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| RESEARCH ARTICLE

The Adaptation Strategies Capacity of Cocoa Farmers in Facing Climate Change toward Sustainable Cocoa Farming in Bantaeng RegencyLaode Muh Zhafran¹ ✉ Eymal B. Demmallino², Nurbaya Busthanul³, Hamka Naping⁴, Amir Yassi⁵ andMuh. Hatta Jamil⁶^{1,2,3,4,5,6}Environmental Management Study Program, Graduate School, Hasanuddin University, Makassar, Indonesia**Corresponding Author:** Laode Muh Zhafran, **E-mail:** adezhafran4@gmail.com

| ABSTRACT

The aim of this study is to examine cocoa farmers' capacity to adapt to climate change in the Bantaeng district. This is a research study including qualitative-descriptive data analysis. This is a way of analyzing research data in order to arrive at a conclusion. Qualitative analysis is used to describe and characterize cocoa farming, as well as to analyze cocoa farmers' adaptation strategies in the research region. The findings indicated that cocoa farmers in Bantaeng, Gantarangkeke, and Tompobulu districts adapted by substituting coffee, cloves, and porang plants for their cocoa plants, but only in the Tompobulu region, where the plants had already matured. Cocoa plants are nearing the end of their useful lives.

| KEYWORDS

Adaptation strategies; Farmer capacity; Cocoa farming; Climate Change Impact

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1. Introduction

Climate plays a significant role in agriculture. Climate dictates the extent of agricultural activities in each region or ecological zone on Earth. Temperature, rainfall, humidity, photoperiod, and altitude are the primary components of climate that interact to form local weather (Opeke, 2015). Due to evapotranspiration effects, the cocoa output is extremely sensitive to changes in sunlight duration and density, rainfall and water application, soil condition, and temperature. Climate change, as has been extensively documented, also plays a significant influence in changing the development of cocoa pests and pathogens and affecting their interactions [Oyekale, 2009]. This results in decreased crop production, which has an effect on income and livelihood [gbongiarhuoyi, 2009]

Climate change has an effect on cocoa trees, which are dry-land crops that rely on rain for water [Sobari, 2015]. The physiological processes of the cocoa plant are directly or indirectly affected by the availability of adequate water [Utomo, 2016]. Due to these physiological requirements, cocoa plants are very vulnerable when water is scarce yet uniformly distributed throughout the year to support their development and productivity [Carr, 2011].

Climate change is a growing international environmental problem [Smith, 2003]. Climate change has a slew of negative repercussions that have a considerable influence on the long-term survival of human existence and other living things on this planet [Baer, 2012]. This phenomenon has an effect on changes in the physical and biological systems of the environment, such as increased tropical storm intensity, altered precipitation patterns, altered seawater salinity, altered wind patterns, altered animal and plant reproduction periods, altered species distribution, and population size, and altered the frequency of plant pest and disease attacks [Smit, 2004]. Numerous climate change-related factors, as well as farmer and agricultural policymaker reactions, will shape the future of Indonesian agriculture, as well as people's livelihoods and the country's welfare [Crane, 2011].

Climate change has happened, and its impacts are seen in plant life, livestock, and the natural environment [Thuiller, 2007]. Climate

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change may exacerbate the difficulty of controlling pests and diseases, as well as land degradation and other challenges. Climate change is caused by changes in temperature, pressure, humidity, precipitation, and wind. Rain is a necessary component of a stable climate, as both living creatures and the natural environment require it [Wang, 2008]. The blooming process that results in the development of fruit ovules is strongly reliant on the strength of the year-round rainfall that cocoa plants receive. Due to their dependency on cocoa trees, farmers must adapt to any foreseeable climate changes.

Climate change's effect is a significant concern in South Sulawesi Province, notably in Bantaeng Regency [Dewi, 2020]. Similarly, according to [Adiyoga, 2018], the agricultural industry in the Province of South Sulawesi was disrupted by a season change in 2018, emphasized by a reduced wet season. Then, in 2019, cocoa productivity in Bantaeng Regency was exceedingly low (0.6 tons per hectare), far less than the 1.5 tons per hectare that could be achieved [Sulawesi, 2020].

Cocoa is an agricultural product from Indonesia that has the potential to considerably contribute to the country's foreign exchange profits [Rifin, 2013]. Indonesian cocoa is ranked third globally, behind Gading Beach and Ghana [Emelda, 2014]. This is supported by Indonesia's continued abundance of cocoa-growing area, manpower, and knowledge [Rifin, 2013]. It is hardly hyperbole to assert that this potential may be developed further [Wardhany, 2018]. Cocoa (*Theobroma cacao*) is a potential foreign exchange earner, and local demand is increasing as the cocoa bean processing sector expands [Fahmid, 2018]. Cocoa culture begins with the production of high-quality cocoa seeds, which are created by the use of high-quality seeds from desirable varieties and suitable cultivation practices, one of which is composting cocoa pods [Yoseva, 2018]. Cocoa is a staple crop on Indonesian plantations and makes a sizable contribution to the country's economy. Cocoa fields in Indonesia spanned 1,700,351 hectares and produced 656,817 tons of cocoa in 2017 [BPS, 2017].

South Sulawesi Province's economy has remained reasonably active in Eastern Indonesia to date [Lamba, 2019]. Additionally, South Sulawesi Province has benefited from the completeness of facilities and infrastructure, as well as robust supporting infrastructure, the availability of potential and opportunities that are ready to be exploited, and the degree of support and devotion of the local government.

Cocoa plantations are spread over 22 regencies and cities in South Sulawesi, producing 116,650 tons and 871 kg of cocoa per hectare in 2013. After that, both output and productivity decreased to 102,696 tons and 102,696 tons, respectively, in 2016. The following data indicate a total increase of 13,954 tons spread among 21 regencies [BPS, 2018]. In 2017, the Bantaeng area has 5,400 hectares of cocoa plantations, producing 2,864 tons of chocolate and averaging 530 kilograms per hectare [BPS, 2018].

Along with a fall in productivity, this environmental shift has an indirect effect on farmers' socioeconomic circumstances, since the majority of cocoa farmers predict raising their agricultural enterprises' maintenance costs as revenue declines [Fatchiya, 2018]. As a result of these challenges, adaptive methods are necessary to solve them. Adaptive initiatives are a sort of reaction that finds novel approaches to the phenomena of climate change in order to address agricultural challenges [Winarto, 2013]. Farmers are adaptive owing to their expertise in agricultural management, and they are devoted to their farming enterprise's economic, social, and environmental sustainability [Fatchiya, 2010].

It is vital to understand the internal and environmental factors that impact farmers' adaptive ability for resolving their farming problems in light of these difficulties. Cocoa plants are evaluated for their adaptive ability in order to determine their level of potential or desire to embrace critical technology in response to commodities and geographical variables brought to them, both technically and managerially. As a result, a plan for enhancing cocoa farmers' ability to adapt to climate change is necessary for the long-term viability of cocoa production. As a result of this context, the purpose of this study is to characterize cocoa producers' potential for adapting to climate change in Bantaeng Regency. As a result of this context, the purpose of this study is to describe the capacity of cocoa farmers in the Bantaeng Regency to adapt to climate change.

2. Methods of Research

This research will take place in the Gantarangkeke Subdistrict of Gantarangkeke Village and Tompobulu of Patalassang Village, both located on the island of Sulawesi in the Bantaeng Regency. The research site was chosen precisely because it is located in the heart of South Sulawesi's chocolate-producing industry. The purpose of this study is to describe cocoa producers' adaptability capabilities to the phenomena of climate change in Bantaeng Regency using data analytic approaches, specifically a qualitative approach.

Qualitative research is more process-oriented and does not require quantitative analysis; qualitative research is also assessed on the basis of its quality, intensity, and frequency. Qualitative research stresses the social construction of reality, the researcher's close relationship with the topic under inquiry, and the constraints imposed by the setting (Prokopy, 2011).

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The nature of this study is qualitative-descriptive. The analytical methodology is a technique for examining research data in order to arrive at a conclusion. Qualitative analysis is used to describe and characterize cocoa farming, as well as to analyze cocoa farmers' adaptation strategies in the research region.

Following the interview, the researcher generated an interview transcript by replaying the audio and scribbling the terms that corresponded to what was recorded. Following the transcription of the interviews, the researchers conducted data reduction by abstraction, which comprises selecting material that is pertinent to the research issue and removing irrelevant data.

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3. Results and Discussion

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Adaptation to climate change in agriculture refers to a shift in cultivation techniques in response to actual or expected changes in the production system's climatic environment. This shift may be spontaneous (e.g., migration during periods of severe drought) or deliberate (e.g., adoption of a drought-tolerant variety) [Füssel, 2017]. Adaptation is usually associated with a cost, for example, in its simplest form, adaptation necessitates financial expenditures on physical infrastructure. Additionally, the work necessary to plan and implement a change in habits comes at the opportunity cost of not being able to devote the time to alternative activities [Bunn, 2017]. As a result, adaptation to climate change is frequently viewed as expensive, while inactivity is considered to be cheap. This contradicts the widespread belief that climate change is becoming a reality and that expected changes will have a large detrimental impact on cocoa output. Thus, cost-effective adaptation is a critical problem for the sector [Hansen, 2012].

The impact of climate change on the macroeconomic (macroeconomic) system may be viewed from both supply and demand perspectives [Tol, 2009]. However, the aggregate impact is determined by the supply side. Due to the fact that climate change may be viewed as a series of long-term and possibly sudden shocks to the supply chain [Dahlmann, 2019]. The capacity of cocoa farmers to adapt to climate change is defined by their ability to deal with the potential consequences of climate change on their social and economic situations.

According to the research on annual crop producers in underdeveloped nations, they are among the most vulnerable to climate-related hazards. Crop failures caused by climate-related hazards can have a detrimental effect on farmers' income, health, and livelihood [Meze-Hausken, 2008]. Vulnerability is a result of a lack of or insufficient adaptation capability, which is frequently the outcome of widespread poverty and an overdependence on rainfed agriculture [Atinkut, 2016]. Farmers with a limited capacity for adaptation are frequently unable to recover from production and revenue losses associated with risk exposure [Castells-Quintana, 2016]. Thus, it is critical to understand farmers' adaptation options and challenges to adaptation within their socioeconomic environment in order to better future climate change adaptation programs [48]. However, little study has been conducted to ascertain how households with varying socioeconomic backgrounds perceive climate change [Adu, 2018].

South Sulawesi province, notably the Bantaeng district, as well as the northern and eastern Luwu districts, is a major producer of cocoa in Indonesia. Indonesia, the third-largest producer of cocoa in the world after the Ivory Coast and Ghana, has been impacted by climate change [Ndamani, 2015]. This crisis was precipitated by the decline in cocoa plants caused by PBK (Cocoa Fruit Borer) insect infestations, which severely reduced cocoa output. Cocoa is a very weather-dependent product. Climate change, which results in year-round rain or a prolonged dry season, along with a lack of upkeep, exposes cocoa trees to pests and diseases. Gardens, which are defined by mature plants (>25 years), a population of less than 300 trees per hectare, and a low rate of productivity, have been seriously impacted. 500 kg per hectare Climate change is a global issue that demands regional adaptation solutions [Pelling, 2005].

Adaptive capacity has the capability to shift the system's position on the surface of high susceptibility to a lower degree of vulnerability by lowering sensitivity or exposure [Gallopin, 2006]. Due to the fact that high adaptive capacity may reduce vulnerability from a high to a low level, if a system's adaptive capacity is insufficient, it will have a high degree of vulnerability [Luers, 2005].

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The ability of the overall human system to adapt to changing selection pressures such as climate change (including extreme climatic variability) is characterized as adaptive capacity [Engle, 2011]. Climate change happens as a result of policies, procedures, or structures aimed at mitigating or eliminating potential damage, capitalizing on current possibilities, or mitigating their consequences. Hogarth & Wójcik (2016) discovered that a progressive method of assessing adaptive ability had a greater influence on transformation. Socioeconomic influences, technological advancements, infrastructural development, and government laws all have an effect on an individual's adaptive potential [Zhang, 2016].

Adaptation strategies are described as patterns of varied efforts organized by people in order to fulfill the bare necessities and address challenges. Farmers postpone rice planting as one of their adaptation tactics in response to climate change. This planting

time must be postponed with the consent of the local farmer group leader [Rahma, 2019]. Individuals' adaptation capacity is defined as their self-awareness of their potential to adjust to changes, starting with their perception and self-efficacy of all the effects of the changes they experience and utilizing all of their potential capacities to adapt to these changes. Adapt as a reactive adaptation after the influence on the social, economic, and ecosystem environment has been noticed. In order to apply innovation, it requires a process of adopting ideas, practices, or objects in a learning process of behavior modification (adaptation process) [Amfo, 2020].

Agricultural adaptation entails two distinct forms of system adaptation. The first is greater diversity, which entails engaging in drought-tolerant and/or temperature-stress-resistant producing activities, as well as activities that make optimal use of and maximize the benefits of prevailing water and temperature circumstances, among other aspects. Diversification of crops in the cocoa and non-cocoa subsectors helps protect against rainfall unpredictability, as various crops are impacted differently by climatic events. The second strategy focuses on crop management practices aimed at avoiding critical crop growth stages coinciding with extremely harsh climate conditions such as mid-season droughts. Crop management practices that can be used include adjusting the length of the growing season and altering planting and harvesting dates [Afriyie-Kraft, 2020].

Adapting to changing climatic circumstances requires maximal capability from both internal and external farmers, both of whom are impacted significantly by their social identity histories. Emphasis on how individual farmers respond to climate change via self-efficacy in utilizing all capacities. Farmers' capability is in critical need of an extension approach that begins with climate change adaptation knowledge, attitudes, and skills so that they can collaborate on developing a strategy.

Cocoa farmers in Bantaeng District, Gantarangeke District, and Tompobulu District have adapted by switching coffee, cloves, and porang plants for their cocoa plants, but only in the Tompobulu region, since the plants in Tompobulu District are no longer fruitful for cocoa plant development.

4. Conclusion

Adaptation strategies are defined as patterns of disparate efforts made by individuals in order to meet basic needs and overcome obstacles. One of the difficulties farmers in Bantaeng encounter is the effect of climate change. The adaptation strategy of cocoa farmers in Bantaeng District, Gantarangeke District, and Tompobulu District is substituting coffee, cloves, and porang plants for their cocoa plants, but only in the Tompobulu area, as the plants in Tompobulu District have reached an age where they are no longer productive for cocoa plant growth.

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