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OPTIMIZING MODERN AGRICULTURAL PRODUCTS THROUGH A DRIP IRRIGATION SYSTEM IN THE PAPUA FARM FARMERS GROUP, AIMAS REGENCY, SOUTHWEST PAPUA

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Abstract

Increasing agricultural productivity in Eastern Indonesia, particularly in Aimas District, Sorong Regency, is a strategic step in supporting local food security and farmer welfare. Papua Farm, a pioneer in hydroponic lettuce cultivation in Papua, faces challenges such as limited water, climate fluctuations, and limited access to modern agricultural technology. A community service program titled "Optimizing Modern Agricultural Products through Drip Irrigation Systems at the Papua Farm Farmer Group, Aimas District, Southwest Papua" was implemented to address these challenges. The drip irrigation system was chosen because it can channel water and nutrients directly to the plant's root zone, reduce water loss due to evaporation, and increase fertilizer efficiency through fertigation. The program was implemented using a participatory approach through stages of socialization, training, demonstration plot installation, mentoring, and evaluation. Results showed a water use efficiency of up to 40%, a reduction in labor costs of Rp1,000,000 per season, and an increase in harvest productivity of around 25% with more uniform crop quality. In addition to technical aspects, this program also increases farmers' knowledge capacity, strengthens group institutions, and opens market opportunities through agribusiness digitalization. Thus, the application of the drip irrigation system has proven effective as a model of modern, sustainable agricultural technology and is worthy of being replicated in other areas with similar conditions.

Keywords: Optimization, Modern Agriculture, Drip Irrigation System, Farmer Group, Papua Farm, Aimas District, Southwest Papua.

INTRODUCTION

Increasing agricultural productivity in eastern Indonesia, including Aimas District, Sorong Regency, plays a crucial role in local food security and improving farmers' welfare. Although Papua has the potential for land resources and a climate that supports various horticultural and vegetable commodities, many farmer groups face classic constraints: uneven water availability, low water use efficiency, fluctuations in crop yields due to erratic rainfall patterns, and limited access to modern agricultural technology. (1) In addition, the use of soil

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moisture sensors and weather monitoring technology can also improve the efficiency of water use in agriculture. Soil moisture sensors help farmers determine the amount of water needed by crops at any given time. By monitoring the weather, farmers can adjust irrigation schedules based on weather forecasts, avoiding unnecessary irrigation during rainy or humid weather conditions. The Papua Farm Farmers Group, as a key player in local-scale production, requires practical, cost-effective, and sustainable solutions to improve the yield and quality of their agricultural products. There are several types of watering systems for plants, one of which is the drip irrigation system. The drip irrigation system is a method of providing water to plants with low discharge and high frequency which occurs continuously either through the surface of the soil or directly to the root zone.(2)

The Papua Farm Farmers Group focuses on hydroponic lettuce cultivation. The group consists of 24 members, led by Billiam Atihuta. Papua Farm was founded out of a desire to produce pesticide-free vegetables and the lack of "western" vegetables being cultivated, leading to its founding. Papua Farm became the first hydroponic farming pioneer in Papua. Papua Farm was founded in 2017 and began operations in 2019, focusing on hydroponic lettuce production. It is located in Aimas Village, Aimas District, Sorong Regency. Aimas District is considered a poor and underdeveloped region.

Market demand is currently at 1 ton per month. This is supported by the potential of Sorong City and Regency as transit points for tourists en route to Raja Ampat. This influx of tourists has led to a high demand for lettuce. Demand for lettuce comes from various sources, including cruise ships, hotels, restaurants, and supermarkets. The presence of tourists as a market for lettuce crops can drive demand for lettuce in Sorong.

Within the Papua Farm, one technology proven to increase productivity, so that use and efficiency can provide nutrient distribution to vegetables, is by using drip irrigation technology or systems. This system allows for the direct delivery of water to the plant's root zone in controlled amounts, reducing water loss due to evaporation and runoff, and enabling the application of fertigation (the application of dissolved fertilizers) which increases fertilization efficiency. Agribusiness digitalization is one relevant solution to address these challenges. Through the use of social media, e-commerce platforms, and other supporting technologies, farmer groups have the opportunity to expand market reach directly to end consumers. (3) In the context of the Papua Farm, the application of drip irrigation has the potential to reduce dependence on seasonal rain, extend the growing season, reduce labor costs for irrigation, and increase productivity per hectare as well as the quality of vegetables. Irrigation is a critical component in agriculture that contributes significantly to productivity and the efficient use of water resources. (4)

Drip irrigation systems can save water usage, because they can minimize possible water losses such as percolation, evaporation, and surface flow, making them suitable for application in agricultural areas with limited water resources. (5) However, the adoption of technologies such as drip irrigation in small-scale farming groups is often hampered by several factors: limited technical knowledge (system design and maintenance), initial capital for installation, availability of spare parts and local materials, and the need to adapt the system to local land conditions and water sources. Therefore, community service activities that are participatory or combine technical training, field demonstrations, installation assistance, and evaluation of

results are needed so that the technology can be adopted appropriately and sustainably by Papua Farm.

The community service program entitled **"Optimizing Modern Agricultural Products through Drip Irrigation Systems at the Papua Farm Farmer Group, Aimas District, Southwest Papua"** aims to bridge these needs. This intervention not only focuses on technology transfer but also on strengthening the institutional capacity of farmer groups, developing simple financing models (e.g., sharing installation costs or microcredit models), and developing maintenance SOPs to ensure the system continues to function optimally in the long term. To assess the success of the program, evaluation and monitoring are carried out through analysis of harvest yields, water use efficiency, and crop productivity. (6) With this approach, it is hoped that there will be an increase in productivity, efficiency of input use (water and fertilizer), and product quality—which in turn will increase the income of farming families and local food security. This system distributes water efficiently directly to the roots of plants, reducing waste and improving agricultural sustainability. (7)

In brief, the background of this community service is based on: (a) the urgent need to increase the efficiency of agricultural production in Aimas; (b) evidence of the technical benefits of drip irrigation in saving water and increasing yields; (c) barriers to technology adoption among small-scale farmer groups that require assistance; and (d) the potential for positive economic and environmental impacts if implemented appropriately and sustainably. This community service activity is expected to become a replication model for other farmer groups in the Southwest Papua region and its surroundings.

IMPLEMENTATION METHOD

The community service program "Optimizing Modern Agricultural Products through Drip Irrigation Systems at the Papua Farm Farmers Group in Aimas District, Southwest Papua" was designed with a participatory and applicative approach, so that the technology can be understood, applied, and maintained sustainably by farmers. The implementation method is carried out through several stages as follows:

1. Preparation and Socialization
   a) Initial coordination with the Papua Farm Farmers Group to identify needs and issues related to irrigation and productivity.
   b) Socialization of the community service program to farmer group members, explaining the benefits, objectives, and working mechanisms of the drip irrigation system.
   c) Determining representative demonstration plot locations.
2. Training and Capacity Building
   a) Providing theoretical training on the working principles, advantages, and maintenance of the drip irrigation system.
   b) Conducting technical workshops in the form of simulations of tool assembly, pipe, hose, and emitter installation.
   c) Introducing the concept of fertigation (fertilization through a drip irrigation system) to increase fertilizer use efficiency.
3. Drip Irrigation System Installation

a) Work with farmers to install the drip irrigation system in a pilot plot.
b) Actively involve farmer group members in the entire installation process to ensure they master the installation techniques.
c) Adapt the system to local conditions (water source availability, land contour, crop type).

4. Mentoring and Monitoring
a) Provide routine mentoring during the trial period, including setting the watering schedule, irrigation volume, and fertigation application.
b) Monitor plant growth, water use efficiency, and crop productivity.
c) Identify technical issues that arise in the field, followed by joint solutions (troubleshooting).

5. Evaluation and Dissemination
a) Evaluate the results of the drip irrigation implementation in terms of increased water efficiency, reduced production costs, and increased crop productivity.
b) Conduct reflective discussions with farmers to assess successes, obstacles, and recommendations for improvement.
c) Develop simple technical guidelines (SOPs) that farmer groups can use for independent system maintenance.
d) Dissemination of program results to other farmer groups around Aimas District to expand the impact of community service.

6. Program Sustainability
a) Encourage farmer groups to develop a follow-up plan (replicability plan), such as gradually expanding the system to other members' lands.
b) Establish collaboration with local governments or agricultural support institutions for support in facilities and continued financing.
c) Foster farmer groups' independence in managing modern agricultural technology based on drip irrigation.

RESULTS AND DISCUSSION

1. Results of the Drip Irrigation System Implementation

The community service program successfully installed a drip irrigation system on a demonstration plot of approximately 0.25 hectares planted with horticultural commodities (cayenne pepper and tomatoes). Key achievements include:

1) Water Use Efficiency: Drip irrigation systems can save up to 40% on water compared to manual watering methods (watering cans/hoses).
2) Improved Plant Growth: Plants exhibit more uniform growth, with stable soil moisture levels that meet needs.
3) Labor Efficiency: Irrigation time is significantly reduced. Farmers who used to need 3–4 hours to water an entire field now only need 1 hour with a simple automation system.
4) More Effective Fertigation: Liquid fertilizer application through drip irrigation systems shows a faster plant response than manual fertilization.
5) Increased Productivity: From initial harvests, farmer groups have recorded an increase

in production of around 20–25% compared to previous methods.

2. Papua Farm Farmers' Group Response
    1) Farmers' group members expressed high enthusiasm, believing the system was practical, labor-saving, and supported increased yields.
    2) Farmers began developing plans to expand the use of drip irrigation on their own land.
    3) The main challenge they faced was the initial cost of installing and maintaining the pipes and filters. However, with the training provided, farmers were able to make minor repairs independently.
3. Challenges Faced
    1) Material Availability: Some drip irrigation components (such as filters and emitters) still have to be imported from outside the region, increasing costs.
    2) Limited Capital: Not all members are able to fully adopt the system immediately due to limited business capital.
    3) Initial Adaptation: Farmers need time to adjust to calculating water discharge and proper watering frequency. (8)

DISCUSSION

The implementation results indicate that the drip irrigation system is an effective solution to address the challenges of water, labor, and agricultural productivity limitations in Aimas District. More efficient water use aligns with the principles of sustainable agriculture, while increased productivity has a direct impact on farmer incomes. Furthermore, this system opens up opportunities for farmer groups to develop modern, technology-based agricultural practices, which can increase the competitiveness of local products in the market. The success of this program also demonstrates the importance of ongoing mentoring so that farmers not only accept the technology but also manage it independently.

From a social perspective, this program strengthens collaboration among farmer group members through collective work during the installation and maintenance stages. Economically, increased harvest yields offer hope for improving the welfare of farming households. The graphic depicts research and community service related to Optimizing Modern Agricultural Products through Drip Irrigation Systems at the Papua Farm Farmer Group.

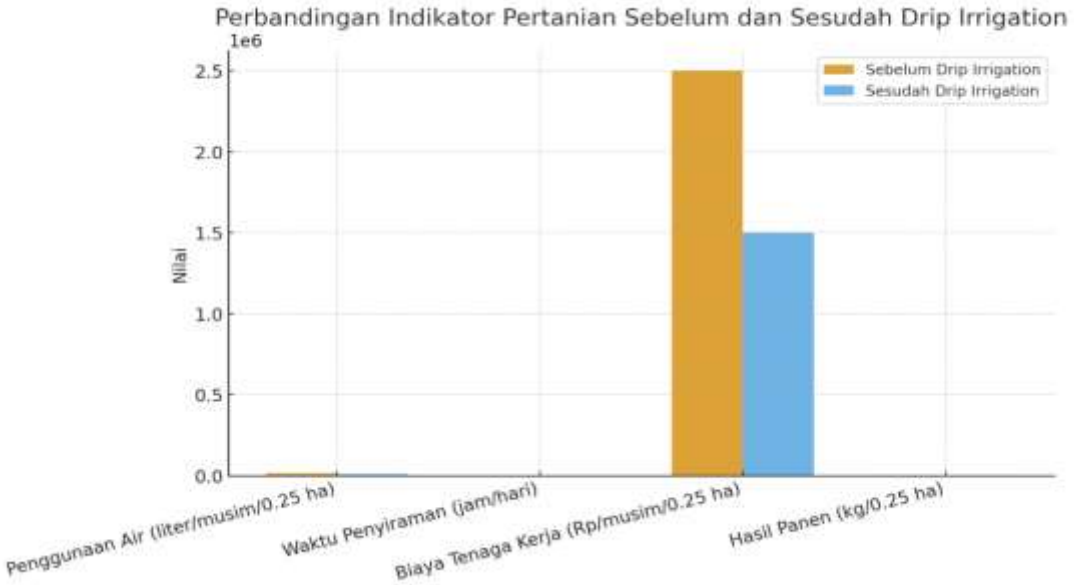

Table 1. Application of Drip Irrigation System

Indicator	Before Drip Irrigation	After Drip Irrigation	Changes/Benefits
Water Use (liters/season/0.25 ha)	15.000	9.000	Save ±40% water
Watering Time (hours/days)	3,5	1,0	More efficient, saves time ±70%
Labor Cost (Rp/season)	2.500.000	1.500.000	Save Rp1,000,000/season
Harvest Yield (kg/0.25 ha)	750	950	Production increase of ±25%
Plant Quality	Not uniform	More uniform	Plant growth is more even
Fertilization Efficiency (Fertigation)	Manual, wasteful of fertilizer	Through the drip system, controlled	More efficient fertilization, faster plant response

Source processed in 2025

Based on Table 1, the implementation of the drip irrigation system at the Papua Farm Farmers Group has shown significant results in increasing farming efficiency. In terms of water use, the need for water decreased from 15,000 liters to 9,000 liters per season for a 0.25-hectare plot, representing a savings of approximately 40%. This demonstrates that the drip irrigation system is able to deliver water directly to plant roots, thereby reducing losses due to evaporation and runoff.

In terms of watering time, before the drip irrigation system, farmers needed an average of 3.5 hours per day to water their fields, but after implementing this technology, it only takes about one hour per day. This time efficiency directly reduces the farmers' workload, freeing up their energy for other agricultural activities.

Efficiency is also reflected in the reduction in labor costs, which dropped from Rp

2,500,000 to Rp 1,500,000 per season. This Rp 1,000,000 savings represents an added economic value that can increase farmers' profit margins.

In addition to savings, crop productivity has increased. Yields increased from 750 kg to 950 kg per 0.25 ha, or approximately 25%. This yield increase was accompanied by more uniform crop quality compared to before the drip irrigation implementation. This is due to the more even and controlled distribution of water and fertilizer.

Furthermore, the application of fertigation through a drip irrigation system makes fertilizer use more efficient. Whereas previously manual fertilization tended to be wasteful, fertilizer can now be distributed in measured amounts directly to the plant's root zone. Plants respond more quickly to fertilization, resulting in optimal growth.

Overall, the data in Table 1 shows that the implementation of drip irrigation not only saves inputs (water, time, and costs) but also increases output in the form of crop yields and product quality. Thus, this technology has been proven to support the optimization of modern agricultural products and has had a positive impact on improving the welfare of Papua Farm farmers in the Aimas District, Southwest Papua.

Figure 1. Socialization of Optimization of Modern Agricultural Products Through Drip Irrigation System at the Papua Farm Farmers Group, Aimas District, Southwest Papua

A community service team conducted a socialization activity with the Papua Farm Farmers Group in Aimas District, Southwest Papua. In this activity, farmers were given an understanding of the basic concept of the drip irrigation system, the benefits that can be obtained, and the steps for implementing it on agricultural land. The socialization was carried out in a participatory manner, where members of the farmer group actively discussed and shared their experiences and the obstacles they faced in land irrigation. This community service activity used a selection approach. Training aims to improve individual or group skills, often in a formal context to improve performance or competence in a field, which can be interpreted as a system of activities for certain communities who are engaged in the same field so that they have improvements in certain skills, can develop a positive attitude towards change based on innovation, and grow confidence in their own abilities to carry out their business so that it will result in improvements after the training. Socialization activities for farmers were carried out twice. (9)

This activity serves as a crucial initial step before system installation, as it provides farmers with insights into how drip irrigation technology can conserve water, reduce labor costs, and increase yields. The farmers' enthusiasm was evident in their active participation in question-and-answer sessions and group discussions, demonstrating their readiness to adopt this modern agricultural technology sustainably.

Figure 2. Nursery And Use of the Drip Irrigation System for Vegetables

The image above shows vegetable nursery activities by members of the Papua Farm Farmers Group. Seedlings are planted in polybags in a growing medium of soil, compost, and rice husk charcoal to maintain moisture and nutrient availability. This nursery stage is crucial for producing healthy, strong, and uniform seedlings before transplanting to the main field. This activity also involves training farmers on seed selection techniques, seedling care, and pest and disease control from the early stages of growth. This allows farmers to optimize plant growth conditions and anticipate plant diseases. (10)

The Application of a Drip Irrigation System for Vegetable Plants demonstrates the use of a drip irrigation system in horticultural vegetable fields. Irrigation hoses are installed along the beds with emitters that deliver water directly to the plant's root zone. This system helps maintain stable soil moisture, reduces water loss due to evaporation, and allows for more efficient liquid fertilizer application (fertigation). By implementing drip irrigation, farmers can conserve water, reduce labor costs, and significantly increase vegetable growth and yields.

Figure 3. Making a Green House Drip Irrigation System

The image above shows the process of building a simple greenhouse used as a pilot location for the application of a drip irrigation system at the Papua Farm Farmers Group, Aimas District, Southwest Papua. The greenhouse functions as a modern cultivation facility that can protect plants from excessive rain, pests, and extreme weather conditions that often occur in the Southwest Papua region. Inside the greenhouse, a drip irrigation system is installed consisting of a main pipe, capillary hose, and emitters that are connected directly to the water source. This system is designed to efficiently distribute water and nutrients directly to the plant's root zone. With the combination of the greenhouse and drip irrigation, humidity and micro-temperature in the cultivated area can be better controlled, thus supporting more uniform plant growth and increasing the quality and quantity of the harvest. (11)

The construction of this greenhouse also involved the active participation of farmer group members, from constructing the framework and installing the UV-repellent plastic roof to installing the drip irrigation network. Through this activity, farmers gained not only new facilities but also practical experience in independently building and managing modern agricultural production facilities.

Figure 4. Hydroponic Drip Irrigation System Training

The image above shows a training session on the implementation of a hydroponic-based drip irrigation system conducted with members of the Papua Farm Farmers Group in Aimas District, Southwest Papua. During this activity, the community service team explained the working principles of the drip irrigation system, its advantages in efficient water use, and application techniques for hydroponic cultivation. (12)

Training participants were enthusiastic about participating in the hands-on session, which

included assembling pipe and hose components, installing emitters, and simulating the distribution of water and nutrient solutions to hydroponic plants. Using this method, farmers gained a practical understanding of how the drip irrigation system can be applied to hydroponic installations, resulting in more uniform, efficient, and high-quality plant growth.

CONCLUSION

The community service project, "Optimizing Modern Agricultural Products through the Drip Irrigation System for the Papua Farm Farmers Group in Aimas District, Southwest Papua," yielded positive results from technical, economic, and social perspectives. The implementation of the drip irrigation system has been proven to increase water use efficiency by up to 40%, reduce labor time and costs, and increase harvest productivity by approximately 25%, resulting in more uniform crop quality.

Furthermore, this technology simplifies fertigation, allowing for more efficient fertilizer application and a faster response to plant growth. Increased yields and input efficiency have a direct impact on farmer incomes and support the realization of sustainable modern agriculture.

From a social perspective, this activity has successfully increased the knowledge and skills of farmer group members, strengthened collaboration among farmers, and fostered the adoption of appropriate technology. Challenges such as limited capital and component availability can be overcome through ongoing mentoring, strengthening group institutions, and support from the government and relevant institutions.

Thus, the implementation of the drip irrigation system can serve as a model for modern agricultural technology innovation worthy of replication by other farmer groups in Southwest Papua and other regions with similar conditions.

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