

# Implication of climate change on coffee farmers' welfare in Indonesia

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**Abstract.** Coffee has become a leading commodity of several countries including Indonesia. Indonesia is the fourth largest coffee producing country in the world after Colombia, Brazil and Vietnam, in which 96% of coffee plantations in Indonesia are smallholdings, with an average land ownership of 0.6 hectares per farmer. However, in recent years the volume of coffee production has decreased due to climate change. Climate change in Indonesia raises the phenomenon of El Nino and La Nina that causing erratic rainfall. Further, it has an impact on coffee production and the farmers' welfare. The purpose of this paper is to describe the effect of climate change on the welfare of coffee farmers in Indonesia. This paper is a compilation of several articles, journals, and books written by experts on coffee, climate change, and the welfare of coffee farmers. The results indicate that climate change is very influential on coffee production volume and quality of post-harvest. Production and post-harvest problems caused by climate change have an impact on coffee quality to decrease, which further affects the income and prosperity of coffee farmers in Indonesia.

## 1 Introduction

Coffee is a leading commodity of Indonesian plantation that has an important role in increasing non-oil exports in Indonesia. Being the world's fourth-largest coffee producer, Indonesia was able to produce 660,000 tons in 2017 [1]. The development of coffee production in Indonesia significantly from year to year. Some regions in Indonesia are known as the world's best coffee producers such as Lampung province which is famous for the largest robusta coffee center in Sumatra, whose coffee variety is famous to foreign countries as well as *Aceh Gayo* coffee, *Sidikalang* coffee in North Sumatra, and also Mandailing coffee. there are also Java island robusta plantations that are quite large in Malang, Temanggung, and Bali province. Narulita et al. [2] explains that Indonesia has a tropical climate which fits perfectly with the growth of coffee crops. As a coffee island nation, Indonesia potentially has a diversity of coffee taste due to the topographic shape in each region.

Coffee becomes one of the consumption products favored by the public whether young or adult. Since coffee is now no longer a matter of consumption alone, but a lifestyle among people who have been entrenched, its demand is always increasing from year after year. However, climate change has affected the instability of coffee production levels worldwide resulting into a fluctuation on its price in the international export market. Consequently, the price of coffee in Indonesia decrease.

Climate change occurs due to changes in air pressure because of global warming, resulting in a global climate change. It also increases the frequency of flood and drought intensity as well as El-Nino periodicity [3]. If it is ignored, climate change will have a negative impact on the productivity of



plants in Indonesia, especially coffee plants that are very vulnerable to temperature. As explained by Karim et al. [4] in their study on the development of Arabica coffee, the climate components that affected coffee plant growth are rainfall, temperature, and humidity.

It is reported that in 2017 the total area of coffee plantations in Indonesia is 1,227,787 hectares. The cultivation of coffee plantation is still dominated by smallholder farmers that own 1,179,769 hectares (96.09%), whereas private plantations only covers 25,493 hectares (2.76%) and 22,525 hectares (1.83%) are of the state plantations. However, the large production area does not significantly increase the coffee production of coffee itself, which is only 519, 521, and 520 kg per hectare in 2017, 2016, and 2015, respectively. This could be due to the impact of recent weather changes, rainfall uncertainty, and a prolonged drought that can affect coffee production and flowering [5].

The average area of coffee plantation cultivated by farmers is only between 0.5-1 ha [5], which cannot meet the needs of farmers' daily living. In addition, it is worsened by the occurrence of climate change that affects the productivity and quality of coffee causing the price to decrease because of its incompatibility with the grade determined by the traders. To formulate the problems of production and post-harvest coffee caused by climate change that affects the quality of coffee in Indonesia, it is necessary to study the relevant theory and the strategy to overcome it. This paper aims at discussing the impact of climate change on the welfare of coffee farmers in Indonesia and how to reduce the impact of climate change on coffee crop production in Indonesia.

## 2 Methodology

This article discusses some studies on coffee, the prosperity of coffee farmers, and climate change obtained from scientific publications and books. The data sources are taken from several national and international journals, books and articles on websites that focus on the study of coffee. The steps in managing the data are started from collecting articles in accordance with the context of the discussion, then filtering and reviewing the data, and finally compiling it into an article.

## 3 Result and discussion

### 3.1 Effects of climate change on coffee production in Indonesia

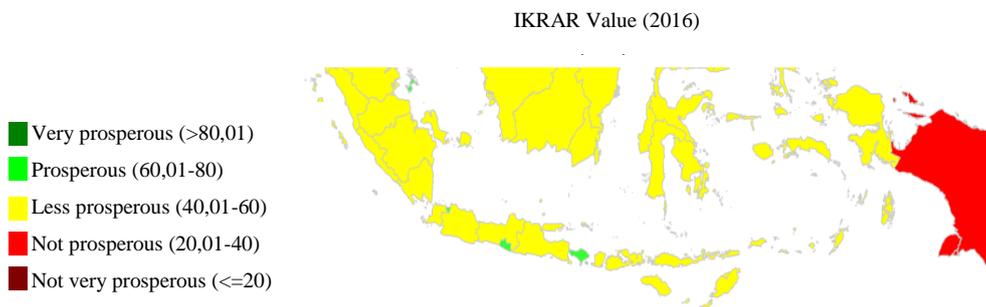
Climate change is very influential in the growth and development of coffee plants. Climate change is an implication of global warming caused by the increasing levels of greenhouse gases, especially carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Armi et al. [6] explains that the increase of greenhouse gases in the air causes the increase of temperatures in the environment so that it will lead to unpredictable weather.

Läderach [7] describes the impact of climate change on coffee quality. It is reported that coffee grows optimally at altitudes between 800 and 1,400 m asl, but this optimum elevation is likely to increase at 1,200 and 1,600 m asl in 2050. This result is consistent with what is expected from the 2.5 °C heating rate, and the moist adiabatic of 0.65 °C per 100 m. Climate change tends to shift the favorable elevation for coffee plants from year after year along with the adaptation process. It may mean that it can be concluded that if coffee farmers do not raise the elevation of the field, the productivity and quality of their coffee will decrease due to the adaptation to the environmental climate.

In addition, climate change also affects the migration of pests insects such as moths and grasshoppers. The increasing temperatures can prolong their flying period of insects and thus allow them to spread over longer distances. Furthermore, insects like moths will live well within moderate temperatures [8], and this will lead to the explosion of pest populations because their breeding rate will frighteningly increase.

### 3.2 The welfare of coffee farmers in Indonesia

According to the data from Indonesian Welfare Data Center in 2016 [9], Indonesia is still categorized as poor in almost all regions except Bali and Jogjakarta which have a prosperous index. This certainly shows a general picture of the welfare of Indonesian society where most of them are less prosperous.



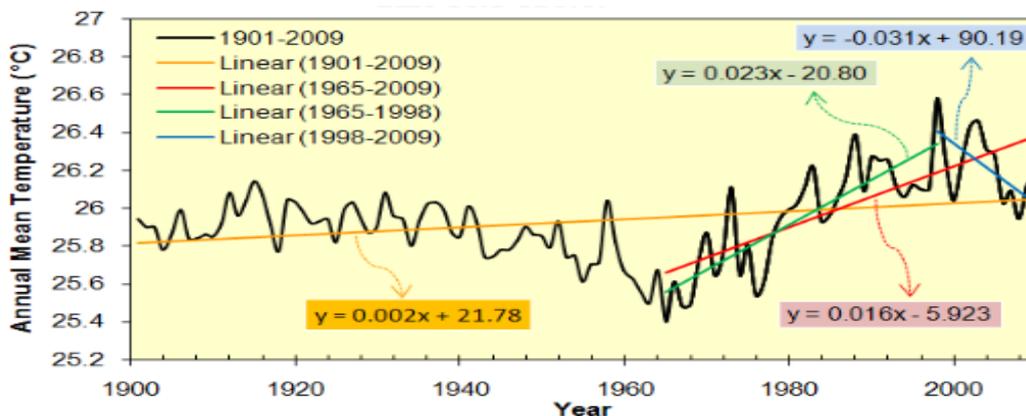
**Figure 1.** Map of the Indonesian welfare index (Welfare Data Center, 2016) [9]

Coffee farmers in Indonesia are unlikely to be prosperous at all before they are able to manage their business properly from the cultivation to post-harvest process. Indonesian coffee consumption is still very low at 0.8 kg per capita per year, whereas that of Brazilian is 6 kg per capita per year. Meanwhile, Norwegian coffee consumption is 10.6 kg per capita per year, and even Finn has reached up to 11.4 kg per capita per year [10]. This low consumption of coffee in Indonesia becomes the opportunity to increase the domestic market share along with the economic growth. However ironically, the welfare of coffee farmers in Indonesia is still questionable. This should be a concern because the average land ownership of smallholder farmers is only 0.6 hectares and the price of coffee offered by middleman is lower. Farmers who sell privately to middlemen tend to accept the price game set by them.

In terms of job creation, coffee commodities provide jobs up to 1.88 million families with an average ownership of 0.6 hectares. Currently, coffee crops in Indonesia are still dominated by smallholder farmers reaching 96% and only 4% are cultivated in large plantations, both private and state [5]. Desianti [11] reveals that the opportunities of gaining profits by coffee farmers both financially and economically in Indonesia is rather high. Thus, the coffee plantation in Indonesia is feasible to continue and the economics of the coffee plantation can run efficiently. The values for coffee plantation areas ranged between 0.35 and 0.90, while the product category rules (PCR) values ranged between 0.52 and 0.97.

### 3.3 Analysis of the relationship between climate change and farmers' welfare

Climate change affects the productivity of coffee crops, both in terms of growth and proliferation. One of the impacts of climate change is the erratic rainfall caused by LaNina storm. Figure 2 is the temperature change quoted from Indonesian Climate Change Sectoral Roadmap National Development Planning Agency (*Bappenas*) 2010 [12].



**Figure 2.** Temperature changes in Indonesia for the period of 1900-2000 (Bappenas, 2010) [12]

**Table 1.** Coffee Production in Indonesia 2012 – 2016.

Year	(Small Hollder)	(Government)	Private	$\Sigma$
2012	661,827	13,577	15,759	691,163
2013	645,346	13,945	16,591	675,881
2014	612,877	14,293	16,687	643,857
2015	602,428	19,703	17,281	639,412
2016	602,160	19,838	17,306	639,305

Source: Directorate General of Plantation Production Development, 2014[13]

From Figure 2 and Table 1 show that there have been changes in temperature from year by year, and coffee production by smallholder farming decreases in the last 5 years, respectively. Changing temperatures cause excessive evapotranspiration of plants, the emergence of forest fires, as well as faster and broader breeding rate of insects. According to Surmaini et al. [14], the average rise in temperature and the disturbed hydrological cycle could lead to longer and more intensive dry season but shorter wet season, increasing dry and wet season anomaly cycle, and also reducing soil moisture. That makes coffee cannot adapt well, hence productivity decreases. Climate change will likely decrease crop yields due to the drought that is caused by longer dry season.

The productivity is certainly very important for the economics of coffee plantation. If the productivity is low then it can be assured that farmers will lose, especially the smallholder farmers in Indonesia who only have land less than 10 ha. Therefore, this will decrease the income of farmers.

### 3.4 Settlement strategy

**3.4.1 Good canopy selection.** At regional level, the shade of coffee plantation contributes to the regulation of water conservation services, watershed management, soil conservation, and landslide prevention. Coffee grows throughout the tropics but is susceptible to local weather changes [15] with the decreasing yields in low rainy season. Furthermore, there is also a narrow temperature range where growth rates and coffee yields are high. The maintenance of temperature and humidity can benefit coffee producers with greater yields. At global level, the shaded canopy system is a major contributor to carbon sequestration and climate change mitigation services. The tropical deforestation and fire use in agricultural areas are the major contributors to the increase of CO concentrations in the atmosphere [16].

**3.4.2 Coffee certification.** According to the Directorate General of Food Processing Indonesia, certification is a system of quality assurance and food security in the form of certification to business actors/farmers/farmer groups as a proof of recognition that the business actors/farmers/farmer groups have fulfilled the requirements in implementing the quality assurance system and food safety consistently issued by the Ministry of Agriculture. The name of the certification is Geographical Indication. The objectives of the certification are to provide quality assurance and food security, protect community and consumer, facilitate re-tracking of possible quality deviations and product safety, and enhance the added value and competitiveness of the product.

Certification on agricultural products is useful to determine the quality of the product. Through by implementing of the certification, it is supposed that there are no changes in its quality and the market confidence will rise with the professionalization through the sale of the product that is in accordance with the market-specified grade. Furthermore, the certification will increase the value of a product and consumer confidence in the product.

**3.4.3 Agroforestry of coffee plantations.** According to Widiyanto et al. [17], the benefits of agroforestry from the environmental standpoint are reducing the surface run-off, soil nutrient leaching, and soil erosion, because the trees' canopies block the processes. Thus, the nutrient content in the soil will remain intact. With agroforestry, there will be an improvement of soil structure due to the addition of

continuous organic material from rotting litter. The soil will be looser so it does not require excessive cultivation of the soil.

In addition, Widiyanto et al. [17] explains that the benefits that farmers gain from the social and economic aspect of the agroforestry system are the improvement and provision of carpentry, firewood, food, fodder, and green manure. Through agroforestry system, farmers can cultivate more than one plant species so that if one crop fails or the price drops, losses can be covered from the other crops. Agroforestry system also establishes and improves farmers' income due to the increase and sustainability of product assurance. Further, farmers will have more time to work in other fields outside the agroforestry because of the easy process of its systems.

*3.4.4 Centralized marketing strategy.* It is a marketing strategy by centring on one management in which all activities of collecting and marketing farm products are carried out collectively or together. Palesangi and Satyarini [18] mentions the concentrated marketing (centralized marketing) is a marketing activity whereby a company or business group seeks a large market share in one or more sub-markets instead of looking for a small market share from a large market. The advantages of employing this method are a clear and easy operational process and stable price of commodity. Collective institution creates a power in determining market share and target market in running farms. If this strategy can be implemented by the coffee smallholder farmers in Indonesia, its marketing will be more effective and centralized hence coffee grading will be more uniform in size and quality.

#### 4 Conclusions

Climate change affects the welfare of coffee farmers in Indonesia, as it is responsible for coffee production decline due to extreme weather. If climate change keeps occurring, the optimum elevation of coffee crops would decrease to 800-900 m asl. Climate change triggers high rainfall causing flowering failure, as well as longer drought causing the flowers fail to bloom. These lead to the coffee production as well as the income of smallholder farms to decrease. The farmers' marketing system caused by climate change is also found as a problem.

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