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Perception and Adaptation Capacity of Farmers to Climate Change

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Abstract. This study examines the perception and capacity adaptive of farmers in facing climate change. Climate change affects the agricultural sector in the stability of food production. Therefore, a change in behavior is needed to minimize its negative impact. Farmers' perceptions about climate change are needed to motivate farmers to take protective measures. Adaptation requires the ability and capacity to adapt. To assess adaptation capacity using a sustainable livelihoods approach based on the availability of five assets. The target population in this study is rice farmers in sub-districts with fertile and infertile land. The data analysis is performed using tabulation and internal and external factors analysis. The result shows that farmers' understanding of climate change is still low, they do not realize that the problems they have faced such as decreasing yields, increasing pests and diseases caused by climate change. The level of adaptation shows that there are slightly more farmers with high adaptation capacity compared to farmers with low adaptation capacity. This implies that it is necessary to increase farmers' understanding of climate change through the ease of accessing information. Adaptation capacity should be increased through the optimum utilization of resources owned by farmers.

Keywords: farmer's perception; adaptation capacity; climate change; sustainable livelihoods approach; internal dan external factor analysis

1. Introduction

The agricultural sector is one of the sectors that are affected by climate change (Funk and Brown, 2009; Falcon *et al.*, 2010; B. *et al.*, 2012). Farmers have a different perception of climate change. Some experiences related to climate change are higher temperature, rapid evaporation from soil, the spread of agricultural pests and weeds on cropland, heavy rain and hail, delayed rainfall, and unclear season (Apata, Samuel and Adeola, 2009; B. et al., 2012; Setiawan, 2012; Obayelu, Adepoju and Idowu, 2014; Elum, Modise and Marr, 2017).

Banyumas District is one of the main producers of food crops in Central Java, Indonesia. However, this area is not free from the impact of climate change. The impact of climate change in 2014, among others are the expanding paddy fields affected by drought up to 153.35% compared to the previous year; the increase in the number of paddy fields that affected by plant-disturbing organisms with 87.40%; and flood that affect 1,313 ha paddy field. The effect of climate change in 2015 is more controllable because the local government performed Special Effort (upaya khusus-UPSUS) program as an effort to minimize the impact of El Nino. However, some problems still occur, compared to the previous year there is an increase in the number of paddy field affected by drought by 44.83% and 26.15% experienced crop failure, there is an increase in plant disturbing organisms attack

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by more than 781.14%, but there is a decline flood areas by 94.21% (Department of Agriculture, Food Crops and Horticulture, Central Java Province/Dinas Pertanian tanaman pangan dan Hortikultur Provinsi Jawa Tengah, 2016).

To solve the problems related to climate change, adjustments are needed in the agricultural sector in the form of planting time shift, types of plants, changes in seeds or other technological changes (Hassan and Nhemachena, 2008; Falco, Veronesi and Yesuf, 2011; B. et al., 2012; Tambo and Abdoulaye, 2012; Bryan et al., 2013; Sukartini and Solihin, 2013; Abid et al., 2015; Elum, Modise and Marr, 2017). This adaptation will increase crop productivity (Falco et al., 2011; Elum et al., 2017). The adjustment process or adaptation is a process performed by the community that will improve their ability to face uncertainty in the future (Elum et al., 2017).

Farmer's decision in adjusting their farm does not happen independently, it is related to farmer's demography, culture, economic changes, information technology transformation, government policy, capital, and labor (Adger, Arnell and Tompkins, 2005). Several parties are involved in the process, including the government as a policymaker and private industry as the producers of factors of production (Smit and Skinner, 2002). Government as the policymaker will affect farmer's adaptation process through various decisions taken, such as the policy concerning the improvement in the access to water, assistance with the supply of factors of production, and improvement of infrastructure (Vermeulen *et al.*, 2012).

Two processes must be passed by farmers in adaptation to face climate change: will they adopt new technology and how many will they adopt. Before conducting adaptation, firstly they need information on the perception of climate change and its impact, and the obstacle experienced by farmers (Tambo and Abdoulaye, 2012).

There are different views about the behavior of farmers, Neo Classical views that farmers are rational creatures. Rational decisions require complete information and resources, while farmers have these two limitations (Simonsen, 1994; Kasper and Streit, 1998). The behavioral economic argues that human has cognitive limitation and sometimes made an irrational decision (Johansson-stenman and Brekke, 2014). One theory that develops about behavior is "protection motivation theory". The theory is based on several previous studies that can be applied to understand the behavior of farmers facing climate change. Farmers who understand that the impacts of climate change will be a threat and understand their capabilities and have confidence that adaptation actions will minimize the impacts of climate change, so farmers will tend to adopt adaptation behavior (Duinen et al., 2015; Truelove, Carrico and Thabrew, 2015; Bagagnan et al., 2019; Luu et al., 2019).

Farmer's decision to conduct adaptation needs adaptation capacity. Adaptation capacity as one of the approaches to find adaptability is a modification from Colman & Young (1989) who classified farmer's willingness to adopt technology into five types; innovator; early adopter; early majority; late majority and laggards. Colman & Young (1989) also state that farmer's decision to adopt new technology is determined by the farmer's technical assessment on that technology, economic ability and opportunity, and social factor.

Adaptation capacity according to Intergovernmental Panel on Climate Change (2014) is the ability to adapt oneself, take advantage of the opportunity to increase their profit, or to solve the consequence of the choices they make. Adaptation capacity is related to the ownership of resources needed to conduct adaptation (Adger and Vincent, 2005). One of the approaches used to assess adaptation capacity is a sustainable livelihood approach based on the availability of five types of assets: human capacity, social capacity, natural capital, physical capacity, and financial capacity (Williges *et al.*, 2017). Limited farmers' resources will hamper the adaptation process (Williams, Crespo and Abu, 2019). This study modifies the classification of farmers based on their adaptation capacity into two types, farmers with high adaptation capacity and low adaptation capacity.

The classification of farmers will facilitate farmers to improve their adaptation capacity which is needed to minimize the impact of climate change that will continue to occur in the future. The study on the perception towards climate change has been done in several African countries (Adger and Vincent, 2005; Deressa, Hassan and Ringler, 2011; Teklegiorgis et al., 2016; Elum, Modise and Marr, 2017; Williams, Crespo and Abu, 2019). Similarly, the study on the adaptation capacity also has been conducted in Europe (Williges et al., 2017), while studies on the adaptation capacity in Indonesia is

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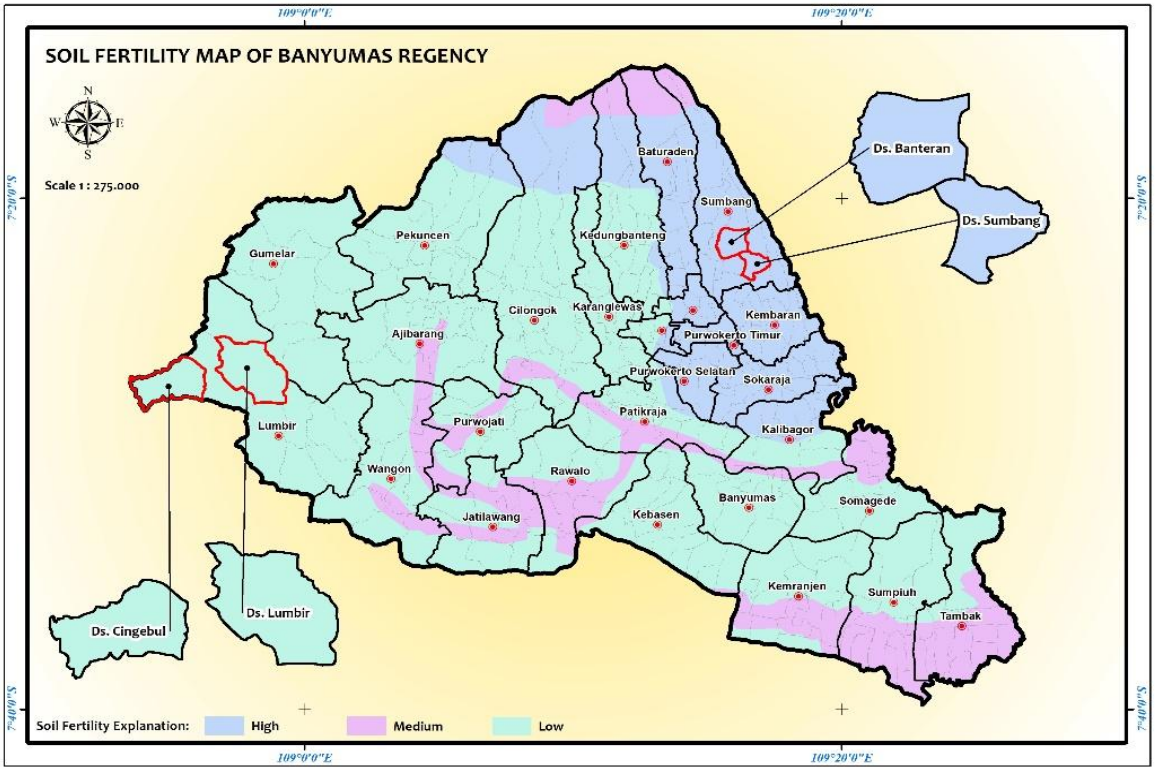
still very limited, one of the studies in this topic is Sumaryanto (2012) research. Thus, a study on farmer's perception toward climate change and adaptation capacity in facing climate change especially in Indonesia is important to be done.

2. Data and Research Method

This study uses primary and secondary data and farmers as unit analysis. The primary data are collected from farmers and include demographic data, perception of climate change, ownership of resources, and farming business. The secondary data is collected from the official government institution, consist of geographical data, climate change, paddy production, and agricultural policies.

The target population in this study is rice farmers in sub-districts with fertile and infertile land based on land type and rainfall. Soil fertility will affect farmer's behavior, firstly it encourages adaptation activities (Bryan et al., 2013) and secondly, it inhibits adaptation activities (Falco, Veronesi and Yesuf, 2011). The sub-district that is the target population are Sumbang sub-district which is a fertile area and Lumbir sub-district which is an infertile area (Farming and Food Resilience Office of Banyumas Regency/Dinas Pertanian dan Ketahanan Pangan Kabupaten Banyumas, 2018). The determination of villages in both subdistricts uses a multistage cluster sampling method with consideration of the area of irrigated paddy fields and the area of the largest rainfed rice fields. Based on these criteria, the village selected from the Lumbir sub-district are Lumbir and Cingebul village, the village selected from the Sumbang sub-district are Banteran and Sumbang village. The total population of farmers in the four villages was 8,829 farmers. Using the Slovin's formula, a total sample of 100 farmers was obtained and selected proportionate randomly. The map of soil fertility and rainfall of Banyumas District is provided in Figure 1 and Figure 2.



Source: Farming and Food Resilience Office of Banyumas Regency/Dinas Pertanian dan Ketahanan Pangan Kabupaten Banyumas (2018)

Figure 1. Soil Fertility Map of Banyumas Regency

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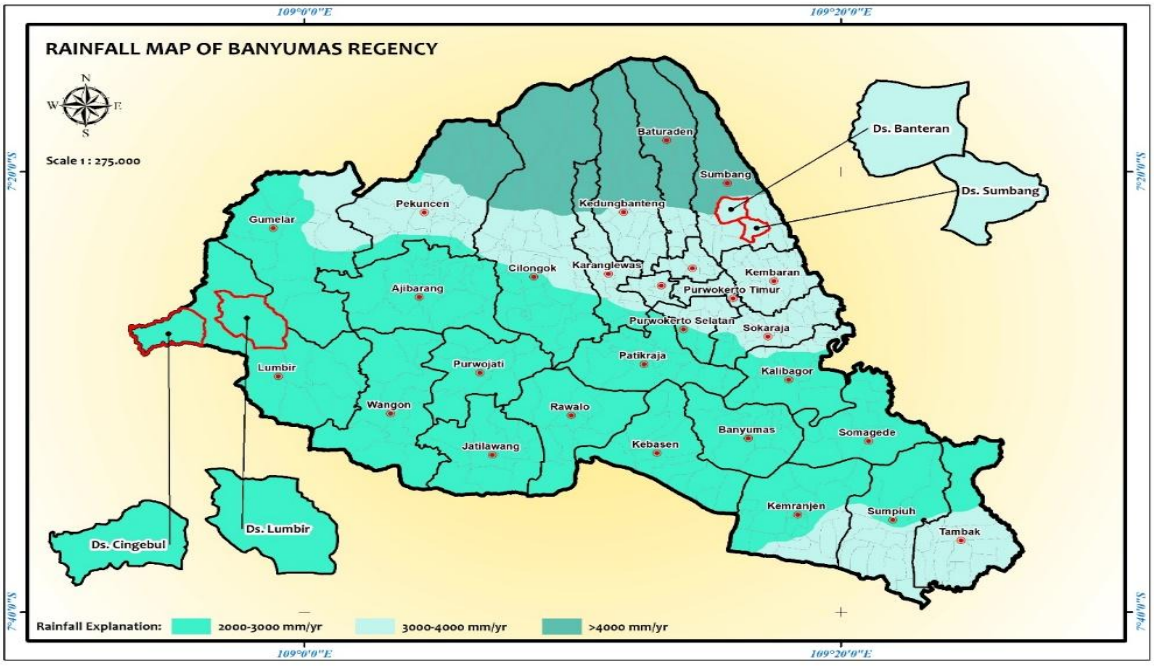

Source: Farming and Food Resilience Office of Banyumas Regency/Dinas Pertanian dan Ketahanan Pangan Kabupaten Banyumas (2018)

Figure 2. Rainfall Map of Banyumas Regency

The analytical technique used to understand farmers' perceptions about climate change is tabulation analysis, as in previous research, namely Deressa, Hassan and Ringler (2011); Teklegiorgis et al. (2016); and Elum, Modise and Marr (2017). To examine adaptation capacity, this study employs internal and external (IE) factor analysis techniques and used a sustainable livelihoods approach. The measures used for human capacity are the interest in becoming farmers, the interests of farming, the desire to adapt technology, the level of education, attitudes to information and the age of farmers. Social capacity uses a measure of ease of access to doing farming. Natural capital uses a measure of land ownership. Physical capacity uses a measure of the distance of residence to the input market. Access to finance uses a measure of purchasing power and access to credit. In addition, it is added by the number of family dependents, local government policies, and food availability. Adaptation capacity is measured in the category, the farmer that has high adaptation capacity (has IE score above average) and farmers with low adaptation capacity (IE score below average).

3. Analysis and Discussion

1. Farmer's Resource Capacity

Five farmers' resources in a sustainable livelihood approach are human capacity, natural resources, social capacity, physical capacity, and financial capacity. The average condition of farmers for each resource is: human capacity seen from the indicators used is in pretty good condition. Based on experience, the average farmer has enough experience, along with the age of farmers, increasing age will increase the experience they have. In addition, having the seriousness of farming by providing enough time, aims to obtain benefits. Farmers have the desire to develop their farming business with their willingness to implement technology as a solution to overcome the problems they face. Most farmers have limited levels of education, this causes a lack of awareness to actively seek information related to their farming business.

The social capacity of farmers is quite good with indicators of ease of doing farming. Farmers have easy access to production and market factors. The natural capital owned by farmers is not very good because the size of land ownership is still narrow, an average of less than 1 hectare, and depends on the leased land. The physical capacity is in a fairly good condition, although the distance between the house and the input market is quite far, it has adequate infrastructure, making it easy for farmers to

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obtain a factor of production. The financial capacity of farmers is not good enough, the indicators used are low purchasing power and limited access to finance.

2. Perception of Climate Change

The perception of climate change is needed to minimize the impact of climate change. Based on the survey, not all farmers understand climate change. Farmer's perception of climate change is provided in Table 1.

Table 1. Number of Farmers based on their Perception of Climate Change

Farmer's Perception	Number of Farmers (%)
Heard about climate change	
a. Yes	39
b. No	61
Source of information	
a. Counseling Officer	28
b. Other farmers	3
c. Media (newspaper, television, radio)	21
d. Others	1
Knowing about the increase in temperature	
a. Yes	24
b. No	76
Has an experience on the increase in temperature	
a. Yes	22
b. No	78
Knowing about the change in precipitation	
a. Yes	63
b. No	37
Has an experience on the change in precipitation	
a. Yes	63
b. No	37
Has the experience of difficulty in finding a water source for the farming	
a. Yes	63
b. No	37
Seasons are more predictable	
a. Yes	8
- Easy to get information	4
- There is no change compared to the previous period	5
- Others	1
b. No	92
- Season changed faster	79
- Different from the previous period	86
- Others	3

Source: Primary data analysis (2019)

The result of this study shows that most farmers (61%) have heard about climate change. The main source of information for climate change is agricultural extension (28%) and media (21%). Agricultural extension has an important role to develop the agricultural sector, in the form of cultivation techniques and information sources such as climate change. The other main source of information is the media.

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Of the two main indicators of climate change, namely an increase in temperature and rainfall, farmers understand better the change in rainfall (63%) than the increase in temperature. Because this will affect their farming business directly through the difficulty to find water sources. This is in line with the projection from BMKG which states that Banyumas District is included in the areas that experience a widespread decline in precipitation, even though in mild intensity (BMKG, 2019).

The limited knowledge of climate change causes farmers that unpredictable seasons are temporary phenomena and will return to normal. The experience of farmers regarding climate change confirms previous research which states that there is higher temperature, late rainfall and unclear season (Apata, Samuel and Adeola, 2009; B. *et al.*, 2012; Setiawan, 2012; Obayelu, Adepoju and Idowu, 2014; Elum, Modise and Marr, 2017).

The impact of climate change that is directly experienced by farmers is a shift in planting time (72%), increased pest (65%), declining crop yield (63 %) and more persistent pests (61%). Complete list of the farmer's experience concerning climate change is provided in table 2.

Table 2. Number of Farmers based on their Experience with Climate Change

Climate Change Impact	Number of Farmers (%)
On farming business	
a. Decreased yields	63
b. Crop failure	20
c. Increased pests	65
d. Persistent Pests	61
e. The shift in Planting time	72
f. Flood	19
g. Others	2
On the livelihood	
a. Considering to change the livelihood	16
• Farming does not provide sufficient results	14
• Farming does not provide bright future	5
• Difficult to obtain production factors	6
• Difficult to sell harvest yields	1
• The climate is hard to predict	2
• Others	1
b. No	84
• Farming provides sufficient income	20
• Farming has a good future	3
• Do not have other skills	73
• Do not have appropriate resources	67
• Others	16

Source: Primary data, 2019

The impact of climate change on their farming has confirmed previous research which states that climate change causes the increase in the number of pests and diseases, the decrease in crops yields, or a more severe condition will result in crop failure (Gornall *et al.*, 2010; Sukartini and Solihin, 2013; Elum, Modise and Marr, 2017). Climate change also affects their livelihood (table 3). There is a small number of farmers who consider changing their livelihood. The reason for this is besides the climate problem, also the low income which results in agriculture not being an attractive livelihood. Farmers who do not own the willingness to change their livelihood are in a larger percentage compared to farmers who want to change their livelihood, even though the main reason is the limited resources available.

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2. Adaptation Capacity

Based on the identification and information obtained, this study prepares the internal factors that consist of five strength and six weaknesses, and external factors that consists of four opportunities and three threats. The internal factors are described in Table 3 and the external factors are described in Table 4.

Table 3. Respondent's Internal Factors

No.	Internal Factors	
	Strength	**Weakness**
1	The low number of dependents	Have a low education level
2	Have sufficient experience in farming	Low awareness to find information about farming
3	Has high interest on farming	The far distance between house and input market
4	Willing to perform adaptation	Farmers are old
5	Respondents farming depends on the available rental lands	Low purchasing power according to the income and spending level
6		Limited access to the sources of funding

Table 4. Respondent's External Factors

No.	External Factors	
	Opportunity	**Threat**
1	The ease of access to perform a farming business	Climate change
2	Strategic plan for 2013-2018 Department of Agriculture, Plantation and Forestry of Banyumas District which aims to develop food crops	Farmers are not the main focus in livelihood
3	Government regulations that support farmers' welfare through counseling and assistance, improvement of incentive through farmers group and other activities	The slow development of technology for climate change adaptation due to limited resources
4	Food availability (rice) is sufficient to fulfill the respondent's needs based on expected food pattern (Pola Pangan Harapan)	

The average farmer's IE score is high with 3.34. This score shows that adaptation capacity is quite high. This means that with the limitation in knowledge on climate change, farmers try to adjust their farming to survive. Farmer's age in line with their experience, become one of the factors for farmers to perform technology change to adapt to the climate condition. This is in line with Colman & Young (1989) who state that one of the sources of technological change at the farmer level is "learning by using", in conducting their farm, farmers will always learn on how to maximize their production.

The government has an important role to play in increasing the adaptive capacity of farmers. One of them is through policies that encourage increased production and farmer welfare. This policy is an opportunity for farmers to increase their adaptation capacities, such as increasing information on climate change and technological developments and the ease of obtaining production factors. These findings confirm the studies of Smit and Skinner (2002) and Vermeulen *et al.* (2012) on the role of government in the adaptation process.

Based on the categories, farmers with above-average IE score or have high adaptation capacity is 58% and 42% have low adaptation capacity. This is due to the limited resources owned by farmers. These results confirm previous research from Takahashi et al. (2016) and Williams, Crespo and Abu, (2019) which states that increasing adaptation capacity is in line with increasing ownership

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of farmers' resources. Williges et al. (2017) also state that financial capacity will increase adaptation capacity with sustainable livelihood approach.

4. Conclusion

This study shows that farmers' knowledge and information on climate change is still limited and relies on information from agricultural extension. Limited knowledge causes farmers to only pay attention to climate change indicators that have a direct impact on the production process such as rainfall, without understanding that increasing pest attacks and decreasing production are also part of the problems caused by climate change. Farmers also have limited resources, which causes 48 percent of respondents are still low in adaptive capacity.

The low understanding of climate change must be addressed immediately because climate change will continue to occur. Farmers' understanding can be improved by optimizing the role of agricultural instructors and the media, as well as community leaders to transfer information, risks and adjustments that must be made to minimize the impact of climate change. Limited resources which are an important factor for increasing adaptation capacity can be supported by providing technical assistance and increasing access to funds from the government to facilitate the adaptation process.

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