



Technology adaptation to climate change in level producers rice in West Java

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Abstract

Climate change has a negative impact on rice production in Indonesia. This research was conducted to identify problems caused by climate change on agriculture, identify the technology to address climate change, and analyze the technological adaptation to encounter the climate change problems in West Java. Problems arising from climate change include increasing air temperature, rainy season shift, and prolonged drought. The impact of climate change on agricultural land in West Java is prolonged drought and land degradation. The most appropriate technology to be applied in West Java in order to address climate change is System of Rice Intensification (SRI). SRI rice cultivation can save water up to 30% compared to conventional cultivation, so it can be applied when the water resources was limited. SRI method that has been applied in West Java shows that organic rice farming produces more rice than inorganic farming. The productivity of inorganic farming are 6.0 - 7.0 tons / ha, whereas the SRI organic farming could produce 8 - 9.2 tons / ha grain. The application of the SRI method in Cibarengkok Village, Bojong Picung, West Java produces 7-8 tons / ha of grain, while the conventional method yields 4-5 tons / ha of grain.

Keywords: *rice, agriculture, climate change, system of rice intensification*

1. Introduction

Climate change is a global problem in recent decades and has become a major issue in various forums of discussion both nationally and internationally. Climate change is a phenomenon that results in erratic weather and the resulting disruption to the survival of living beings. The impact of climate change can be observed in various sectors such as forest fires that severely damaged by El Nino, the difficulty of obtaining clean water in some areas due to the prolonged drought, the rising sea levels, the emergence of new diseases that threaten human health [1].

In addition, climate change also affects agriculture and food sector. The agricultural sector is vulnerable to climate change as it affects cropping patterns, time of planting, planting index, productivity, and quality of results. Based on Suberjo [2], climate change through global warming would reduce agricultural production by 5-20%.

One of the agricultural sectors that is vulnerable to climate change is rice production. This is because rice a type of plant that needs plenty of water. Rice farmers grow rice during the rainy season to ensure that water is abundant and continuous. Climate change and erratic weather can be detrimental to farmers and reduce the level of rice production in Indonesia. If not anticipated this could threaten Indonesian food security, considering that rice is a staple food of the people of Indonesia.

West Java is one of the rice-producing areas in Indonesia. At the national level, West Java rice production contributes to approximately 15% of the total national production. This is despite the fact that agricultural land in West Java continue to decline. Based on BPS data [3], the agricultural land area in West Java decreased by about 32 750 hectares in the last seven years. Agricultural area in West Java today is around 912 794 ha.

The decline in agricultural land is mainly due to the conversion of agricultural land into property and industrial complex. In addition, public infrastructure development is also contributing to the shrinkage of farmland in West Java. For example, the construction of service Teak Kerta lead over wetland function area of 1800 ha. This result in the lost of 10 746 tons of dry grain that can be produced on these lands [4].

The decline of the agricultural land area in combination with climate change would have a negative impact on rice production in West Java. To maintain rice production in West Java with limited land, then efforts should be made to improve land productivity. One of the efforts to maintain or even increase the productivity of land in West Java is to implement and conduct technological innovation that targeted and appropriate.

Therefore, this study aimed to identify the problems mainly caused by climate change on agricultural land in West Java, to identify technologies that can be applied to overcome these problems, and analyze the application of these technologies in West Java.

2. Material and Methods

2.1. Time and Location

The study was conducted in the building Labtek XI School of Life Sciences and Technology, starting from the date of 22 April - May 2, 2018.

2.2. Method

The method used in this study is the case study method to obtain data and information on the application of technology to address the impact of climate change on the level of producers in West Java. The case study method was carried out following the approach procedure according to Easton [5].

3. Results

3.1. Identification of problems in the area under rice cultivation due to climate change

Climate change is something that is difficult to avoid and impacts various aspects of life. Change and climate anomalies affect the ability and dynamics of agricultural production. Climate change is the dominant influence on the agricultural sector is as follows.

- Increased air temperature

Increased temperatures could affect the acceleration of the evaporation of water, soil and plants, so the plants will be vulnerable to water shortages that ultimately can reduce production. In addition, with the rising temperatures it will provide conditions conducive to the proliferation of some types of insect pests that potentially lower productivity was even able to take off the harvest.

- Shifting the rainy season

Changes in rainfall patterns will have an impact on the high intensity of rain in a short period and will menumbulkan yagng floods cause decreased agricultural production, especially rice because the rice fields submerged in water. The rains also resulted in the loss of land due to erosion and landslides.

The results of the FAO study [6] showed variability and climate change affecting 11% of agricultural land in developing countries which could reduce food production and lower the Gross Domestic Product (GDP) to 16% [7]. Variability and climate change with all its effects might cause a loss of production of up to 20.6% for rice [8]. While the need for food especially rice continues to increase in line with population growth. It is estimated that in 2025 the population will reach 262 million people with rice consumption of 134 kg per capita, thus the need of national rice reached 35.1 million tons, 65.9 million tons of GKG [9].

- Drought (El Nino)

The emergence of the El Niño climate anomalies and the Indian Ocean Dipole (IOD) simultaneously positive implications for the timing of planting. For example, in 1997-1998 as a result of these two phenomena, the time of planting in the rainy season in 1997-1998 have shifted up to 2-3 months, and it affected the time of planting in the next season [10]. This phenomenon lowered the production of rice by 6.5% which increased rice imports to 3 million tons in 1998 [11].

Similarly, against the growing season, there was a shift between 10-20 days of normal planting period [12]. It is also supported by the IPCC report in 2007, that in three decades, temperatures in several regions in Indonesia is getting warmer. This will have a direct impact on rice, because rice is the crop which in certain phases are very sensitive to heat. At every 1 degree increase in temperature at night will reduce the 10 percent level of fertility of rice. This can be seen from the decline in the production of IR 64 (rice being grown in Indonesia) from 6 tons to just 1.5 tons per hectare in 2007.

- Climate change in West Java

Referring to the data Meteorology and Geophysics Agency (BMKG), in West Java, the minimum temperature, maximum and average in July, August, September 2017 is still in the normal range (based on an average of 30 years from 1981 to 2010); there is no significant increase. Bandung's normal minimum air temperature (1981-2010) is 17,6-18,1°C. Bandung normal maximum air temperature is around 28,5 - 29,5°C. But still an increase in average air temperature of 0,2° C per year. The rainfall pattern in West Java was also shifting. Earlier, September already entered the rainy season, but this time the rainy season begins in October, so it also affects the process of rice cultivation in West Java. This has shown the impact of climate change in West Java.

- Drought rice

One of the impacts of climate change in West Java is, the shrinkage of agricultural land every year. That is because floods, droughts and plant pests often cause tidal increase rice productivity. 2014 rice production decreased by 11.566 million and depreciation of about 3,000 hectares of land.

The decline was due to the rice fields in the northern coast (North Coast) experienced flooding in December-January, 2014 covering an area of 96 thousand hectares. In addition, 51,000 ha of rice fields in Indramayu have puso. Harvest 2015 again decreased as a result of a prolonged drought. A total of 112,000 hectares of drought-affected, 42,000 hectares have puso, and the area was greatest in Indramayu discount rice area of about 17,000 hectares.

- Degradation of Land Resources

In addition, the threat of which is indirectly affected by climate change is the degradation of land resources. Due to erratic weather phenomena with land clearing practices, as well as the excessive use of inorganic materials, a decline in production failures even. According to Havlin et al. [13], soil fertility will decline due to the use of inorganic fertilizers continuously and causing damage to the physical, chemical and biological soil. This situation is exacerbated by the many farmers who use chemical fertilizers on an ongoing basis. Therefore, it requires an effort to meet the welfare needs of farming communities without compromising the quality of agricultural land.

3.2. Technology to address climate change

- System of Rice Intensification (SRI)

System of rice intensification (SRI) is, a method that came from Madagascar in 1983 to 1984. The intensive culture method was discovered by FR. Henri del laulani inadvertently. It was then developed and introduced by the Association Tefy Science (ATS). SRI was first entered Indonesia in 1997 in Bogor and brought by Prof. Norman Uphoff from Cornell University, United States (book). From the test results, SRI technique by the Institute for Research and Development of Agriculture in West Java Sukamandi during the dry season in 1999 obtained yields as much as 6.2 tonnes / ha and in the 1999/2000 rainy season the average yield of 8.2 tonnes / ha [14].

SRI method which is currently widely applied in Indonesia is different from that developed in Madagascar. Based Purwasasmita and Sutaryat [14], the SRI method in Indonesia has been developed, refined, and has a more comprehensive understanding and thorough. This method is known as Organic SRI Indonesia. There are 3 main foundations of Organic SRI Indonesia.

- First, multiply the number of tillers of rice plants.
- Second, eliminate stagnant water in the fields.
- Finally, changing the concept of fertilizing with natural plant bioreactor.

Planting with SRI method, done with rice seedling was aged 7 days and had pieces of seed as the provision of food. Seedlings planted in shallow, single and tenuous (30 cm between the point of planting) soil. In contrast to conventional cropping pattern that has been done. Conventional farmers will use the 24 day-old rice seedling, planted three seeds in one point of planting and spacing of which is denser. Apparently, in this way it will eliminate the chance of early bud growth and decrease the fertility of rice, due to a struggle for space and nutrients. So that the amount of rice gained in conventional manner is less than SRI rice.

Second, runway becomes one of the hallmarks of SRI. This method is able to conserve water usage significantly for applying intermittent irrigation. This dry wet cycle will pay attention to the condition of land, type of soil and water availability. Land is kept moist during vegetative period. This will increase the amount of oxygen needed for growth of roots [14]. SRI method can save water of up to 46% compared to conventional methods. In the conventional method, the rice is soaked to reduce the number of weeds. However, it turns out it has removed the root function as a carrier of nutrients, into a large room air storage. This leads to the life cycle of microbes in the root system is disrupted and disconnection of microbial life. As a result, the growth rate of rice will be hampered.

Lastly, the conversion of fertilizer for natural bioreactor for the fulfillment of nutrients from the soil. SRI method using compost to trigger a cycle of space and local microorganisms (MOL) as nutrients for the rice cycle. At the trial for 24 rice planting season without the use of fertilizers and chemicals anything, showed productivity and better quality [14]. SRI system is the answer to the pain of farmland in West Java. Inorganic fertilizers are given farmers often exceed dose limits. Research in Karawang, shows the soil organic matter content of paddy fields do not reach 2%. In good, soil, it should contain 6-8% organic ingredients. This marks the biological damage. Nitrogen fertilizer is given continuously will cause acidification of soil and decrease the number of worms. In fact, the health and quality of land is a major key factor in supporting the sustainability of rice production and agriculture in general.

- Application of SRI in West Java

SRI planting method itself was developed in West Java by the Board of Forestry and Environmental Observer Tatar Sunda (DPKLTS). The system was developed in accordance with the environmental, social and economic development in West Java. Based on the research results are reported [15], the SRI method has been applied in Bandung District, District Bojongsong an area of 249 ha, 20 ha Banjaran, Ciparay covering 241 ha, 20 ha Citrus solokan and Baleendah area of 20 ha. The results show that organic rice farming produces more than rice harvest inorganically. Organic agricultural products are usually 6.0 to 7.0 tonnes / ha, whereas the SRI can reach 8 to 9.2 tonnes / ha. Results of the study reported that the village Cibarengkok, Kec.Bojong Picung obtain 7-8 tonnes / ha of SRI method. While conventional methods obtained an average grain yield of between 4-5 tons / ha.

Improved results do not necessarily give a significant increase in income for farmers. Februriani [16], conducted research in Cianjur on SRI farmers' income when compared to conventional farmers. SRI farmers' income is higher than the conventional method. However, it is not significantly different. This is due to the total cost of farming methods in SRI being higher than conventional methods. SRI's largest expenditure is in labor and compost. SRI farmer's working hours are longer and SRI method requires a high tenacity. Apart from that, the conventional system can not adapt to changes in the current environment. SRI is more water-efficient system and adaptive to drought.

- SRI Implementation Challenges

Application of SRI in West Java is still experiencing problems. Based on research done by Sari [17] in Depok, it was found that the farm in West Java also interact directly with the industrial area, so that the amount of land continues to decline and a lot of agricultural land is contaminated by sewage. The role of government is essential in regulating land management. The public perception with SRI method also complicates the reception. So far, conventional farmers believe that with the addition of fertilizer and pesticide use of chemicals will result in higher productivity. Thus, the extension of this method must be done intensively and mentoring.

Heryadi and Rofatin [18] review the implementation of organic rice farming in Tasikmalaya regency. Tasikmalaya district became famous with SRI rice. However, its development is still running in place, even to the extent of a decline in the number of Organic SRI farmers. One reason is the compost needs being unmet. Provision of organic fertilizer can be done with the cooperation of surrounding farms. Thus integrating agriculture and livestock in the area around. Lastly, there is an urgent need to monitor the implementation of Organic SRI Indonesia. This should be done to simplify the certification process of organic rice conducted by the authorities.

Conclusion

Based on the explanation of the research results, we obtained the following conclusions:

- Climate change adversely affects rice production in Indonesia. The problems arising from climate change are increasing air temperatures, shifting rainfall season, and prolonged droughts.

- The impact of climate change on agricultural land in West Java is particularly dry paddy fields and degradation of land resources.
- The most appropriate technology to be applied in West Java in order to address climate change is, the application of the System of Rice of Intensification (SRI) method. SRI rice cultivation can save water up to 30% compared with conventional cultivation. However, this method causes an increase in operating costs and need regular maintenance to rice plants from being attacked by weeds (due to the prohibition to inundate the crops).

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