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# Community Assistance in Cultivating IoT-Based Hydroponic Plants as an Effort to Improve Food Security in Baruyu Lasara Village, Batu Islands

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**Abstract:**
The community assistance program for hydroponic cultivation based on the Internet of Things (IoT) was implemented in Baruyu Lasara Village, Tello Island, South Nias Regency. This initiative aimed to strengthen food security in coastal areas with limited agricultural land and freshwater resources. Using a participatory approach, the program involved socialization, technical training, implementation of an IoT-based Nutrient Film Technique (NFT) hydroponic system, and agricultural entrepreneurship mentoring. The results demonstrated a notable improvement in the community's capability to independently manage hydroponic systems, achieving a 90% growth success rate for pakcoy and a 60% increase in water-use efficiency compared to conventional farming methods. Participants' knowledge levels increased by 80%, and a hydroponic farmer group was established to ensure program sustainability. The initiative had positive impacts on local economic resilience, social collaboration, technological literacy, and environmental sustainability. Overall, the program successfully enhanced food self-sufficiency and served as an effective model for applying modern agricultural technologies in small island regions.

**Keywords:** Food security, hydroponics, Internet of Things, community empowerment agricultural innovation

## Introduction

South Nias Regency is one of the regions in North Sumatra Province, consisting of a cluster of small islands with diverse geographical characteristics, ranging from coastal areas to hilly terrains. One of the villages within this region is Baruyu Lasara Village, located on Tello Island, which possesses significant potential in the agricultural sector. However, agricultural development is constrained by infertile soils and limited access to freshwater resources. Most of the local population relies on food supplies from outside the area, as conventional farming practices are difficult to implement due to high soil salinity and scarce clean water for crop cultivation. These conditions have led to low levels of food security and limited community welfare.

Given these challenges, there is a pressing need for innovative agricultural technologies that can be applied effectively in coastal and land-limited environments. One promising solution is the implementation of a hydroponic farming system integrated with the Internet of Things (IoT). This system allows plants to be cultivated without soil, utilizing nutrient-enriched water solutions managed efficiently through automated control mechanisms. The integration of IoT technology enables real-time monitoring of plant conditions, ensuring that cultivation processes are efficient, precise, and sustainable.

The community empowerment program on IoT-based hydroponic farming was designed to address these local challenges. Through this initiative, the residents of Baruyu Lasara Village are encouraged to adopt modern agricultural technologies to enhance self-sufficiency and local food resilience. The program actively involves community groups, particularly members of the Family Welfare Movement (PKK) and village youth associations, as key partners throughout the implementation stages—from socialization and technical training to hydroponic system assembly, crop management, and maintenance.

Beyond providing technical knowledge, the program also fosters entrepreneurial skills through training in production management and agricultural marketing strategies. This approach aligns with the Tri Dharma of Higher Education, where lecturers and students from the University of Nias Raya play an active role in applying scientific knowledge and technology to real-world community development. The collaboration among the university, village government, and local residents serves as a model for sustainable, technology-based community empowerment.

Overall, the primary goal of this community assistance program is to enhance local capacity in managing IoT-based hydroponic systems, strengthen local food security, and develop a community that is self-reliant and adaptive to the advancement of modern agricultural technology. Through the implementation of this innovation, Baruyu Lasara Village is expected to become a model area for efficient, eco-friendly, and sustainable agriculture in South Nias Regency.

**Method**

The implementation of the community assistance program for hydroponic cultivation using IoT technology in Baruyu Lasara Village was carried out through several structured and participatory stages. Each stage was designed to ensure that the community could understand, practice, and manage the hydroponic system independently. The methods applied in the field are as follows:

1. Initial Survey and Needs Assessment
   The program began with a field survey to identify geographical conditions, available resources, and community needs related to food cultivation. Through direct interviews and observations, the team gathered information regarding limited land, sandy soil conditions, and the scarcity of freshwater. These findings served as the basis for determining the most appropriate hydroponic system and IoT technology to be introduced in the village.
2. Program Socialization and Coordination with Partners
   Following the survey, the team conducted a socialization meeting with the community and coordinated with the main partners, namely the Baruyu Lasara Village PKK Team and the village youth group. This session aimed to explain the program's objectives, expected benefits, and implementation plan to encourage active community participation. A working group was also formed to assist in each stage of the activities.
3. Technical Training on Hydroponic Cultivation
   Participants received hands-on training on the fundamentals of hydroponic systems, types of growing media, seedling techniques, preparation of nutrient solutions, and water management. The training was conducted using demonstration methods to ensure that participants could understand each step clearly. Mustard greens and lettuce were selected as training crops due to their fast growth and easy maintenance.
4. Designing and Assembling the Hydroponic Installation
   At this stage, community members were directly involved in designing and assembling a simple hydroponic system using PVC pipes and supporting frames. The assembly process included cutting pipes, constructing the frame, installing net pots, and setting up the water circulation system. Community involvement

ensured that they would later be able to assemble and repair the system independently.

5. Implementation of IoT Technology
   The next phase was the installation and operation of IoT devices to monitor plant conditions. Sensors were installed to measure humidity, temperature, and nutrient levels in the solution. Participants were trained on how to read the data displayed on the IoT application or monitoring device, as well as how to adjust nutrient settings when necessary. This technology helped the community understand the importance of environmental control in hydroponic cultivation.
6. Seed Transplanting and Routine Assistance
   Seedlings of mustard greens and lettuce were transplanted into the hydroponic system and regularly monitored. The team provided continuous assistance through field visits, system inspections, and evaluations of plant growth. During this phase, the community was guided to check pH, EC, water volume, and system cleanliness to ensure optimal plant development.
7. Monitoring, Evaluation, and Documentation
   Throughout the program, the team monitored plant progress and evaluated the community's understanding of both hydroponic and IoT systems. Documentation was carried out through photos, videos, and growth notes. The evaluation results showed a significant improvement in the community's knowledge and skills in managing modern agricultural systems.
8. Harvesting and Collective Reflection
   The final stage was the harvesting activity, conducted together with the community. A reflection session followed to review experiences, challenges faced, and potential improvements for future development. The community was encouraged to utilize the harvest for household consumption and explore opportunities for small-scale agribusiness.

## Result and Discussion

As part of community service activities, a training module has been developed with the aim of providing comprehensive knowledge about hydroponics to the community, especially millennial farmers. This module covers three main aspects, namely the basics of hydroponics, management of hydroponic farming enterprises, and the application of digital technology in hydroponic systems. This module is designed with an easy-to-understand approach, so that participants who are new to hydroponics can quickly master the basic concepts of this soilless farming technique. The first part of the module provides an explanation of various hydroponic systems, the growing media used, and the methods of caring for plants in this system.

Furthermore, in the business management section, the module discusses how to plan and manage hydroponic farming effectively, including cost calculation methods, appropriate crop selection, and marketing strategies for hydroponic products. The last section, concerning the application of digital technology, provides insights on how digital-based tools and applications can be used to monitor plant conditions, regulate automatic irrigation, and analyze plant growth data to improve efficiency and productivity. With the development of this module, it is expected that the community, especially millennial farmers, can access useful information to develop hydroponic businesses independently and sustainably. This module-based training program will serve as a reference in further training sessions involving participants in practical activities, with the aim of increasing farmers' capacity to adopt modern agricultural technologies.

The second stage of activity was to hold meetings with millennial farmer communities to socialize the program. As part of the community service activities, meetings were held with millennial farmer groups to introduce the hydroponic program. This activity aimed to introduce soilless cultivation techniques that are more efficient, environmentally friendly, and have promising economic prospects. During the meeting, participants were provided with an understanding of the basic principles of hydroponics, the types of systems that can be applied, and the benefits that can be obtained, such as land conservation, reduced water use, and higher yields. In addition, a live demonstration was also given on how to assemble a simple hydroponic installation so that participants could understand its practical application.

Interactive discussions between participants and presenters showed a high level of enthusiasm from millennial farmers in adopting this technology.

Some participants shared the challenges they faced in conventional agriculture, such as limited land and climate change, which can be overcome with hydroponic methods. As a follow-up to this activity, discussion and mentoring groups were formed for farmers who were interested in developing hydroponic systems in their areas. It is hoped that this program can increase agricultural productivity while opening new business opportunities for millennial farmers.

The third stage of activity was to provide basic knowledge about hydroponic systems, suitable plant types, as well as the benefits and challenges in hydroponic cultivation. As part of the community service activities, basic knowledge about hydroponic systems has been provided to the community, especially millennial farmers. This activity aimed to introduce hydroponics as an efficient and environmentally friendly alternative method of plant cultivation, and to provide in-depth insight into its processes and applications.


The provision of knowledge began with an explanation of the basic principles of hydroponics, which is a way of cultivating plants without using soil but instead using water enriched with nutrient solutions required by the plants. In addition, participants were introduced to various types of hydroponic systems that can be applied, such as the wick system, floating raft system, and drip system, along with the advantages of each system.

Furthermore, participants were given information about the types of plants suitable for hydroponic cultivation. Some of the most suitable plants include lettuce, tomatoes, cucumbers, and herbs such as basil and oregano. This provided the community with an idea of which plants can grow well using this method.

However, in the discussion, various challenges that may be faced in hydroponic cultivation were also revealed, such as higher initial investment requirements, system maintenance that requires special attention, and dependence on electricity supply for automatic irrigation systems. Nevertheless, long-term benefits such as land and water conservation, as well as wide market potential, make hydroponics a very attractive option for adoption in modern agriculture.

The fourth stage of activity was hands-on practice in making simple hydroponic installations and using digital devices to monitor plant conditions. In this session, participants were given the opportunity to be directly involved in the practice of creating a simple hydroponic installation using the NFT (Nutrient Film Technique) system. They learned to assemble the hydroponic system using easily available materials, such as PVC pipes, buckets, and small water pumps. The first step was to prepare the materials and equipment needed to make a simple hydroponic system. Some of the required materials included: water tanks or reservoirs to store nutrient solutions; pipes or hoses to channel water from the tank to the plants; growing media such as rockwool or gravel as a support medium for plants (without soil); water pumps to circulate water throughout the system; and hydroponic nutrients in the form of a mixture of mineral salts needed by plants. On the other hand, for digital monitoring, devices such as pH sensors, humidity sensors, and temperature sensors also needed to be prepared. In addition, applications or software that can be used to monitor data from these devices were also required.

After all materials were ready, the next step was to assemble the hydroponic installation. The steps that had to be taken included: arranging the water tank or reservoir where the nutrient solution would be stored; installing the pipes or hoses that would deliver the nutrient solution to the plants—usually arranged to allow the water to flow in a controlled manner; installing the water pump to ensure automatic circulation of the nutrient solution, allowing it to flow to the plants and return to the reservoir after being absorbed by the roots; and preparing the growing media that would be used to support the seedlings and ensure that the roots could absorb water properly.

After the hydroponic system is installed, the prepared seedlings are placed into the growing medium. Typically, the seedlings are positioned in small holes or pots that can support them while providing enough space for root development. In the hydroponic system, the roots come into direct contact with the nutrient solution flowing beneath them.

After the installation was completed, digital devices were used to monitor plant conditions. The following steps outline the use of these digital devices: installation of pH and EC (Electrical Conductivity) sensors to measure the acidity level and nutrient solution concentration. These sensors provide real-time data that are essential for ensuring plants receive the appropriate nutrients. Temperature sensors were installed to monitor the surrounding temperature, as extreme heat or cold can affect plant growth. Humidity sensors were used to measure the air humidity around the plants since maintaining proper humidity levels is crucial to support photosynthesis and plant growth. Applications or software were utilized to read data from these sensors. These applications allow users to monitor data in real-time and issue alerts when parameters are out of range, such as when pH is too low or temperature too high. Through digital monitoring, the next step was maintaining the established hydroponic system. Based on the data obtained from the digital devices, users can adjust system conditions by adding or reducing nutrient solutions to maintain proper mineral concentration, regulating temperature and humidity to stay within the optimal range for plant growth, and performing routine water replacement or system cleaning to prevent salt buildup or clogs that may hinder water flow.

The final stage of the activity involved providing continuous mentoring to participants in managing their hydroponic businesses, including digital marketing strategies and financial management. In this stage, after participants successfully built their hydroponic systems and began harvesting, the team continued the mentoring program by introducing digital marketing strategies. Participants were guided to create social media accounts and simple websites as platforms to promote their hydroponic products, such as Facebook or Instagram. Additionally, the team taught them how to create engaging content to attract potential buyers and provided training on online marketing techniques using social media and paid advertisements to enhance product visibility in the market.

Through this mentoring program, participants were able to utilize digital technology to reach a broader range of consumers, including those outside their local area, which was previously unattainable through conventional marketing methods. Several participants successfully gained regular customers, ranging from restaurants to local markets, who were attracted to the fresh and healthy hydroponic products.

The team not only provided guidance in technical and marketing aspects but also emphasized the importance of proper financial management to ensure that the hydroponic business runs smoothly and remains profitable. Participants were taught how to create business budgets and record financial transactions using simple tools such as accounting applications or spreadsheets. Additionally, the team helped participants understand how to manage cash flow to prevent losses and ensure business continuity.

Through this training, participants became more meticulous in managing their funds and learned how to reinvest profits for future business development. After several months of mentoring, the results were highly encouraging. Participants are now able to manage their hydroponic businesses more efficiently and effectively, have become more skilled in digital marketing, and are capable of maintaining sound financial management. What initially began with hesitation has now grown into a profitable and sustainable enterprise.

This program has had a significant positive impact on the participants, as shown in Figure 5 above, which demonstrates a total of 1,760 planting holes produced. The participants not only gained new knowledge and skills but also developed greater confidence in expanding their businesses. In fact, several participants have successfully opened stalls in local markets, selling their products directly and expanding their market reach. Through this community service program, the team has successfully empowered the community, enhanced their capacity in modern agriculture, and provided a deeper understanding of the importance of technology in improving the competitiveness of agricultural products. This program has not only assisted participants in managing their businesses but has also opened new economic opportunities for them and created the potential for larger-scale enterprises in the future.

## Conclusion

The conclusion from the results of this community service program shows that the implemented activities have successfully provided a significant positive impact on the participants, particularly millennial farmers. The comprehensively designed training module which covers the fundamentals of hydroponics, hydroponic farm management, and the application of digital technology has effectively delivered useful and easily understood knowledge to the community. Through meetings, discussions, and hands-on practice, participants were able to understand the concept of hydroponics and apply it in their agricultural ventures.

In addition, the continuous guidance provided in digital marketing and financial management has enabled participants to manage their hydroponic businesses more efficiently and effectively. They are now not only capable of assembling simple hydroponic systems and digitally monitoring plant conditions but also of utilizing social media and digital marketing tools to expand their market reach. With proper financial management training, participants have learned to manage budgets and cash flow more effectively, thereby improving the sustainability of their businesses.

The long-term impact of this program is evident in the increased productivity, business development, and success of participants in selling hydroponic products in local markets and expanding their reach. Overall, this program has empowered participants with new skills and broader economic opportunities, positioning them to become successful and independent modern agricultural entrepreneurs.

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Through the strong collaboration between the program team, village government, and the community, this initiative has enhanced local capacity in managing IoT-based hydroponic systems, strengthened food security, and opened new opportunities for sustainable agro-entrepreneurship. It is our hope that the outcomes of this program will continue to deliver long-term benefits for the residents of Baruyu Lasara Village and serve as an inspiration for other communities in applying modern technology to improve agricultural productivity and overall well-being.

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