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Indonesia, Rice production relating to food insecurity and climate change

Rice Production, Food Insecurity, and Climate Change in Indonesia

As a Southeast Asian archipelago on the equator, Indonesia has a tropical climate perfect for feeding its population of 260 million people (CIA, 2017). The main Indonesian diet is composed of eating rice three times a day with some type of meat or fish and side vegetables (Knowles, 2011). Rice is consumed at 150 kilograms per capita per year (McGovern, 2018). Agriculture is one of Indonesia's main industries, and one third of Indonesians are farmers. With rice being consumed at such a high rate, Indonesia has a high demand for rice. However, rice production in Indonesia has not been stable. This paper will investigate and identify causes for instability in Indonesia's rice production and explore potential solutions.

Indonesia is the third largest rice producer in the world. In 2017, Indonesia produced 74.2 million tons of unmilled rice (McGovern, 2018). Nevertheless, since 2003, the Indonesian government has been forced to import rice every year from neighboring countries. In 2016, Indonesia imported $524 million worth of rice from Thailand and Vietnam (Simoes, 2016). The Indonesian government had sought to reduce rice consumption by encouraging alternative food options; however, there was pushback from the public (McCarthy & Obidzinski, 2017). Indonesians' heavy reliance on rice has resulted in high demand and it has often been hard for rice farmers to keep up with the production. Unstable rice production has contributed to food insecurity issues in Indonesia. In the meantime, conventional methods of rice cultivation also resulted in increased methane emissions due to environmentally unfriendly farming practices as well as the overuse of chemical fertilizer (McCarthy & Zen, 2013). Indonesia's inability to achieve rice self-sufficiency has resulted in serious social, economic, and environmental challenges. Indonesia's rice shortage is a complex problem where production, distribution, and consumption all play a role. In terms of production, more optimal and environmental-friendly farming practices should be explored to address the challenges.

Though most of Indonesia is rural, younger generations are moving towards the cities and out of the fields. Large cities such as Jakarta, Surabaya, and Bandung suffer major infrastructure issues. Many areas in these cities lack satisfactory housing, dependable supplies of water, and adequate school and health facilities. These areas are called *kampung*. *Kampung* typically consist of small brick houses that have to find a supply for their own water and electricity which is often obtained illegally from hooking up to the power supply of the national electric company (Adams et al., 2018). In spite of the poor living conditions of some *kampung*, the Indonesian government nevertheless has recognized the importance of education. According to the World Factbook, 95.4% of Indonesians are literate, and higher education enrollment is evenly distributed between men and women (CIA, 2017).

In spite of the younger generations' preference for urban living, rice production in Indonesia is primarily carried out by small farmers in rural areas (FAO, 2015). Smallholding farmers account for 90% of rice production (Indonesia Investments, 2017). While Indonesia is considered a

middle-income country, there are still many hunger hotspots where parts of the population struggle with feeding themselves. To fully comprehend the situation, it is important to understand the life of a rice farmer. A typical day for a farmer consists of six to nine hours of grueling labor. Less than fifty percent of farmers own their land, and for those who do, they cultivate landholdings of about 0.6 hectares. In rural areas, farmers will often experience crop failure and have few other income opportunities. The average family size is five to six members with the household usually headed by men. Only 47 percent of the total household income is originated through crop production (FAO, 2015). The rest is supplemented through sand mining in the rivers or illegal logging in the forest. During each harvest season, farmers are the first to suffer from food insecurity that lasts for about two months until the next harvest season. If food is too expensive, poor families subsist by eating cheap insubstantial food like instant noodles to substitute proper meals. Families may also cut down rice consumption and eat meals without any protein. To look for more food, the men might go fishing while women collect wild ferns in the forest (McCarthy & Zen, 2013). However, water and fish in areas heavily polluted by overusing chemical fertilizers could become toxic and inedible. As a farmer from Indramayu said, before the Green Revolution, he could fish and drink the water from the rice paddies, but now he will be poisoned (Wicaksono et al., 2017).

Many provinces in Indonesia are permanent agricultural lands that lack nutrients due to constant farming. As a result, farmers used chemical fertilizers to replenish the soil while combating pests. However, overusing harmful chemical fertilizers not only led to more nutrients being pulled out of the soil but also caused health issues for farmers, pH changes in the soil, and more greenhouse gas emissions. Changes in the pH of the soil would cause a sudden drop in yield and rice quality. Being the least educated of the entire population, many farmers believed that chemical fertilizers are “medicine” for their “sick” crops. They also believed that using the “medicine” would increase rice yield (Wicaksono et al., 2017). However, plants only use 50% of fertilizers that are applied to the soil. Often 20% is lost to evaporation, another 15-25% will pull nutrients out of the soil, and 10% will interfere with surface and groundwater (Savci, 2012). For instance, on Bali island, use of urea and compound fertilizers together resulted in the nitrogen input to be as high as up to 120 kilogram per hectare. (Shiotsu et al., 2015). This presented great challenges environmentally, creating conditions that contributed further to climate change while hurting the crops and people.

Rice production and climate change are interrelated in many ways. Due to Indonesia’s geographical factors and climate, rice production is vulnerable to climate change. Rice is already a vulnerable crop that can often fail due to various factors during production. For the past three decades, Indonesia has experienced several natural disasters, 80% of which were due to climate change (Sulistyawati et al., 2018). Some effects of climate change included sea level rising, flooding, droughts, landslides, and temperature increasing. Indonesia was among the many nations that suffered during recent El Niño and La Niña phenomena. In 2008, the La Niña event increased flood damage in Indonesia, while during the El Niño in 2015, serious drought affected 815,132 hectares of rice fields (Rumanti et al., 2018).

With the temperature rising since 1990, Indonesia has seen a 0.3℃ increase in temperature per year which led to decreasing rice yield. Every time the temperature rose by 1℃, irrigated paddy yields decreased by 11.1% and rainfed yields decreased by 14.4% (Yuliawan, 2016). Indonesia

has also experienced 2-3% more precipitation each year which led to many areas being flooded. There are two types of flooding: flash and stagnant. During flash floods, paddy fields were inundated for a few days to two weeks. On the other hand, during stagnant flooding, paddy fields were partially submerged (about 50 cm) for a few weeks to several months. In 2016, flooding affected 71,900 ha of agricultural land in Central, East, and West Java, Aceh, and South Sumatra provinces. Impacts of climate change made rice production in Indonesia become even more vulnerable (Rumanti et al., 2018).

The Indonesian government has sought several solutions to increase rice yield. Self-sufficiency in rice production would usually be seen as a point of pride for Indonesia. However, with rice production not meeting the demand, panic and social issues erupted which forced the government to import rice on emergency basis. Imported rice often disturbed the local market, leading to rice price increases and other economic issues. The Indonesian government has tried to solve the issue by establishing policies to reduce the need for food imports so as to protect the domestic markets against turbulent international prices. The government has also attempted to expand agricultural production by providing incentives for private sector investors in pursuit of large-scale production approaches (McCarthy & Obidzinski, 2017). In the Mega Rice Project in Kalimantan, of all the investors, only one company chose to plant rice while other companies chose to invest in tourism. That company ultimately had only below average productivity, with a mere 2.5-3 tons per hectare versus the average rice yield of 4.6 tons per hectare. The Mega Rice Project turned out to be a disappointment and was abandoned. Its failure confirmed that large-scale farming was not a solution to increase rice production in Indonesia. One of the practical challenges was the lack of available land, as most of mineral lands were already allocated to mining and oil palm companies while the forest land were under moratorium (McCarthy & Obidzinski, 2017). Solutions to increase Indonesia's rice production therefore have to be sought within Indonesia's tradition of small scale farming.

Indonesia's complex rice shortage problem requires using multiple solutions at the same time. Considering how to increase rice yield without further aggravating the effects of climate change, this paper suggests adopting more environmentally farming practices, investing in farmers' education, and looking into growing more climate-ready rice varieties.

To start with, to cut down on greenhouse gas emissions, more environmentally farming practices have to be adopted. Conventional Indonesian rice farming practices contributed to the increase of greenhouse gas emissions. For instance, 23.7% of Indonesian farmers left the unused rice straw rot in the fields. Allowing the rice straws to rot in the field is one of the main causes of methane emissions from rice farming (Frimawaty et al., 2013). Other alternative organic fertilizing method such as using cattle manure could be explored. Educating farmers on better farming techniques is crucial in developing sustainable farming practices while cutting down use of chemical fertilizers.

Several programs were already established to fight the overuse of chemical fertilizer. They were often ineffective due to the fact that agricultural extension agents came into the villages to introduce new solutions from the government without properly teaching the farmers (McCarthy & Zen, 2013). One effective new program in West Java nicknamed "Science Field Shops" has become quite established. Farmers meet monthly at each other's homes with scientists

specialized in agrometeorology and environmental anthropology. Farmers would report their rainfall and crop data, and discuss problems that they face. By sharing their experience, farmers and scientists work together to solve the challenges. In this program, farmers learned how to grow a healthy crop, which insects or predators are helpful or harmful, etc. After going through the program, most farmers have successfully cut down the use of chemical fertilizer and pesticides. They learned to preserve certain predators such as snakes and spiders. They have also organized to create clubs such as Indramayu Rainfall Observers Club and the East Lombok Rainfall Observers Group (McCarthy & Zen, 2013).

Not only do rice producers need to adopt more environmentally friendly farming practices to slow down climate change, they also need to grow more climate-ready rice. Not wanting to discredit the work that has been done, but rather acknowledging it, it must be understood that since the 1970s, Indonesia's average rice yield has risen over 90% from 2.35 ton per hectare to 4.62 ton per hectare because of the collaborative work of Indonesia's National Rice Research Program and the International Rice Research Institute. The IRRI has created many different varieties of climate-ready rice that can tolerate submergence, salt infiltrating the soil, poor soil, and drought. While these are all effective and high yielding, they have lower nutritional value and are not prepared for all different types of weather. For example, Ciherang, a popular GMO Indonesian variety, possesses good agronomic characteristics but at the time, it could not tolerant flooding. Now, it has been upgraded with Sub1 and QTL traits which allow the rice to be submerged for up to 17 days of complete water submergence and also to be drought tolerant (IRRI, 2015). In spite of these qualities, if salt infiltrates the soil or the soil is of poor quality, the rice yield will still be low. The nutritional value should also be figured into consideration. The IRRI had also supported the development of nutritionally high rice. The most recent development was the Golden Rice. Since rice is usually low in iron, zinc and vitamin A, Golden Rice was marketed as nutritionally high because it contained higher levels of vitamin A than most rice. However, after a consultation process on Golden Rice, the FDA concluded the opposite: Golden Rice does not meet the nutritional requirements to make that health claim (Wilson & Latham 2018). It would be recommended that through this partnership with the IRRI, research could be done on creating and promoting one rice variety containing all of these climate-ready traits while still be nutritionally high and not require the use of heavy chemical fertilizer.

Indonesia has one of the largest and continuously growing populations that depend on rice as the main part of their diet. However, rice production is not stable. When supply does not follow demand, social problems often occur causing the Indonesian government to making rash decisions that often lead to economic challenges. The instability is further exacerbated by climate change and bad farming techniques due to the lack of education on the farmers' end. Climate change and rice production are interrelated. Rice production contributes to climate change, while climate change slows rice production down. To avoid this issue, farmers must be educated while switching to a more climate-ready and nutritious rice variety. Indonesia cannot continue to develop and urbanize if the country has to constantly battle food insecurity.

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