



Cultivating a Sustainable Future: Modern Agriculture in Peri-Urban Food Security

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study aims to explore the phenomenon of food security and identify the contribution of modern agriculture in overcoming food security problems in the peri-urban area of East Java. In recent decades, the development of Jongbiru areas has undergone a rapid transformation into an urban area where industrial development is relatively rapid and large. This research design is carried out through the Community pilot project development model scheme and FGD with stakeholders in the peri-urban area of East Java, Indonesia. Through the PRA-pilot project approach, this research

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found challenges faced by the community. Knowledge, skills regarding modern agricultural (particularly in hydroponic), accessibility about their economic viability being the major challenges to faced. The results show there are lot of postive responds from the pilot project. Participants eager to implement the material knowledge by themself at their own home. Further, this PRA have potential for village economic development and support the achievement of the SDGs, such as poverty alleviation, food security, and the promotion of sustainable agricultural innovation. The study also emphasizes the importance of policy and infrastructure support to ensure the initiative's sustainability, which aligns with the literature highlighting the importance of millennial involvement in agricultural innovation.

Keywords: Food security; peri urban; east java; agriculture.

1. INTRODUCTION

Urban farming is one of the most essential issues in village development (Poulsen et al., 2017, Fanzo, 2018), Urban farming is one of the most essential issues in village development (Poulsen et al., 2017, Fanzo, 2018), especially in villages that have undergone a transformation from the agricultural sector to urban areas (Sroka et al., 2023). Villages close to industrial centres often face challenges in maintaining the traditional agricultural industry (Fantini, 2023). Urban farming plays a vital role in mitigating the impact of this transformation by providing sustainable local food resources and reducing dependence on supplies from outside villages. In its implementation, urban farming contributes to SDGs (Zero hunger) (Lile et al., 2023, Sumardjo et al., 2023, Hendriadi et al., 2023) which aims to end hunger, achieve food security, and improve nutrition. Where, from previos research shows that modern agriculture also contributed to nutritional challenges. Urban farming could be a solution to overcome food supply uncertainty and provide better access to quality food resources for the community. In addition, urban farming also be the alternative efforts in realizing the goals of Sustainable Cities and Communities (Henfrey et al. 2023, Mensah, 2023, Sari et al., 2023) by creating a sustainable and inclusive urban environment. By bringing agricultural resources closer to urban communities, urban farming facilitates the optimal use of available land and promotes environmentally friendly village development.

One of the popular methods in urban farming is hydroponics. According to De Bon et al. (2010), hydroponics is unlike the conventional farming. Hydroponics grows food without the need for soil and plants are grown on artificial or natural substrates and their roots may readily take up nutrients from a ready-made nutrition solution. Hydroponic food gardening can be accomplished in a variety of ways, and the choice of technique

relies on a number of variables, including the particular plant, climate, and financial constraints De Bon et al., (2010). One type of hydroponic system has several variations such as the Nutrient Film Technique (NFT) where the roots of the plant are partially submerged in a thin stream of nutrients, the Deep Flow Technique (DFT) where the roots are fully submerged in a nutrient solution, the Wick System which uses a wick to channel nutrients, and the Drip System which flows nutrients through droplets (Chowdhury et al., 2020, Al-Tawaha et al., 2018).

Urban and peri-urban agriculture is essential in enhancing the strength of resilient food systems in cities (Santini, 2022, Kosciwa, 2014). Further, agriculture contributes to diversifying food value chains, improving the livelihoods of urban residents, and ultimately improving urban food security (Santini, 2022, Lee-Smith et al., 2019). This is because modern agriculture on limited land in peri-urban can be said to be more productive and produce higher yields on limited land compared to agriculture in rural areas due to better access to inputs and labour (Lee-Smith et al., 2019, De Zeeuw et al., 2011, Addo, 2010). Thus, the hydroponic farming with a landless farming technique, holds promise in urban areas due to its high yields, climate-smart nature, and ability to control environmental conditions (Gumisiriza et al., 2022). However, this is also inseparable from several challenges and obstacles. One of them is limited access to inputs (physical capital), pollution risks, and potential negative impacts on the environment (Addo, 2010, De Bon et al., 2010). High investment costs and lack of knowledge some people and communities are also be major obstacles to adopting hydroponic systems (De Zeeuw et al., 2011, Gumisiriza et al., 2022) in a sustainable way. Further, small-scale implementation in urban and rural settings is particularly difficult due to limited access to suitable technologies (Velazquez-Gonzalez et al., 2022).

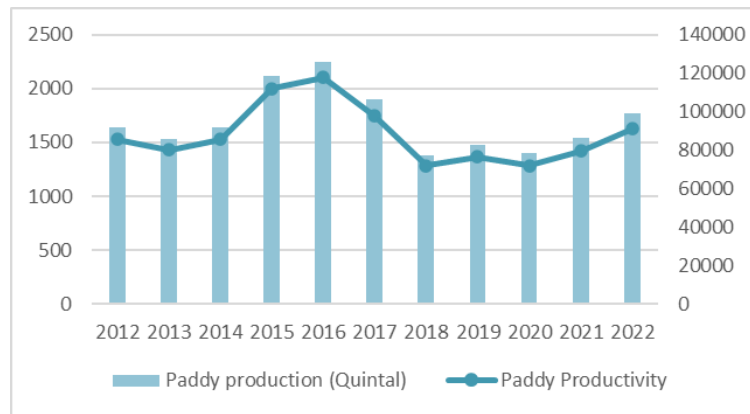


Fig. 1a. Rice productivity
Source: BPS (2023)



Fig. 1b. Jongbiru Village Map
Source: Google Maps

The phenomenon of rapid urbanization also occurs in Jongbiru, East Java. This village is a peri-urban area. In recent decades, it has undergone a rapid transformation into an urban area where industrial development is quite rapid and large. This development has a significant impact on the shift in the social and economic structure in the village. Where originally the community was in the agricultural sector, it must shift towards industry. Thus, food vulnerability is inevitable in this region. From the Fig. 1b shows that Jongbiru's green areas have been depleted since settlements, industrial areas, and toll roads were established. This finding is also supported by rice productivity (Fig. 1a) which has continued to decline in the past few years (BPS, 2024). In the process of urbanization, there is a shift in rice fields where rice productivity was the main commodity in this region and then shifted to other crops before finally the landowner considered

selling it to stakeholders to be converted into an expansion of the tobacco industry area (due to the higher price given from the stakeholders). Besides, addressing climate change risks also being one of factors decreasing (Karimi, 2023, Lisanty et al., 2021). Thus, the problem of increasing population and food insecurity becomes unavoidable. In this case, to increase awareness of food insecurity in the surrounding area, it is important to increase young community knowledge in increasing agricultural production on limited land.

This study aims to discuss in more depth the existing conditions of the peri-urban area in East Java. In previous research, (Zou et al., 2024, Sarkar et al., 2015, Majumder, 2024) many discussions about modern agricultural innovations and food security have been very influential. However, there is still a few research

on the analysis behavioral of implementation of modern agricultural techniques specifically in peri-urban areas that directly target the younger generation to be able to participate in food security efforts but does not consider the aspect of understanding the adaptability of the community, especially the young generation in peri-urban areas, to modern agriculture and its direct impact on local food security. Thus, this study complements the gap through a pilot project to disseminate modern agriculture to the community and the younger generation to improve food security in Jongbiru, Indonesia.

2. METHODOLOGY

2.1 Research Design and Data Analysis

Based on the research phenomenon described above, the stages of this research are designed to include three aspects: preparation (situation analysis and consolidation with partners), implementation of activities, and evaluation. The research method used in this activity is a community development approach with Participatory Rural Appraisal (PRA) which involves the community directly as a subject and object in implementing community service activities (Preece, 2006). This approach encourages active community participation in hydroponic development programs in Jongbiru Village. In some community service activities using participatory methods have shown success in promoting hydroponic agriculture in urban areas with limited land availability, increasing knowledge and enthusiasm among the participants (Jafaruddin, 2021).

The PRA method was initiated to be able to encourage positive interaction among participants and provide insights for environmental educators, although there are several challenges in its implementation. A participatory approach using hydroponic techniques has also been used in urban agriculture initiatives. A model is also used, which emphasizes community involvement in all stages of activities, from planning and implementation to program evaluation. In addition, a persuasive approach is applied by providing appeals and support without elements of coercion, so that the community voluntarily plays an active role in this activity. The PRA-inspired approach has been used in urban settings to engage young people in learning ethnic gardening practices in community gardens (Lara et al., 2018).

Radhakrishnan et al., (2020) PRA have explored the factors that affect participation in urban farming projects, including analysis of constraints and participation (Karimi, 2023). The findings above align with the purpose of this research itself, which is to ensure that the program is carried out in accordance with the needs and conditions of the local community. The educational approach, which includes socialization, training, and mentoring, is also applied as a means for knowledge transfer and community empowerment. The targets in this activity include TPS 3R managers, youth organization cadres, women and health cadres, as well as village local government. Finally, balance between these activities is essential at the end of the day. The sustainability of programs that massively move from community participation will be a force in effectively increasing food security.

2.2 Materials and Methods

There are three main stages in this community service program, namely preparation (situation analysis and consolidation with partners), implementation of activities, and evaluation. The planning phase includes an in-depth analysis of the problems faced by the local community, as well as consolidation with relevant partners. In this stage, the needs and potentials of the community related to urban farming, especially hydroponics, are identified. Consolidation activities with partners (the village and local community groups) are key to understanding environmental dynamics, village situations, and determining the most appropriate approach to be implemented.

The implementation of activities includes the application of various models and strategies that have been designed by researchers in an effort to empower the community in developing urban farming in answering existing problems through workshops, capacity building, assistance from the planting process to post-harvest (making financial reports and small business schemes) for villages in a sustainable manner to prepare human resources properly with qualified capacity fulfillment.

In the final stage, a thorough evaluation was carried out after providing education and handing over pilots to measure the extent of the program's impact on improving food security, community knowledge, and the sustainability of urban farming in Jongbiru Village. Thus, the stages of preparation, implementation of

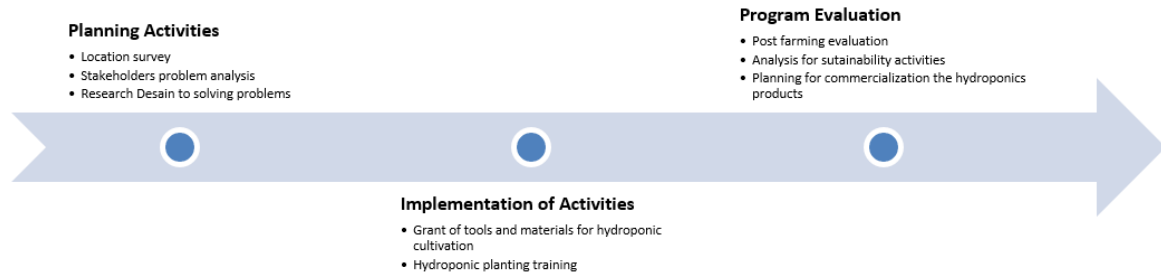


Fig. 2. Project flow

Source Adapted form (Prasetyani & Mahendrastiti, 2022)

activities, and evaluation of activities become a solid foundation to achieve the goals of this service program and provide optimal benefits for the people of Jongbiru Village. The evaluation will be carried out as a whole to determine the degree of success of the activity based on the targets that have been set. In addition, the results of the evaluation are expected to be used as a basis for recommendations for future activities.

3. RESULTS AND DISCUSSION

The observation results show that there is concern for the local government in the problem of vulnerability that has emerged and is characterized by an increase in the export of several food needs from other cities. Second, the decline in the motivation of the younger generation to agriculture land that still exists and tends to choose to work in the industrial sector. Another finding in the observation section, many people are not aware of the implicit impact of the development of their area as an industry. Technically, the challenge faced by stakeholders

(local governments, village communities) is limited infrastructure due to the high cost of installing hydroponic media equipment. Moreover, they also still have a little knowledge to start the aquaponic activity. This finding is in line with several studies (De Zeeuw et al., 2011, Gumisiriza et al., 2022) that state that difficulties in installation costs and knowledge are barriers in the sustainability of hydroponic implementation.

After the planning and observation stages, the implementation stage was start to solve the problems that faced by stakeholders and young communities. The activities of this pilot project are designed in a period of one year where planning activities are the initial stages this prgram brings from Community Services of Universitas Negeri Malang. In this pilot project grants given to the community are pair of package hydroponic tools in some points in the Jongbiru Village. This is in line with the team's main goal to be able to introduce modern agriculture in response to being able to adapt to shifting regional functions.



Fig. 3. Transfer knowledge session

Source: author's

In the second stage, providing knowledge insights to the community is also part of this grant activity. The analysis and service results demonstrate that hydroponic training has the potential to empower the millennial generation and also being a way to transfer knowledge from practitioner to the community particularly to the young community.

The hydroponic agriculture training for the millennial generation in this village significantly improved participants' knowledge of landless farming methods. Initial surveys indicated that 75% of the 75 participants were unfamiliar with hydroponics, and only 10% had prior hands-on experience. This gap highlights the initial challenge of engaging millennials in agriculture, often viewed as lacking innovation and profitability. The training effectively addressed these issues through group discussions and hands-on activities, particularly in setting up simple hydroponic systems, which enhanced participants' understanding of core hydroponic concepts and techniques. Social media also served as a crucial platform, fostering continuous learning and engagement with hydroponic practices among young participants.

However, some challenges were identified during the training session. Limited access to hydroponic materials and equipment in rural areas is a significant obstacle that can affect the sustainable implementation of this technique. So this is also be a limitation in this research because the team only provides grants in several village points. Furthermore, there are also advance obstacles to changing the mindset of some participants who still need to be convinced about the economic feasibility of hydroponic agriculture. Nevertheless, the post-training assessment showed a significant improvement in participants' understanding and skills. Many participants showed interest in applying hydroponic techniques on a small scale in their homes as a first step, which indicates that the training has successfully instilled an interest in sustainable agriculture among millennials.

After the training, some participants successfully started a hydroponic project at home with the facilitator's support. The project serves as a personal trial and an example for the community, with the potential to evolve into a small business that can improve the family and village economy. This demonstrates the real contribution of this activity to achieving several Sustainable Development Goals (SDGs), such as poverty

alleviation (SDG 1), improving food security (SDG 2), and promoting sustainable agricultural innovation (SDG 9), as supported by references (Lile et al., 2023, Sumardjo et al., 2023, Hendriadi et al., 2023). Furthermore, the active participation of the millennial generation in this activity indicates an increased awareness of the agricultural sector's importance in supporting village sustainability, as well as their motivation to be more involved in community activities focused on sustainable development. To ensure the sustainability of this initiative, a follow-up plan has been prepared, including follow-up mentoring and the establishment of hydroponic farmer groups aimed at strengthening knowledge networks and facilitating the marketing of hydroponic products.

The findings of the research align with several studies that propose a dual-track strategy for involving the millennial generation and improving the livelihoods of smallholders (Lakitan, 2019). These studies show that subjective norms and peer pressure influence millennials' intentions to participate in urban agriculture (Lara et al., 2018). Urban agriculture improves food security and addresses other urban challenges, such as unemployment and community degradation (Sondakh et al., 2020). To fully harness this potential, policymakers must provide infrastructure, conduct training programs, establish food security departments, and create special land-use zoning for urban agriculture (Carzedda et al., 2021, Steenkamp et al., 2021, Dholwani et al., 2018).

Based on the framework summary and activity implementation, it can be concluded that achieving food security in both rural and urban areas requires a central driver, with the community and youth playing a key role in establishing a sustainable urban farming chain. Access to capital for knowledge, information, and supply chains for diversified urban farming (such as hydroponics) products is crucial for pre-implementation. Additionally, food availability, accessibility, stability, and utilization are interconnected factors in achieving sustainable food security. The implementation process starts with local food production to ensure availability for the community. To sustain urban farming programs, food supply stability is essential to ensure consistent availability, unaffected by factors like climate change or market volatility. Ultimately, the focus is on providing the right food to meet daily nutritional needs (Hertati et al., 2023, Mukhlis et al., 2023).



Fig. 4. Implementation activities
Source: author's

Rural Food Security Program Framework

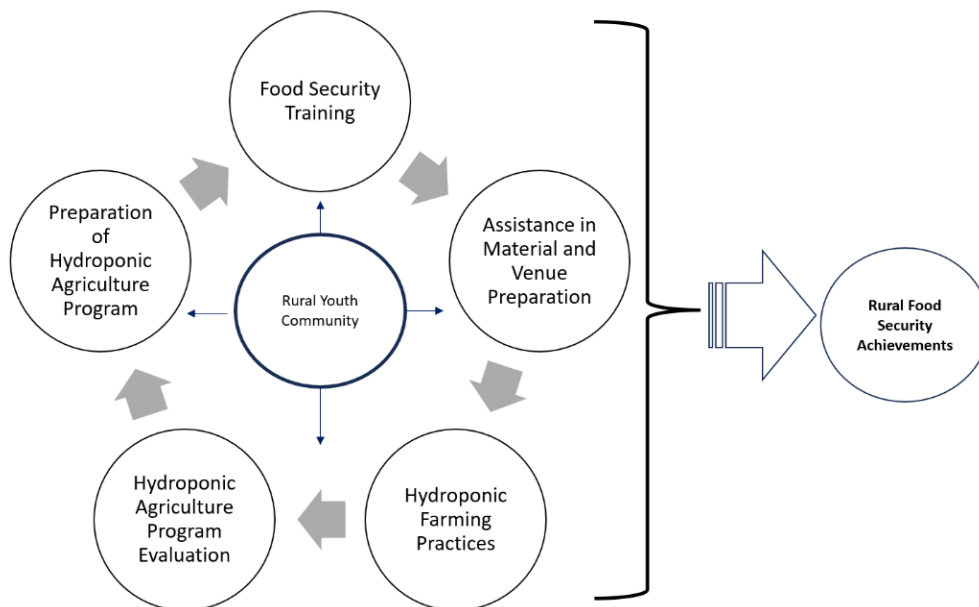


Fig. 5. Rural food security program framework
Source: Author's

4. CONCLUSION

Based on the framework summary and activity implementation, it can be concluded that achieving food security in both rural and urban areas requires a central driver, with the community and youth playing a key role in establishing a sustainable urban farming chain. Access to capital for knowledge, information, and supply chains for diversified urban farming (such as hydroponics) products is crucial for pre-implementation. Additionally, food availability, accessibility, stability, and utilization are interconnected factors in achieving sustainable

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DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing

of manuscripts for checking a grammar for this manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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