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Study of the Impact of Climate Change on Corn Crop Agriculture in Sawahan Village

Malika Balgis[a*], Herlina Noor Agustina[a]

[a]*Environmental Science Study Program, Faculty of Mathematics and Natural Science, Sebelas Maret University, Indonesia*

ABSTRACT. Indonesia is a tropical country that has two seasons, namely the dry and rainy seasons. Climate change that occurs in Indonesia today is the difference in length between the dry season and the rainy season which can disrupt the stability of agriculture such as corn. Sawahan Village has a fairly widespread corn commodity. This study aims to examine the impact of climate change on corn agricultural crops in Sawahan Village. The method used in this research is by direct observation of the condition of the corn fields in Sawahan Village, Ngemplak Sub-District, Boyolali Regency and a literature study is carried out which then the data is analyzed using qualitative descriptive methods. The results of the data that have been obtained from the study are that the highest rainfall occurred in 2016 of 2998 mm which affected the production of corn produced in 2017. At air temperature, the temperature increased in the first three years, namely 2015-2017 and 2018-2020 of 0.975 degrees Celsius. The increase in temperature and humidity due to climate change triggers an increase in the growth of pests that disturb farmers' crops in Sawahan Village, such as leafhoppers, rats, and snails. The planthoppers became the most severe nuisance pests, thus allowing the greatest corn crop failure to occur. Thus, it can be concluded that some of the impacts caused by climate change affect the productivity of food crops, including the productivity of corn in Sawahan Village.

Keywords: climate change, corn, rainfall, temperature.

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1. Introduction

Indonesia is a country with a two-season tropical climate consisting of the dry season and the rainy season. In general in Indonesia, the rainy season occurs in the western monsoon and the dry season occurs during the east monsoon. Although the season occurs periodically, it is possible that the season will experience shifts such as the longer the rainy season and the retreat of the dry season (Rahayu et al., 2018). Today does not deny that Indonesia has experienced climate change which is influenced by human activities directly or indirectly so as to change the composition of the atmosphere and enlarge climate diversity in a fairly long period (Houghton, 1996 in Prasetyo et al., 2021). In a number of regions in Indonesia, the symptoms of climate change are increasingly felt, especially the dry and rainy seasons (Adib, 2014).

Climate change in the present day occurs because it is influenced by several factors, including the influence of the greenhouse gas effect, land use change, damage to coastal ecosystems, and others. The greenhouse effect is caused by the increasing concentration of carbon dioxide (CO2) gas and other gases such as methane (CH4), nitrous oxide (N2O), in the atmosphere (Pratama, 2019; Surtani, 2015). The effects of greenhouse gases accelerate global warming resulting in climate change. Global warming is the rise in the earth's temperature as a result of the trapping of large amounts of greenhouse gases that make the sun's thermal energy trapped in the atmosphere (Kusumawardhani and Gernowo, 2015). In addition, the conversion of agricultural land to built-up land and then turning into uncontrolled urban activities is one of the elements causing the increase in air temperature in cities and their surroundings so that they are very vulnerable to climate change (UN Habitat, 2011). Research conducted by Dunggio and Wunarlan (2013), states that there is a very strong correlation between variable changes in land function change and temperature rise.

Climate change results in an increase in global temperature, changes rainfall patterns, rising sea levels, and increases the frequency and intensity of extreme weather events (Ruminta et al, 2018). The increase in global temperature due to climate change has impacts such as the disruption of forests and other ecosystems (Kusumawardhani and Gernowo, 2015). The main problems in increasing agricultural production on dry land are environmental factors related to climate change and early season shifts (Rahmani and Hariyono, 2019). Climate change can affect the quality of crops from agriculture and plantations. Some plants that have a degree of resistance to weather changes, result in poor crop quality (Managi and Kaneko, 2015). Indonesia is an agricultural country where it has a variety of agricultural products such as rice, corn, cassava, potatoes, tubers, and so on. In Indonesia, corn crops are also the main commodity after rice. Climate change that has

*Corresponding author: malika19balgis@student.uns.ac.id

occurred has an impact on most agricultural sectors, one of which is agriculture in Sawahan Village.

Sawahan Village is a village located in the lowlands, where the area consists of many rice fields, gardens, residential land, factories, and schools. The rice fields produce a lot of agricultural products, where the main commodity is rice and the second is corn. Corn crop farming is highly dependent on weather and environmental conditions. Therefore, the occurrence of climate change will greatly affect the productivity of corn crops in Sawahan Village. This study aims to determine the impact of climate change on corn crops in Sawahan Village, Ngemplak Sub-District, Boyolali Regency.

2. Materials and Methods

2.1 Research Procedure

The location of this study was conducted in Sawahan Village, Ngemplak Sub-District, Boyolali Regency, Central Java. The study site was chosen by taking into account several considerations including corn agricultural products that are affected by weather related to the occurrence of climate change events. The study was conducted from May to July 2022.

Fig. 1 Location of research in Sawahan, Ngemplak, Boyolali.

This study was conducted by collecting primary and secondary data. Primary data were obtained through direct observation and interviews on the impact of climate change on the agricultural sector of corn crops. Observations were made by direct observation in the field and documenting agricultural land for corn crops in Sawahan Village. Then, the interview was conducted directly with the farmers of Sawahan Village. As well as, secondary data are obtained through the study of literature.

2.2 Data Analysis

Data analysis in this study was carried out using a qualitative descriptive analysis method. The results of the study based on primary and secondary data that have been obtained are processed, then explained descriptively and analyzed using literature studies, theories, and other research sources that have been carried out previously as other supporters. This research is focused on assessing and analyzing the impact of climate change on corn crop farming in Sawahan Village, Ngemplak, Boyolali.

3. Result and Discussion

3.1 Corn Corp Field in Sawahan Village

Sawahan Village is one of the villages in Ngemplak District, Boyolali which has a lot of agricultural land. Based on the results of interviews that have been conducted with farmers in Sawahan Village, it is known that the area of land owned by each member of the Farmer Group is different, namely two to three stakes with an area of 3,300 meters to 3,400 square meters per peg. There are various kinds of agricultural products in Sawahan Village, including rice, corn, cassava, chili, long beans, eggplant, cucumber, bitter gourd, melon, tomato, watermelon, and so on. However, most of the things that are often grown by farmers in Sawahan Village today are rice, long beans, and corn.

Fig. 2 Corn farmland in Sawahan Village.

Corn (*Zea mays L.*) is one of the products of agricultural commodities that has various benefits. Corn can be used as a food and raw material for processed industrial production. Based on the results of interviews that have been conducted with farmers of Sawahan Village, corn planting in Sawahan Village is carried out by seeding which are then planted on agricultural land. Farmers in Sawahan Village plant seeds obtained from government subsidies or private purchases. The corn planting system applied by farmers follows the tradition of going down and downhill, where planting is carried out an elongated row system facing the direction of the sunrise or often referred to as the array system. The corn planting period is 1 month of seeding and 3 months of growth to harvest. As well as, the growing season for corn is usually carried out from the 6th month. This is because corn is a palawija crop, where the palawija crop is suitable when planted in the dry season. At this time a short rain time interspersed with the sun is much better than continuous rain, because the rainwater will reduce organic matter and nutrients as soil aggregates and adhesives (Wirosoedarmo *et al*., 2011). Changes in soil physical properties such as aggregate stabilization, fill weight, and soil pores will affect the growth of maize crops (Widodo and Kusuma, 2018). Most of the crops including corn are planted in the rainy season, the harvest produced will be inappropriate.

3.2 Effect of Climate Change on Corn Corp Productivity

The growth of corn crops in Sawahan Village is also influenced by climate change. The shift in the rainy season causes shifts in planting and harvesting times for foodstuffs

such as rice, corn, and other crops (Ruminta and Handoko, 2016). Climate change affects agriculture through its impact on crop growth, development, and yield (Ruminta *et al*., 2018). Climate change has an impact on plant physiology that affects plant growth and production (Timotiwu *et al*., 2021). Based on the results of interviews with farmers in Sawahan Village, climate change has made it difficult for farmers to determine planting time strategies because of the weather predictions at this time that often change. According to Surmaini and Faqih (2016), seasonal predictions are used by farmers to strategize in adjusting planting time and commodity selection. Erratic weather due to climate change causes high rainfall, where rainfall greatly affects planting success (Suciantini, 2015).

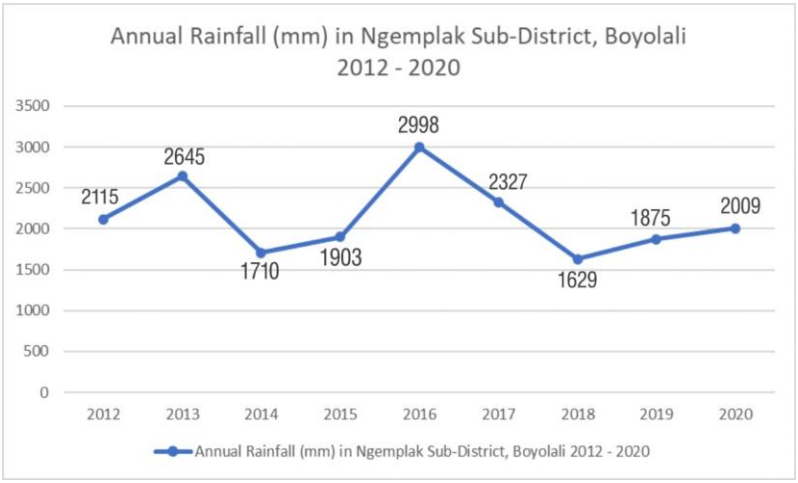

Fig. 3 Annual Rainfall (mm) in Ngemplak District, Boyolali in 2012-2020 (BPS Ngemplak Boyolali, 2013-2021).

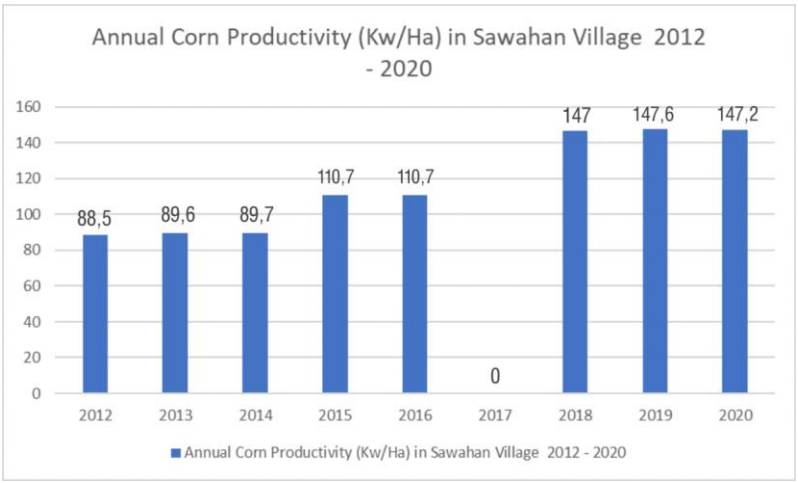

Fig. 4 Annual Corn Productivity (Kw/Ha) in Sawahan Village 2012-2020 (BPS Ngemplak Boyolali, 2013-2021).

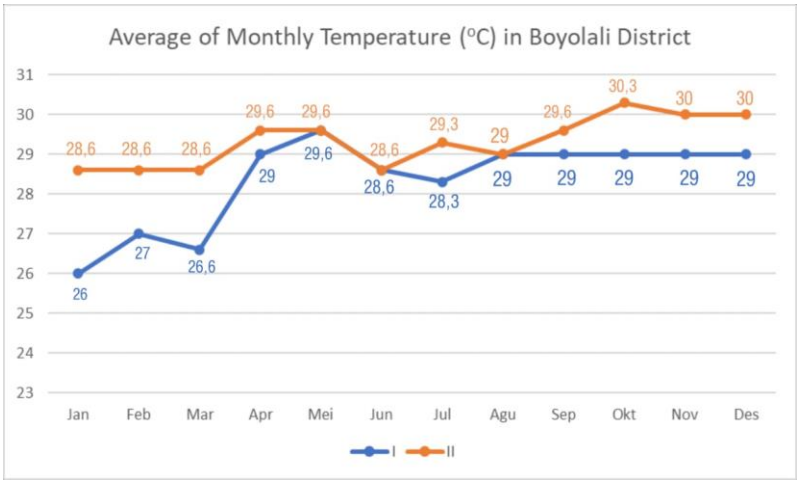

Fig. 5 Average of Monthly Temperature (°C) in Boyolali District (BPS Boyolali, 2017, BPS Boyolali, 2020).
Note: I = 2015 - 2017; II = 2018 – 2020.

Table 1
Total Corn Harvest Productivity Per Year in Sawahan Village (BPS Ngemplak Boyolali, 2013-2021).

Year	Corn Productivity (Kw/Ha)
2012	88,5
2013	89,6
2014	89,7
2015	110,7
2016	110,7
2017	0
2018	147
2019	147,6
2020	147,2

Table 2
Average of Monthly Temperature (˚C) in Boyolali District (BPS Boyolali, 2017, BPS Boyolali, 2020).

Month	Temperature (°C)	Temperature (°C)	Temperature Changes (°C)
	I	II	
January	26	28,6	+2,6
February	27	28,6	+1,6
March	26,6	28,6	+2,0
April	29	29,6	+0,6
May	29,6	29,6	0,0
June	28,6	28,6	0,0
July	28,3	29,3	+1,0
August	29	29	0,0
September	29	29,6	+0,6
October	29	30,3	+1,3
November	29	30	+1,0
December	29	30	+1,0
Average	28,341	29,316	+0,975

Note: I = 2015 - 2017; II = 2018 – 2020.

The highest intensity of rainfall in Ngemplak District, Boyolali occurred in 2016 with a rainfall value of 2998 mm and the lowest rainfall occurred in 2018 with a rainfall value of 1629 mm. Rainfall in Ngemplak sub-district, Boyolali increased in 2012 to 2013 and experienced a significant increase from 2015 to 2016.

Climate change has a real impact on the agricultural output of corn crops in Sawahan Village, Ngemplak District. This is supported by food crop statistics based on the BPS Ngemplak District (2021), the result of the correlation between Fifure 3. with Table 1. shows that the high rainfall in Sawahan Village in 2016 as much as 2998 mm/year affected the level of corn productivity in 2017 which greatly decreased production. It can be seen that in 2016 corn productivity was classified as a lot, namely 110.7 Kw/Ha and in 2017 it decreased drastically to 0 Kw/Ha. Then, from 2017 to 2018 there was a decrease in the level of rainfall, namely to 1700 mm/year so that in 2018 there was an increase in corn productivity, which produced 147 Kw/Ha. And in 2020, with increased rainfall, it affects corn production yields from 2019. It can be seen that in 2019 corn productivity was 147.6 Kw/Ha and in 2020 it decreased to 147.2 Kw/Ha. This is because rainfall with prolonged intensity will have the potential to interfere with the growth of corn plants (Herlina and Prasetyorini, 2020). Corn is a plant variety

that cannot withstand inundation because it interferes with the process of aeration and respiration of plants (Aqil, 2013). In addition, based on the BPS of Ngemplak District in 2020, the harvest area in Ngemplak District in 2020 experienced a decrease in harvest area to 49 Ha. This is because the area of other crops is damaged due to extreme weather. Based on the results of interviews that have been conducted with farmers in Sawahan Village, extreme weather that occurs due to climate change greatly affects agriculture. According to Santoso et al. (2011), high rainfall levels result in the roots of corn plants lacking oxygen, causing plants to become thin.

Temperature is seen as representing the amount of energy received by plants to enter phases of plant growth and development (Sumarlin et al., 2018). The increase in air temperature in the atmosphere by 5°C will be followed by a decrease in corn production by 40% and soybeans by 10-30% (Efendi et al., 2014). High temperatures will affect the growth process of corn plants because it will result in a decrease in the availability of water in the soil. In the last 6 years, the average temperature increase in Boyolali Regency has not increased significantly and this has not greatly affected the yield of corn productivity, especially in Sawahan Village, Ngemplak Boyolali. Farmers in Sawahan Village mitigate the occurrence of drought if there is a rise in temperature which results in a lack of water availability for the corn growth process.

The increase in air temperature and humidity due to climate change allows triggering an increase in the growth and development of plant-disturbing pests. Thus, these pests can attack farmers' crops which will result in crop failure. The types of pests that attack farmers' crops in Sawahan Village are leafhoppers, rats, and snails. Based on the results of interviews with farmers in Sawahan Village, leafhopper pests are among the pests that attack the most severely, making it possible for the greatest crop failure to occur. The way leafhopper pests interfere with corn plants is by eating the stems of the plants. As time increases, plant pests will spread evenly, causing corn plants to collapse and will reduce the amount of corn crop yields. According to Handoko et al. (2008) in Widiarta (2016), corn yields will decrease by 10.5-19.9% due to the increase in air temperature until 2050 if efforts are not made to adapt.

4. Conclusion

Climate change affects the productivity of food crops, including the productivity of corn crops in Sawahan Village. This can be seen from the impact of climate change which results in an increase in rainfall, an increase in temperature and humidity, as well as an increase in pests and diseases that affect corn productivity in Sawahan Village. Rainfall greatly affects corn productivity because corn is a plant variety that cannot withstand inundation because it interferes with the process of aeration and respiration of plants. The increase in temperature basically has a great influence on the productivity of corn crops but in Sawahan Village a not very significant increase in temperature has no impact on the productivity of corn crops.

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