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MORALITY BEFORE KNOWLEDGE

The effects of climate change on agriculture and food security

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ABSTRACT
Background: Climate change is an environmental issue that affects a lot of human activities and causes damages to the Earth which of course will have linkages to the living creatures' life. Agriculture is a part of human activities that becomes a source of human life and influences food security. It also contributes to generating oxygen (O2) and absorbing carbon dioxide (CO2) in the air. As climate change is getting uncertain each time and influenced by some factors that make climate change getting worse, this gives some impacts on agriculture and food security. Besides, there will be other issues that come from agriculture and food security matters due to climate change, such as hunger due to food crisis, etc. Thereupon, we need to know the effects of climate change on agriculture and food security to mitigate and adapt to climate change. The objective of this literature study is to elucidate the impacts of climate change on agriculture and food security to understand the things that should be done to tackle the possibilities of bad impacts on human life. **Methods:** The method that was implemented was a qualitative method that utilized literature review to do the identification, evaluation and collecting information that was needed. Some papers and journals related to climate change, agriculture, and food security were used in literature review. **Findings:** Food production from crops and livestock is crucial for global food security. However, significant challenges to food production arise due to climate change and related factors. Heat exposure significantly affects livestock performance and welfare. Climate change also leads to soil erosion, resulting in decreased soil productivity, loss of carbon and organic nutrients, and reduced soil fertility. **Conclusion:** It is suggested to comprehend the effects of climate change on agriculture that will influence food security along with the well-being of people in running life.

KEYWORDS: climate change; food security; greenhouse gas emmisions.

1. Introduction

Climate change is a never-ending environmental issue that is always discussed each year even at an international conference. Basically, it happens naturally on Earth, but now it is fastened with anthropogenic activities such as deforestation, the use of fossil fuels, increasing livestock farming, and many more that trigger the increase of greenhouse gas on Earth which eventually causes climate change issues (Arora, 2019). All countries are struggling in various aspects of life, including in the fields of agriculture and food security which are increasingly becoming the focus of attention due to the COVID-19 pandemic situation and the uncertainty of climate change issues. Agriculture and food security are the two things that are tied together. Their food security and agricultural success indicate the

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welfare of the people of a country. Therefore, several things must be considered to achieve agricultural success, including food and safety.

Human activities and their interactions with the land, such as forestry and agriculture, have a considerable impact on the functioning of the Earth system. Agriculture, in particular, has increasingly become a critical sector for climate change adaptation and mitigation activities, as well as ensuring food security for a rising world population. Climate change and agricultural outcomes have an impact on our ability to meet at least seven of the seventeen Sustainable Development Goals (Loboguerrero et al., 2019). Some people consider climate change to be an environmental problem that is common and can be resolved quickly, where the handling must be completed by the government or other related parties who are responsible for this problem. Meanwhile, climate change worsens due to human activities, resulting in greenhouse gases or other factors influencing climate change. Besides, it influences the various aspects of life, particularly in agriculture and food security, which have relationships with all living creatures' life on Earth. Therefore, it is important to know and understand the impact of climate change on agriculture and food security. This knowledge will encourage awareness and readiness to take action to mitigate bad situations that may occur.

2. Methods

In order to compile all information needed in this journal, some journals were used and cited related to climate change, agriculture, and food security. The information was taken from the references which were found from various websites and reference app managers in a certain range of years when the references were published.

Agricultural systems are the fundamental connection between the climatic system and grassland, crop, and livestock production. Several possible indications were considered throughout this project. The following table (Table 1) lists indicators that match the requirements and have been evaluated for their viability as feasible indicators for detecting agricultural responses to climate change (Hatfield et al., 2020).

Table 1. Climate change and agricultural response indicators

Agricultural component	Climate factor	Impact on the agricultural system	Indicator
Livestock	Extreme climate events	Mortality and loss of productivity	The annual sum of comprehensive climate indices for a specific location
	Extreme cold/heat events	Mortality and loss of productivity	The annual sum of temperature-humidity index values and wind chill index values at a specific location
Soil	Carbon sequestration and greenhouse gas exchange	Soil quality, nutrient cycling, water infiltration, carbon sequestration, and soil aggregation,	Organic carbon changes
	Precipitation	Infiltration and soil water content	Water availability for plant production
	Intense rainfall	Nutrient the runoff, and soil erosion and loss of topsoil,	Increase in R value, rainfall intensity
Plant's	Temperature	Chilling hours for perennial plant's	Sufficient exposure to temperatures below a species specific threshold to induce flowering

	Temperature	Growing degree days (GDD) and plant development, the average annual minimum temperature, and phenology	Plant hardiness zone map
	Temperature, CO_2, and precipitation	Gross and net primary productivity	Productivity of ecosystems
	Temperature, precipitation, and CO_2	Biomass, yield	Crop productivity and economic benefits
	Temperature	Phenological development	Changes in the onset of the phenological, development, for example bud break and first flower
Pests	Temperature and precipitation	Increased weed pressures	Invasive weed distribution
	Temperature and humidity	Increased disease pressure or pest attacks	Shifting ranges and populations of insects and diseases
Economics	Extreme events in rainfall and temperature	Loss of productivity, livestock losses, or crop.	Claims and compensation for livestock or crop insurance

(Hatfield et al., 2020)

3. Result and Discussion

According to the previous indicators in Table 1, heat stress significantly affects livestock performance and well-being. The results of previous research explain that livestock performance and welfare are greatly influenced by exposure to heat stress, which is one of the impacts of climate change. The total heat exchange between the atmosphere and animals is influenced by the level of humidity and heat in the air, air currents, and thermal radiation. Thus, it can be said that the animal's response to temperature is effectively a combination of environmental variables. For humans, the beneficial effect is a comfortable sensation. Meanwhile, in animals, this effect has an impact on performance, health and welfare. Because this index combines several environmental components, it is much more powerful in characterizing environmental impacts on animal productivity and welfare. Thermal indices have also been developed to better characterize the influence of various environmental variables on animals (Hatfield et al., 2020).

Soil is the foundation of agricultural productivity. Therefore, soil erosion due to water or wind will have an impact on reducing the land's ability to produce feed, food or fiber efficiently. Various natural and artificial causes can damage soil such as erosion, compaction, salinization, poisoning, and loss of organic matter. Soil erosion that occurs due to climate change has the most direct and widespread impact through decreasing soil productivity, increasing the potential for loss of carbon and organic nutrients, and decreasing soil fertility. Plant biomass production, rate of degradation of plant residues, soil microbial activity, rate of evapotranspiration, cover and hardening of the soil surface, as well as shifts in land use influenced by climate change are the causes of soil erosion due to climate change. Changes in the erosion power, or erosivity, of rainfall will also be the most significant impact of climate change on water erosion. Based on the results of research using erosion simulation models, the response to erosion is much more sensitive to the volume and severity of rainfall than other environmental variables.

Soil organic carbon is also influenced by abiotic and biotic variables. Monitoring the state of soil organic carbon on agricultural land can be an indicator of how climate variability

and change affects the agricultural sector, as well as how these impacts and changes affect carbon stocks. Understanding these aspects is critical in developing mitigation strategies. But on the other hand, distinguishing between climate impacts and their management has proven problematic.

Crop insurance claims and payouts measure the potential economic impact of extreme events on agriculture and indicate the potential for those consequences to emerge as climate conditions change. Crop insurance can cover various crop impacts such as hurricanes, hail and pest damage. However, the damage to agricultural production most closely related to extreme events is damage caused by drought, floods, or humidity/rainfall disasters. The total proportion of compensation for drought, flooding, and excess moisture is a potential measure of the extent and direction of change in agricultural damage from extreme events.

Food production from crops and livestock is essential for survival, and the continuous need to produce more food globally to support the world's rising population increases the risk of food production and security disruptions. The disruption induced by climate change and the indirect effects of increased insect, disease, and weed pressures are not factored into these food production estimates. The impacts on crop production due to climate change can be summarized as positive due to increased carbon dioxide, harmful due to increased temperatures, and varying depending on the timing and amount of rainfall (Loboguerrero et al., 2019).

4. Conclusion

Based on the research results, there is a link between the impact of a climate change on agriculture and food security. Agricultural activities will be disrupted due to several indicators such as soil, plants, pests, economy, etc. With the disruption of agricultural activities, food security problems will arise because almost all food sources come from agriculture. In order to prevent any bad possibilities from happening, we need to take action to maintain the climate condition and take care of our Earth.

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