Study of ENSO impact on agricultural food crops price as basic knowledge to improve community resilience in climate change

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Abstract. Climate change has become a pivotal issue and impacted on the socio-economic community because it contributes not only to prolonged land droughts and fires in the dry season but also to increased rainfall and flooding in the wet season. One of the climate change phenomena in Indonesia is El Nino Southern Oscillation (ENSO) consisting of El Nino and La Nina. The ENSO phenomenon drives rainfall variability that impacts on the agricultural sector which depends on water availability. The objective of this study was to analyse the impact of El Nino and La Nina on the prices of six agricultural food crops using static panel data. The data used consist of 23 provinces affected by El Nino and La Nina in 2010-2017. Rainfall is used as a proxy for El Nino and La Nina, supported by a negative and significant correlation between Oceanic Nino Index (ONI) and rainfall. The results showed that El Nino has greater impacts on food prices than La Nina by increasing the price of rice, sweet potato, and mung bean. While La Nina has a significant impact in increasing the price of cassava. Considering the importance of food crops for Indonesians, efforts can be made to improve community resilience, such as using adaptive varieties of climate, developing agricultural insurance, time and planting patterns adjustment and agroforestry patterns for communities nearby the forests in the framework of climate change mitigation and adaptation. Ultimately, this study can provide important insights to formulate effective mitigation and adaptation strategies to minimize the climate change impact.

1. Introduction
Global warming has become one of the most important issues of the 21\textsuperscript{st} century. Global warming disrupts various climate parameters that will undergo permanent or called climate change. Climate change contributes to causing prolonged droughts, land and forest fires, increased rainfall, flood and landslides that adversely affects community socio-economic conditions. One form of climate change is the El Nino Southern Oscillation (ENSO) phenomenon. ENSO is a recurring pattern of climate change variability that is initiated by temperature anomalies and sea level water pressures and also impacts on rainfall variability in regions around the equator including Indonesia. The ENSO phenomenon consists of three phases namely El Nino, neutral, and La Nina. El Nino and La Nina are global events caused by ocean interaction with the atmosphere and characterized by an increase or decrease in sea surface temperatures across the Central and Eastern Pacific along the equator compared to average temperatures [1]. This leads to a decrease in rainfall intensity during El Nino and an increase in...
rainfall intensity during La Nina [2]. The ENSO phenomenon can be monitored by the Oceanic Nino Index (ONI). ONI is derived from Sea Surface Temperature (SST) measurement by National Oceanic and Atmospheric Administration (NOAA) at Nino 3.4 region [3]. ONI tracks 3-month average SST, namely previous, current, and 1 following month , then it is compared to normal SST in current month [4]. A strong La Nina presents if the ONI is -0.5 or lower and a strong El Nino exists if the ONI is +0.5 or higher. According to the Climate Prediction Center (2021), strong El Nino occurred in 1991, 1992, 1997, 2002, and 2015, while strong La Nina occurred in 1999, 2000, 2007, 2008, and 2011. Although ENSO has a significant impact on rainfall changes, there are other factors affecting climate differences among regions such as regional altitude, regional pressure, ocean current conditions, latitude, and ground level [5].

One of the most affected sectors by the ENSO phenomenon is agriculture [6,7]. The impact can be seen from the aspects of production, prices, and income of farmers [8,9]. Furthermore, El Nino and La Nina have become a serious threat to agricultural production. A significant decrease in rainfall due to El Nino can lead to crop failure because of drought, while increased rainfall due to La Nina can cause flooding and stimulate increased disruption of plant destruction organisms (OPT). [10] added that ENSO has a greater impact on food crops due to its relatively short lifespan. In addition, the production process of food crops is highly dependent on water availability, climatic conditions, and seasons. Decreased food production due to El Nino and La Nina can trigger rising food prices and inflation. This condition can disrupt food security and stability, especially rice, soybean, cassava, sweet potato, mung bean, and peanut that are the basic foods of most Indonesians. Extreme ENSO conditions can also cause natural disasters such as floods and landslides that interfere with food distribution access, thus increasing food prices [11]. Rising food prices due to the ENSO phenomenon is worth noting because it can affect macroeconomic conditions and economic stability.

Research on the impact of climate change (temperature, rainfall, storms and other aspects of weather) on economic performance (agricultural production, commodity prices, and economic growth) has grown rapidly [8]. [7] found that El Nino caused decreasing food crop production in Zimbabwe, while, La Nina increased food crop production. [12] in his research in China found that La Nina has a positive impact on wheat productivity compared to El Nino. [6] in his research in Brazil found that the North-eastern region of Brazil is vulnerable to El Nino, while La Nina has a greater impact in the South region. [8] found that the El Nino phenomenon provides a different response to a country's economy. Australia, Indonesia, India, Chile, New Zealand, South Africa, and Japan experienced a decrease in economic activity during the El Nino. In contrast to these conditions, the United States and the European region, as a matter of fact, experienced an increase in economic growth during the El Nino [8].

Rapid development on climate change research shows the importance of quantifying the impact of climate change on economic performance. This is because understanding the relationship between climate change and the economy is a key to the formulation of effective policies, especially in this regard to climate change mitigation and adaptation strategies. Most of the previous research objects focused on a country as a whole or a combination of several countries. Empirical facts show that climate change will give different impacts among regions within a single country [8,13]. Therefore, this study aims to analyse the impacts of climate change on food prices in Indonesia with provinces affected by ENSO as the research object. This research is expected to provide information on areas affected by ENSO and the magnitude of food prices. This information is required to formulate effective mitigation and adaptation strategies to improve community resilience to climate change. The impact of ENSO on food prices per commodity became important information to develop a pattern of innovation that must be undertaken in the process of food crop production to deal with climate change problems in the future.
2. Methods

2.1. Type and data sources
This study used secondary data in the form of panel data that merges between time series and cross section data. The cross-section data used were 23 provinces in Indonesia affected by El Nino and La Nina and also producing food crops. The data period used were annual data from 2010-2017 considering that there has been a complete ENSO phenomenon of El Nino, neutral, and La Nina in that period. The secondary data used in this study were obtained from various institutions, literature studies, and internet browsing. Details of the data used are presented in Table 1.

| No | Type of data                     | Unit         | Sources                                                                 |
|----|---------------------------------|--------------|-------------------------------------------------------------------------|
| 1  | Oceanic Nino Index (ONI)        |              | Climate Prediction Centre in National Oceanic and Atmospheric Administration (NOAA) website |
| 2  | Consumer-level food prices      | IDR/Kilograms| Ministry of Agriculture of Republic of Indonesia                         |
| 3  | Rainfall                        | Millimetres  | NASA Langley Research Centre                                             |
| 4  | Food crops productivity         | Quintal/Ha   | Ministry of Agriculture of Republic of Indonesia                         |
| 5  | GRDP per capita                 | Thousand IDR | Central Bureau of Statistic of Republic of Indonesia                     |
| 6  | Substitution products prices    | IDR/Kilograms| Ministry of Agriculture of Republic of Indonesia                         |

2.2. Data analysis
This study used descriptive analysis, spatial correlation, and static panel data. Correlation methods are used to identify provinces affected by the El Nino and La Nina phenomenon. The selected provinces will be analysed further using static panel data to determine the impact of ENSO on its food prices.

2.2.1. Correlation analysis between Oceanic Nino Index (ONI) and rainfall. The provinces used as objects in this study were determined by correlation analysis between ONI and rainfall values. This correlation analysis aims to identify the degree of the linear relationship between two variables [14]. Correlation coefficient values range (-1 ≤ r ≤ 1) with stronger relationships with the value of 1 or -1. A positive coefficient value describes a directly proportional relationship between two variables and otherwise for negative coefficient values. The formula for finding correlation coefficients is:

\[
 r_{xy} = \frac{n \sum XY - \sum X \sum Y}{\sqrt{(n \sum X^2 - (\sum X)^2)(n \sum Y^2 - (\sum Y)^2)}}
\]  

(1)

\( r \) is a correlation coefficient, \( X \) and \( Y \) are variables that the correlation value will be identified. After the correlation coefficient value was obtained, statistical tests were conducted to test the significance of the correlation coefficient. The hypothesis for testing t-statistics in this study is:

\[
 H_0 : r = 0
\]

\[
 H_1 : r < 0
\]

The t-statistical test formulation is formulated as follows:

\[
 t = \sqrt{n - 2} \sqrt{1 - \rho^2}
\]

(2)

\( \rho \) is coefficient correlation and \( n \) is number of observation.
2.2.2. ENSO impact analysis on food crop prices. Static panel data analysis was used to suspect the ENSO’s impacts on food prices in the affected provinces in Indonesia. [15] stated that there are three possible models formed in the analysis of data panel regression, they are pooled OLS models, fixed effects (FEM) models, and random effect (REM) models. All of three models will be tested to get the best panel regression model that matches the actual conditions. The tests used are Chow test, Hausman test, and LM (Breusch Pagan) test. The formulation of the econometrics model of regression panel data to analyse ENSO’s impacts on food prices was stated in the following equation:

\[
\begin{align*}
HrgB_t &= \alpha_0 + \alpha_1 PrdvB_t + \alpha_2 CH_t + \alpha_3 PDRB_t + \alpha_4 Subs_t + \varepsilon_{it} \\
HrgK_t &= \alpha_0 + \alpha_1 PrdvK_t + \alpha_2 CH_t + \alpha_3 PDRB_t + \alpha_4 Subs_t + \varepsilon_{it} \\
HrgUK_t &= \alpha_0 + \alpha_1 PrdvUK_t + \alpha_2 CH_t + \alpha_3 PDRB_t + \alpha_4 Subs_t + \varepsilon_{it} \\
HrgUJ_t &= \alpha_0 + \alpha_1 PrdvUJ_t + \alpha_2 CH_t + \alpha_3 PDRB_t + \alpha_4 Subs_t + \varepsilon_{it} \\
HrgKH_t &= \alpha_0 + \alpha_1 PrdvKH_t + \alpha_2 CH_t + \alpha_3 PDRB_t + \alpha_4 Subs_t + \varepsilon_{it} \\
HrgKT_t &= \alpha_0 + \alpha_1 PrdvKT_t + \alpha_2 CH_t + \alpha_3 PDRB_t + \alpha_4 Subs_t + \varepsilon_{it}
\end{align*}
\]

Where:

- $Hrg_{it}$ = Consumer-level prices of rice (B), soybean (K), cassava (UK), sweet potato (UJ), mung bean (KH), and peanut (KT) in the province $i$ affected by El Nino and La Nina in the year $t$ (IDR/Kilograms)
- $CH_{it}$ = Rainfall intensity in provinces $i$ affected by El Nino and La Nina in year $t$ (millimetres)
- $Prdv_{it}$ = Productivity of rice, soybean, cassava, sweet potato, mung bean, and peanut in the province $i$ affected by El Nino and La Nina in the year $t$ (Quintal/Ha)
- $PDRB_{it}$ = GRDP per capita in provinces $i$ affected by El Nino and La Nina in the year $t$ (Thousand IDR)
- $Subs_{it}$ = Substitution products prices of rice, soybean, cassava, sweet potato, mung bean, and peanut in the province $i$ affected by El Nino and La Nina in the year $t$ (IDR/Kilograms)

3. Result and discussion

3.1. Spatial correlation between ONI and rainfall for the determination of El Nino and La Nina in the affected provinces

The importance of determining ENSO affected areas is based on the facts that there are differences in El Nino and La Nina impacts among regions. Regarding rainfall, [16] stated that the impacts of ENSO are different in each region in different rainfall patterns. Strong ENSO's impacts on rainfall changes were experienced by regions with monsoon and local rain patterns, while the regions with equatorial rain patterns have a weak ENSO's impact.

![Figure 1. Correlation between ONI and rainfall based on province](image-url)
As previously stated, El Nino and La Nina climate anomalies cause significant rainfall changes in some parts in Indonesia. In addition to El Nino and La Nina, other factors related to geographical conditions such as latitude, altitude, sea currents, land level, and regional pressures also affected the climate and rainfall in a region [5]. This is reinforced by the fact that the occurrence of El Nino in 2015 did not have a significant impact on decreasing rainfall in all regions in Indonesia. Based on rainfall data from NASA Langley Research Centre (2021) when El Nino occurred in 2015, there are several provinces with very low rainfall (1,500-2,000 mm) and other provinces have a fairly high rainfall (3,500 - 4,000 mm). Based on this fact, it can be mentioned that the decrease in rainfall in a region of Indonesia is not necessarily caused by the El Nino phenomenon as well as the increase in rainfall intensity that occurs in a region in Indonesia is not necessarily caused by La Nina. As a result, it is required to identify provinces affected by El Nino and La Nina.

In this study, the determination of the affected regions (provinces) of ENSO was in reference to the correlation between ONI and rainfall. The results of the correlation analysis showed most of the correlation values were negative (Figure 1). It means that if the ONI is high, the intensity of rainfall decreases (El Nino); if the ONI value is low, the rainfall increases (La Nina). The correlation coefficient describes the degree of relationship between the two variables. Higher correlation values implied a strong relation between ONI and rainfall. Furthermore, t-statistical tests were conducted to notice whether ONI is significantly correlated with rainfall in each province.

Correlation significance test of ONI and rainfall using t-statistical test with H0:r =0 means that ONI has no significant impact on rainfall in the province and H1:r<0 means that ONI has a significant relationship with rainfall in the province. Based on the comparison of t-table (1.6520) with absolute t-statistical values, 27 provinces were most affected by El Nino and La Nina because ONI significantly affects rainfall in the province. On the consideration of data availability, the provinces used as research objects are 23 provinces namely Bali, Banten, Yogyakarta Special Region, Gorontalo, Jambi, Central Java, East Java, South Kalimantan, Central Kalimantan, East Kalimantan, Lampung, North Maluku, Maluku, West Nusa Tenggara, East Nusa Tenggara, West Papua, Papua, West Sulawesi, South Sulawesi, Central Sulawesi, Southeast Sulawesi, North Sulawesi, and South Sumatera. The number of provinces affected by ENSO in Indonesia is in line with [17] stating that the ENSO phenomenon is more likely experienced by tropical countries because ENSO affects even more rainfall in the equator area. Furthermore [4] stated that Indonesia's tropical climate causes a high level of sensitivity to climate change phenomena, such as El Nino and La Nina.

3.2. ENSO impacts on agricultural food crop price in Indonesia provinces affected El Nino and La Nina

3.2.1. Determination of the best model. The impacts of El Nino and La Nina on food prices were analysed using a regression of static panel data. Determination of the best model is undertaken using the Chow and Hausman test. Chow test is used to choose between Common Effect Model (CEM) and Fixed Effect Model (FEM). Hausmann test is employed to choose between Fixed Effect Model (FEM) and Random Effect Model (REM). From the results of both tests, it was decided to use FEM for the six commodities (Table 2). Furthermore, to produce BLUE models, a classic assumption test is conducted. The estimation shows the statistical probability value of Jarque Bera on the rice price model is greater than the confidence level of 5%, so it has met the assumption of normality. On the other hand, the other five models having a statistical probability value of Jarque Bera are smaller than the confidence level of 5%. Moreover, the residual model is not distributed normally, but it can be ignored because this study used large amounts of data as stated by [18].
3.2.2. ENSO impact on food crop price. El Nino and La Nina negatively affect food production, especially in affected areas. ENSO's climate anomalies have a double impact in the tropics compared to other regions, so it can reduce the economic growth of countries in Africa and the Asia Pacific, particularly developing countries [17]. The model estimation results are presented in Table 3. The probability (F-statistic) values of the six models analyzed are smaller than the confidence level of 5% which means that the model is worth using and there is at least one independent variable that significantly affects dependent variables. The goodness of fit model can be seen from the value of the coefficient of determination (R^2). The R-squared (R^2) value for the six food commodities built is able to explain the diversity of food commodity prices well.

### Table 2. Chow and Hausman test result

| Test type    | Rice price | Soybean price | Cassava price | Sweet potato price | Mung bean price | Peanut price |
|--------------|------------|---------------|---------------|-------------------|----------------|-------------|
| Chow test    | 0.0000*    | 0.0000*       | 0.0406**      | 0.0000*           | 0.0000*        | 0.0000*     |
| Hausman test | 0.0000*    | 0.0054*       | 0.0036*       | 0.0000*           | 0.0000*        | 0.0000*     |
| Decision     | FEM        | FEM           | FEM           | FEM               | FEM            | FEM         |

Note: * Significant at 1% level; ** Significant at 5% level

### Table 3. Results of estimated factors that affect the price of food crop commodities

| Variable             | Coefficient | Rice       | Soybean    | Cassava    | Sweet Potato | Mung Bean   | Peanut     |
|----------------------|-------------|------------|------------|------------|--------------|-------------|------------|
| Productivity         | -17.34937   | -112.1779**| -2.662392  | -3.136002* | 51.96458     | -237.6505** |
| Rainfall             | -0.202480*  | -0.271965  | 1.216854   | -0.347305* | -0.902816*   | 0.017833    |
| GRDP per capita      | 0.322727*   | 0.013721*  | 0.152930** | 0.214257*  | 0.424289*    | 0.495151*   |
| Substitution price   | 0.183749*   | 1.026235*  | 1.152697*  | 0.106937*  | 0.422526*    | 0.458489*   |
| Constanta            | -987.3872   | 4091.376*  | -8327.838* | -582.7464* | -1483.393*   | -2215.224   |
| R-squared            | 0.920636    | 0.618747   | 0.635894   | 0.953191   | 0.904236     | 0.939055    |
| Adj R-squared        | 0.907493    | 0.610228   | 0.575596   | 0.945439   | 0.888275     | 0.928898    |
| Prob (F-Statistic)   | 0.000000    | 0.000000   | 0.000000   | 0.000000   | 0.000000     | 0.000000    |

Note: * Significant at 1% level; ** Significant at 5% level

Based on the model's estimation, there are 3 variables that significantly affect the price of rice, namely rainfall, GRDP per capita, and substitution price. The variable of productivity negatively affects the price of rice. This result is in line with the theory of demand and supply although the impact is not significant. This is due to the productivity (as a picture of production) in this study which only includes domestic production. In fact, rice supply in Indonesia is combined with domestic production and imports. In accordance with these findings, [19] also found that although the influence is negative, the total domestic rice production does not significantly affect the national rice price.

The production of food crops including rice is closely related to climatic conditions, one of them is rainfall. Rainfall plays an important role in agricultural production as water provider for crops. The results of this study showed that rainfall negatively affects the price of rice which means a decrease in rainfall of 1 millimetre will increase the price of rice by IDR 0.0204 per Kg (ceteris paribus). The negative relationship between rainfall and rice prices suggests that the El Nino phenomenon has a greater impact on rice prices than La Nina. This result is supported by the research of [20] which stated that rice production during El Nino decreased by 4.15% compared to normal but increased by 1.45% during La Nina. [21] also revealed that El Nino negatively affects rice production in Southeast Asia, China, India, Central Asia, Sub Saharan Africa, and some parts in Brazil.

In Indonesia, most rice plants are planted on rice fields so they are highly dependent on the water availability. El Nino that led to a significant decrease in rainfall and a longer dry season reduced water availability in irrigation and ultimately led to a decrease in crop yields due to crop failure [22]. Food crop commodities in Indonesia are generally cultivated in April and September along with the
occurrence of El Nino commonly impacting cultivated plants which are still young and vulnerable to water shortages [10]. Production failure due to El Nino will ultimately shift the rice supply curve to the top left and create a new balance price higher than the previous one.

Soybean productivity has a negative and significant impact on its price. This result is also in accordance with the theory of demand and supply stating that increased productivity soybeans will shift the supply curve to the bottom right and form a lower balance price than before. These results are in line with [23] stating that if soybean supply increases, the price of soybeans will fall. Rainfall negatively affects soybean prices but not significant. These results suggest that soybean prices are more predominantly impacted by El Nino than La Nina. In line with these findings, Rajit el al. (1991) in [10] revealed that soybean plants are not resistant to water shortages and are also sensitive to excess water even though the water needs are not very large. Furthermore,[10] explained that most soybean are cultivated in dry land where water supply is highly dependent on rainfall. Therefore, El Nino that generally occurs in the dry season tends to cause a relatively large decrease in production in soybean crops due to the limited water supply needed by plants. In the end, El Nino increases the chances of production failure, so it triggers a rise in soybean prices.

Different results are shown by the price model of cassava and peanuts. Rainfall has a positive and significant impact on the price of cassava. Every 1 millimetre increase in rainfall will also increase the price of cassava by IDR 1,216 per Kg. These results show that cassava prices are more predominantly impacted by La Nina than El Nino. Horton (1998) in [10] stated that cassava plants are highly resistant to drought and can last for five months in water shortage. The deep rooting system causes cassava to be resistant to water shortage and El Nino causes the increase in temperature. Therefore, the impact of the decrease in cassava production due to El Nino is the lowest [10]. In contrast, La Nina conditions followed by increased rainfall and a longer rainy season triggered flooding and decay of cassava plants.

Like cassava, rainfall also positively affects peanut prices but not significant. These results show that La Nina has a greater impact on peanut prices than El Nino. La Nina followed by an above-normal increase in rainfall and a longer rainy season was not always beneficial for the production of food crops including peanuts. La Nina climate anomalies actually increase the chance of production failure because it triggers catastrophic floods and landslides and causes plants to rot quickly.

El Nino and La Nina also have an indirect impact in lowering the productivity of food crops due to increased pest attacks. It led to lower production and productivity that triggered rising food crop prices. Based on the model's estimates, productivity variables negatively impact the prices of cassava, sweet potato, and peanut. Nevertheless, its impact is only significant on sweet potato and peanut. The overall results are in accordance with the theory of demand and supply. Increasing cassava production will shift the supply curve to the bottom right; therefore, it will create a new price higher than before. This result is in line with [24] stating that increased productivity will lead to a decrease in prices.

Climate factors such as El Nino and La Nina also influence the productivity of other food crops such as sweet potato and mung bean. ENSO, which is proxied by rainfall variables, negatively affects the price of sweet potatoes and mung beans. This suggests that El Nino has a greater impact on the prices of both commodities than La Nina. Due to significant rainfall decreases and longer dry seasons when El Nino occurs leads to increased chances of sweet potato and peanut production failure. Peanuts and sweet potatoes are generally grown on dry land so it is highly dependent on rainfall in the availability of water supplies. [10] added that the decrease in the production of sweet potato and peanut due to El Nino reaches 3.30% and 4.74% respectively.

Gross Regional Domestic Product (GRDP) per capita positively and significantly affects the prices of the six food crops analysed. GRDP per capita is an indicator that describes the level of population welfare in an area. Improving welfare affects the increasing purchasing power of the community and leads to increased demand for food crops. The results of this study are in accordance with the theory of demand and supply. Increasing the welfare or income of the population will shift the demand curve to the top right to form a new balance with higher prices. In line with these results, [25] stated that the
increased income changed consumption patterns resulting in an increase in demand for agricultural commodities.

The substitution commodities price positively and significantly affects the prices of the six food crops analysed according to the theory of demand and supply. An increase in the price of a commodity will encourage consumers to consume similar substitute products that trigger a rise in the price of substitution goods. The pairs of food commodity substitution items analysed in this study are rice substituted with corn, soybeans substituted with rice, sweet potatoes substituted with cassava, and mung bean substituted with peanut. [26] revealed that cassava is substituted with sweet potatoes. In line with the results of this study, [19] found a positive relationship between the price of corn as a product of rice substitution and the price of rice itself. [23] also found a positive relationship between the price of corn and soybeans in relation to each other as a substituted product.

Overall, of the six food crops analysed, El Nino has a greater impact on food prices than La Nina. In accordance with these results, [10] stated that El Nino gives a more serious threat to food production than La Nina. El Nino phenomenon followed by a significant decrease in rainfall compared to normal levels, the beginning of an erratic dry season and a longer dry season have an impact on the failure of food crop production which depends heavily on the season and water availability. [27] added the impact of climate change in the form of drought to be the main cause of crop failure. In food crops, El Nino negatively impacts production while La Nina actually stimulates the increase in food production due to increased water availability as a result of increased rainfall [10,20,27].

3.3. Mitigation and adaptation strategies to address the impacts of El Nino and La Nina

The ENSO phenomenon is known to have an impact on increasing food prices, so a comprehensive mitigation and adaptation strategy involving many parties are needed. Mitigation focuses on prevention efforts to reduce the impact of climate change; while adaptation is an effort, activities and technologies to adapt when climate change occurs [28]. These mitigation and adaptation efforts are expected to increase the resilience of the community to face climate change. The following are policy recommendations that can be applied in addressing the impacts of climate change, especially the ENSO phenomenon.

3.3.1. Development and use of climate adaptive varieties (superior seeds resistant to extreme weather). The development of food crops that are tolerant to environmental stress such as rising air temperatures, droughts, inundation (floods) and salinity is very important in adaptation to climate change. The government through the Ministry of Agriculture has issued several varieties that are resistant to dry climate such as Dodokan and Silugonggo rice, Argomulyo and Burangrang soybeans, Jerapah and Singa peanuts, Kutilang mung bean and also Bantimurung, Anoman and Sukmaraga corn [29]. Although there are many climate adaptive varieties, the adoption rate by farmers is still low. Therefore, we need to introduce these varieties which are supported by the local conditions adaptation system.

3.3.2. Cropping time and pattern adjustment. El Nino and La Nina causes uncertainty on the beginning and duration of the rainy and dry seasons. This causes shifts in time, season, and cropping patterns, especially short-lived food crops. The IAARD has published a planting calendar (KATAM) which contains the right planting time and is adjusted to the dynamics of the climate [30]. The KATAM facility which is still available online is an obstacle for farmers and creates additional costs for its accessibility. Agricultural extension agents are expected to hook up the gaps in information and communication technology faced by farmers.

Adjusting cropping patterns can also be a solution to minimize the impact of climate change. [10] recommends a rice-rice-rice cropping pattern during La Nina and a palawija-rice-palawija cropping pattern during El Nino. For farmers around forest areas, agroforestry patterns can be an option in the context of climate change mitigation and adaptation. [31] states that the joint use of land for forests and agriculture will reduce greenhouse gas emissions and increase food production more effectively.
than saving forests and intensifying agriculture. Furthermore, agroforestry systems also produce higher production and both in quantity and value as sustainable income, so that they can be an alternative income associated with variations in climate change [31]. The intercropping system in the form of cultivating agricultural commodities combined with forestry plants in the Social Forestry program is one of the strategies that can be offered. If properly designed and guided, agroforestry with an intercropping system in land between forest areas can be directed to increase national food production by planting certain commodities having high economic value, such as food crops, palawija, and horticulture [32].

3.3.3. Improvement of irrigation or drainage systems on agricultural land. Other efforts to minimize the impact of ENSO that can be taken is the improvement of irrigation or drainage systems in agricultural land, especially in dry land for the cultivation of food crops such as soybeans, sweet potatoes, and mung beans. Good irrigation systems can accommodate excess rainfall during La Nina and become suppliers of water needs during El Nino. Farmers can also develop rainfall harvesting techniques, for example by making pond (embung).

3.3.4. Development of climate prediction systems and dissemination of anomaly climate information. In anticipation of greater losses due to climate change, it is necessary to develop an accurate climate anomaly using early detection system to provide early warning to farmers and related parties about imminent climate change. These forecasts include the time of the event, the length of the event, the level of anomalies, the potential impact on water availability, and food production as well as the distribution of vulnerable areas.

3.3.5. Development of agricultural insurance. The impact of climate change refers to disruptions or conditions of loss and benefit physically, socially, and economically caused by climate change. These impacts are often inevitable due to unpredictable climate change. To overcome this, it is necessary to develop climate-based agricultural insurance to reduce farmers' losses due to crop failure.

Ultimately, efforts to mitigate and adapt the impacts of climate change should pay attention to several important points. Mitigation and adaptation activities should be designed to be location-specific by considering the geographical conditions of each region so that the technology applied must be appropriate by adopting local wisdom. In addition, climate change adaptation and mitigation actions must provide benefits in improving the welfare of farmers.

4. Conclusion
Indonesia's position around the equator causes the entire Indonesian region to be affected by El Nino and La Nina climate anomalies with varying intensity. Stronger ENSO impacts occur in most of Sulawesi, Kalimantan, Nusa Tenggara, Papua, parts of Java, and Sumatra. This anomalous climate causes drastic changes in rainfall intensity as evidenced by the negative and significant correlation between ONI (as an indicator of ENSO) and rainfall. El Nino and La Nina phenomenon have an impact on food prices of different magnitudes per commodity. El Nino has a greater impact on the prices of rice, soybean, sweet potato, and mung bean. Meanwhile, La Nina has a bigger impact on cassava and peanuts prices. From six food crops analysed, El Nino had a greater impact on food prices than La Nina.

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