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The impact of climate change on agricultural production with a cases study of Lake Tempe, district of Wajo, south Sulawesi

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Abstract

The purpose of this study is to find out the impact of climate change on agricultural production. The data analysis method used in this study is a combination of qualitative descriptive and quantitative statistical analysis. The research was conducted in Lake Tempe, Wajo Regency, South Sulawesi, in four selected villages located on the outskirts of Lake Tempe, namely Laelo Village, Salo Menraleng Village, Mallusesalo Village, and Pallimae Village. The location was deliberately chosen because Lake Tempe is the largest lake in South Sulawesi with a uniqueness that occurs in the community due to the problems faced in the event of a change of seasons. A simple random sampling of 180 respondents is investigated. The data collected include primary data and secondary data. Primary data was obtained through interviews and in the form of questionnaires. Secondary data was obtained from the village office, food and agriculture office, fisheries office, and regional disaster management agency. Then the multiple linear regression analysis is applied to the data. The results show that the effect on agricultural production is variable production, namely climate change, land area, and farmer training and the farmers understand the occurrence of this climate change in their region and its effects on their method of cultivation. The impact often experienced by farmers is crop failure and a decline in quantity and quality of agricultural crops.

Keywords: agricultural production, climate change, farmers, fishing

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INTRODUCTION

Global warming over the last century has resulted in climate change, which is been the most crucial issue in the policy of development and transnational governance in the 21st century. Most of the events of the disaster are environmental disasters such as nipple winds, floods, and landslides, which are heavily influenced by the symptoms of climate change. Agricultural systems depend on environmental factors such as the intensity of time and the distribution of the rainy season (Lázár et al., 2015). A better knowledge of the different ways of socio-cultural groups according to climate change is critical to the implementation of climate policy (Ruiz et al., 2020).

The impact of climate change on developing countries is very significant seen from the change patterns in weather because the communities in these country rely heavily on farming for their livelihoods (Chuang, 2019). For instance, the impact of climate change in the form of increased levels of CO_2 can increase photosynthesis and efficiency of water use, which consequently increases crop productivity. Meanwhile, a flat temperature increase can trigger crop disease while increasing water pressure, which therefore reduces crop productivity (Rojas-Downing et al., 2017).

In many countries, the general public becomes concerned as press reports, personal experience, and scientific information all point to the increasing frequency and severity of extreme weather events related to climate change. One of the causes of farmers leaving olive groves due to the significant effect on the soil degradation process in particular areas of olive plantations is very susceptible to the impact of climate change and very severe extreme weather (Palese et al., 2013).

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The first generation of climate change impact assessment began in the mid-1980s in Ontario (Canada) (Steiger et al., 2019). In recent years the phrase climate change has become familiar, like the harsh environment of regularly hitting the headlines. Climate change continues to impact these water systems, including water quantity and quality impacts. Some of the effects of climate change to the amount of water are melting glaciers, seasonal rainfall changes, increased river flows and increasing groundwater contribution to these streams, melting Perma-ice that impacts the flow of groundwater into rivers and streams, and deep-creasing evapotranspiration (Harper et al., 2020). A more general use, common in the scientific community, refers to the changes brought by any source, human or natural.

Agriculture is a high-risk type of business because it relies heavily on natural conditions (Muller et al., 2017). The natural condition that supports is a factor of a determinant for the achievement of production of agricultural products both from the quantity and quality aspects.

Unfriendly natural conditions in farming, such as erratic climates, floods, droughts, pest attacks, can cause the quantity and quality of agricultural products to decline, even resulting in crops failing to harvest during extreme climate events such as droughts and floods. Abnormal weather such as rain, drought, high temperatures, drought, and frost damage increases the uncertainty of agricultural production (Mi et al., 2020). Drought predicted to lower agricultural yields may be due to a variety of factors including decreased photosynthesis rates (Fahad et al., 2017). Field studies offer an opportunity to examine the effects of climate variability and natural settings in unusual circumstances that are expected to become more intense with climate change forecasts (Ahmed et al., 2014).

As in many developing countries, agriculture plays an essential role in the Indonesian economy. As well as most developing countries, agricultural extension services are run by government departments and are part of the general public administration (Baiyegunhi et al., 2019). Its production accounted for 13% of Indonesia's gross domestic product (GDP) and provided a livelihood for nearly 27 million agricultural households. In Indonesia, agriculture remains the primary source of livelihoods of rural populations (Otekhile & Verter, 2017).

Among the various plants cultivated in Indonesia, rice is a significant food plant. Of the 27 million farmer households, 17 million were rice farmers with average land ownership of 0.6 ha. In general, agricultural households in Indonesia have deficient levels of education, adopt and use inefficient technologies (Effendy et al., 2019). As smallholders, farmers are economically more vulnerable to external shocks, such as those caused by climate change. However, in practice, there is a contractual bias against agribusiness companies and often exposes smallholders to previous post-risk risks (Abebe et al., 2013). In Indonesia, rice farming is heavily influenced by climate change.

The enhanced frequency and intensity of the changing rainfall, temperature rise, and sea-level rise contributed significantly to the decline in rice productivity. They were changing rainfall patterns, causing frequent droughts around the world (Fahad et al., 2017). The frequency of extreme events, such as floods and droughts, increases the loss of crops. Increasing temperature causes the proliferation of pests and diseases. Thus, efforts to reduce and adapt to the risk of climate change are required for the resilience of rice farming in Indonesia. Climate change studies in Indonesia have expanded and covered various aspects such as agriculture, farmer livelihoods, natural disasters and coastal territorial management, climate change politics, and community perspectives. The Cutting-edge research on climate change notes that climate change shows symptoms that indicate a threat to sustainable food production in Indonesia (Su et al., 2020).

In recent years, the rainy season exists in the regions of the Villages whereby NSAA is located, not only in Indonesia, but in other countries such as China, America, Africa, and Europe, weather variability is higher (more dry and rainy months), but historically, drier weather (Arias et al., 2019). Shifts also cause a change in the growing season and harvest food commodities (rice, plants, and vegetables) (Verhofstadt & Maertens, 2015). Also, the rainy season affects road access, which can hinder physical access to the market for food (Anderzén et al., 2020). Floods and droughts cause failed planting, crop failure, and even lead to Puso. Those have an impact on the decline in farmer production and income. For rural farmers' incomes to increase, local governments are required to educate village farmers about counseling services for sustainable agriculture and its best practices (Otekhile & Verter, 2017). As a result, as the country with the fourth most populated in the world and one of the largest producers and consumers of rice, Indonesia is characterized by rural poor people who depend on rice production for their livelihood (Ooi et al., 2019).

The condition of Lake Tempe is a unique ecosystem because, in the dry season, some parts of the lake water are submerged by flood (Germadan Rescue Movement), 2014). But in the dry season, it turns into dry land used for Rice and Palawija with such ecosystems causing the communities around the lake to become communities that have double status as farmers and fishers. In the rainy season, they become lake fishermen. In contrast, in the dry season, they become farmers or farm workers. When the flood struck, what happened was the sinking of the rice fields of the lake community and the evacuation of the people of Lake Tempe.

Confidence in the quality of counseling education processes has reportedly increased participation in agricultural projects (Baiyegunhi et al., 2019). It is academically interesting to study, so this article aims to find out how the impact of predictor variables including climate change, farming experience, land area, education, and agricultural training experience on agricultural production in Lake Tempe and how their strategy in addressing the various obstacles caused by the changing seasons.

MATERIALS AND METHODS

This study used qualitative descriptive and quantitative statistical analysis. Information related to the literature-identified key of the impact of climate change on agricultural production was collected through the survey, in-depth and semi-structured interviews. The research was conducted in Lake Tempe, Wajo Regency, South Sulawesi, in four selected villages located on the outskirts of Lake Tempe. Namely, Laelo Village, Salo Menraleng Village, Mallusesalo Village, and Pallimae Village, with a uniqueness that occurs in the community due to the problems faced in the event of a change of seasons. 180 respondents were selected by simple random sampling. The data collected is secondary data and primary data. Primary data was obtained through interviews and in the form of questionnaires. Secondary data was obtained from the village office, food and agriculture office, fisheries office, and regional disaster management agency. Then the multiple linear regression analysis is applied to the data. The following model is a multiple linear regression model with five predictor variables, x_1, x_2, x_3, x_4, and x_5.

$$\mathrm{Y} = \mathrm{a} + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + \varepsilon \quad (1)$$

Where Y = Production, a = Constant, b_1= Climate change / rainy days (days/years) with dummy, b_2= Farming experience, b_3= Land area, b_4= Education, b_5= Agricultural training experience, ε = errors.

We selected *a* and *b* estimates in order to minimize the amount of square prediction errors. The equation for prediction is:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 \quad (2)$$

RESULTS AND DISCUSSION

The phenomenon of climate change is taking place across Indonesia. For example, in the Wajo region, rainy seasons start later and end earlier, although the amount of rain remains approximately the same, resulting in higher intensity of rainfall. As a developing country, Indonesia is extremely vulnerable to climate change and Indonesia is very dependent on natural resources and the agricultural sector in the agricultural society. Agriculture is of vital importance in Indonesia, not only because majority of people of Indonesia are skilled farmers, but also because agriculture is a vital sector for food security. However, due to the shortage of human capital and the magnitude of land conversion, the growth of the agricultural sector is far behind relative to other industries, and this is made even worse by the advent of climate change.

Climate change is a global phenomenon, whereas adaptation is mostly site-specific (Choudri, Al-Busaidi, & Ahmed, 2013). In order to protect it from the negative impacts of climate change, deliberate measures and improvements are necessary in our existing community (Stehr & Storch, 2005). Adaptation strategies include both strengthening the ability of people, organizations, communities or governments to adapt to the impacts of climate change and converting ability into action through the implementation of adaptation decisions (Tompkins & Neil Adger, 2005). The direct and indirect impacts of climate change on agriculture will affect the sustainability of agriculture, such as the need for individual food, feed and fibers, and contributing to bioenergy needs; the quality of the environment and the foundation of resources; the economic sustainability of agriculture; and the standard of living of farmers, field workers and community as a whole. Since agricultural systems are ecosystems dominated by humans, the situation of agriculture to climate change is highly dependent not only on the thermodynamic impacts of climate change, but also on human responses to mitigate these effects (Marshall 2010).

This research was conducted in Lake Tempe, Wajo Regency, South Sulawesi, in four selected villages located on the outskirts of Lake Tempe, namely Laelo Village, Salo Menraleng Village, Mallusesalo Village, and Pallimae Village. The location was deliberately chosen because Lake Tempe is the largest lake in South Sulawesi with a uniqueness that occurs in the community due to the problems faced in the event of a change of seasons. The survey was conducted on 180 individuals. The data collected include primary data and secondary data. Primary data was obtained through interviews and in the form of questionnaires. Secondary data was obtained from the village office, food and agriculture office, fisheries office, and regional disaster management agency. Then the multiple linear regression analysis is applied to the data. After that, the heteroskedasticity test, normality test, and t-test are performed to test whether, in regression models, there is variance inequality from residual one observation to another, to determine whether sample data has been drawn from a normally distributed population (within some tolerance), and the t-test is used to check the significance of individual regression coefficients in the multiple linear regression models respectively.

Description of Tempe Lake

Tempe Lake is a lake located at Wajo Regency. The geographical location of Wajo Regency is located at coordinates between 3°39' - 4°16' South Latitude and 119° 53' - 120°27' 'East Longitude. Wajo regency as

(a) (b)

Fig. 1. (a) Map of the study area (b) Geographic location of the study area

other regions in Indonesia, namely tropical climate with a temperature of approximately 27-30 ° C (Wajo Regency in Figures, 2020) as shown in **Fig. 1**, that marks the drought. The rainy season every year lasts a bit short, which is an average of 3 months from April to June, except in the northern part of the Pitumpanua sub-district, there is a rainy season similar to Luwu Regency and the following months are humid, while the dry season occurs in July- November.

People's Lives Around Lake Tempe

The lake becomes an essential resource for the community. Lake Tempe is used by all organizations that want to take advantage of it without exception. Therefore, the role of custom becomes crucial in regulating it. People of Wajo regency try to care for and maintain the lake as they look after their bodies. Mainly, those who live around the lake and rely on their lives directly or indirectly against the lake and the biota that is in it.

If any lake rules are violated, it means that they have injured themselves with their own hands. However, when the lake is damaged, the communities around the lake are the first to be affected. Those who suffered the most losses from floods and droughts occurred on the lake. As experienced by the people of Lake Tempe during the rainy season, he did not leave their homes just for other purposes, such as buying goods according to their needs. It is the same in Lake Tempe, there is no major industry that utilizes the lakes or biota-biota that is in the lake for industrial purposes. The activity is more widely used by the surrounding community who become small fishermen. They use the lake as a place where they make a living to eat daily, as well as for sale to meet their other needs. That is why there are no special requirements or levy charges on fishers. People domiciled in the lake area can become a fisherman without having to be given certain conditions as long as it also complies with all the rules in the lake. There is no specificity about the people who want to be fishermen.

Tempe Lake Utilization Activity Pattern

Lake Tempe's fishing community's knowledge of all seasons has been around for a long time, but some say that the current season is unpredictable. The rainy season sometimes unpredictably when it is summer/dry. Sometimes in the rainy season, the weather is scorching as in the dry season. The activity of this fishing community varies depending on the conditions of the season. There are three seasons that occur every year, i.e. (1) The western season that falls in November to April, in June becomes the preceding month entering the eastern season, (2) from July to April. September enters the eastern season, and (3) Pancaroba season from October to December. The graph for the rainfall in the valley region affecting Lake Tempe is shown in **Fig. 2**.

The location of these fishermen settlements is the shore of Lake Tempe, which instinctively every year experiences flooding, as a result of the experience of sharing their knowledge based on several types of knowledge systems used as markers. Their knowledge system is like star formation in the sky that is a sign of the western or eastern seasons—the behavior of some animals around fishing settlements, such as frogs that emit a lot of noise. Means going into the rainy season until floods and ants that rise above the house or into the corn farmland make signs for their knowledge of the seasons.

Fisherman's activity when looking for fish is entirely in Lake Tempe. For people whose primary profession is the fishery, usually have a lifestyle that they routinely do, and there are two activity patterns, the activity usually changes due to the changing seasons. The first pattern of movement, usually the measure of fishermen, will begin in the morning after dawn prayer. At 5:00 a.m., anglers head to the lake to catch fish then go home at 6:30 a.m. to sell the catch. Wives usually sell these catches. The data related to food disasters in Wajo region in presented in **Table 1**.

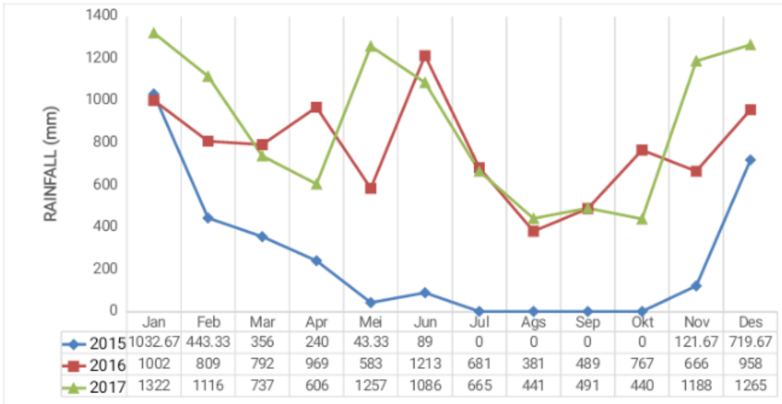

Fig. 2. Graph of rainfall in the valley region affecting Lake Tempe

Table 1. Wajo Regency flood disaster data

	Time	Total	Injured	Died/ Disappeared	Submerged	Badly Damaged	Moderately Damaged	Slightly Damaged	Suffered/ Displaced
1.	null	null	null	null	null	null	null	null	null
2.	2002	1	null	9	15,795	null	0	0	56,213
3.	2003	1	0	9	3,560	0	0	0	0
4.	2004	1	0	0	0	0	0	0	0
5.	2006	0	0	0	0	0	0	27	0
6.	2007	2	0	9	13,872	0	0	0	8,388
7.	2008	1	0	0	430	0	0	0	139
8.	2010	6	0	9	23,533	22	0	57	3,895
9.	2012	1	0	0	0	9	0	57	0
10	2013	1	0	2	23,000	0	0	0	0
11.	2014	4	0	2	12,877	0	0	0	995
12.	2015	3	0	0	16,320	11	0	0	53
13.	2016	7	40	0	5,376	0	0	0	1,759
14.	2017	9	17	1	6,556	5	3	50	18,696
15.	2018	3	0	8	15,130	0	0	0	55,083
16.	2019	2	0	0	2,521	0	0	0	2,705
17.	null	41	null	49	138,970	null	3	191	147,926

Table 1 contains the data on flood disasters in Wajo from 2000-2019. However, the information on flood disasters in Wajo district does not all occur gradually every year. As in 2000, 2001, 2005, 2009, and 2011, there was no flood ingestion in the district. **Table 1** shows the number of disasters that occurred in 2017 recorded nine floods throughout the year. There were nine deaths and missing floods, but the number who suffered from the flooding reached 56,213 in 2002, not even a few experienced submerged houses about 15,795 houses/buildings. The worst impact during this flood disaster occurred in 2010 with very severe has implications with the potential for flooding occurring six times during the year with a record of 9 fatalities. Three thousand eight hundred ninety-five victims suffered and displaced, and submerged homes reached the highest level of 23,533 units with 22 damaged and 57 minor damaged. Following are the heteroskedasticity test, normality test, and t-test performed.

Heteroskedastisity Test

The heteroskedasticity test aims to test whether, in regression models, there is variance inequality from residual one observation to another. One way of detecting the absence of heteroskedasticity is by looking at plot charts. If there are specific patterns, such as the dots that exist, form a particular design, such as the drops that exist, create an exact regular way (wavy, widened, then narrowed). Then, there are symptoms of heteroskedastisity, if the pattern is clear. As well as the dots spreading above and below the number 0 on the Y axis, there is no heteroskedasticity.

The results of the heteroskedasticity test can be seen in **Fig. 3**.

From **Fig. 3**, we can conclude that these characteristics are met so that it is said that in the regression model the effect of climate change on agricultural production does not occur heteroscedasticity problems. So that the classic assumption test of heteroscedasticity is fulfilled. And it is worthy of use in research.

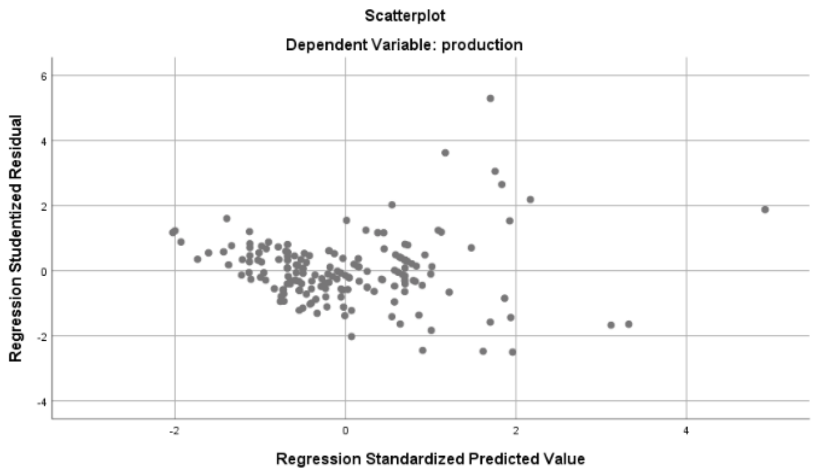

Fig. 3. Heterokedastisity Test Results

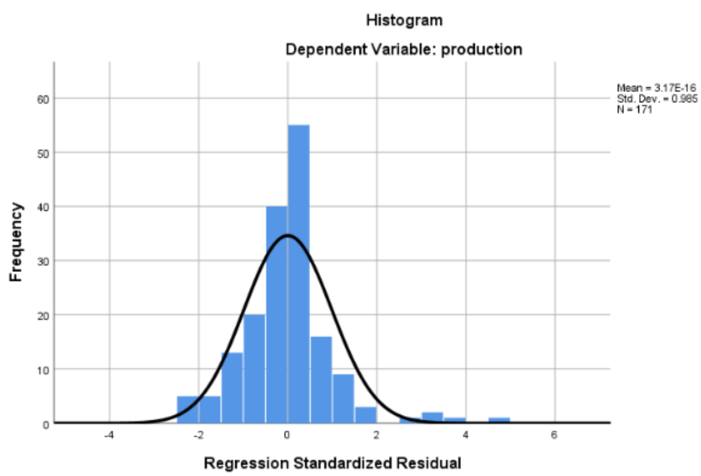

Fig. 4. Histogram Normalities Test Results

Normality Test

A normality test is used to determine whether sample data has been drawn from a normally distributed population (within some tolerance). The normality test results with the histogram method can be seen in **Fig. 4**.

From the histogram static test results, it can be seen that the normally distributed data with a mean = 3.17E-16, standard deviation = 0.985, and the total of the entire sample is 180. Thus, the analysis can be continued.

The normality test results in graphic form can be seen in **Fig. 5**.

In **Fig. 5**, it can be seen that the standard probability plot chart shows a normal chart pattern. This is a plot chart test from the point that spreads around the normal chart, and its spread follows a diagonal line.

Multiple linear regression analysis

The t-test is used to check the significance of individual regression coefficients in the multiple linear regression models. Adding a significant variable to a regression model makes the model more effective, while adding an unimportant variable may make the model worse. The results of the t-test in this study can be seen in **Table 2**.

Based on **Table 2**, the t-test results in this study can be explained as follows: Climate change (X_1) test results with SPSS having variable X_1 obtained a calculated value = 8,466 with a significant level of.000. Using the

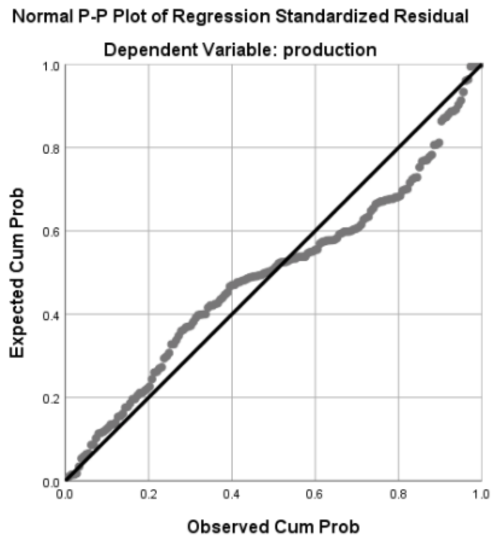

Fig. 5. Normality Test Results

Table 2. t-test results

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound	Correlations Zero-order	Correlations Partial	Correlations Part	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	7067.125	1585.436		4.458	.000	3936.768	10197.483					
	Climate change	-5401.26	637.988	-.382	-8.466	.000	-6660.93	-4141.589	-.413	-.550	-.380	.992	1.008
	Farming experience	.848	26.858	.002	.032	.975	-52.181	53.878	.178	.002	.001	.893	1.119
	Farm size (ha)	3542.28	305.701	.559	11.587	.000	2938.695	4145.876	.637	.670	.520	.865	1.155
	education	-50.735	144.380	-.017	-.351	.726	-335.805	234.335	.160	-.027	-.016	.898	1.114
	Agricultural training	1289.542	192.331	.319	6.705	.000	909.795	1669.289	.489	.463	.301	.888	1.126

a. Dependent Variable: production

0.05 significance limit, the amount of such significance is smaller than the 5% level, which means climate change affects agricultural production. These impacts include the sustainability of agriculture, such as the need for individual food, feed and fibers, and contributing to bioenergy needs; the quality of the environment and the foundation of resources; the economic sustainability of agriculture; and the standard of living of farmers, field workers and community as a whole. Although dependent variables are not the value of agricultural production but specifically, we estimate how agricultural profits are affected by temperature and precipitation (Deschênes & Greenstone, 2012). Farm experience (x_2) test results with SPSS having variable X_2 obtained a calculated value of =.032 with a significant level of.975 by using a significance limit of 0.05, the value of such significance is smaller than the level of 5%, means that long-lasting farming does not affect agricultural production.

Farm size (X_3) test results with SPSS having variable X_3 obtained a calculated t value = 11,587 with a significant level of.000 by using a significance limit of 0.05, the value of such significance is smaller than the level of 5%, means the area of land affects production. Education (X_4) test results with SPSS having variable X_4 obtained value t count = -.351 with a significant level of.726 by using a significance limit of 0.05, the value of such significance is smaller than the level of 5%, means education does not affect agricultural production. Agricultural training (X_5) test results with SPSS having variable X_5 obtained a calculated value = 6,705 with a significant level of.000 by using a significance limit of 0.05, the value of such significance is smaller than the level of 5%, means that agricultural training affects agricultural production.

Based on **Table 2**, it can be concluded that 3 variables have a significant effect on production, namely climate change, land area, and farmer training. This is a result due to its significance value < of a probability of

0.05. By using the values in equation 2 based on the results obtained from **Table 2**, there are multiple regression equations as follows:

$$Y = 7067.125 - 5401.262x_1 + .848x_2 + 3542.285x_3 - 50.735x_4 + 1289.542x_5$$

The above equation shows that the value of Constant (*a*) is 7067.125, which means that if there is no change in free variables or is considered the same as then rice production in Lake Tempe, Wajo Regency, Sulawesi-south amounts to 7067.125. Coefficient (b_1x_1) means that climate change variables (x_1) negatively affect production (Y), indicates that if climate change variables increase by 1 point, while other free variables are considered fixed, then production will decrease by -5401.262. The old coefficient of farming (b_2x_2) is defined as negatively affecting production (Y), indicates that if the old variable is farmed to increase one point.

In contrast, the other free variable is considered fixed causes increase the production by.848. The coefficient of land area (b_3x_3) is defined as a variable land area (x_3) positively affecting production (Y), indicates that if a variable region of land increases by one point. In contrast, another free variable is considered fixed; it will lead to an increase in income by 3542,285. The educational coefficient (b_4x_4) is defined as an educational variable (x_4) negatively affecting production (Y), leads to a decrease in education variables, while other free variables are considered fixed, increasing production by -50,735.

Agricultural training coefficient (b_5x_5) is defined as a variable agricultural training (x_5) positively affecting production (Y), indicates that if agricultural training variables increase by one point, while other free variables are considered fixed, it will lead to an increase in income of 1289,542.

Based on **Table 2**, it can be concluded that three variables have a significant effect on production, namely climate change, land area, and farmer training. This is due to its significance value < of a probability of 0.05.

CONCLUSION

Based on the results of the study using the above multiple linear regression tests, it can be concluded that 3 variables have a significant effect on production, namely climate change, land area, and agricultural training. This is due to its considerable value of a probability of < 0.05. The three variables that affect agricultural production, namely climate change, land area, and agricultural training, while two variables including, the experience of farming and education, have no impact.

It realizes high food production under climate change; it is essential to maintain or improve food yield and stability. This is particularly relevant in developing countries, where population growth is often higher than increased food production and agricultural innovation. An increase in food production supported by agricultural innovation means that it is at risk of food insecurity. Here, the highlights of the climate have been evaluated by many researchers in terms of total profit or crop loss. Some studies have shown that crops tend to be more volatile with increased climate variability under future climatic conditions. Therefore, some of the potential benefits of climate change in total Agricultural production can be overcome by increasing variability year on year, but it leading to long-term food supply instability.

Some studies on climate change provide useful information that the higher amount of negative highlights of the historical climate on crop yields, faster adaptation measures should be implemented to offset the loss of yields. Increasing temperature trends show most of the negative highlights on these crops except at some high altitudes. If the observed temperature trend continues in the future, the highlights tend to be mostly negative on crop production in the basin. However, the plant production can be obtained from heating at relatively higher altitudes provided other conditions, such as water availability, soil fertility, etc., which are beneficial.

This research is urgently needed to be known by government stakeholders and those who have the resources to take policy. Planting various crop varieties, cultivating various crops, soil and water conservation strategies and shifting planting dates are among the main climate change adaptation strategies used by farmers in the study areas. The authors examined the impact of climate change on agricultural production around Lake Tempe by working on a combination of key data and secondary data in terms of linear regression models of multiple production variables, climate change, farming experience, land area, education, and farming experience.

Several recommendations from the analysis are proposed based on the results. One recommendation is whether high-technology interventions are needed in high-risk regions, particularly watershed infrastructure creation and enhancement, responsive superior varieties, approved seeds, compatible organic and chemical fertilizer, agricultural machinery, and climate information knowledge extension. A strategy to adapt to the impacts of climate change in both the near and far future should be established and enforced in an acceptable manner.

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