

Implementation of Climate-Smart Agriculture (CSA) Practices for Sustainable Agriculture Development by Millennial Farmer in West Java Province

(Case Study in Nudira Fresh, PT Nudira Sumber Daya Indonesia)

Triya Ayu Retnaningtyas¹, Dwiningtyas Padmaningrum², and Sapja Anantanyu²

¹Postgraduate School, Sebelas Maret University, Surakarta, Indonesia

²Sebelas Maret University, Surakarta, Indonesia

triya.ayu99@student.uns.ac.id

Abstract. Climate change affects the decline and stagnation of agricultural production which can threaten food security and sustainability. Although the agricultural sector is vulnerable to climate change, it also plays a significant role in triggering climate change. Climate-Smart Agriculture (CSA) practices on cherry tomatoes in Nudira Fresh are the millennial farmer's strategy in efforts to build sustainable agriculture, as well as with the Sustainable Development Goals (SDGs) related to climate action. Climate-Smart Agriculture (CSA) aims to: 1) increase agricultural productivity and income, 2) build agricultural adaptation and resilience to climate change, and 3) reduce and or eliminate greenhouse gas emissions. The purpose of the study is to explore the implementation of CSA by millennial farmers in Nudira Fresh. The method used in this research is descriptive qualitative, with primary and secondary data collection. The research results show that the practice of cultivating cherry tomatoes in Nudira Fresh is based on an analysis of 3 pillars of CSA, including: 1) increasing productivity and income by cultivating various cherry tomatoes, 2) building plant adaptation and resilience to climate change by using greenhouses supported by plant management technology and growth control applications, and 3) reducing the contribution of greenhouse gas emissions by using growing media in the form of cocopeat.

Keywords: Climate Change, Climate-Smart Agriculture, Greenhouse, Millennial Farmer, Sustainable Agriculture.

1 Introduction

Agricultural development in the current era has a direction towards advanced, independent and modern agriculture for the realization of an Indonesia that is sovereign, independent and has a personality based on mutual cooperation. Modern agriculture is very strategic in supporting the national economy, especially in realizing food security, increasing competitiveness, absorbing labor and alleviating poverty. Based on data from the Coordinating Ministry for Economic Affairs in 2022, agriculture is the second largest supporting sector for the national economy with a contribution value of 13.28 percent to the national Gross Domestic Product (GDP) [1].

In terms of the agricultural sector's contribution to the national economy, agriculture is facing the challenge of extreme climate change. The Intergovernmental Panel on Climate Change (IPCC) proves that climate change has an impact on ecosystems and human life throughout the world. Global climate change results in increasing air temperatures; rising sea levels; changes in the pattern of the rainy and dry seasons which are erratic, resulting in degradation of land and water resources, floods and droughts; increasing intensity of climate extremes such as heat waves (El Nino) and wet waves (La Nina); to increased pest attacks and plant diseases [2][3]. Climate change also results in a decrease in water availability, changes in plant productivity, and loss of biodiversity. West Java Province is one of the regions in Indonesia that is affected by climate change due to the El Nino event or long dry season in 2020. Based on the Meteorology, Climatology and Geophysics Agency in 2022, air temperatures in West Java, especially Bandung, have increased by up to three degrees Celsius during the 45th year. last year and experienced 239 rainy days throughout 2022. Climate change has an impact on the decline and stagnation of agricultural production which threatens food security [4].

Even though the agricultural sector is vulnerable to climate change, in fact agriculture is also a sector that plays a significant role in triggering climate change. Based on data from the Ministry of National Development Planning in 2021, agriculture is capable of producing greenhouse gas emissions of 13% of the total greenhouse gases in Indonesia [5]. Based on the Intergovernmental Panel on Climate Change (IPCC) in 2021, the largest contribution from the agricultural sector is from land cultivation which produces N₂O by 38% [6]. The government has made strategic efforts to sensitize farmers in carrying out agricultural practices that pay attention to their impact on the environment. Based on Presidential Regulation Number 71 of 2011, the agricultural sector needs to reduce its emission levels by 8 Gg CO₂eq [7]. Millennial farmers, as competent human resources who are committed to agricultural development, are required to contribute and be adaptive to facing climate change by helping to reduce emission levels. Millennial farmers can become superior, advanced and competitive human resources as determinants of the progress of agricultural development. The solution to adapting to climate change that can be implemented by millennial farmers is by implementing Climate-Smart Agriculture (CSA) practices and reducing or abandoning conventional agricultural practices.

Nudira Fresh, which is a business unit of PT Nudira Sumber Daya Indonesia and is located in Warnasari Village, Pangalengan District, Bandung Regency, seeks to implement smart and adaptive agricultural cultivation practices to climate change. General Manager Nudira Fresh is one of the Indonesian Millennial Farmer Ambassadors from West Java Province who is competent and committed to sustainable agricultural development. Nudira Fresh, with cherry tomatoes as its superior product, is one of the agricultural practices that uses a greenhouse equipped with the most advanced technology in Indonesia. The agricultural technology used by millennial farmers supports the government's strategic efforts to reduce the level of greenhouse gas emissions resulting from agricultural practices. This strategy is stated in the ratification of the Paris Agreement in Law Number 16 of 2016 that Indonesia has committed to reducing greenhouse gas emissions by 2030 with a target of 29% [8].

Climate-Smart Agriculture (CSA) can be an approach to facing the challenges of climate change. Climate-Smart Agriculture (CSA) is pursued by the Ministry of Agriculture of the Republic of Indonesia to face and anticipate climate change, minimize the impact on food security and the national economy, and help guide the actions needed to change and redirect the agricultural system to support development efficiently. The three main pillars of Climate-Smart Agriculture (CSA) include: 1) Increasing agricultural productivity and income in a sustainable manner, 2) Increasing adaptation and building resilience to climate change, and 3) Reducing and/or eliminating greenhouse gas emissions [9].

Based on the background above, this research aims to explore the implementation of Climate-Smart Agriculture (CSA) practices based on its 3 pillars by Nudira Fresh millennial farmers. Through this research, it is hoped that it can provide recommendations regarding smart and climate adaptive agricultural practices in an effort to reduce the contribution to greenhouse gas emissions for sustainable agricultural and environmental development.

2 Methodology

This research uses a qualitative descriptive approach, namely by exploring or photographing the social situation being studied thoroughly, broadly and in depth [10]. Research is carried out by observing, evaluating, drawing conclusions, and providing comments on conditions that occur in the field [11]. Observations are carried out systematically, focused, and based on scientific grounds [12]. This research was carried out by collecting primary and secondary data. Primary data was extracted using in-depth interviews with informants and direct observation of the research location. Meanwhile, secondary data is carried out by reviewing the literature and previous relevant research results, as well as recording the available data.

Research related to the implementation of climate-smart agricultural practices by millennial farmers was carried out at Nudira Fresh, which is a business unit of PT Nudira Sumber Daya Indonesia located in Warnasari Village, Pangalengan District, Bandung Regency. The research location was determined purposively based on the fact that Nudira Fresh has become one of the agricultural practices that uses greenhouses equipped with the most advanced climate adaptive technology in Indonesia. This is also a contribution from millennial farmers in reducing the impact of agricultural activities on greenhouse gas emissions.

3 Results and Discussion

3.1 Climate Smart Agricultural Practices for Sustainable Agricultural Development

Sustainable agricultural development is a holistic approach in developing the agricultural sector by paying attention to economic, social and environmental sustainability. This is very important in facing various current conditions such as climate change, increasing population, and inequality in access to agricultural resources. The principles of sustainable agricultural development include [13][14]:

- a. Conservation of natural resources: is a principle of energy efficiency that encourages the wise use of natural resources such as land, water and biodiversity. This involves agricultural practices that maintain soil quality, reduce erosion, and manage water efficiently.
- b. Sustainable productivity: is an effort to increase agricultural productivity in a way that does not damage the environment and involves the use of technology and implementing environmentally friendly agricultural practices.
- c. Equal distribution of benefits: is an effort to reduce inequality between farmers and the community in access to agricultural resources and profits.
- d. Agricultural diversification: is an effort to plant various types of crops and cultivate livestock so that it can help increase food security and reduce the risk of weather disturbances or disease.

In principle, Climate-Smart Agriculture (CSA) is an approach to developing agricultural strategies that helps guide actions to support development effectively, as well as ensuring sustainable food security and security in the face of climate change conditions. Climate-Smart Agriculture is one of the efforts to achieve Sustainable Development Goals (SDGs) number 13, namely climate action, overcoming the impacts of climate change and building resilience to it. This includes efforts to reduce greenhouse gas emissions and increase adaptive capacity and resilience to climate change. The prioritized value in Climate-Smart Agriculture is 'sustainability' by integrating three dimensions in sustainable development, namely economic, social and environmental. So the three main pillars of Climate-Smart Agriculture include [15][16]: 1) Increasing agricultural productivity and income in a sustainable manner, 2) Adapting and building resilience to climate change, and 3) Reducing and/or eliminating greenhouse gas emissions in production agriculture. Referring to these 3 pillars, millennial farmers can carry out smart agricultural practices by efficiently managing plants, soil and water.

3.2 Climate Smart Agriculture Practices at Nudira Fresh

Nudira Fresh is a business unit of PT Nudira Sumber Daya Indonesia which operates in the export and agribusiness sectors. Nudira Fresh focuses on cultivating cherry tomatoes for the purpose of penetrating the export market. Nudira Greenhouse is capable of producing 1 ton of export quality cherry tomatoes per week. Currently, Nudira Fresh's production is marketed to various regions in Indonesia and market share in various countries. General Manager Nudira Fresh is one of the Indonesian Millennial Farmer Ambassadors from West Java Province. Millennial farmers are required to be able to adapt to agricultural digitalization technology and innovation, as well as pay attention to the sustainability of the agricultural environment during the production process. Millennial farmers as human resources who are qualified, committed, and adaptive to agricultural innovation and technology are expected to bring progress to agricultural development. Millennial farmers also play an important role in realizing sustainable food through competencies that are in line with the industrial revolution 4.0 and supporting national economic progress by marketing exports of agricultural products [17][18].

Nudira Fresh has attempted to implement climate-smart agricultural practices, meaning implementing an agricultural approach designed to reduce its impact on climate change, save natural resources, and maintain and increase agricultural productivity and plant resilience. The following is the practice of cultivating cherry tomatoes at Nudira Fresh based on an analysis of the 3 pillars of Climate-Smart Agriculture.

Increase sustainable agricultural productivity and income. Climate-Smart Agricultural (CSA) practices implemented by millennial farmers at Nudira Fresh have been proven to produce higher productivity and income compared to conventional agricultural practices. This is in line with previous research that implementing climate-smart agricultural practices (managing nutrients, water and soil) can double or even triple crop yields [19]. An important specs for achieving sustainable increases in productivity and income include: 1) Integrating

genetic resource diversity to reduce business risks and maintain sustainable productivity, and 2) Supporting innovation in climate change adaptive technology that can increase productivity while avoiding the impact of environmental damage.

Before committing to climate-smart agriculture, Nudira Fresh focused on one cherry tomato variety, namely Aruru. Focusing on one variety causes Nudira Fresh to be very dependent on market demand for that variety. If there is a change in market trends or a decrease in demand, this will result in a decrease in income. but, at the moment Nudira Fresh has sought a variety of cherry tomato varieties with the aim of reducing the risk of business failure. These varieties include Aruru, Floridity, Sugary, Pomegranate, and Amber.

Nudira Fresh cherry tomatoes start to be productive 60 days after planting and are productive for 6 months. When the productive period is over, the plants will be replaced with new plant seeds. Overall, Nudira Fresh is able to produce 1-1.2 tones of cherry tomatoes per week or the equivalent of 4-4.8 tones per month. The productivity of one Nudira Fresh cherry tomato plant reaches 22 kg per square meter per year, while cherry tomatoes with one variety and conventional cultivation only produce 4-5 kg per square meter per year. To maintain the sustainability of production results, nurseries are carried out with a capacity of 1% of the total plant population per month.



Fig. 1. Aruru Variety Cherry Tomatoes, Nudira Fresh's Flagship Product

The cherry tomatoes produced by Nudira Fresh have superior specifications to be suitable for export, especially the Aruru variety. The superior specifications of cherry tomatoes include having a perfectly round shape, measuring 10-15 grams/fruit, bright red in color, and a sweetness level of 7-8 briks. So apart from being marketed to various local areas such as Bandung, Jakarta, Tangerang, Bogor, Depok, Bali and Palangkaraya, Nudira Fresh cherry tomatoes also have export demand from Malaysia, Singapore, Bahrain and Saudi Arabia. Based on business analysis, in order to meet export demand, the quantity of cherry tomatoes produced must be large enough to meet the feasibility quantity for transportation.

Adapting and building resilience to climate change. The ability to understand and predict climate changes such as shifts in rainy and dry season patterns, the vulnerability of regions and agricultural systems to climate stress, the possibility of outbreaks of pest and disease attacks, and so on are important things that millennial farmers need to understand. This is because climate change conditions can affect production levels, food security and agricultural income.

Nudira Fresh uses a greenhouse as an effort to adapt and build the resilience of cherry tomato plants to extreme climate changes. The Nudira Fresh Greenhouse measures 34 x 80 meters with a height of 4 meters and is equipped with various advanced agricultural tools and technology. This technology includes machines and installations that automatically distribute nutrients to each plant (called crop management technology), water pH sensors, air temperature and humidity sensors, sunlight sensors, large exhaust fans, small exhaust fans, and cooling pad walls. Machines and installations can prevent the risk of losing nutrients that will be given to plants or the dissolution of fertilizer carried by water as occurs in conventional agricultural cultivation. The machine is connected to a computer system with a grow control application, which is able to record all data and intervene in temperature regulation and plant irrigation. Greenhouses with crop management technology and grow control

applications can monitor the conditions of temperature, water vapor, humidity, light and pH of plants, so that the nutrients distributed to each plant can be regulated and adapted to their needs.

Exhaust fans and the cooling pad wall in the Nudira Fresh greenhouse is also designed optimally to maintain temperature conditions so that cultivation in it can be more efficient compared to agricultural practices without a greenhouse. The function of the exhaust fan is to remove hot air, regulate air circulation, and maintain a cool temperature in the greenhouse. Meanwhile, the cooling pad wall functions to reduce temperature, regulate humidity, and can reduce energy consumption because its operation does not require large amounts of electrical energy.



Fig. 2. Crop Management Technology

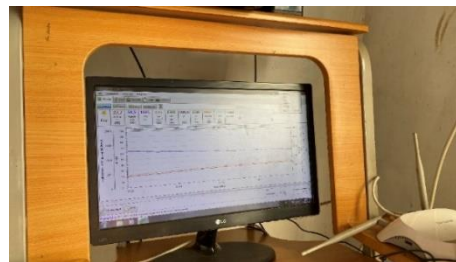


Fig. 3. Grow Control Application



Fig. 4. Exhaust fan



Fig. 5. Cooling pad wall

Cultivating Nudira Fresh cherry tomatoes in a greenhouse can eliminate various obstacles such as those that occur in conventional cultivation, such as the influence of weather and pest attacks and plant diseases. Greenhouses are able to protect plants from climate change, and can help prevent damage and crop failure. This is in accordance with previous research which compared agricultural cultivation supported by greenhouses and conventional cultivation, that greenhouses that can control environmental conditions including temperature are able to produce higher products [20]. Apart from that, it can prevent pest attacks and plant diseases, because the greenhouse is a closed building so there is no access for plant pests. Standard Operating Procedures (SOP) for cultivation management at Nudira Fresh are also strict, including using special clothing and footwear and spraying disinfectant when workers enter and leave the greenhouse. Disinfectants play a role in eliminating the chance of disease attacks coming in from outside the greenhouse during cultivation.

Reduce and/or eliminate greenhouse gas emissions in production agriculture Apart from being an effort to build adaptation and resilience of cherry tomato plants to climate change, the greenhouse at Nudira Fresh is

an effort to contribute to millennial farmers in reducing or even eliminating greenhouse gas emissions that can arise from agricultural practices. Installing a greenhouse can not only create a controlled environment where temperature, humidity and light can be regulated precisely, it can also reduce the use of fertilizers, pesticides and herbicides on plants. This is because a controlled environment can reduce the need for plants to use chemicals which can produce harmful emissions for the environment. In line with previous research that the use of greenhouses can reduce the use of chemical fertilizers which have a negative impact on the environment, so that greenhouses support more sustainable and environmentally friendly agriculture [21].

The cultivation of cherry tomatoes carried out by millennial farmers at Nudira Fresh does not use soil as a growing medium, but uses cocopeat. Cocopeat is a recycled product from processed coconut fiber waste. Millennial farmers choose cocopeat growing media to replace other growing media which can produce higher greenhouse gas emissions during the process of use. Cocopeat media is used to reduce the need for soil, thereby reducing the risk of soil erosion which can trigger the release of carbon into the atmosphere. In addition, cocopeat media has a higher capacity to absorb and store water than soil media. This enables more efficient use of water in agricultural cultivation, reduces the need for excessive watering, and reduces the energy impact associated with water management. Cocopeat media also contains several nutrients that plants need, so it can reduce plant dependence on the use of chemical fertilizers which can produce greenhouse gas emissions. Moreover, cocopeat media can contribute to storing carbon from the environment which would previously decompose and be released into the atmosphere.

The Climate Smart Agriculture (CSA) practice at Nudira Fresh, which is based on the 3 pillars above, provides significant changes to planting conditions before and after its implementation. Before the implementation of Climate Smart Agriculture, crop varieties were more vulnerable to high temperatures, erratic rain patterns and weather instability. However, through adjusting planting practices and installing greenhouses accompanied by various smart agricultural technology tools, plants become more resilient to climate change and productivity increases. Apart from that, sub-optimal use of water, land and other agricultural inputs has previously caused environmental degradation. Meanwhile, implementing Climate Smart Agriculture by using organic fertilizer, regulating crop rotation, as well as providing nutrition and managing water wisely can reduce negative impacts on the environment and maintain the sustainability of resources.

4 Conclusion

Millennial farmers are required to be able to adapt to agricultural digitalization technology and innovation, as well as pay attention to the sustainability of the agricultural environment when carrying out agricultural cultivation. Millennial farmers implement the Climate-Smart Agriculture (CSA) pillar in the cultivation of cherry tomatoes at Nudira Fresh by managing plants, soil and water. Implementation of these pillars includes: 1) Increasing agricultural productivity and income in a sustainable manner by seeking a variety of cherry tomato varieties such as Aruru, Floridity, Sugary, Pomegranate, and Amber which are marketed domestically and abroad, 2) Building plant adaptation and resilience cherry tomatoes against climate change by installing greenhouses supported by crop management technology and grow control applications, water pH sensors, air temperature and humidity sensors, sunlight sensors, large exhaust fans, small exhaust fans, and cooling pad walls, and 3) Reducing contribution on greenhouse gas emissions from agricultural production using growing media in the form of cocopeat.

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