Sustainable Agriculture: Integrating Traditional Practices With Modern Technology For Food Security

Dwi Febri Syawaludin[1], Nila Atikah[2], Ahmad Bahar Sagita[3], Oxy Hendro Prabowo[4], Oriza Aditya[5]
Universitas Catur Insan Cendekia[1], Universitas Islam Bunga Bangsa Cirebon[2], STMIK IKMI Cirebon[3], Universitas Cendikia Mitra Indonesia[4,5]
Email:febrisyawaludin445@gmail.com, nilaat990@gmail.com, baharsagita1@gmail.com, prabowooxy1@gmail.com

INFO ARTICLE	ABSTRACT
	This research aims to explore the integration of traditional agricultural practices with modern technology in an effort to improve food security in Indonesia. Using a qualitative approach, this study involves interviews, questionnaires, and field observations conducted in two agricultural villages. The results show that technologies such as automated irrigation systems and soil sensors can improve resource use efficiency and crop yields. However, the main challenges faced are limited infrastructure and lack of training for farmers. These findings underscore the importance of the government's role in supporting technological infrastructure in rural areas and providing adequate training for farmers. This research provides practical implications for policymakers in formulating strategies that support the adoption of sustainable agricultural technologies. Although this study has limitations in regional coverage, the results provide important guidance for the development of the agricultural sector in Indonesia.

INTRODUCTION

Agriculture has been the backbone of global food security for thousands of years. However, with the world's population increasing projected to reach 9.7 billion by 2050, global food demand will increase drastically. In this situation, traditional agricultural systems are faced with severe challenges due to land limitations, climate change, and land degradation due to unsustainable agricultural practices. The agricultural sector is also one of the main contributors to greenhouse gas emissions, which exacerbates the impact of climate change and damages land productivity.

In Indonesia, which is an agrarian country, the main challenges for the agricultural sector are declining land productivity, extreme weather, and the lack of modern technology used by smallholders. The overuse of chemical fertilizers and pesticides has led to a decrease in soil fertility, creating a dangerous cycle of dependence and exacerbating environmental damage. Local farmers also have limited access to modern technology that can increase productivity and efficiency in farming.

Dwi Febri Syawaludin, Nila Atikah, Ahmad Bahar Sagita, Oxy Hendro Prabowo, Oriza Aditya

Several previous studies have shown the importance of adopting modern technology to improve agricultural yields. For example, research by Smith et al. (2019) found that the integration of precision agriculture systems with soil sensors can improve the efficiency of water and fertilizer use, thereby reducing negative impacts on the environment. Meanwhile, research by Zhang and Li (2020) shows that the implementation of sustainable traditional agricultural practices, such as crop rotation, can help maintain soil fertility in the long term.

This research is particularly urgent given the growing reliance on intensive farming methods that damage ecosystems and threaten future food security. With natural resources becoming increasingly limited, a more holistic approach is needed that combines proven traditional practices with modern technology to create more sustainable agricultural systems.

This study emphasizes the integration of traditional agricultural practices that have been neglected for a long time with modern technology that has not been widely adopted by smallholders in Indonesia. The novelty of this research lies in the exploration of hybrid methods that combine local knowledge with technological innovations to face future agricultural challenges.

This research aims to:

1. Identify traditional practices that are still relevant to be applied in modern agriculture.
2. Exploring agricultural technologies that can support food security in remote areas.
3. Develop agricultural models that combine traditional practices with modern technology to improve agricultural yields.

This research is expected to provide the following benefits:

1. Helping smallholder farmers increase their agricultural productivity through accessible technology.
2. Reducing the negative impact of agriculture on the environment through a sustainable approach.
3. Providing policy recommendations that support the application of technology in the agricultural sector.

The implication of this study is to provide guidance for the government and relevant institutions to design targeted training and subsidy programs for smallholders. In addition, this research can also encourage further innovation in the development of agricultural technology that can be accessed by all levels of society.

RESEARCH METHODS
Research Design

This research uses a qualitative approach with an exploratory design. The purpose of this design is to deeply understand the phenomenon of integration of traditional practices and modern technologies in sustainable agriculture, through in-depth interviews and direct observation in the field.

Location and Subject of Research

This research was conducted in two agricultural villages in Indonesia that have great potential in adopting modern agricultural technology but still rely on traditional practices. The subjects of the study include local farmers, agricultural extension workers, and managers of agricultural technology companies.

Research Instruments

The main instruments used in this study are semi-structured interview guidelines, questionnaires, and observation sheets. The interviews were conducted in depth to gain perspectives from farmers regarding their experiences using traditional technologies and practices.

Data Collection Techniques

Data is collected through three main methods:

1. **Interviews**: Interviews are conducted with management and farmers to understand the challenges and opportunities in the integration of technology with traditional practices.
2. **Questionnaires**: Questionnaires are distributed to licensed employees and agricultural extension workers to get their views on the effectiveness of the technology.
3. **Observation**: Hands-on observations are made in the field to see how farmers use technology in their daily practices.

RESULTS AND DISCUSSION

Research Results

General Description of Respondents

The study involved 50 respondents consisting of local farmers, management of agricultural technology companies, and licensed employees of agricultural extension workers. The majority of respondents are small farmers who manage less than 2 hectares of agricultural land. Most of the respondents were over 40 years old and had worked in agriculture for more than 20 years. They generally rely on traditional agricultural practices and have limitations in accessing modern technology.

Key Findings from Interviews with Management

Interviews with the management of agricultural technology companies revealed that technology adoption in the agricultural sector is still constrained by several factors, including a lack of infrastructure and high initial investment costs. However, they also emphasized that technologies such as automated irrigation systems, crop monitoring drones, and soil sensors have shown positive results in increasing agricultural productivity. One agricultural technology manager stated, "We are seeing a 30% increase in crop yields on fields that use soil sensor technology to measure moisture and fertilizer needs."

Findings from the Licensed Employee Questionnaire

A questionnaire distributed to 20 agricultural extension workers showed that most respondents felt optimistic about the potential of technology in improving agriculture in remote areas. As many as 75% of them agree that technology can help reduce fertilizer

Dwi Febri Syawaludin, Nila Atikah, Ahmad Bahar Sagita, Oxy Hendro Prabowo, Oriza Aditya

and water use significantly. However, 60% of respondents also stated that training for farmers is still very much needed to ensure that the technology can be used effectively.

Observation Results

Direct observations in the field show that most farmers still use traditional methods such as manual irrigation systems and simple rotational planting patterns. However, in some lands, the use of automatic irrigation technology has begun to be adopted, especially on land managed by farmers who have received training from agricultural extension workers. The use of this technology has been proven to help increase water use efficiency by up to 40%.

Visualization of Findings

Here are the tables and figures that support the findings:

Table 1. Increased Crop Yield with Soil Sensor Technology

Plant Type	Yield without technology (tons/ha)	Yield with Technology (Tons/Ha)	Percentage Increase
Rice	4.5	6.0	33%
Corn	3.2	4.0	25%
Soybean	1.8	2.4	33%

Discussion Results

Interview Data and Interpretation of Interview Results

From interviews with agricultural technology management, it was found that one of the main factors hindering technology adoption is the high initial cost. In addition, the absence of supporting infrastructure such as stable internet access is a big obstacle for farmers. The interpretation of these findings suggests that government and donor support is needed to provide infrastructure and subsidies for smallholders.

Discussion of Questionnaire Results

The results of the questionnaire show that most agricultural extension workers believe in the effectiveness of technology. However, training is a determining factor in the success of technology implementation. This is in line with research by Smith et al. (2019), which shows that proper training can increase the success of technology adoption by up to 50%. This discussion emphasized that technology education and training for farmers needs to be a priority in government programs.

Analysis of Observation Results

The results of observations show that modern technologies such as automatic irrigation are beginning to be adopted in some regions. The use of this technology shows an increase in water efficiency and crop yields. This proves that although the technology is still in the early stages of adoption, the impact is already significant. This data supports the research of Zhang and Li (2020) which shows that technology can increase efficiency by up to 40% in the use of natural resources.

Comparison with Previous Research

This research is consistent with previous research that highlights the importance of integrating modern technology in agriculture. However, the novelty of the study is a

hybrid approach that combines traditional practices with technology, something that has not been widely explored in previous studies.

Practical Implications

This research provides practical implications in the form of guidance for the government and related institutions to focus on improving technological infrastructure in rural areas. With adequate infrastructure and proper training, technology can be more widely adopted by smallholders, improving national food security.

Research Limitations

The limitation of this study lies in the scope of the research area which only includes two villages in Indonesia. In addition, the limited number of respondents makes the results of this study may not be generalized to all regions of Indonesia. Further research with a wider scope is needed to get a more comprehensive picture.

CONCLUSION

This study shows that the integration of traditional agricultural practices with modern technology has great potential in improving food security, especially in remote areas. Through interviews, questionnaires, and field observations, it is proven that technologies such as automatic irrigation systems and soil sensors can improve the efficiency of resource use as well as crop yields. However, the adoption of this technology still faces major challenges, especially related to infrastructure and limited training for farmers.

The government and related institutions need to pay special attention to the development of technological infrastructure in rural areas and provide intensive training for farmers so that technology can be used to the fullest. This research provides practical advice for policymakers to design programs that can support the wider adoption of agricultural technology in Indonesia.

Thus, this research is expected to make a real contribution to improving national food security through a sustainable and innovative approach. Although it has some limitations, the results of this study provide important guidance for the future development of the agricultural sector.

Dwi Febri Syawaludin, Nila Atikah, Ahmad Bahar Sagita, Oxy Hendro Prabowo, Oriza Aditya

BIBLIOGRAPHY

Smith, J., et al. (2019). Precision Agriculture and Sustainability: Integrating New Technology with Traditional Farming. Journal of Agricultural Science.

Zhang, T., & Li, W. (2020). The Role of Traditional Practices in Modern Agricultural Sustainability. Agriculture and Food Security.

Lee, H., et al. (2018). Water Efficiency through Technology in Arid Farming. Global Environmental Research.

Johnson, M. (2017). Sustainable Agriculture in Developing Countries: Challenges and Opportunities. World Agriculture Review.

Anderson, P. (2020). Agricultural Innovation and Food Security: A Global Perspective. Journal of Rural Development.

Budi, S. (2019). Application of Agricultural Technology in Indonesia: Challenges and Opportunities. Journal of Agriculture.

Rachman, A. (2021). Technology and Innovation in Indonesia's Agricultural Sector. Journal of Technology Innovation.

Suwandi, R. (2020). Technology Involvement in Sustainable Agriculture. Indonesian Agricultural Journal.

Fajar, T. (2022). Use of Soil Sensors to Increase Agricultural Yields. Journal of Agricultural Technology.

Simatupang, B. (2021). The Influence of Technology on the Efficiency of Natural Resource Use. Journal of Agribusiness.

Harahap, D. (2021). The Impact of Technology on Increasing Agricultural Production in Indonesia. Indonesian Journal of Agricultural Sciences.

Purwanto, A. (2019). Technology in the Agricultural Sector: Solutions for Food Security. Journal of Food Security.

Rahmawati, S. (2020). Technology Implementation in Traditional Agricultural Practices. Journal of Agricultural Sciences.

Widodo, A. (2018). Sustainable Farming Practices: Lessons from Indonesia. Asia Pacific Journal of Rural Development.

Mulyono, Y. (2019). Strategies for Improving Food Security Through Agricultural Technology. Journal of Village Development.