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FARMERS' CAPACITY AND RICE PRODUCTIVITY IN CLIMATE CHANGE ADAPTATION IN CENTRAL LAMPUNG REGENCY, INDONESIA

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ABSTRACT
Climate change is an extreme natural change condition due to global warming that cannot be avoided, and will have a broad impact on various aspects of life, including the agricultural sector. The impact of climate change that occurs in the agricultural sector, namely flood and drought that cause plants to crop failure , is becoming greater, causing significant reduction in agricultural production, especially rice, requiring that farmers have the ability to adapt to climate change. The purposes of this study are to analyze the relationship between the performance level of agricultural extension workers and the capacity level of farmers in regard to climate change adaptation, and to analyze the relationship between the level of farmer capacity in climate change adaptation and rice productivity. The research was conducted in Central Lampung Regency in 2019 using a total of 100 rice farmers. The data analysis method used is Spearman rank correlation analysis. The results show that the performance level of agricultural instructors is significantly related to the level of knowledge capacity, attitude, and skills of farmers in climate change adaptation. Knowledge capacity, attitude, and skills of farmers in climate change adaptation are significantly related to rice productivity.

Contribution/Originality: The results show that the performance level of agricultural instructors is significantly related to the level of knowledge capacity, attitude, and skills of farmers in climate change adaptation. Knowledge capacity, attitude, and skills of farmers in climate change adaptation are significantly related to rice productivity.

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1. INTRODUCTION

Climate change is an extreme natural change caused by global warming from the emission or release of greenhouse gases, which are increasing day by day and threaten human life and biodiversity on earth. Global warming has a direct effect on rainfall (Rahman, 2018). The phenomenon of climate change is increasingly felt by the Indonesian people and it can be seen from climate change, which causes various disasters such as floods, landslides, long droughts, strong winds, and high seas. Climate change is unavoidable and will have a broad impact on various aspects of life. The impacts of climate change, which include rising sea levels and temperature (Mumenthaler, Renaud, Gava, & Brosch, 2021), increased rainfall, increased evaporation in summer (Konapala, Mishra, Wada, & Mann, 2020), and increased intensity of tropical storms, cause losses in various aspects of life (Hsiao et al., 2021). The wider impact of climate change is not only damaging the environment but also endangering human health, disrupting the availability of food in the agricultural sector, economic development activities, natural resource management, and infrastructure. The effect of climate change on the agricultural sector is multidimensional, from resources, infrastructure, and agricultural production systems to aspects of food security and independence (Murniati & Mutolib, 2020), and also the welfare of farmers and society.

The agricultural sector is one sector that is vulnerable to the impacts of climate change, especially rice farming. This is because the availability of food in the agricultural sector is intended to fulfil the basic nutritional needs of households that are highly dependent on climatic conditions. The share of household food expenditure is relatively high and the share of non-food expenditure is low relative to total expenditure (Murniati & Mutolib, 2020). Extreme climate change in the agricultural sector is often called El Nino, which is an event where the summer is relatively longer with the implication of drought events, while La Nina is characterized by high rainfall intensity which has an impact on flooding. Extreme climatic events, especially El Nino or La Nina, result in (1) crop failure, reducing IP which leads to decreases productivity and production; (2) damage to agricultural land resources; (3) increasing frequency, area, and weight/intensity of drought; (4) increasing humidity; and (5) increased intensity of disturbance of plant pest organisms (OPT) (Skendžić, Zovko, Živković, Lešić, & Lemić, 2021). Iizumi et al. (2014) indicated that climatic anomalies such as El Nino have a negative impact on agricultural productivity. Climate change affects productivity and production in the agricultural sector, which has a negative socio-economic impact (Ketema & Negeso, 2020).

Climate change will be a serious threat to the agricultural sector and has the potential to create new problems for agricultural sustainability. This is in line with the position of Alalade, Oladunni, Akinboye, Daudu, and Ogunrinde (2019), that climate change has undesirable effects on agricultural activity. According to Lipińska (2016), in agriculture, weather conditions such as climate change have the same impact, on both the quality and quantity of production, including farmers' income. In addition, climate change that continues to occur will have an impact on increasingly frequent pest and disease attacks, thereby reducing rice production (Skendžić et al., 2021). Decrease in production is due to reduced sink formation, shorter growth period, and increased respiration (Hatfield & Prueger, 2015). Climate change causes increasing rainfall in certain areas (Tabari, 2020) and, at the same time, drought happens in other places (Mann & Gleick, 2015). Changes in weather patterns and temperature due to climate change result in high pest interactions with plants. Boer et al. (2017) showed that brown planthopper tends to increase significantly when rainfall in the transitional season increases.

Anticipating reduction in climatic change and its adverse impacts, adaptation is considered an important response (Ho & Shimada, 2018). Human response to climate change is very important to understanding and estimating the level of adoption of adaptation strategies used by farmers to reduce the impact of climate change on crop production (Akintonde & Shuaib, 2016). Climatic change affects productivity and production in the agricultural sector that will result in primarily negative socio-economic impacts. Central Lampung Regency is a district in Lampung Province which is now the main center of rice production, but productivity is still below national productivity even though adaptation activity to climate change has been carried out. However, most of this adaptation activity is only relatrd to handling pest attacks resulting from climate change. The low level of rice productivity by farmers reflects their level of capacity in adapting to climatic change, which is not yet optimal. According to Juana, Kahaka, and Okurut (2013), if nature can not be renewed then humans are expected to be able to update technology and adapt to existing natural conditions.

The phenomenon of climate change that occurs increasingly creates demands on farmers' awareness about how important it is to increasing their capacity to adapt. Adaptation to climate change by farmers certainly requires them to further increase their capacity by updating the latest innovations in support of their farming activities in increasing productivity. Farmers who have a good capacity are expected to have an effect on the productivity of rice production. Based on the description above, this study aims to analyze the relationship between the performance level of agricultural extension workers and the capacity level of farmers in adapting to climate change, and to analyze the relationship between farmers' capacity in adapting to climate change and rice productivity.

2. MATERIALS AND METHODS

2.1. Site and Research Period

The research location in Central Lampung Regency was determined purposively with the consideration that it is the largest rice producer in Central Lampung Regency and is an area affected by the unavailability of irrigation water due to irrigation improvements. The period of the research was from October 2019 to March 2020.

2.2. Research Procedure

The research method used is a survey method. The population in this study are rice farmers assisted by extension workers who are members of farmer groups totaling 17.988 farmers. Determination of the number of samples in this study refers to the Yamane formula, namely:

$$n = \frac{N}{Nd^2+1} \qquad (1)\ 99{,}44 = \frac{17.988}{17988(0{,}1^2)+1}$$

Information:
n = Number of samples.
N = Number of population.
d^2 = Precession (set at 10% with α = 90%).

2.3. Data Analysis

Analysis is based on calculations obtained from a sample of 100 farmers. The types of data used are both primary and secondary. The collected data were analyzed using descriptive statistical analysis and rank Spearman correlation. Descriptive statistical analysis was conducted to describe or provide an overview of the object under study by scoring the method in three categories, namely low, medium, and high. Rank Spearman correlation analysis was used to analyze the relationship between farmers' capacity in adapting to climate change and rice productivity. The criteria set by rank Spearman correlation analysis are if the significance value is <0.05 then there is a correlation and otherwise if the significance value is >0.05, where there is no correlation. The data were processed using the Statistical Package for the Social Sciences 23 (SPSS 23) tool. The framework of the relationship between the capacity of farmers in adapting to climate change and rice productivity can be seen in Figure 1.

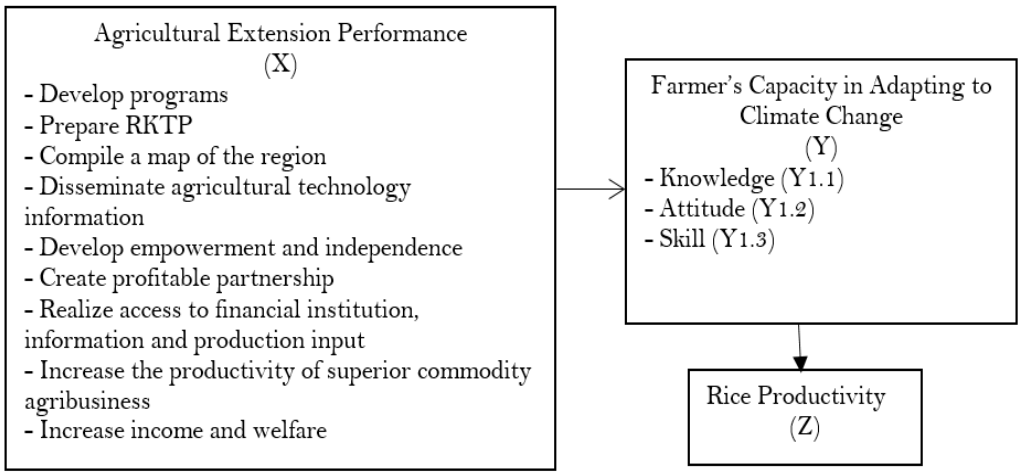

Figure-1. Framework for the relationship between farmers' capacity in adapting to climate change and rice productivity.

3. RESULTS AND DISCUSSION

3.1. The Performance of Agricultural Extension

The performance of agricultural extension workers refers to Undang-Undang No. 16 of 2006, which is judged by the success of extension workers in carrying out their main task of compiling agricultural extension programs, preparing annual agricultural extension work plans, compiling maps of agricultural extension areas, disseminating agricultural technology information, developing empowerment and independence of farmers, realizing profitable partnerships, realizing access to financial institutions, information, and production facilities, increasing the productivity of agribusiness for superior commodities, and increasing farmers' income and welfare. The results of this analysis in Central Lampung Regency can be seen in Table 1.

Table-1. Performance of agricultural extension in Central Lampung Regency.

No.	PPL performance indicator	Mode	Classification
1	Develop agricultural extension programs	1	Low
2	Compile RKTP	1	Low
3	Develop a map of agricultural extension areas	1	Low
4	Disseminate agricultural technology information	1	Low
5	Develope empowerment and independence	1	Low
6	Create profitable partnerships	1	Low
7	Realize access to financial institutions, information, and production input	2	Medium
8	Increase the productivity of superior commodity agribusiness	2	Medium
9	Increase income and welfare	2	Medium
	PPL performance level	1	Low

Table 1 shows that the performance of agricultural extension in Central Lampung Regency is classified as low. This can be seen from the performance of agricultural extension workers in carrying out their main task of preparing agricultural extension programs, preparing annual agricultural extension work plans, compiling maps of agricultural extension areas, disseminating agricultural technology information, developing the empowerment and independence of farmers, and realizing profitable partnerships classified as low, while the performance of agricultural extension in realizing access to financial institutions, information, and production facilities, increasing the productivity of agribusiness for superior commodities, and increasing the income and welfare of farmers is classified as medium. The low performance of agricultural extension workers is due to the fact that they rarely involve farmers in preparing agricultural extension programs, preparing annual agricultural extension work plans, or compiling maps of agricultural extension areas, because they used references from previous years and not all members of farmer groups take part in supporting extension activities, so that farmers' assessment of the performance of agricultural extension workers is low. This is because agricultural extension workers only coordinate with farmers' groups' administrators, such as the chairman or secretary. In addition, farmers rarely meet with extension worker because the extension area is vast and not all farmers can be visited by extension workers.

3.2. Farmers' Capacity Regarding Climate Change Adaptation

Current climatic conditions always undergo erratic changes such as flood and long drought, beyond the expectations of farmers, resulting in many pests and plant diseases leading to crop failure. It is proven that farm productivity in the research area is still low, so that farmers' capacity in adapting to climate change is needed. The results show that the level of adaptation of farmers to climate change is classified as low in regard to knowledge, attitude, and skills in adapting to climate change. This is in line with Salampessy, Lubis, Amien, and Suharjito (2018), whose research showed that the capacity of farmers to adapt to climate change was low. The results of the study can be seen in Table 2.

Table-2. Farmers' capacity to adapt to climate change.

Farmers' capacity to adapt to climate change	Classificattion	Class interval (score)	Total	Percentage
Knowledge	Low	4–6	64	64.00
	Medium	7–9	34	34.00
	High	10–12	2	2.00
Average		6.0		
Attitude	Low	9–14	57	57.00
	Medium	15–21	41	41.00
	High	22–27	2	2.00
Average		14.2		
Skills	Low	6–9	21	21.00
	Medium	10–11	51	51.00
	High	15–18	28	28.00
Average		12.5		

Table 2 shows that the level of famers' capacity in adapting to climate change is classified as low. This can be seen from the knowledge capacity and attitude of farmers in adapting to climate change, which is classified as low, and the skill capacity is classified as medium. Knowledge, attitude, and skills are the main components that shape the behavior of farmers. Knowledge is the basis for an individual to have the ability to make decisions. Low capacity is due to lack of knowledge. Farmers' knowledge in adapting to climate change is related to their ability to know the strategies required to reduce the negative impacts of climate change, such as their knowledge of lowland rice varieties that are tolerant to immersion, drought, and pests. In addition, farmers' knowledge remains low in recognizing the correct time of year to determine the start cultivation, planting, crop rotation, and the commodities to be planted; even farmers do not know of good irrigation water management systems and water storage technology to face a long dry season due to the negative impact of climate change. Based on the results of the research, information related to climate change adaptation is rarely obtained by farmers, even that related to water storage technology.

The level of farmers' capacity on the indicator of attitude in adapting to climate change is also classified as low. This is reflected in the attitude of farmers who rarely rest their land, rotate crops between seasons, plant according to cropping commodities with weather conditions, plant according to lowland rice varieties that are tolerant of soaking, drought, and certain pest that can be planted, rarely use organic fertilizer and organic pesticides, rarely coordinate with water user group to always maintain the condition of irrigation water, search for information related to climate, even farmers do not use water storage technology to deal with the long dry season. However, some farmers who always carry out simultaneous planting as a strategy to reduce the negative impacts of climate change and others carry out other work activities outside of agriculture to earn income in anticipation of crop failure. Based on the results of research, farmers in carrying out rice farming activities are always accustomed to follow their parent's farming activity from generation to generation so that new innovation in rice farming is difficult to adopt.

The level of farmers' skills in climate change adaptation is classified as medium. This can be seen in activities to solve the problem of tackling pests due to the impact of climate change, to be able to do other jobs besides farming

rice to increase income, to process agricultural product to gain added value, and to plant other commodities to increase income. However, the skills of farmers in managing waterways and participating in counseling and training activities related to climate change remain low. Based on research, farmers are rarely visited by agricultural extension workers even though they often need information related to farming. In addition, extension workers' efficiency is less than optimal in carrying out their roles and functions (Listiana, Sumardjo, Sadono, & Tjiptopranoto, 2018). Farmers' capacity to adapt to climate change is very important to reduce the negative impacts that occur. According to Ho and Shimada (2018), adaptation is considered an important response. Human response to climate change is very important in understanding and estimating the adoption level of adaptation strategies used by farmer to reduce the negative impacts of climate change, especially on crop production (Akintonde & Shuaib, 2016).

3.3. Rice Productivity Level

Increasing the productivity of rice farming is part of the main goal of farmers. The level of productivity depends on the technology and the suitability of the local climate. The level of rice productivity in Central Lampung Regency is presented in Table 3.

Table-3. Distribution of rice farming productivity levels in Central Lampung Regency.

Level of rice productivity (tons ha^{-1})	Category	Total (individuals)	(%)
4.10–4.93	Low	42	42
4.94–5.76	Medium	37	37
5.78–6.60	High	21	21
Total		100	100

Table 3 shows that the level of rice productivity is classified as low. This proves that farmers' ability has not been maximized and there is still variation in the levels of rice productivity among farmers. The average productivity of rice farmers in the study area is only 5.1 tons/ha, below the average maximum productivity which can reach 6.6 tons/ha. The low productivity of rice is due to the inefficiency of farmers, so it is necessary to increase their capacity and the need for technical guidance so that the knowledge and technical skills of farmer can increase.

3.4. Relationship between Agricultural Extension Performance and Farmers' Capacity to Adapt to Climate Change

Agricultural extension plays a role in helping farmers in relation to their farming problems. In addition, the existence of agricultural extension can change farmers' behavior to further increase their capacity. Agricultural extension workers who carry out their roles and functions must be able to satisfy farmers so that the latter will give a good assessment of the performance of the workers. The results from research on the relationship between agricultural extension performance and the level of farmers' capacity in adapting to climate change can be seen in Table 4.

Table-4. Results of the relationship between the agricultural extension performance and farmers' capacity to adapt to climate change.

Parameter	Level of farmers' capacity in adapting to climate change		
	Knowledge	Attitude	Skills
Agricultural extension performance	0.619**	0.881**	0.877**

Information: * Significantly related to α = 0.05, ** significantly related to α = 0.01.

Based on the results of rank Spearman correlation test, the performance level of agricultural extension is significantly related to knowledge (rs = 0.619), attitude (rs = 0.881), and skills (rs = 0.887) of farmers' capacity to adapt to climate change, where each variable is positive at the 99.99% confidence level. This means that the higher the level of performance of agricultural extension workers, the greater the knowledge, attitude, and skills of farmers' capacity in adapting to climate change. Agricultural extension provides information related to efforts to reduce the negative impacts of climate change, such as helping to increase farmers' knowledge of lowland rice varieties that are tolerant to soaking, drought, and pests.

In addition, agricultural extension also provides information related to the correct time to determine the start of cultivation and planting, crop rotation, the commodities to be planted, and explanations regarding good irrigation water management and water storage technology to deal with the long dry season resulting from negative impacts of climate change. However, extension activities in providing information to farmers are not carried out routinely and only a few members receive such information. Information related to strategies dealing with climate change is needed because it is to minimize the occurrence of crop failure. Therefore, farmers really need the role of agricultural extension.

Agricultural extension has a relationship with farmers' capacity (Anwarudin, Sumardjo, Satria, & Fatchiya, 2020). Agricultural extension is a facilitation agent for farmers to obtain information related to their farming. Agricultural extension as an information agent for farmers is to change farmers' behavior regarding aspects of knowledge, skills, and attitudes so that they know, want, and are able to implement changes in their farming practices in order to achieve increased production and income and improvement of family welfare (Ardiyansyah, Sumaryo, & Yanfika, 2014).

3.5. Relationship of Rice Productivity with Farmers' Capacity to Adapt to Climate Change

Based on the results of the rank Spearman correlation test, farmers' knowledge, attitude, and skills in adapting to climate change are significantly correlated with rice productivity. The results can be seen in Table 5.

Table-5. Relationship between farmers' capacity to adapt to climate change with rice productivity.

No	Farmers' capacity in adapting to climate change	Rice productivity
1	Knowledge	0.476**
2	Attitude	0.749**
3	Skills	0.766**

Information: * Significantly related to α = 0.05 ** , significantly related to α = 0.01.

Table 5 shows that the level of farmers' ability to adapt to climate change is significantly related to rice productivity. This means that the increasing capacity of farmers in regard to climate change adaptation will increase rice productivity. Therefore, the adaptive capacity of farmers regarding climate change is needed to maintain their productivity. Adaptation efforts needed by farmers in dealing with the impacts of climate change require adaptation technology. Trenberth et al. (2014) explained that adaptation technology that can be applied by farmers, including adjusting planting time, using drought-tolerant varieties, soaking, salinity, and developing water management technology. In line with the research of Murniati and Mutolib (2020), the ability of farmers to adjust or adapt to climate change by implementing strategy efforts can reduce losses due to climate change and will not have a significant effect on reducing production and income.

The knowledge level of farmers' capacity in adapting to climate change is significantly related to rice productivity (rs=0.476), which has a positive value. The knowledge level of farmers' capacity in adapting to climate change such as their knowledge of lowland rice varieties that are tolerant to soaking, drought, and pests; of recognizing the correct season to determine the start of tillage and planting, crop rotation, and commodities to be planted; and of knowing a good irrigation water management system and water storage technology to deal with the long dry season resulting from the negative impacts of climate change, can all increase rice productivity. Farmers with good knowledge capacity will be readily able to make decisions, especially in regard to increasing production. Increased production will occur if the knowledge gained is adopted by farmers. According to Ntshangase, Muroyiwa, and Sibanda (2018), the success of adoption depends on farmers'. Furthermore, this was reinforced by Liu, Bruins, and Heberling (2018), that knowledge is one component of farmers' behavior that is also a major factor in the adoption of innovation.

The attitude level of farmers' capacity in adapting to climate change is significantly related to rice productivity (rs=0.749), which has a positive value. This means that the ability of farmers' attitude in adapting to climate change will give a positive response to rice productivity. Attitude is a psychological (mental) process that occurs by providing a behavioral response in the form of action against an object that has been observed. Farmers' attitudes in making adaptation decisions are important regarding climate change, such as crop rotation, coordinating with farmer groups using water in improving irrigation, searching for information related to climate, using water storage technology to deal with the long dry season, and using seed according to rice varieties tolerant to flooding, drought, and certain pests. In addition, there is an attitude of farmers' adaptation to climate change, namely planting simultaneously as a strategy to reduce the negative impacts of climate change and carrying out other working activities outside of agriculture to earn income in anticipation of crop failure. According to Alalade et al. (2019), non-agricultural activity helps farmers spread production risks. The existence of this attitude will certainly have an influence on positive changes in rice productivity.

The skill level of farmers' capacity in adapting to climate change is significantly related to rice productivity (rs=0.766), which has a positive value. This means that the ability of farmers to adapt to climate change will provide a positive response to rice productivity. The skill of farmers' capacity is needed to analyze what becomes necessary, problems, and opportunities in achieving their goals, namely good productivity. This is in line with the research results of Ali, Ghosh, Osmani, Hossain, and Fogarassy (2021) that the skill of farmers' capacity affects rice productivity. Montes de Oca Munguia, Pannell, and Llewellyn (2021) stated that the skill of farmers' capacity has an effect on rice production. The high skill of farmers' capacity will have an effect on work more effectively and efficiently in achieving goals. Listiana, Sumardjo., Sadono, Tjiptopranoto, and Ariyanto (2019) also imvestigated internet usage in agricultural extension activities in Lampung Province, Indonesia.

However, success in achieving goals requires skills that are obtained from knowledge and attitude being carried out continuously. Attitude will be present if the individual already has the knowledge of identifying what has happened and what action must be taken, so that with the knowledge gained they can readily make decisions to achieve their goals. Based on farmers' knowledge, attitude, and skills, they will form capacity regarding a challenge, in this case climate change adaptation, to achieve the desired goal, namely rice productivity, so it can be concluded that there is a relationship between the capacity of knowledge, attitude, and adaptation skills in climate change and rice productivity.

4. CONCLUSIONS

The peformance level of agricultural extension is significantly related to farmers' capacity levels of knowledge, attitude, and skills in regard to climate change adaptation. Farmers' capacity of knowledge, attitude, and skills in regard to climate change adaptation is significantly related to rice productivity. Therefore, to increase rice

productivity, it is necessary to increase farmers' capacity for climate change adaptation, which is supported by the performance of agricultural extension.

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