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THE IMPACT OF CLIMATE CHANGE AND ADAPTATION STRATEGY OF ARABICA COFFEE FARMERS IN CENTRAL ACEH REGENCY

Achwan Syamratul, Hamid Ahmad Humam*, Romano

Master Program of Agribusiness, Faculty of Agriculture, University of Syiah Kuala, Indonesia

*E-mail: syamratulachwan14@gmail.com

ABSTRACT

The climate change and adaptation strategies for Arabica coffee farmers in Central Aceh Regency; the research that discuss the impact of climate change on Arabica coffee farming and how is the adaptation strategies of Arabica coffee farmers in Central Aceh Regency. The method used in sampling techniques is *simple random sampling* with 40 people were sampled. The analytical tool is a questionnaire given to arabica coffee farmers involved in coffee farming. From the results obtained, there are three categories of adaptation strategies undertaken by farmers in overcoming or mitigating the risk of impacts from climate change. These strategies include making *rorak* (dead-end trenches), planting *shade plants* and conducting water conservation. The study showed that the farmers was made the *rorak* manually by digging a 3 x 1 meter width and with 20-50 cm height, then the *rorak* excavation soil was used as a mound of soil that serves to hold water. The percentage of *shade plant* grown by coffee farmers in Central Aceh Regency are: *lamtoro* (65%), *avocado* (65%), *kopyor orange* (65%), *jackfruit* (47.5%), *gayo tangerine* (52.2%), *banana* (55%), *durian* (52.5%), *mahogany* (60%) and *sengon* (62.5%). Water conservation carried out by coffee farmers in Central Aceh Regency is by making infiltration wells that functioned as groundwater reserves in long droughts. As much as 66.5% of Coffee farmers in Aceh Tengah Regency experience the symptoms of climate change.

KEY WORDS

Strategy, adaptation, climate change, coffee farmers.

Indonesia is the third largest coffee producing country in the world today after Brazil and Vietnam. Gayo Arabica Coffee is one of Indonesia's leading export commodities which have been known in the domestic and international markets. Arabica coffee began to be cultivated in the Gayo highlands around 1924 brought by the Dutch, after the completion of the construction of the road from Bireun to Takengon in 1913. Arabica coffee was first grown in the Paya Tumpi Village area, and then spread to the Blang Gele Burni Bius area, Redines, Bergendal and Bandar Lampahan, but the cultivation is still limited to Dutch people and few among local people. Broad cultivation began only at the beginning of Indonesian independence in 1945 (Renes, 1989).

One of the famous national coffee production centers in Indonesia is in Central Aceh Regency. It can seen in Table 1.

Table 1 – Extent of Planting and Production of Arabica Coffee of smallholders plantation by Year in Central Aceh Regency, 2015

Year	Extent of Planting (Ha)	Production (Ton)	Produktivitiy
2012	48.300	25.370	0,525
2013	48.300	25.927	0,536
2014	48.300	26.852	0,556
2015	48.300	25.927	0,536

Source : BPS of Aceh Tengah Regency (2016).

Based on Table 1 above, it can be seen that the production reached 26,825 tons in 2014, with 0.556 Ton / Ha productivity, which is increased if compared to 0.536 Ton / Ha productivity in 2013 and 0.525 Ton / Ha in 2012, while in 2015 the productivity began to

decline to 0.536 Ton / Ha. This shows that Aceh Tengah has unwittingly begun to enter an irregular climate.

We realize that plantation crops sectors are very dependent on climate change. A supportive climate will help agricultural productivity increase so as to provide abundant benefits for farmers. But on the contrary, a unfavorable climate change can causes fluctuating profits and even tends to decline for farmers. Coffee farmers in Central Aceh are no exception.

Climate change has potential for the community environment. Environmental changes that occur generally harm the lives of humans and other creatures, these environmental changes result in various disasters such as floods, droughts, landslides, and storms. A recent severe climate change occurred in American with storm, which took lives, property and socio-cultural arrangements (Patz, 2005).

Climate change is no longer an issue, climate change is a fact that must be faced by people on this earth, climate change is not only a used for academics, government and business purposes, simply because this topic has become the main topic in public because of they felt its direct and tangible impact. Mass media; print, electronic and online, also enliven the topic of climate change, including reporting the challenges, opportunities and practices of the community in an effort to prevent and adapt to climate change.

Humans are one of the causes of climate change with the increasing number of population; they exploit natural resources and process them for the needs and welfare of their lives. So that globalization movement emerged which caused the impact of global and local environmental changes (Achmadi, 2008). Erratic climate change causes various problems both in food crops and health that spread rapidly. Some micro-organisms in the resting stage can be found at low temperatures. After the temperature rises the microorganisms will develop from a variety of disease outbreaks that have been described by scientists as a result of global warming and carbon dioxide would rises by twice and four times from 1990 in the span of 100 years and it would increase sea level by 0.25 m (Latif, 1996).

The impact of limate change to the agricultural sector is damage (degradation) and a decrease in the quality of land and water resources, agricultural infrastructure, decreased production and productivity of food crops, which can lead to threats of vulnerability and food insecurity and even poverty. This makes the farmers confused about climate change, such as the high frequency of rain which does not even stop, for example the coffee plantations of farmers are damaged due to too often rain. Pest attacks also reduce crop production. Farmers are in dire need of information about climate, but weather forecast information is sometimes inaccurate so farmers do not get the accurate information.

Adaptation is needed for climate change impacts on agriculture with the support of innovative and adaptive technologies. Even the agricultural sector policies in dealing with climate consider the position of adaptation efforts as strategic and top priority. Adaptation efforts are seen as a rescue step so that Arabica coffee farmers and coffee farming marketing targets can be achieved. To be easily implemented, the efforts to anticipate climate change impacts require clear socialization and guidelines, including adaptation strategies and action programs.

The purpose of this research are:(1) to describe coffee farmers' perceptions and responses to climate change symptoms in Central Aceh and (2) to find out the adaptation strategies of Arabica coffee farmers in Central Aceh in reducing the risk of changes climate.

METHODS OF RESEARCH

Determination of the location of the research was carried out intentionally, took place in Central Aceh, with consideration that this area prone to an erratic climate against arabica coffee farmers. The object of the study was Arabica coffee farmers who were involved in Arabica coffee cultivation in Central Aceh Regency.

The scope of the research is focuses on the impacts of climate change in Central Aceh on Arabica coffee plantations and the adaptation of Arabica coffee farmers and the

formulation of strategies to overcome the impacts of climate change. The sampling method carried out in this study is simple *Random Sampling Method* in which the sampling method is taken from all members of the population randomly without regard to certain values or sequences in the population (Nasution, 2004).

The population in this study is 249,282 Arabica Coffee Farmers (BPS of Aceh Tengah Regency, 2016) which is the Central Aceh Regency Community. With that large population, 80 samples were taken. Based on Roscoe (1975) quoted by Uma Sekaran (2006) provides a general reference to determine the sample size; the sample size of more than 30 people and less than 500 people is appropriate for most studies. In this study, Arabica coffee farmers in the location that has been determined will be sampled and was willing to fill out a questionnaire prepared by the researcher. The data collected in this study consisted of primary and secondary data. Primary data is data obtained from direct observation through research objects. Secondary data is data obtained directly by conducting interviews and direct observation.

RESULTS AND DISCUSSION

In this study, an analysis was conducted to find out the perception of coffee farmers in Aceh Tengah towards climate change. The data analysis is done using the *logit* model. The data collected is then processed into *Eviews 8* software. The *logit* model implemented has dependent variable (Y) with binary categories (1 and 0). Where, the number "1" is a farmer who perceives that the climate starts to change and the number "0" is a farmer who perceives that the climate remains (unchanged).

The results of *Tobit* regression analysis can be seen in the following table:

Table 2 – Results of Tobit regression analysis with 5% confidence level

Variable	Coefficient	Probability	z-Static
Age	-0.042481	0.4331	-0.783924
Education	-0.063824	0.7157	-0.364175
Experience	0.003344	0.9467	0.066885
Anxiety	-0.374544	0.6577	-0.443140
Role in Groups	-0.069464	0.9352	-0.081319
Constants	3.421290	0.2348	1.187979

After regression, odd ratios need to be searched to acquire the logit model. Odd ratio = $e^{\text{coefficient}}$, where the value of $e = 2.72$. Therefore, the resolution can be seen in the following table.

Table 3 – Odd Ratio value

Variable	Regression Coefficient	Odd Ratio = $e^{\text{Regression Coefficient}}$
Age (X1)	-0,042481	0,958382949
Education (X2)	-0,063824	0,938132268
Experience (X3)	0,003344	1,003351717
Anxiety (X4)	-0,374544	0,687440041
Role in Groups (X5)	-0,069464	0,93285277

Then the *logit* model in the research that can be found out is:

$$\text{Logit}\{E(Y_1|X_i)\} = \text{Logit}(P_i) \ln \frac{p}{1-p} = 3,421 + 0,958X_1 + 0,938X_2 + 1,003X_3 + 0,687X_4 + 0,932X_5$$

In the *Age* variable, it can be concluded that the older the age of a coffee farmer, the stronger the perception of climate change. Royhan (2014) has the same conclusion that the older the age of the farmer, the higher the productivity in farming and mindset in farming.

As well as *Age*, in *Education* variable, the higher the education of farmers, the more they perceive a climate change in Central Aceh. Kurniawati (2012) concluded that education

is a significant factor in perceiving climate change. Because education can help influence peasants to do something in adapting themselves in climate change.

In the third variable, *Experience*, it has the same interpretation. The more experienced the coffee farmers, the more prominent the perception of climate change if compared to the farmers who have less experience. In Rudi's study (2013), experience is an indicator to determine the perception of climate change. He concluded that the more one's experience with farming, the more sensitive the farmer will be in his farming environment. Likewise stated by Nurcahya (2015) in an empirical study he concluded that experience significantly influences the perception of climate change.

In the Anxiety variable, the farmers who feel anxious are 0.68 times more they perceive the climate change would occur if compared to the farmers who have less feeling of anxiety about coffee plantations. In Sumardi's research (2015), anxiety on climate change is a variable that can be used to measure perceptions. He reveals that the greater the level of anxiety of a person means that the more sensitive they perceive to climate change that occurs towards his farming.

The fifth variable is *the role in the farmer group*. It can be seen in the table that can be interpreted that if the farmer does not belong to any farmer group, the perception of climate change is also less perceived. Elyzabeth (2013) stated that the level of human intensity in meeting will affect education, skills, environment and information. The results obtained in this study are supported by the theory; if coffee farmers in Central Aceh Regency often socialize in groups, then there is a possibility that information about climate will be obtained which can affect the perception of individual farmers.

Adaptation Strategy:

- There are various ways of adaptation strategies for climate change to reduce risks that are likely to occur. This adaptation strategy is used by coffee farmers in Central Aceh in an effort to increase or maintain the productivity of coffee plants.
- In Frank and Eakin's research (2011) there are several flexible adaptation strategies that can be applied to coffee cultivation. The strategy is done by replacing superior seeds, composting, increasing water usage, planting *shade plants*, varying planting schedules, and conducting soil conservation.
- On the other hand, to maintain the welfare of coffee farmers towards climate change, it is necessary to diversify income. This means that coffee farmers can carry out other farming activities such as the livestock or non-agricultural sectors. This was stated by Anna (2016).
- In this study, the climate change adaptation strategy undertaken by coffee farmers in Central Aceh is done by making *Rorak* (dead-end trenches), planting *shade plants* and conducting water conservation. *Rorak* (dead-end trench) is one of the soil conservation techniques as a water absorption hole during the dry season. Usually, *rorak* is made with a length of 3 meters and a width of 1 meter with a height of 40 cm to 50 cm. *Shade plants* are plants used as canopies in coffee plants, this *shade plant* is jackfruit and petai. Water conservation is an adaptation strategy which is done by managing water for coffee crop irrigation and carried out by coffee farmers in Central Aceh.

Types of Adaptation Strategies. There are three types (ways) of climate change adaptation strategies used by coffee farmers. Those are: (1) making *rorak* (dead-end trenches), (2) planting *shade plants* and (3) carrying out water conservation. In Figure 1 below, it can be seen that there are 48% of farmers who use adaptation strategies by making *rorak*. There are 38% planting *shade plants* and 13% of 40 farmers who carrying out water conservation.

The findings obtained from this research are that (1) coffee farmers in Central Aceh assume that making *rorak* is far more economic and efficient to carry out climate change adaptation strategies, (2) planting *shade plants* is also done by farmers as a climate change adaptation strategy. In addition to supplementing side income, coffee farmers in Central Aceh are also believe that the good coffee productivity is influenced by *shade plant*, especially when there is only little intensity of rainfall.

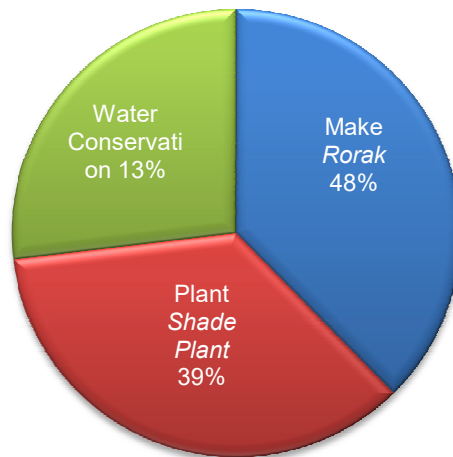


Figure 1 – Percentage of Adaptation Strategies for Climate Change in Central Aceh Regency

Making Rorak (Dead-end Trench). In this study, it can be summarized that making *rorak* (dead-end trenches) is a common strategy used by coffee farmers in Central Aceh. In addition to affordable operational manufacturing prices, *roraks* are also used as recharge and water reserves during the dry season.

Rorak making is done by individual farmers which is usually made with a size of 3 m x 1 m (length x width) with a height of 20 cm - 50 cm. The results of excavation from the manufacture of *rorak*, coffee farmers in Central Aceh made a mound of soil around the planting of coffee with a height of 10 - 20 cm and a width of 30 cm, while the length followed the length of farmer's land.

Planting Shade Plants. The second strategy commonly practiced by farmers is by planting *shade plants*. *Shade plants* can provide various functions, those are:

- Shading plant; can reduce the maximum temperature or minimum temperature for coffee plants. This function is more useful in the dry season;
- As a wind breaker; young coffee plants that are blown away by the wind can be detained or broken down by shade trees so they don't fall or are damaged;
- Can prevent erosion; the *shade plants* planted can maintain soil erosion or contour so that the coffee plant is maintained;
- As a side income; *shade plants* can also be a side income to meet the life needs of coffee farmers.

Variations in the percentage of *shade plant* grown by coffee farmers in Central Aceh can be seen in the chart below.

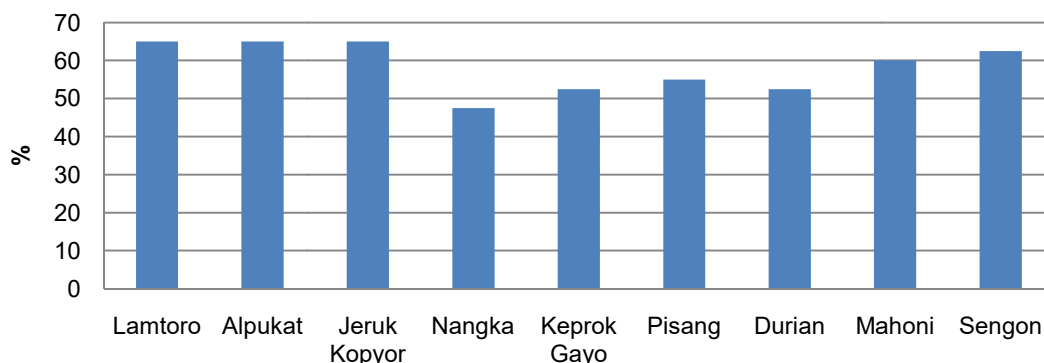


Figure 2 – Percentage of Shade Plants Used by Coffee Farmers in Central Aceh

There are nine types of shade plants used by coffee farmers in Central Aceh: *lamtoro*, *avocado*, *kopyor orange*, *jackfruit*, *gayo tangerine*, *banana*, *durian*, *mahogany* and *sengon*. But, Coffee farmers in Central Aceh prefer *jackfruit*, *bananas* and *avocados*. In addition to

increasing their income, the shade plant is also very suitable to be planted in the coffee plantation area. Meanwhile *jackfruit*, *gayo tangerine* and *durian* are plants that are rarely planted as shade plants around the coffee plantation area. This is because the three plants only become intercrops in some plantation areas owned by coffee farmers in Central Aceh Regency. Another thing that causes a small number of percentages (of the three plants) is the topography or slope/tilt mismatches in the coffee plantation area, because farmers are worried about landslides or other things that cause the plant to become damaged.

CONCLUSION AND RECOMMENDATIONS

As many as 66.5% of Coffee farmers in Aceh Tengah experienced the symptoms of climate change. From the *Age* variable, the longer the life of a coffee farmer in Central Aceh, the more sensitive they perceive the symptoms of climate change. *Education* factor of coffee farmers also provide the same conclusion; the higher the education of coffee farmers, the more sensitive they will perceive the symptoms of climate change. In the *Experience* variable, the more experience the coffee farmers have, the more sensitive they feel the symptoms of climate change. Then at the level of *anxiety*, it can be concluded that farmers who have higher anxiety will be more sensitive to feel the symptoms of climate change compared to farmers who have less anxiety. In the last variable, *farmers who are a member of a farmer group* will be more sensitive to the symptoms of climate change.

Climate change adaptation strategies done by farmers are by making *rorak* around coffee plants, planting *shade plants* and conserving water for coffee plants. The making of *rorak* is done manually by farmers by digging a 3 m x 1 m trench with a height of 20-50 cm, and then the *rorak* excavation is used as a mound of soil that serves to hold water. The percentage of *shade plants* grown by coffee farmers in Central Aceh Regency are: *lamtoro* (65%), *avocado* (65%), *kopyor orange* (65%), *jackfruit* (47.5%), *gayo tangerine* (52.2%), *banana* (55%), *durian* (52.5%), *mahogany* (60%) and *segon* (62.5%). Water conservation carried out by coffee farmers in Central Aceh Regency is by making infiltration wells that function as groundwater reserves in long droughts.

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