



THE IMPACT OF CLIMATE CHANGE ON PRODUCTIVITY AND FOOD SECURITY IN INDONESIA

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ABSTRACT

El Nino (drought) and La Nina (floods) effects of climate change will significantly reduce production and productivity in the agricultural sector, particularly in food crops. The availability and accessibility of food will be impacted by climate change, disrupting food security and vulnerability. This research aims to examine in more depth the impacts caused by climate change and ways that can be taken to mitigate the risks posed. This research was carried out using the PAR (Participatory Action Research) method through FGD (Forum Group Discussion), which was carried out with representative experts, such as academics, farmers, BULOG and BMKG. The results of the research show that there are many impacts caused by climate change on food security, such as drought and floods resulting in changes in the planting season, an increase in weeds, pests and diseases in plants, and increasing temperatures will cause crop productivity to decrease, causing a decrease in crop yields. So, in facing the challenges and impacts of climate change, there needs to be significant and continuous collaboration from all aspects of dealing with climate change so that food security is achieved. Providing complete information to farmers regarding the challenges and solutions in facing climate change, research that can be carried out to reduce and mitigate climate change, the existence of adequate availability aspects to support universal food security and agricultural adaptation in facing climate change as well as climate change adaptation strategies indispensable for sustainable food security.

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INTRODUCTION

The global climate is experiencing significant changes and has a severe impact on human life. The changes faced include changes in temperature, rainfall and wind patterns, the impact of which will be felt more by humans who depend on the agricultural sector (Ali et al., 2017; Li et al., 2017; Raza et al., 2019). Climate change also has an impact on farmers' crop production which only depends on natural conditions, especially in areas that are prone to drought or flooding. Seasonal food crops are the plants most vulnerable to the impacts of climate change, especially El-Nino and La Nina (Eitzinger et al., 2018; Sintayehu, 2018). Climate change will also cause an increase in water consumption, accelerated fruit/seed ripening, decreased harvest quality and decreased food crop productivity (Fahad et al., 2017; Korres et al., 2016)

In 2060 the IPCC reports that climate change will increase world temperatures by 0.6 and 2.50C (Kristvik et al., 2019). Climate is a determining and fundamental factor in cultivating plants (Azadi et al., 2019). If climate change experiences rapid changes, it will have a negative impact on plant productivity. If this change process takes place quickly and is very drastic, the plants will only be able to adapt slowly so that the plants are more vulnerable to damage by other living creatures, such as pests and disease (Adu et al., 2018). Because crops directly depend on weather, the agricultural industry is among the first to be impacted by climate change. (Pakmehr et al., 2020; Savari et al., 2020).

Climate change can impact sustainable development and is the most critical threat and endangers natural resources, the environment, and aspects of health, food, and the circulation of economic activities (Ghanian et al., 2020; Zobeidi et al., 2016). Besides that, climate change also threatens the agricultural sector with the potential for increased soil erosion, which will impact production results and the quality of the products produced (Kulmer et al., 2020; Nicholas et al., 2021; Pakmehr et al., 2021; Savari et al., 2020). So, it is very necessary to manage and improve land for food crops as an alternative to dealing with climate change (Toyibulah et al., 2022). It is because farmers are very vulnerable to climate change. After all, farmers' livelihoods depend on natural conditions (Mashizha, 2019). The occurrence of significant climate change will impact not only food production but also supply, farmer income and food security (Anriquez & Toledo, 2019; Asmare & Meheret, 2018; Firdaus et al., 2019).

Food security is one of the global issues listed in the 2030 Sustainable Development Goals (SDGs) agenda, namely to end hunger, achieve food security and better nutrition and support sustainable agriculture. The Food Security Agency (2018) stated that food security is a condition where food must be met for the people of the country up to the crossing, reflected in the availability of sufficient food, both in quantity and quality, safe, diverse,

nutritious, equitable and affordable so that it is able to meet aspects of human life needs. As an agricultural country with abundant natural wealth, Indonesia could not create a solid agricultural system from upstream to downstream when the climate change crisis occurred. This can be seen from indicators of weakening national food security with the increasing volume of imports of strategic commodities. This cause is caused by the low productivity of food commodities with increasing per capita demand and food consumption. So, this research is very interesting to carry out, where climate change is currently experiencing extreme weather and affecting national food productivity. Therefore, more specifically, this research aims to (1) find out the direct impact of extreme climate change in Indonesia, which farmers feel as agricultural objects on national food production, (2) Steps that can be adapted to mitigate changes in this climate to support independent food security in Indonesia.

RESEARCH METHODS

Method of Collectiong Data

This research was conducted in July 2023 in Medan City, North Sumatra Province. This research was conducted hybridly (online and offline) by inviting several stakeholders according to predetermined classifications and criteria. Several criteria were used to invite stakeholders, namely academics, farmers, BULOG and BMKG.

Data Analysis Method

This research uses the Participatory Action Research (PAR) research model in looking for something to connect the research process to social change. Using the PAR model as a model in this research is a form of active participation from stakeholders regarding potential and existing problems, as well as encouraging inclusion or participation in change activities that will be implemented (Rahmat & Mirnawati, 2020).

This research was conducted through FGD (Focus Group Discussion). The FGD was carried out with several stakeholders who had been invited and was carried out with the aim of creating adaptations that farmers could implement in facing climate changes that have frequently occurred recently. The FGD activity began with several trigger questions. The flow of FGD activities carried out will be described as follows:

1. This activity will begin with an opening by the moderator through trigger questions
2. For each question asked by the moderator, each stakeholder is free and allowed to respond in turn
3. Each stakeholder has the right to respond to the moderator's questions without any order in who responds first

4. Stakeholders are allowed to respond to statements from other stakeholders as long as they are still in the discussion category.

Some of the lighter questions are explained as follows:

1. What is Indonesia's role in supporting SDG number 2 in zero hunger?
2. Has the increase in productivity and implementation of food security that has been carried out in Indonesia gone well so that it supports SDGs number 2, 12 and 13 in zero hunger?
3. How far has this implementation been carried out?
4. Have the policies that have been stated been realized and mainstreamed farmers as core implementers in food handling?
5. One of the challenges of food security in Indonesia is climate change. In addition, given Indonesia's enormous population and dispersed geographic area, food security and satisfying needs are becoming increasingly crucial (in the case of rice goods). What steps has BULOG taken or will take in logistics management through inventory management, distribution and control of rice?
6. Management of food availability must be designed in such a way as to meet food needs in the future because food production is seasonal, limited and not evenly distributed between regions. What methods have been used to deal with food availability?
7. Data from GFSI shows that Indonesia's food supply availability is rated as poor, with a score of 50.9. Nutritional quality also only received a score of 56.2, while sustainability and adaptation scored 46.3. In these three indicators, Indonesia's food security is considered worse than the average for Asia Pacific countries. In supporting national food security, BULOG's main task is to maintain food security in the three main commodities, namely rice, corn and soybeans. What is BULOG's view of this?

RESULTS AND DISCUSSION

Impact of Climate Change on Food Security

Changes in air temperature and rainfall are among the parameters of the impact of global climate change, which is occurring in several regional areas in Indonesia. Apart from that, climate change parameters are also shown by temporal temperature and rainfall trends. The climate change phenomenon has implications for food crop production. Several research compilations state that in Indonesia, there is a potential negative impact of climate change on food crop production in the form of reduced productivity or increased pest and disease attacks (Perdinan et al., 2019; Spash, 2007).

Climate change not only impacts several regions in Indonesia, but almost all regions in Indonesia feel the impact of climate change as evidenced by declining agricultural productivity. Some declines in productivity are already visible. According to several studies, climate change has resulted in a

decline in global corn yields of 3.8% between 1980 and 2010 (Lobell et al., 2011). A recent study from IWMI also estimates that wheat production will experience a 50% decline in production by 2050. It will also have an impact on economic losses due to extreme weather conditions, which are increasing due to climate change. It is predicted that average temperatures will increase and rainfall patterns will change. Therefore, more severe events will likely occur due to the impact of climate change in the next few decades. Especially in countries close to the equator, they will feel more extreme impacts due to global warming.

The results of the FGD discussion stated that climate change is predicted to bring hotter and drier temperatures, changes in rainfall patterns, and extreme weather. It has been seen in several regions in Indonesia, where rice harvest usually occurs twice a year. However, recently, some regions have only been able to harvest rice once a year. It is due to extreme weather changes such as drought and floods, which farmers have often experienced in recent years. Several studies show that there is an increase in global average temperature from 1.80 to 4.00C, which is warmer than the end of the previous century (IPCC, 2007).

Sustainable Development Goals (SDGs) are one of the steps that can be adopted to reduce and deal with climate change. As one of the countries participating in the SDGs movement, Indonesia is committed to implementing its targets, including ending poverty by achieving food security and encouraging sustainable agriculture. So, through the National Food Agency, Indonesia is trying to measure the achievements of food security development as outlined in the Food Security Index (FSI) in a region. Food security is the availability and fulfilment of food for the country and individuals in sufficient quantity, quality, safety and quantity. It does not conflict with norms, religion, and culture in society, with the hope that people can sustainably live healthy, active, and productive lives. (Tono et al., 2021). Food availability, affordability and food quality and safety are a system connected to food security (Kementan, 2021).

Aspects of food availability include production, stock and the balance of food imports and exports. Management of food availability must be managed in such a way. Even though food is seasonal, limited and not evenly distributed throughout Indonesia, the volume of food is sufficient and the supply is stable from time to time. Fulfilling food consumption, especially rice as the main food ingredient, is an important aspect of provision, considering the population is increasing every year. In general, rice harvested by farmers will go through post-harvest activities such as drying and milling to produce rice. The rice is then stored for sale through supermarkets or wholesalers who sell the rice to retailers or small traditional markets. Another route is that small factories that process paddy into rice send the rice to Village Unit Cooperatives (KUD) or business units owned by the community, which then send the rice to the

Logistics Affairs Agency (BULOG). BULOG is a state-owned company that can sell rice at lower prices for household needs, especially to the less fortunate, through a rice distribution program called Beras Sejahtera (RASTERA). This effort shows the government's commitment to helping farmers and households access staple foods and maintaining food security.

Apart from that, the government is also trying to reduce dependence on imported rice to meet Indonesia's rice needs. It is proven in Table 1, which shows that in the 2019-2021 period, Indonesia's rice supply depended on imported rice, only 1.01% to 1.27%. Apart from that, the SSR value for rice also shows that rice production from 2019 to 2021 shows that most of Indonesia's rice needs can be met by domestic production, which means that Indonesia has achieved rice self-sufficiency. Even though Indonesia is facing extreme climate change, the government is making efforts to support farmers so that domestic rice production can be fulfilled without having to import rice.

Table 1. Import Dependency Ratio (IDR) and Self Sufficiency Ratio (SSR) Rice, 2019-2021

No	Description	Year (Tons)		
		2019	2020	2021
1	Production			
	- Grain	54.604.033	54.649.202	54.415.294
	- Rice	34.957.502	34.986.419	34.836.671
2	Export	1.075	852	3.753
3	Import	449.824	356.556	407.891
4	Production + Import - Export	35.406.251	35.342.124	35.240.809
5	IDR (%)	1,27	1,01	1,16
6	SSR (%)	98,73	98,99	98,85

Source: BPS

However, it is different for other food commodities, which can be seen in Table 2, showing that there are three main food commodities which have relatively high levels of dependence on imports, namely soybeans, sugar and beef. It is due to farmers' unpreparedness in facing extreme climate change, followed by high demand for these commodities. Apart from that, the government pays more attention to rice production compared to other commodities. So, to overcome this, there needs to be effective cooperation between all relevant stakeholders so that Indonesia is able to fulfil national food security.

Table 2. Import Dependency Ratio (IDR) and Self Sufficiency Ratio (SSR) other commodity, 2019-2021

No	Commodity	IDR (%)			SSR (%)		
		2019	2020	2021	2019	2020	2021
1	Corn	4,31	3,65	4,14	95,70	96,62	95,87
2	Soya bean	86,39	89,58	92,20	13,73	10,52	7,88
3	Chili	3,60	2,78	3,98	96,96	98,01	96,73
4	Onion	0,02	0,05	0,04	100,54	100,42	100,17
5	Sugar	64,79	72,65	72,72	35,27	27,94	32,08
6	Beef	28,54	27,31	32,90	71,47	72,70	67,11
7	Meat	0,00	0,00	0,00	100,01	100,01	100,00
8	Egg	0,04	0,04	0,04	95,03	97,06	99,96

Source: BPS and Ministry of Agriculture

Even though the majority of national food commodity production produces good production, the Global Food Security Index (GFSI) shows that Indonesia experienced a decline in its food security index score from 58 to 63. The decline in three indicators of the food security index in 2022 is due to a decrease in food quality and safety scores. One effort to increase the score of this indicator is by increasing the government's commitment to the agricultural sector in terms of financing, climate management and repairing and renewing damaged food ecosystems. Currently, the Ministry of Agriculture has carried out a program to provide people's food on a large scale, spatial planning and development of regional infrastructure for production center areas, as well as development of digital-based logistics, processing and added value, distribution and marketing systems. This program is known as a food estate, which is being developed in several regions in Indonesia. It is hoped that this will not only meet the GFSI criteria but that the program will continue and be evenly implemented in all regions in Indonesia.

Climate Change Mitigation on Food Security

Overall, climate change and food security have various interrelated risks and uncertainties. In a complex way, FAO illustrates food security with four parts, namely: (1) availability of food in sufficient quantities with appropriate quality, (2) easy access for individuals to obtain appropriate and nutritious food, (3) utilization of food through a diet that is good enough to achieve good nutritional conditions where all physiological needs are met, and (4) stability, in order to achieve food security, you must have adequate access to food at all times.

In the last 5 years (2015-2019), the agricultural sector has referred to the agricultural paradigm for development by making the agricultural sector a balanced and comprehensive driving sector, including demographic, economic,

cross-sectoral, spatial and institutional transformation, and development governance. It paradigm provides direction that the agricultural sector covers a broad and multifunctional range of interests. Apart from being the main sector for food security, the agricultural sector has other strategic functions, including resolving environmental and social problems (poverty, justice, etc.) as well as providing tourism facilities (agrotourism). This sector is very dependent on nature and will have an impact if global climate change occurs.

So, to face the challenge of climate change, the government's role is very necessary, especially in adaptation activities that require relatively high investment. Adaptation activities that can be carried out include: (1) developing and accelerating the adoption of farming technology that is more productive and adaptive to climate change, (2) providing effective agricultural infrastructure to support the application of climate change adaptive technology, (3) developing a climate information network -agriculture, (4) development of institutions to protect farmers against the negative impacts of extreme climate on farming and (5) input and output price policies for farming that are conducive to farmer income.

Apart from that, several other adaptations can be carried out by all relevant stakeholders, from the community farmers to the government, to reduce vulnerability and offset the potential damage caused by climate change to food security, including:

- a. Social capital, this adaptation is one of the steps that can be taken to deal with food security due to climate change by increasing opportunities to access various types of social support that are needed. For example, by assisting households that have low incomes, making it difficult to access food.
- b. Financial capital, where there is a direct subsidy policy from the government to support the agricultural sector and provide protection for consumers by guaranteeing food purchasing prices.
- c. Human capital, which includes competence, knowledge, characteristics and personality as well as creativity in creating economic value. For example, providing training/counselling to farmers to overcome climate fluctuations in fruit and prevent negative impacts due to climate change by providing education in the form of knowledge and skills in using technology used to deal with climate change.

Physical capital, where there is good management and provision of infrastructure and technology from the government that can support farmers in facing extreme climate change. Farmers who use good technology in the agricultural sector will accelerate the growth of food production and productivity so that they can create sustainable food security.

CONCLUSIONS AND POLICY IMPLICATIONS

Conclusions

Climate change has a very significant impact on national food security. Droughts and floods result in changes in the planting season and an increase in weeds, pests and diseases in plants; an increase in temperature will cause plant productivity to decrease, causing a decrease in crop yields. This sector is very dependent on nature, so appropriate steps are needed to mitigate climate change. Providing complete information to farmers regarding the challenges and solutions in facing climate change, research that can be carried out to reduce and mitigate climate change, the existence of adequate availability aspects to support universal food security and agricultural adaptation in facing climate change as well as climate change adaptation strategies indispensable for sustainable food security. Apart from that, collaboration and cooperation from all stakeholders is also needed to reduce the impact of climate change. With collaboration, reducing the impact of climate change will decrease and run well.

Suggestion

Based on the results of this research, researchers suggest that the government, especially the government of North Sumatra, provide education and fully support farmers facing extreme climate change, for example, by providing policies in the form of continued education in dealing with climate change, stability and accessibility of food. After these improvements, food output will increase, and food security will be achieved, ultimately improving the community's quality of life.

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