africa reported by Ojo et al. (2021) and Poortinga et al. (2019) in Europe and specifically Rondhi et al. (2019) in Indonesia, it was stated that female farmers believed in climate change and were more adaptive in dealing with the negative impacts of climate change. Farming experience and education have a positive relationship to the perception of climate change. Education was able to increase the ability to receive information about the climate, which has an impact on cognitive abilities. The more experienced and educated farmers are, the better their ability to adapt to climate change (Ojo and Baiyegunhi, 2021; Appiah and Guodaar, 2021).

Based on farm characteristics, the larger the land owned by the farmers, the more belief they will be on the impacts caused by seasonal climate events. This was in contrast to the study reported by Amare and Simane. (2017) in Ethiopia and Koirala et al. (2022) in Nepal, reported that farmers with larger land perceived that climate change had less impact on agriculture than those with smaller land. However, another study conducted by Thoai et al. (2018) in Vietnam and Ahmed et al. (2021) in

Bangladesh reported that farmers who have large lands believe in the negative impacts caused by climate change. These farmers were also more adaptive in dealing with climate change than farmers who have small lands. Based on the results of previous studies and the results of this study, the influence of land area needs to be studied specifically according to the location and context. In the study area, the rainy season usually lasts longer than the dry season, and at least floods occur every year. Therefore, farmers who plant rice more than once a year have experienced flooding, and flooding due to seasonal climate events has a negative impact on rice production.

Farmers who cultivate the land using traditional mechanization believe in seasonal climate events. This was similar to that reported by Jha and Gupta, (2021), who reported that farmers who cultivate land in the traditional way believe that climate change is occurring and its impact on land cultivation becomes more difficult. Farmers who use chemical fertilizers believe in climate change, and this was also in accordance with a previous study result reported by Martey and Kuwornu, (2021) in Ghana that farmers who use chemical fertilizers believe that climate changes have an impact on soil fertility, the intents of use of chemical fertilizers was an effort to fertilize the soil. Farmers with irrigated farming types have a stronger belief in the negative impact of seasonal climate events than farmers with rain-fed farming types. The results in this study differ from those reported by Hein et al. (2019) in Myanmar reported that rice farmers with irrigated types of agriculture have a lower perception of the impact of climate change than farmers with rain-fed types. This could be because at the location of this study, farmers with rain-fed farming systems have not experienced extreme drought conditions so agricultural crops are not too dependent on irrigation. Farmers with rain-fed agriculture believe in climate change if they experience extreme drought conditions and low rainfall (Aliyar et al., 2022).

Farmers who grow rice for family consumption believe that seasonal climate events has an impact on rice production. The results of this study were also in accordance with the study of Mekonnen et al. (2021), who reported that farmers believe drought and extreme rains as a result of climate change affect the harvest of agricultural crops, which have an impact on food security at the family level. Assistance from extension officers does not affect farmers' perceptions of the impact of climate change. This is because there were still few farmers who received assistance from extension officers. Farmers who do not receive assistance from extension officers have limited knowledge about climate change (Jost et al., 2016). In addition, this can also indicate the weak role of extension officers in providing information about climate change to farmers. It was necessary to strengthen extension officers to provide information on the impacts of climate change on agriculture as well as adaptation efforts that can be adopted at the local level (Afsar and Idrees, 2019). Previous studies conducted by Zakaria et al. (2020) in Ghana and Anik et al., (2021) in Bangladesh show that farmers who have access to extension workers have good adaptability in dealing with climate change.

Adjusting the planting season followed by the use of chemical fertilizers and controlling pests and diseases was the most adaptive response by farmers to prevent yield failure due to seasonal climate events. The results of this study were the same as reported by Zama et al. (2021) in Cameroon. Farmers prefer the strategy of adjusting to the planting season because it is considered the most effective for reducing yield failure due to climate (Wang et al., 2022). The adaptive response carried out by farmers needs to get further support, such as assistance from extension officers. In addition, adaptation strategies by planting rice varieties that were more tolerant to flood and drought conditions can also be considered. In this study, the choice of variety was the least response chosen by farmers. Anik et al. (2021) reported that in Bangladesh by strengthening information services on climate, measurable use of fertilizers, use of flood or drought-tolerant varieties, and regular assistance from agricultural extension officers can help rice farmers in dealing with climate change.

Conclusion

Farmers believe that climate was the biggest stressor on rice production compared to environmental damage, pests, and diseases. Floods were climatic events that most often caused the failure of rice production. However, farmers were more dominant in stating that neither the dry season nor the rainy season has changed. The vegetative growth phase was a phase that was prone to failure due to flooding and drought.

Farmers who believe seasonal climate events had a moderate to strong impact on rice production are more likely than those who think seasonal climate events had no impact. The perception of farmers in assessing seasonal climate events from socio-demographic conditions was determined by gender, farming experience, and education. Meanwhile, farm characteristics were determined by land area, cultivation period, rice variety, land management method, fertilization, type of rice field, and the purpose of farming. Adjusting to the planting season, the use of chemical fertilizers, and controlling pests and diseases were the most dominant responses by farmers in dealing with seasonal climate events.

The implications that can be given to the government at the local level were. 1) The availability of information about the weather must be done massively with the current technology so that farmers easily get information about the weather (rainy season and dry season); 2) Induction of rice varieties that are more flood-tolerant needs to be carried out to farmers so that they can adapt when a flood event occurs; 3) Female farmers with higher education and long experience in farming can be used as cadres as extension officer to farmer groups through intensive training on climate change adaptation and mitigation efforts; 4) Planting twice a year was one option to increase rice production, but farmers need to be accompanied by extension officers who are capable of paying attention to the planting season, the use of fertilizers and the selection of rice varieties.

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