

Enhancing Food Security In Rural Communities Through Implementation Of Hydroponic Technology

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ABSTRACT:

Not all rural areas in Indonesia have fertile agricultural lands which are suitable for growing food crops, including vegetables. One of them is Dukuh Plampang II, Kalirejo Village in Kapanewon (Subdistrict) Kokap, Kulonprogo Regency, Special Region of Yogyakarta, the location of the Yogyakarta Muhammadiyah University Community Service Program (Kuliah Kerja Nyata – KKN) in Even Semester 2022/2023 Group 103. So far, the people of Dukuh Plampang II have met their needs for food, especially vegetables, by relying on supplies from mobile vegetable retailers. Besides having to spend a certain amount of money to buy vegetables, this dependence is also vulnerable to the risk of supply delays caused by one or another constraint. In the long term, this dependence can also reduce the level of food security. The purpose of the KKN activities at that location was formulated as an effort to increase food security with an effort to reduce dependence on external supplies such as mobile vegetable sellers. The form of technology introduced is vegetable farming using hydroponic facilities. This research uses the participatory social action research (Riset Transformasi Sosial Partisipatif – RTSP) method in the form of a participatory and transformative research approach that aims to bring about social change and overcome social problems through a collaborative and empowering process. This study examines the link between the main values of community empowerment in increasing the food security of rural communities by cultivating vegetables through hydroponic technology. Hydroponics is a method of cultivating vegetables by utilizing water without using soil as a nutrient medium. This research also shows that the use of hydroponic technology in growing vegetables can help rural communities maintain their own food security. Hydroponic technology can also be used as an alternative for rural communities who have dry land and can also reduce the community's dependence on the supply of vegetables by mobile vegetable traders. Apart from that, the Women Farmers Group (Kelompok Wanita Tani – KWT) in the Dukuh Plampang II has the motivation to use hydroponic technology.

Key Words: Food Security, Rural Communities, Hydroponic, Participatory Social Action Research

INTRODUCTION

This paper aims to expose that the application of hydroponic technology can enhance food security among rural communities, especially in the areas with land that is not fertile for farming. Food security is a basic need for all living creatures that must be met for their survival. It includes adequate access to safe, nutritious, affordable food, as well as the ability to maintain it over the long term. Rural communities often face challenges in achieving food security for several reasons. One of them is the limited access to the resources and infrastructure needed for food production such as fertile agricultural land, no irrigation water management, and lack of agricultural technology. These limitations can hamper agricultural productivity and increase dependence on external food supplies. In certain conditions where smooth external supplies are delayed, this can of course increase food insecurity for local residents.

One of the rural area that has dry land and is dependent on food supplies from outside is Plampang II. It is one of nine hamlets in Kalirejo Village, Kapanewon (Subdistrict) Kokap, Kulon Progo Regency, Yogyakarta Special Region. The sub-district itself located on an area of 1,259 hectares and most of the land is dry, rocky land. As a result, it is very difficult for people to develop food crops, particularly vegetables. Besides, Kalirejo Village has no village market. The closest traditional market is located in Pripih Hargomulyo village, almost six kilometers distance from Plampang II. Therefore, the residents of Plampang II meet their daily food needs, especially vegetables, by relying on supplies from mobile retailers. Of course, apart from having to spend a certain amount of money to buy vegetables, this dependence is also vulnerable to the risk of delays in supply caused by one problem or another. In the long term, this dependence can also reduce the level of food security.

One effort to overcome the problem of food crop productivity on barren, rocky and water-scarce land is to utilize hydroponic cultivation technology. Hydroponics is a method of cultivating vegetables by utilizing water (without using soil) as a media source for plant nutrition, including nutrients.

A previous research entitled "Hydroponic Technology as a Food Security Solution during the Covid-19 Pandemic for the Community of Blang Poroh Village, Lhokseumawe City," resulted in the conclusion that hydroponic technology is very suitable to be developed in Gampong Blang Poroh Village because the technology is simple and does not require large areas of land. In another research revealed that hydroponics technology plays a role in enhancing the local economy in Kalirejo village (East Java) community. Hydroponic technology has many advantages, including being easy to apply to various conditions in the home yard, easier to control the plant's need for nutrients, higher and more uniform crop yields, guaranteed harvest quality because it does not use chemical fertilizers and pesticides, fewer materials (e.g., soil and fertilizer) are required, there are almost no parasites around the plants, and it is easier to transplanting the plants.

LITERATURE REVIEW

Food security

Food security is a condition where household food needs are met, which is reflected in the availability of sufficient food, both in terms of quantity and quality, safe, equitable and affordable. Food is a basic human need that must be met at all times. Food has a very important meaning and role in the life of a nation. Food availability that is less than needed can create economic instability which can endanger economic stability and national stability. According to Indonesian Law (*Undang-Undang*) No. 18/2012 on Food, food security is a condition where food is met for the country as well as individuals, which is reflected in the availability of sufficient food, both in quantity and quality, safe, varied, nutritious, equitable and affordable and does not conflict with the religion, beliefs and culture of the community, to be able to live a healthy, active and productive life in a sustainable manner.

Food security has three aspects in creating food security, namely, availability, access and utilization. The availability aspect provides guidelines for villages to produce their own food security by carrying out business activities in the fields of agriculture, livestock, fisheries and plantations. Villages can decide on the type of business that suits geographical conditions and also has business prospects. Villages can also help to increase food production which is already carried out by village community groups. For example, if there is a fish cultivation group in the village, it is better for the village to support that group rather than for the village to build its own cultivation starting from scratch. By having the ability to produce their own food, villages have independent food security for their villages. The affordability aspect shows a person's ability to obtain food needs. This means that someone can fulfill their needs easily. The utilization aspect refers to how to utilize post-harvest results such as sales and profits. Villages can realize the utilization aspect after the village has activities in the availability aspect. These aspects can create food security which has a vision and mission to create a prosperous and prosperous society.

In the Indonesian 2020-2024 Food and Nutrition Strategic Policy (*Kebijakan Strategis Pangan dan Gizi*), there are four pillars influencing food security, namely:

1. Access to agricultural resources which include the availability of land, irrigation water, seeds and fertilizer which are important factors in increasing agricultural production. Access to these resources can be influenced by geographic, social and economic factors;
2. Infrastructure includes the availability of infrastructure such as roads, irrigation and post-harvest which are very important in supporting food production and distribution in rural areas. Good infrastructure can speed up the flow of goods and expand market access for farmers;
3. Markets, good market access can increase farmers' income and strengthen food security. The presence of markets close by and easy accessibility can enable farmers to sell their crops at better prices;
4. Agricultural technology, the use of modern agricultural technology such as the use of organic fertilizer, good soil cultivation and the use of superior plant varieties can increase agricultural productivity. Access to agricultural technology is also important in overcoming climate change and the risk of natural disasters; and,

5. Government policies that support agriculture, such as fertilizer subsidies, capital assistance, and farmer training, can help improve the food security of rural communities. Policies that focus on developing agricultural infrastructure and managing disaster risks are also important in improving food security.

A study that examined the food security of households in the Kalirejo village community showed that: (1) The average level of household food security in Kalirejo Village is included in the food vulnerable group; and (2) the length of education of the housewife, number of household members, and income influence food consumption in Kalirejo Village.

Hydroponic Agricultural Technology

Hydroponics is agricultural cultivation without using soil, so hydroponics is an agricultural activity that is carried out using water as a medium to replace soil. The hydroponic farming system can utilize narrow land. Agriculture using a hydroponic system does not require a large area of land to implement, but in the hydroponic farming business it is only worth considering considering that it can be done in the yard, roof of the house or other land. The term hydroponics was first proposed by William F. Gericke in 1937. The term terminology comes from the Greek hydro which means "water", and ponos which means "power". Thus, in general it means an agricultural cultivation system without using land but using water containing nutrient solutions for plants. Hydroponic cultivation is usually carried out in a greenhouse to ensure optimal plant growth and is completely protected from the influence of external elements such as rain, pests, disease, climate and so on.. Hydroponic plant cultivation has various application techniques, such as static culture, flow culture, aeroponics, mist ponics, ebb-and-flow, run-to waste, and so on. One system that is easier to make is the wick system, which is a simple hydroponic system and has a low level of difficulty for beginners. The latter option is what is being practiced at Plampang II with the aim of providing an example that is easiest to be replicated by members of the local community.

METHOD

This research was conducted in Plampang II Hamlet, Kalurahan (Village) Kalirejo, Kapanewon (Sub-district) Kokap, Kulon Progo Regency, Yogyakarta Special Region Province. Kalirejo is one of five villages in the Kapanewon and one of eighty eight Kalurahans in Kulon Progo Regency (Kulonprogo, 2022). The geographical position of Kalirejo Village is at 07°49'44" South Latitude and 110°03'53" East Longitude with a height approximately 600 meters above sea level (Administrator, 2020). This place was chosen as the location for community empowerment under study because it coincides with the students' community service program (Kuliah Kerja Nyata – KKN) Group 103 for an effective month (at minimum 240 work hours). During the activity, this research was carried out collaboratively between the researcher and the students.

This research uses participatory social action research methods. It is a participatory and transformative research approach that aims to bring about social change and overcome social injustice through a collaborative and empowering process. It combines research methodology with social activism to generate knowledge, challenge existing power structures, and advance social justice. The method is characterized by the active involvement and participation of community members, stakeholders and researchers throughout the research process (Kaur et al., 2020). It emphasizes the importance of paying attention to the voices of marginalized and/or oppressed

community groups, and involving their participation in the decision-making process related to research objectives and results. In the method, the research process goes beyond the traditional notion of the researcher as an impartial observer. Instead, researchers actively engage with communities and organizations to identify and understand social problems, determine research questions, and develop strategies to address these problems. Though the implementation of its key elements, such as participatory approach (Sadabadi & Rahimi Rad, 2021), action-oriented focus (Buhagiar & Sammut, 2020), reflectivity and empowerment (Burrows & Harkness, 2016)(Ros-Sánchez et al., 2023), collaboration and partnership (Walton, 2021), and dissemination of science and technology (Pawar, 2015), this activity ensures that the research is relevant, meaningful, and based on the experiences and needs of the communities involved. By integrating research and social action, this action research aims to empower marginalized communities, challenge unjust systems, and contribute to the creation of a more just and inclusive society. This approach provides a platform for collective learning, advocacy, and transformative action.

Research data sources include both primary and secondary data. Primary data was obtained from the field, sourced from stakeholders and the results of direct observation. Meanwhile, secondary data was obtained from the Indonesian Central Statistics Agency (*Badan Pusat Statistik - BPS*), official government and village websites, research results published in scientific journals, as well as news from various online media. Primary data was collected using a participatory approach, namely participatory rural appraisal (PRA) in the form of a focus group discussion (FGD). In fact, since the initial observations were made (15 to 22 July 2023), the PRA and FGD process with stakeholders has been carried out. Meanwhile, secondary data was collected by searching data from BPS, official government websites in general and focused on the local government publication; while the research results from relevant expertise were searched via Google Scholar and Mendeley; then news from various media, including social media, is searched by surfing using relevant key words.

The analysis begins long before the field research is carried out, namely in the form of statistical data analysis as well as analysis of literature and news in various online media. Furthermore, the knowledge obtained from the first step was confirmed with stakeholders in the PRA forum in the form of FGD. The results are findings in the form of existing potential and problems faced by the communities who are research partners. The next analysis is regarding needs and targets to increase knowledge and insight, skills, attitudes and behavior that will be formed jointly between researchers and partners. Finally, an evaluation and formulation of a follow-up plan was carried out in accordance with the needs assessment and subsequent achievement targets.

RESULT AND DISCUSSION

The problem that exists in Kalirejo Village, which is particularly densely populated in Plampang II Hamlet, is that the low level of soil fertility, which has an impact on the absence of land and inaccessible water sources for growing vegetables. As consequence, the Plampang II villagers rely on mobile traders to meet their need of fresh vegetable. To anticipate the food security matter, KKN students created innovations to build hydroponics as an alternative solution to problems in carrying out vegetable farming activities with limited land. The following are the stages implemented in empowering the Plampang II residents in utilizing hydroponic technology.

1st stage: Installation planning and preparation

The first step in making hydroponic planting media starts from making a design, calculating the size and length of the supporting wooden frame, calculating the length of 2.5 inch PVC pipes, and what equipment must be prepared, including a water pump, screws, PVC glue, buckets, wood saws, hacksaws, and 2.5 inch knee-type PVC. Then, the hydroponic framework began to be created and formed. Starting from cutting wood and ensuring the proper height and width of the frame. After the wooden frame has been cut, the next step is to put the pieces of wood together to form a 4-level frame in a horizontal shape with a height of 1.5 meters and a width of 1 meter. The next stage is measuring and cutting the PVC pipe according to the design. After going through these stages the PVC pipe is then attached using PVC pipe glue.



Fig 1. The making of hydroponic frame



Fig 2. The hydroponic frame is ready

2nd stage: Trials

After going through the planning and preparation stages, the next step is the trial process by flooding the glued PVC pipe with water using a pool water pump machine. After the water flows, then check the flow of standing water in each PVC pipe.



Fig 3. Trial of PVC Pipe Water Flow in a Hydroponic Framework

3rd stage: Socialization

After going through the trial phase, the next stage was to socialize hydroponic technology to the Plampang II Padukuhan community, accompanied directly by the resource person, namely Mr Novi Setiawan. He is an entrepreneur from Bantul District Yogyakarta who has owned the *BriqCo* Enterprise since 2009. This company focuses on exporting coconut charcoal briquette products. Apart from that, currently Mr Novi Setiawan is also pioneering and developing hydroponic technology which focuses the results of the technology into a product. He applies hydroponic technology for vegetables such as caisim and chilies next to his shop so that their growth progress can be monitored every day.

In the socialization occasion, the resource person started with the definition, advantages and benefits of hydroponic plant cultivation, as well as training on how to cultivate using the technology. This activity was attended by 30 Plampang II residents. Among those present included the Women's Farmers Group (*Kelompok Wanita Tani – KWT*), students from other universities who were also carrying out community service, and Karang Taruna (Youth Club) of Plampang II. This activity received a good and positive response from the community.



Fig 4. Socialization of Cultivation using hydroponic technology by Mr. Novi Setiawan (left, bearded)

4th stage: Sowing Plant Seeds

The next stage is to sprinkle the seeds using rockwool. Rockwool is a collection of foam-shaped fibers made from melted volcanic rock such as basalt. The seeds are placed on top of the Rockwool while flowing with enough water so that the rockwool remains wet. This sowing takes 4-5 days to grow true leaves from the seeds.



Fig 5. Growth of true leaves of caisim plants

5th stage: Fertilizing and Transferring Rockwool to Planting Media Cups

This fertilization uses hydroponic nutrient fertilizer, namely AB-MIX fertilizer which is obtained at the local agricultural shop. AB-MIX fertilizer is a fertilizer consisting of a mixture of two fertilizers, namely concentration A of the element calcium (Ca) and concentration B of the element sulfate (S) and phosphate (P). The fertilizer is then dissolved in the water in the bucket in a ratio of 10 liters of water mixed with 100 ml of AB-MIX fertilizer.

6th stage: Accompaniment

At this mentoring stage, the UMY 103 KKN group provides online mentoring. By asking the person responsible for caring for the plants and hydroponic facilities by asking about the water content in the bucket, plant growth and the availability of AB-MIX fertilizer.



Fig 6. Caisim cultivated using hydroponic technology

7th stage: Evaluation

At this evaluation stage, the UMY 103 KKN group carried out online monitoring by contacting Ibu Dwi Wuryaningsih as the Head of the Padukuhan Plampang II hamlet or Ibu Sukila as the representative of the Women's Farmers Group to determine the growth of plants grown in hydroponic media, with the aim to take responsibility for caring for the plants.

8th stage: Formulation of follow-up Plans (intensification or extensification)

At this stage of formulating a follow-up plan, it is hoped that the women farmer group can add planting media and teach it to other villages or other women farmer groups in order to create food security and increase income from selling plants produced from hydroponics.

CONCLUSION

With the right approach, the people of Plampang II village, especially members of the Women's Farmers Group (KWT) in the hamlet, can gain knowledge, motivation and skills regarding hydroponic planting. It is hoped that the successful implementation of the first hydroponic cultivation will inspire other residents of Plampang II Village to replicate and disseminate this technique, which in turns, it could enhance their food security.

This research is limited on horizontal hydroponic technology and has not applied the concept of vertical hydroponics yet. Actually, the concept of vertical hydroponics saves space more efficiently than horizontal hydroponics. Apart from that, plant growth in the vertical hydroponic concept also has faster growth than horizontal hydroponics because of direct access to nutrients and controlled environmental conditions. It is recommended that in future community empowerment activities, the development of vertical hydroponic cultivation can be implemented.

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