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Evaluation of Climate Change Impacts on Lettuce Hydroponic UMKM (Case Study of Alam Tani Hidrofarm Kudus)

Delbi Rizka Adik Azhari[1], Riyan Andni[2]
[1,2]Institut Agama Islam Negeri Kudus, Indonesia

ABSTRACT

Background. Changes in climate have a significant impact on various aspects of work, especially in the modern agricultural sector. Therefore, the UMKM sector of Alam Tani Hidrofarm Kudus is facing new challenges such as in the production process.
Purpose. This study aims to describe, explain and evaluate the effect of climate change on the growth of vegetable crops in the UMKM Alam Tani Hidrofarm Kudus.
Method. The research method used is a qualitative approach with a case study approach. Data were obtained through observation, in-depth interviews, and data and document collection.
Results. The results showed that climate change resulted in various impacts such as decreased productivity and quality in hydroponic lettuce crops. Factors such as temperature extremes, changes in rainfall, humidity, diseases and pests, plant nutrients, environment, variety and technology used. However, this study also identified various evaluations to improve the productivity and quality of hydroponic lettuce crops. These solutions include regular irrigation systems, greenhouses, variety selection, proper nutrient utilisation, monitoring, the use of smart technology, and the use of temporary protection.
Conclusion. Temperature variations and unpredictable rainfall patterns can disrupt the balance of the hydroponic environment resulting in slowed growth and reduced crop quality. These factors can undermine food security and the sustainability of cultivation. In addition, this research underscores the need for strategic adaptation, such as the use of climate control technologies, selection of climate-resilient varieties, and efficient water management. Facing the challenges of climate change in the context of hydroponic farming requires an integrated approach involving various parties, including farmers, researchers, and policy makers to ensure a stable and sustainable food supply.

KEYWORDS

Climate Change, Hydroponics, UMKM

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Correspondence:

Delbi Rizka Adik Azhari,
delbirizkaadikazhari@gmail.com

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INTRODUCTION

Climate change has become one of the major challenges faced by humanity in the 21st century. According to research conducted by the Intergovernmental Panel on Climate Change study, during the period from 1899 to 2005, the global average temperature rose by about 0.76 degrees Celsius. During 1961 to 2003, the global average sea level increased by 1.8 mm per year (Rychert & Wilkins, 2019).

In addition, there was an increase in the intensity of rainfall and flooding, the frequency of droughts, and erosion. Extreme weather phenomena such as El Nino, La Nina, tornadoes, hailstones and cyclones are also becoming more frequent (Tsai dkk., 2020).

Climate change is ongoing in the tropics, and the effects of climate change are already being felt in many parts of the world, including Indonesia. The agricultural sector is one of the sectors that is easily affected by the effects of climate change. Agriculture plays an important role in the development of Indonesia as more than 88.89% of the population relies on agriculture as their main source of income. The impact of climate change will pose a significant challenge to the economic contribution of the agricultural sector in Indonesia (Rands, 2009). Global warming is an environmental issue that results in climate change, which occurs slowly over a relatively long period of about 50-100 years. Climate change is an undeniable fact. Indonesia's territory from Sabang to Merauke, which includes more than 17,000 islands with a diversity of geographical locations, is often associated with the complexity of seasonal predictions (Clarke & Unsworth, 2020). The effects of climate change negatively impact various fields of work and development sectors, especially in the agricultural sector. This presents new challenges to agricultural production, particularly to the sustainability of food crops. In simple terms, climate change reduces agricultural productivity and in many cases even damages crop yields (Loey dkk., 2021).

Signs of climate change include drought, rising air temperatures, catastrophic flooding, changes in the length of the rainy season, rising sea levels and an increase in extreme weather (Jain dkk., 2021). In recent years, changes in the rainy season have resulted in the quality of hydroponic vegetables declining due to the lack of sunlight required for growth, resulting in crop failure. At the same time, market demand for lettuce vegetables decreases during the summer as many competitors sell lettuce using conventional (soil) methods at below-market prices (Sovacool dkk., 2020).

Changes in rainfall patterns, resulting in a shift between the dry and wet seasons, have led to necessary adjustments in current cropping patterns that no longer conform to past traditions. In times of extreme dry weather, irrigation water availability becomes limited, resulting in reduced production (Asongu & Odhiambo, 2019). The impacts of climate change on fruit and vegetable crops in tropical Indonesia include reduced yields in both quantity and quality, increased risk of pest and disease attacks, and risk of crop failure due to extreme climatic conditions (Frizzo-Barker dkk., 2020). However, rural farmers have local knowledge that can support adaptation to climate change for their survival. Farmers already have a deep understanding and experience of the impacts of climate change, such as shifts in planting seasons, temperature fluctuations, rainfall variations, as well as extreme weather such as changes in rainfall patterns, windy rainfall conditions, significant temperature increases, and increased risk of plant pest organism (pest) attacks (Chung dkk., 2020).

Despite being faced with tremendous challenges due to climate change, rural farmers are still able to survive and adapt by relying on knowledge derived from their local environment. This fact shows that farmers have awareness and involvement in creating knowledge and implementing it to address problems, fulfil needs, and respond to dynamic changes (Troup dkk., 2022).

This research focuses on evaluating how to deal with the impacts of climate change in order to meet consumer demands throughout the two seasons, namely the rainy season and the dry season (Fischer, 2020). The purpose of this study is to analyse and evaluate farmers who are engaged in hydroponic plant cultivation, especially lettuce, in dealing with the impacts of climate change on UMKM Alam Tani Hidrofarm Kudus. In this research, the approach used is an environmental sociology perspective (Ohashi & Phelps, 2023). This approach involves assessing farmers' activities with a focus on the interplay between humans and the environment in which they live. This becomes important because humans are highly dependent on natural conditions for their survival. Cultural ecology theory states that humans or communities must adapt to environmental changes in order to continue to survive and live their lives (Al Eid & Arnout, 2020).

Humans and nature are integral parts of an interrelated ecosystem. Nature acts as an environment where humans live and grow. However, the charm of nature also raises concerns about human survival. Seeing that the increase in environmental complexity is due to the progress of greater thermodynamic efficiency. More complicated socio-cultural systems evolve from simpler ones in the long run (Son dkk., 2021). However, when we examine the process on a shorter time scale, we can see the socio-cultural "microevolution" that explains the variation in unique customs of different regions. By looking at the microevolutionary process in detail, it is possible to explain why there are many differences in the specialised customs of different regions (Hays & Handler, 2020). Changes in environmental conditions have always encouraged humans to evolve themselves. Humans, whether consciously or unconsciously, negatively impacting the sustainability of the environment, will result in worse living conditions for humans. This concept is used to explain farmers' relationship with nature through their evaluation of environmental issues, such as climate change (Cifuentes-Torres dkk., 2021).

The study was conducted to investigate how Alam Tani Hidrofarm Kudus business owners can evaluate climate change on their business so that they can still fulfil their customers and manage their environment sustainably (Rachmadtullah dkk., 2022). The findings of this study can provide an understanding of the effects of climate change on humans, especially farmers, as well as provide an innovative outlook on strategies for evaluation that can be applied by farmers in the face of climate change (Hamel dkk., 2021).

RESEARCH METHODOLOGY

This research uses a descriptive qualitative approach, with the type of case study research, which is research conducted in depth on a problem that becomes the object of research (Hamilton & Finley, 2019). The instrument used was field research, which was pursued through participant observation, in-depth interviews and documentation (Sundler dkk., 2019; Teti dkk., 2020). This research was conducted in July 2023 - August 2023 in Honggosoco Village, Jekulo District, Kudus Regency. Data were analysed using the Miles and Hubermann interactive model, which consists of data reduction, data display, and conclusion drawing.

RESULT AND DISCUSSION

The Impact of Climate Change on Lettuce Hydroponic Crops at MSME Alam Tani Hidrofarm Kudus

Figure 1.
Lettuce Crops in the Rainy Season

Figure 2.
Lettuce Crops in the Dry Season

In the two figures above, it can be seen that recent climate change can affect lettuce hydroponic plants at UMKM Alam Tani Hidrofarm Kudus in various ways, including:

Temperature Extremes

Extreme temperature changes, such as heat waves and or sudden low temperatures can disrupt the photosynthesis process and the growth of lettuce plants at UMKM Alam Tani Hidrofarm Kudus. This can result in a decrease in crop productivity and quality, which impacts farmers' income. Increased temperature can disrupt plant physiological processes. High temperatures during critical phases disrupt plant development and processes. Coupled with droughts and monsoons can lead to catastrophic results in modern agriculture. Increased temperature and humidity can also lead to the onset of pests and diseases in crops.

Changes in Rainfall

Variations in rainfall can affect water availability in hydroponic systems. Lack of water can cause stress to the plants, while excess water can reduce oxygenation to the roots and usually cause root problems such as root rot. During the rainy season, the raw water is usually mixed with soil sedimentation which reduces the quality of the raw water, as well as the quality of the vegetables due to lack of sunlight.

Air Humidity

Changes in air humidity can affect the rate of water evaporation from the plant surface and growing medium. Low humidity can result in reduced plant quality, while high humidity can increase the risk of fungal diseases on lettuce leaves.

Diseases and Pests

Climate change can also affect the cycle of diseases and pests that plague lettuce hydroponic plants. Fungal diseases and pest attacks may become more frequent or even more severe as a result of changes in temperature and humidity.

Nutrients available to Plants

Climate variability can affect the availability of nutrients to plants. Changes in temperature and water availability can affect the plant's ability to absorb nutrients from the nutrient solution. Hydroponic farming systems in lettuce vegetables utilise a method of growing without the use of soil, but using nutrient solutions rich in essential nutrients. Water and nutrients are supplied directly to the plant roots through various techniques, such as floating raft systems or wick systems. With hydroponics, farmers can better control the growing environment of plants and produce better and faster yields compared to conventional farming.

Environment

In hydroponics, the environment is very important to consider. Climate change requires adjustments in environmental control systems such as room temperature, humidity, lighting, and air circulation.

Varieties used

In the face of climate change, selecting crop varieties that are more resistant to extreme conditions or fluctuations may be a solution. Some lettuce varieties may have better resistance to environmental changes than others.

Technology used

The use of technology in hydroponics such as environmental sensors and automation systems can help in addressing the impact of climate change. This can help in better monitoring and regulation of the growing environment. Such as monitoring water during the dry season, because in the dry season hydroponic plants require quite a lot of water compared to the rainy season.

Given all these impacts, it is important to consider adaptation and mitigation strategies to maintain the sustainability of lettuce hydroponic farming, especially at Alam Tani Hidrofarm Kudus UMKM in the midst of ongoing climate change.

Evaluation of the Impact of Climate Change on Lettuce Hydroponic Crops at UMKM Alam Tani Hidrofarm Kudus

Hydroponic plants can actually be a solution for conventional farmers to reduce climate change (Ahmad dkk., 2020). Where more than 70% of hydroponic planting activities can save water, production time is not too long and can be produced continuously without a harvest period in one harvest. However, hydroponic plants themselves still have shortcomings in two seasons, both the dry season and the rainy season (Tatas dkk., 2022; Yang & Kim, 2020). When the dry season arrives, UMKM Alam Tani Hidrofarm Kudus can maximise its productivity because its needs in farming are met, such as sunlight lighting to photosynthesise plants can be maximised, but market conditions are difficult to reach, because many buyers choose a cheaper price with a price of around IDR 9,000,. while the selling price of UMKM Alam Tani Hidrofarm Kudus is around IDR 20,000,. When the rainy season arrives, UMKM Alam Tani Hidrofarm Kudus has less than optimal productivity, due to lack of sunlight which causes low air humidity so that there is mould on the plants, so that the harvest time is not optimal (Siregar & Razali, 2022). When the rainy season arrives, there is a lot of raw water but the quality of the raw water used is quite murky due to the mixing of raw water with soil sedimentation. Whereas during the rainy season market demand increases, because many competitors experience crop failure. And at times like this, the owners of UMKM Alam Tani Hidrofarm Kudus expand the market (Velazquez-Gonzalez dkk., 2022).

Hydroponic plant farmers can use several alternatives in dealing with the dry season and the rainy season so that they can still meet consumer needs (Urbina dkk., 2020). The following are some alternatives that can be used by lettuce hydroponic plant farmers, especially farmers at UMKM Alam Tani Hidrofarm Kudus, to deal with the dry season and the rainy season so that they can still meet consumer needs:

Regular Irrigation System

Using a regular and controlled irrigation system can help lettuce hydroponic plants get enough water without depending on the weather. This can be done through drip irrigation technology or sensor-based irrigation.

Greenhouse or Greenhouse

Using a greenhouse allows control of the growing environment, including temperature and humidity. This will help the plants keep growing optimally without being affected by weather changes.

Choosing Weather-Resistant Varieties

Choosing crop varieties that are resistant to extreme weather can help reduce the risk of damage and ensure the continuity of production such as lettuce plants.

Proper Utilisation of Hydroponic Nutrients

Providing proper and balanced nutrition will help the plants stay strong and resistant to weather fluctuations so that the quality produced will also be better.

Real-time Environmental Monitoring

Utilise weather and environmental monitoring technology to enable farmers to take quick action when extreme changes occur.

Reserve Storage

Keeping an inventory of backup crops can help maintain continuity of supply when the weather does not favour production.

Application of Smart Technology

The use of smart technologies such as automation and sensors can help improve efficiency and response to weather changes.

Utilisation of Temporary Protection

During periods of excessive rain or heat, farmers can utilise temporary shelters such as plastic covers or shades to protect crops from rainwater or excessive heat.

CONCLUSION

Based on the above discussion, it can be concluded that unpredictable temperature variations and rainfall patterns can disrupt the balance of the hydroponic environment resulting in slowing growth and reduced crop quality. These factors can undermine food security and the sustainability

of cultivation. In addition, this study highlights the need for strategic adaptation, such as the use of climate control technologies, selection of climate-resilient varieties, and efficient water management. Facing the challenges of climate change in the context of hydroponic farming requires an integrated approach involving various parties, including farmers, researchers, and policy makers to ensure a stable and sustainable food supply.

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