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The Effect of Increasing Temperature on Welfare of Plantation Farmers

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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Original Research Article

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ABSTRACT

Agricultural productivity is a determining factor in achieving food security in Indonesia. Increase in agricultural productivity yields is strongly influenced by climate change. Extreme climate change has resulted in crop failure due to land drought and flooding. The existence of this incident provides an opportunity to decrease the welfare of farmers, especially plantation farmers in Indonesia. The purpose of this study was to determine the effect of temperature on the welfare of plantation farmers in Indonesia. The data used in this study was sourced from the 2018 National Socio-Economic Survey (SUSENAS) data, with a total of 66,754 households in Indonesia. The analytical method used is Ordinary Least Square (OLS). The results of this study indicate that an increase in temperature causes drought, and has an impact on decreasing agricultural productivity. The decrease in the production of agricultural products certainly reduces the income of farmers, which results in a decrease in the level of welfare of farmers. Government policies in terms of climate engineering are needed, as well as assistance programs for farmers to maintain the welfare of farmers.

Keywords: Temperature; climate; farmer welfare; government assistance.

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1. INTRODUCTION

Climate change has a wide impact on people's lives. One of the climatic factors that can be felt is a significant increase in the earth's temperature [1–5]. The increase in the earth's temperature not only has an impact on increasing the earth's temperature, but also changes the climate system which affects various aspects of changes in nature and human life, such as water quality and quantity, habitats, forests, health, coastal ecosystems, and agricultural land [6–10]. Climate change that occurs globally is a threat to actors in the agricultural sector [11–14]. Extreme weather will certainly have an impact on the agricultural sector. Extreme drought and heavy rainfall can have a negative impact on the loss of crop productivity. Climate change can disrupt food availability and threaten food security.

Extreme drought and heavy rainfall can have a negative impact on crop productivity loss. Climate change can disrupt food availability and threaten food security. In simple terms, reduced production will result in higher food prices. The high price of food products often triggers an increase in the price of other products [15–18]. The simultaneous impact that can occur in the community due to the high price of goods is a high crime rate and conflict between the community and policy makers [19–21].

The decline in agricultural productivity will certainly threaten the welfare of farmers. Based on data from the Central Statistics Agency (BPS) in 2020, according to the main source of income, the number of households classified as poor in Indonesia mostly comes from the Agricultural Sector, with a percentage of 46.30% [22]. The results of the National Labor Force Survey (Sakernas) in February 2021, the jobs that absorb the most labor are the agriculture, forestry and fishery sectors, with a percentage of 29.59% [23]. In addition, based on BPS data, the welfare of Indonesian farmers in several areas has decreased. Farmers' Exchange Rates (NTP) in seven provinces were below 100 in August 2021. The seven provinces that had NTPs below 100, namely Bali at 92.88, East Nusa Tenggara at 95.05, West Java at 96.46, Special Region Yogyakarta by 96.63, Banten by 96.65, South Sulawesi by 98.19, and Southeast Sulawesi by 99.87 [24]. Farmer's Exchange Rate less than 100 indicates that farmers suffer losses because farmers' income is smaller than the initial expenditure of the index calculation period.

Based on the results of the calculation of the farmers' exchange rate, the plantation subsector is the subsector that has the highest FTT, when compared to other subsectors. This is a double-edged sword, on the one hand, when people choose the plantation sub-sector as their main source of income, it will generate relatively high household income. However, on the other hand, when the community has made the plantation sub-sector a source of income and climate change has an impact on crop yields, many households will fall into the poor category. This study seeks to answer anomalies that occur in farmers in the plantation sub-sector. Farmers in the plantation sub-sector are expected to remain at an optimal level of welfare.

To maintain the level of community welfare, the government has made a policy of providing Social Assistance (Bansos) for the community. The social assistance program for the community consists of the Poor Rice Program (Raskin), the Smart Indonesia Card (KIP), the Prosperous Family Card (KKS), the Hopeful Family Program (PKH) and the Social Assistance Program (Bansos). The social assistance program is the government's commitment to accelerate poverty reduction. The government realizes that the decline in people's welfare will have an impact on the socio-economic aspects of the community. So that the right Social Assistance Program is expected to minimize worse conditions in the community.

2. DATA AND METHODOLOGY

The data used in this study was sourced from the 2018 National Socio-Economic Survey (SUSENAS) conducted by the Central Statistics Agency (BPS), with a total of 66,754 household observations, covering all provinces in Indonesia. The climatic factor used in this study is the temperature sourced from the Meteorology, Climatology and Geophysics Agency (BMKG). Welfare indicators for plantation farmers sourced from SUSENAS, are measured based on household participation in government assistance programs. The method of analysis used Ordinary Least Square (OLS). The OLS method is used to determine the effect of the independent variable on the dependent variable [25]. In this study, control variables will also be

added to determine regional conditions and ensure the strength of the model.

In this study, several control variables were added, including the island of Java and areas belonging to the category of disadvantaged areas. The choice of the variable Java Island as the control variable is because Java is the center of government and economy, so that the rise of public activities has an impact on the level of population density. While the selection of regions is lagging behind, because these areas tend to be natural so that public activities are relatively rare. The two control variables above describe contradictory phenomena. Control variables will be used in stages to determine the strength of the model. A good model can be indicated by the direction of the model and the significance of the model that does not change, when the control variables are added gradually.

The models that will be formed in this research are:

$$participation\ in\ social\ assistance = \alpha + \beta_1 temperature + \beta_i X_i + \varepsilon$$

3. RESULTS AND DISCUSSION

Based on the results of data processing, it is known that temperature affects the welfare of plantation farmers. These results are in line with several studies that have been conducted [26-29]. The complete results of this study can be seen from the table that has been presented, based on the type of assistance program followed by the household.

Table 1a presents information on the effect of temperature on poverty as measured by plantation farmers who are recipients of the Rice Poor Program (Raskin). From these results obtained a positive and significant coefficient of 0.0392204. From these results it can be interpreted that an increase in temperature has an impact on the welfare of plantation farmers. Gradually the increase in temperature that occurs has the potential to cause land drought, resulting in a decrease in agricultural productivity. The decline in the production of agricultural products will certainly reduce the income of farmers and have a negative impact on the level of welfare.

The Rice for Poor Families Program (Raskin) is a food subsidy intended for poor families as an effort from the government to improve food security and provide protection to poor families. Concretely, the Raskin Program will reduce the expenditure burden of Target Households (RTS), through fulfilling some basic food needs in the form of rice and preventing a decrease in recipients' energy and protein consumption.

Table 1a. The Effect of Temperature on Plantanation Farmers in the Raskin Program Recipients

```
. reg r1601 suhu if r804==3, r

Linear regression                               Number of obs     =     66,754
                                                F(1, 66752)       =      58.27
                                                Prob > F          =     0.0000
                                                R-squared         =     0.0009
                                                Root MSE          =     .49554

------------------------------------------------------------------------------
             |               Robust
      r1601  |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        suhu |   .0392204    .005138     7.63   0.000     .0291499    .0492908
       _cons |   -.641109   .1409919    -4.55   0.000    -.9174531   -.3647649
------------------------------------------------------------------------------
```

Table 1b. The Effect of Temperature on Plantation Farmers Recipients of the Raskin Program in Java and Disadvantaged Regions

Independent Variables	Model 1	Model 2	Model 3
	(1)	(2)	(3)
Temperature	0.039***	0.034***	0.031***
	(0.005)	(0.005)	(0.005)
Disadvantaged Regions		0.108***	0.111***
		(0.005)	(0.005)
Java			0.101***
			(0.012)
Constant	-0.641***	-0.514***	-0.445***
	(0.141)	(0.141)	(0.139)
Observations	66,754	66,754	66,754
R-squared	0.001	0.010	0.011
Dependent Variable : Raskin			
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

In Table 1b, a control variable is added to test the previously obtained model. The control variables included in this model are plantation farmers on the island of Java and farmers in disadvantaged areas. The addition of these two variables is in line with the previous model, which can be seen from the temperature coefficient value which remains positive and significant, namely 0.034 when the underdeveloped region variable is included and 0.031 when the underdeveloped region variable is included in Java.

Table 2a presents information on the effect of temperature on poverty as measured by plantation farmers who are recipients of the Smart Indonesia Program. From these results obtained a positive and significant coefficient of 0.0180084. From these results it can be interpreted that an increase in temperature has a negative impact on the welfare of plantation farmers.

The Smart Indonesia Card (KIP) program is an assistance in the form of cash, access expansion, and learning opportunities from the government given to students and students who come from poor or vulnerable families to finance education through the Smart Indonesia Card (KIP).

Table 2a. Effect of Temperature on Plantation Farmers Who are Recipients of the Smart Indonesia Program

```
. reg pip_1606 suhu if r804==3, r

Linear regression                               Number of obs     =     66,754
                                                F(1, 66752)       =      22.45
                                                Prob > F          =     0.0000
                                                R-squared         =     0.0004
                                                Root MSE          =     .36594

------------------------------------------------------------------------------
             |               Robust
    pip_1606 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        suhu |   .0180084   .0038011     4.74   0.000     .0105582    .0254586
       _cons |   -.334787   .1042637    -3.21   0.001    -.5391438   -.1304302
------------------------------------------------------------------------------
```

Table 2b. The Effect of Increasing Temperatures on Plantation Farmers Recipients of the Smart Indonesia Program in Java and Disadvantaged Areas

Independent Variables	Model 1	Model 2	Model 3
	(1)	(2)	(3)
Temperature	0.039***	0.034***	0.031***
	(0.005)	(0.005)	(0.005)
Disadvantaged Regions		0.108***	0.111***
		(0.005)	(0.005)
Java			0.101***
			(0.012)
Constant	-0.641***	-0.514***	-0.445***
	(0.141)	(0.141)	(0.139)
Observations	66,754	66,754	66,754
R-squared	0.001	0.010	0.011
Dependent Variable : Raskin			
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Table 3a. Effect of Temperature on Plantation Farmers Recipient of the Family Welfare Program

```
. reg r1608 suhu if r804==3, r

Linear regression                               Number of obs     =     66,754
                                                F(1, 66752)       =      26.37
                                                Prob > F          =     0.0000
                                                R-squared         =     0.0005
                                                Root MSE          =     .37978

------------------------------------------------------------------------------
             |               Robust
      r1608 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+----------------------------------------------------------------
        suhu |   .0211858   .0041255     5.14   0.000     .0130998    .0292718
       _cons |  -.4064362    .113166    -3.59   0.000    -.6282415   -.1846308
------------------------------------------------------------------------------
```

In Table 2b, a control variable is added to test the previously obtained model. The control variables included in this model are plantation farmers on the island of Java and farmers in disadvantaged areas. The addition of these two variables is in line with the previous model, which can be seen from the temperature coefficient value which remains positive and significant, namely 0.034 when the underdeveloped region variable is included and 0.031 when the underdeveloped region variable is included in Java.

Table 3a presents information on the effect of temperature on poverty as measured by smallholders who receive the Smart Indonesia Program. From the results of the table obtained a positive and significant coefficient of 0.0211858. From these results it can be interpreted that an increase in temperature has a negative impact on the welfare of plantation farmers.

The Prosperous Family Card (KKS) is a card issued by the Government as a marker for underprivileged families, as a substitute for the Social Protection Card (KPS). Through the implementation of this program, the use of technology was introduced to reach the underprivileged so that program distribution could be better and more efficient. With the implementation of this program, the government can increase the dignity of underprivileged families with protection and empowerment and not just give charity. So the increase in temperature is in line with the increasing number of farmers receiving the Prosperous Family Card Program (KKS) assistance.

In Table 3b, a control variable is added to test the previously obtained model. The control variables included in this model are plantation farmers on the island of Java and farmers in

disadvantaged areas. The addition of these two variables is in line with the previous model, which can be seen from the value of the temperature coefficient which remains positive and significant, namely 0.018 when the underdeveloped region variable is included and 0.017 when the underdeveloped region variable is included in Java.

Table 4a presents information on the effect of temperature on poverty as measured by plantation farmers receiving the Family Hope Program. From the results of the table obtained a positive and significant coefficient of 0.0175008. From these results it can be interpreted that an increase in temperature has a negative impact on the welfare of plantation farmers.

The Family Hope Program (PKH) is a social protection program that provides cash assistance to Very Poor Households (RTSM) and for RTS family members are required to carry out the terms and conditions that have been set. This program in the short term aims to reduce the burden on RTSM and in the long term is expected to break the poverty chain between generations, so that the next generation can get out of the poverty trap.

Table 3b. The Effect of Temperature on Plantation Farmers Recipient of the Family Welfare Program in Java and Disadvantaged Areas

Independent Variables	Model 1	Model 2	Model 3
	(1)	(2)	(3)
Temperature	0.021***	0.018***	0.017***
	(0.004)	(0.004)	(0.004)
Disadvantaged Regions		0.069***	0.070***
		(0.004)	(0.004)
Java			0.028***
			(0.009)
Constant	-0.406***	-0.326***	-0.307***
	(0.113)	(0.113)	(0.113)
Observations	66,754	66,754	66,754
R-squared	0.000	0.006	0.007

Dependent Variable : Program Perlindungan Sosial
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4a. The Effect of Temperature on Plantation Farmers Recipient of the Family Hope Program

```
. reg r1609 suhu if r804==3, r

Linear regression                               Number of obs     =     66,754
                                                F(1, 66752)       =      24.17
                                                Prob > F          =     0.0000
                                                R-squared         =     0.0004
                                                Root MSE          =     .33713

------------------------------------------------------------------------------
             |               Robust
      r1609 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+----------------------------------------------------------------
       suhu |   .0175008   .0035594     4.92   0.000     .0105244    .0244772
      _cons |  -.3493968   .0976239    -3.58   0.000    -.5407396    -.158054
------------------------------------------------------------------------------
```

Table 4b. The Effect of Temperature on Plantation Farmers Recipients of the Family Hope Program in Java Island and in Disadvantaged Areas

Independent Variables	Model 1	Model 2	Model 3
	(1)	(2)	(3)
Temperature	0.018***	0.015***	0.015***
	(0.004)	(0.004)	(0.004)
Disadvantaged Regions		0.045***	0.045***
		(0.003)	(0.003)
Java			-0.004
			(0.008)
Constant	-0.349***	-0.296***	-0.299***
	(0.098)	(0.097)	(0.098)
Observations	66,754	66,754	66,754
R-squared	0.000	0.004	0.004

Dependent Variable : Program Keluarga Harapan
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5a. The Effect of an Increase in Temperature on Plantanation Farmers Recipient of the Regional Government Social Assistance Program

```
. reg r1611 suhu if r804==3, r

Linear regression                               Number of obs     =     66,754
                                                F(1, 66752)       =      13.98
                                                Prob > F          =     0.0002
                                                R-squared         =     0.0002
                                                Root MSE          =     .25999

------------------------------------------------------------------------------
             |               Robust
       r1611 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        suhu |   .0104232   .0027882     3.74   0.000     .0049584    .015888
       _cons |  -.2130778    .076465    -2.79   0.005    -.3629493   -.0632064
------------------------------------------------------------------------------
```

In Table 4b, a control variable is added to test the previously obtained model. The control variables included in this model are plantation farmers on the island of Java and farmers in disadvantaged areas. The addition of these two variables is in line with the previous model, which can be seen from the value of the temperature coefficient remains positive and significant, namely 0.015 each when the variables are included in disadvantaged areas and when the variables are included in disadvantaged areas and Java Island.

Table 5a presents information on the effect of temperature on poverty as measured by plantation farmers who receive the Regional Government Social Assistance Program. From the results of the table obtained a positive and significant coefficient of 0.0104232. From these results it can be interpreted that an increase in temperature has a negative impact on the welfare of plantation farmers.

The Social Assistance Program originating from the Regional Government (Pemda) is a program initiated by the Regional Government in order to maintain the welfare of the community. In addition, this program is usually to fill the difference in recipients of assistance that has been determined by the central government. In practice, assistance programs from the central government sometimes cannot target all target households (RTS), so that the regional government through the APBD issues social assistance programs. Basically this assistance program is in line with the assistance issued by the central government.

Table 5b. Effect of Temperature on Plantanation Farmers who Receive the Government's Social Assistance Program in Java and Disadvantaged Areas

Independent Variables	Model 1	Model 2	Model 3
	(1)	(2)	(3)
Temperature	0.010***	0.007**	0.006**
	(0.003)	(0.003)	(0.003)
Disadvantaged Regions		0.074***	0.075***
		(0.003)	(0.003)
Java			0.017***
			(0.006)
Constant	-0.213***	-0.126*	-0.114
	(0.076)	(0.076)	(0.076)
Observations	66,754	66,754	66,754
R-squared	0.000	0.015	0.015
Dependent Variable : Subsisi dari Pemerintah Daerah			
Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

In Table 5b, a control variable is added to test the previously obtained model. The control variables included in this model are plantation farmers on the island of Java and farmers in disadvantaged areas. The addition of these two variables is in line with the previous model, which can be seen from the temperature coefficient value that remains positive and significant, namely 0.007 when the underdeveloped region variable is included and 0.006 when the underdeveloped region variable is included in Java.

Through the indications of the recipients of several aid programs above, it is known that the increase in temperature has an impact on the welfare of the community. Efforts are needed from the central and regional governments to monitor the impact of climate change in each region, so that agricultural productivity can be maintained [30–32]. Real form can be through counseling related to planting and harvesting period, seeds used, treatment methods, etc. In addition, the government also needs to prepare anticipatory steps when natural disasters still occur, so that the welfare of the community is maintained. Government support is very important in maintaining the sustainability of agricultural production

4. CONCLUSION

In the midst of climate change that occurs in all parts of the world, there are social and economic impacts on society. An increase in temperature is known to have an impact on decreasing agricultural productivity, which contributes to an increase in the number of poor farmers in Indonesia. This phenomenon can be seen from the increase in potential recipients of government assistance programs such as the Poor Rice Program (Raskin), Smart Indonesia Card Program (KIP), Prosperous Family Card (KKS), Family Hope Program (PKH) and Social Assistance Program (Bansos). Government efforts are needed to anticipate climate change trends that have an impact on people's live.

DISCLAIMER

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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