

## Hydroponic and Toga Innovations: Solutions for Utilizing Limited Land in Ketimang Village

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DOI : <https://doi.org/10.61796/jscs.v2i3.396>



### Sections Info

#### Article history:

Submitted: July 31, 2025

Final Revised: August 11, 2025

Accepted: August 26, 2025

Published: September 23, 2025

#### Keywords:

Innovation

Hydroponics

Family Medicinal Garden

(TOGA)

### ABSTRACT

**Objective:** Limited agricultural land in rural areas due to land conversion drives the need for innovation in farming, and this study aims to implement a hydroponic system and a Family Medicinal Garden (TOGA) as an alternative cultivation method in the limited space of the Ketimang Village community, Wonoayu District, Sidoarjo Regency.

**Method:** The methods used include clearing the planting area, sowing seeds, and arranging plants according to function and aesthetics. **Result:** The results of the study indicate that the community can utilize limited land to obtain fresh vegetables and family medicinal plants, while simultaneously increasing food security and household economic opportunities. **Novelty:** The application of the hydroponic system and TOGA has proven to be efficient, productive, and has the potential to provide added value through sustainable management.

## INTRODUCTION

Agriculture is a vital sector supporting food security and public welfare. However, the drastic increase in land demand due to the conversion of agricultural land to residential and infrastructure development is increasingly limiting the space for crop cultivation, especially in rural and urban areas. This situation creates an urgent need for innovation in farming techniques, particularly in small and limited areas. One innovation that is starting to be widely adopted is the hydroponic system, which allows for farming without the need for large areas of land and without soil as a growing medium[1], [2].

Hydroponic systems utilize nutrient solutions containing essential nutrients needed by plants, allowing for more controlled and efficient plant care. The advantages of hydroponics include up to 90% less water consumption, reduced pesticide use, and the ability to grow in various media such as pipes, vertical racks, or simple containers in the yard [3], [4]. This method is highly relevant in limited land use, even in densely populated areas, and can produce faster and more sustainable harvests.

Furthermore, the use of Family Medicine Gardens (TOGA) as a form of community empowerment to meet the need for traditional medicine is also increasingly important. TOGA not only serves as a source of herbal medicines for alternative medicine and the prevention of minor ailments, but can also increase household economic value through its derivative products [5], [6]. The TOGA program contributes to the preservation of traditional medicine culture and the sustainability of existing local resources [7].

The combination of hydroponic and TOGA systems demonstrates synergistic potential for simultaneously improving food security and public health, especially in

areas with limited land [8], [9]. Community education and training in the application of these two systems provides an opportunity to optimize the use of home gardens for productive and economical results [2], [10]. Thus, this innovation can be an effective solution to address the challenges of limited land use and the current needs for family food and medicine.

Agriculture is a crucial sector in supporting food security and public welfare. However, the increasing demand for land for housing and infrastructure has resulted in limited agricultural land, including in Ketimang Village, Wonoayu District, Sidoarjo Regency. This situation makes it difficult for the community to cultivate crops conventionally.

The term hydroponics comes from the Latin "hydro" (water) and "ponous" (work), meaning working with water. Scientifically, hydroponics is the cultivation of plants without soil, using media such as sand, gravel, or broken roof tiles, supplemented with a nutrient solution containing all the essential elements necessary for plant growth and yield (Amaliyah, 2023; Amos Hosea P et al., 2023; Mellisa, 2024; Sulistyowati et al., 2023). Hydroponics also offers several advantages, including climate independence, continuous harvests, and easier plant care [11], [12], [13].

As a solution, hydroponics systems emerged as a soil-free farming method using nutrient solutions. This system has proven effective in producing healthy plants in limited space. Furthermore, Family Medicine Gardens (TOGA) are also a community empowerment strategy to meet the need for traditional medicine while providing added economic value. Thus, the application of hydroponics and TOGA can be an innovative alternative for optimally utilizing limited land [14].

The community's use of traditional medicine (TOGA) is based on formal and informal education, age, personal experience, and external sources such as television and the internet. It's also possible that schools utilize medicinal plants as first aid for teachers and students to address illnesses. Since ancient times, Indonesians have been able to utilize natural resources, including plants. One benefit of plants is the medicinal properties they contain, making them useful for treating illnesses [14].

Planting medicinal plants is often used as spices, and they can also be used as medicine before seeking medical care. This can be done immediately by school residents as first aid. Providing these medicinal plants will address the challenges of limited access to healthcare facilities, such as the distance to pharmacies and hospitals. Furthermore, this can be an alternative to addressing the community's weak purchasing power and the soaring prices of modern medicines, which are forcing the public and government to seek solutions by returning to nature [10].

Several previous studies have also shown relevant results. Roidah (2014) stated that land utilization with a hydroponic system can increase crop production efficiency. Hidayanti and Kartika (2019) confirmed that AB Mix nutrients significantly influence the growth of red spinach plants hydroponically. Furthermore, Novita Sari and Thomas (2023) emphasized the importance of cultivating Family Medicinal Plants (TOGA) to create a healthy society. This demonstrates that the application of hydroponics and

TOGA is not only practically relevant but also supported by academic research findings [15].

### **Research Design and Instruments**

This research was conducted using a participatory action research (PAR) approach, emphasizing direct community involvement in every stage of the activity. The research instruments used included questionnaires, in-depth interviews with residents, and direct observation of land conditions and plant growth success. Quantitative data were measured using plant growth parameters such as plant height, number of leaves, and fresh weight of the harvest. Qualitative data were obtained from community responses regarding the benefits, constraints, and economic opportunities experienced after implementing hydroponics and TOGA [16].

### **RESEARCH METHOD**

This research method is descriptive, with a direct application study approach in the Ketimang Wonoayu Village community. The activity stages include:

1. Cleaning – Clear the medicinal plant area of weeds, trash, and dirt and erect a fence around the medicinal plant. In hydroponics, the installation is ensured to be sterile of moss and plant debris, and the water circulation is smooth and efficient.
2. Sowing – Vegetable seeds (pak choy, spinach, water spinach) are sown in rockwool and placed in net pots, then fed with AB Mix nutrients. Rhizomes of medicinal plants (ginger, turmeric, galangal, pandan, chili, lemongrass, and moringa) are planted directly in the medicinal plant garden.
3. Plant Arrangement – Hydroponic seedlings are transferred to installations such as NFT or DWC with regular spacing. For TOGA, arrangement is based on function, size, and aesthetics, carried out directly on the medicinal plant garden.

This descriptive method aligns with the approach used in hydroponic cultivation research by Natasya Aulia Rahman et al, which emphasized the application of the Nutrient Film Technique (NFT) system for vegetable crops. Furthermore, the TOGA seeding and arrangement methods are also in line with research by Sabarudin et al, which highlights the importance of systematically managing family medicinal plants [17], [18].

### **RESULTS AND DISCUSSION**

The research results show that the combination of hydroponics and traditional herbal medicine (TOGA) not only serves to meet household food needs but also strengthens the community's social aspects. Through collaborative activities in building hydroponic installations and managing TOGA gardens, the community demonstrated a high level of solidarity. This demonstrates that innovative agricultural programs such as this can serve as a means to strengthen social ties at the village level.

From an environmental perspective, hydroponic systems have positive impacts, reducing the use of chemical pesticides and increasing water efficiency. This system has been proven to save up to 90% of water compared to conventional farming methods.

Meanwhile, TOGA contributes to the preservation of local biodiversity, as many of the cultivated medicinal plants are endemic species that have rarely been optimally utilized.

Economically, micro-business opportunities based on hydroponic and traditional vegetable crops are increasingly open. Hydroponic vegetables can be sold in local markets at a relatively higher price than conventional vegetables because they are considered healthier and more hygienic. Meanwhile, derivative products from traditional vegetable crops, such as essential oils, herbal powders, or instant herbal drinks, have the potential to become superior village commodities with wider market reach. To support this, further training is needed on small business management, product packaging, and digital marketing strategies.

The implementation of the hydroponic system and TOGA Garden in Ketimang Village provided several important findings:

**A. Utilization of narrow land**

Residents can utilize yards or limited spaces productively. The use of hydroponic systems allows them to utilize limited space, such as yards, gardens, and even indoor areas. Several studies have shown that this method of cultivation yields more sustainable yields and is more efficient than conventional open-air farming, Roidah; Solikhah et al. The training and education provided to residents strengthens their understanding and skills in managing hydroponic systems, including creating growing media and regulating nutrients [1].

**B. Availability of food and medicine for the family**

Hydroponics produces fresh vegetables, while TOGA provides herbal plants for health. Hydroponics produces fresh vegetables such as bok choy, spinach, and kale that are nutritious, pesticide-free, and can be harvested quickly and repeatedly. Similarly, TOGA gardens provide a variety of medicinal plants such as ginger, turmeric, galangal, pandan, chilies, lemongrass, and moringa that are easy to obtain, maintain, and use as traditional remedies for treating minor ailments at home [6]. This reduces the community's dependence on chemical drugs and rarely accessible health facilities.

**C. Improving household food security**

The availability of natural vegetables and medicines reduces dependence on the market. The availability of hydroponic vegetables and family medicinal plants directly improves food security and public health. Planting TOGA becomes part of a promotive and preventive strategy to overcome minor illnesses without having to go directly to health services, while hydroponics allows for a consistent supply of fresh vegetables [4], [19]. Thus, both synergistically reduce the economic burden on households related to food and medicine purchases.

**D. Economic opportunities**

Hydroponic and herbal medicine harvests have the potential to be sold and even developed into herbal derivative products. In addition to the benefits of personal consumption, hydroponic and herbal medicine harvests can be sold to supplement family income. Various communities have demonstrated that sustainable management, coupled with marketing training, can open up potential micro-business opportunities with

derivative products such as instant herbal remedies, loose leaf tea, and even valuable ornamental plants [4], [7]. The use of hydroponic media also reduces long-term costs, although it requires an initial investment, due to efficient water and nutrient use and minimal pesticide use.

The main factors that directly influence hydroponic plant growth are raw water, nutrients/fertilizers and minerals, growing media, oxygen availability, and seed quality. Furthermore, environmental factors include temperature, light, and humidity (RH). One of the problems encountered with bok choy and water spinach plants is a lack of light due to the location of the PVC pipe being covered by the roof tiles of one of the residents' houses, resulting in less than optimal plant growth during the seeding process and when transferred to the NFT system. Factors that cause this, such as tall but weak stems, thin, and yellowing leaves to wilt, are caused by three causes. First, a lack of nutrients causes plants to exhibit deficiency symptoms, characterized by yellowing of hydroponic plant leaves. One of these is an insufficient nutrient content required by plants in the AB-mix nutrient. Then, a lack of sunlight during the growth process also causes symptoms such as yellowing (unhealthy green) leaves. This is caused by the lack of sunlight needed for photosynthesis, resulting in the plant being unable to process its food. Furthermore, the auxin hormone will have a negative impact when the sown seeds break and are deprived of sunlight. The auxin will continue to work and trigger the emergence of finch. Third, the water flow in the pipes and some flannel fabrics cannot absorb water, so the plants in the PVC pipes receive less water [20].

This finding is in line with previous research which shows that hydroponic systems increase land use efficiency (Roidah, 2014) and TOGA plays an important role in supporting public health [6].

These results align with research by Hidayanti and Kartika (2019), which found that nutrient management significantly impacts hydroponic plant growth. Furthermore, findings regarding the benefits of TOGA are reinforced by research (Sari & Andjasmar, 2023a) that indicates TOGA plays a crucial role in improving public health while providing economic value.



**Figure 1.** Hydroponics & TOGA Plants.

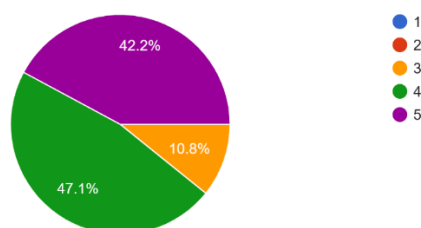
The novelty of this research lies in:

1. The integration of hydroponic systems with Family Medicinal Gardens (TOGA) simultaneously in narrow land spaces in rural areas, which were previously implemented separately.
2. The participatory approach (Participatory Action Research) directly involves the Ketimang Village community, so that the research results are not only limited to cultivation techniques, but also touch on social, educational, and economic empowerment aspects.
3. Utilizing the home yard as a productive area for food and family medicine, which provides dual benefits: food security and health based on local wisdom.
4. Contribution to social strengthening of the community through mutual cooperation in the construction of hydroponic installations and TOGA management, which is rarely explored in previous hydroponic research.
5. Sustainable economic potential from the development of TOGA derivative products (herbal drinks, instant herbal medicine, essential oils), combined with healthy hydroponic vegetables as the village's leading commodity.

Some challenges identified in the preservation and care of traditional medicinal plants include a lack of specialized care knowledge and limited community resources. However, regular outreach and mentoring programs can increase participation and ensure optimal plant growth (Listyaningrum et al., 2024). Meanwhile, in hydroponics, challenges such as the need for nutrient monitoring and the availability of technical training can be addressed with ongoing guidance and support from farmer groups and relevant agencies [1].

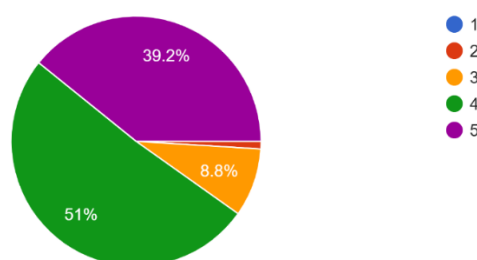
Penerapan sistem hidroponik membantu saya memanfaatkan lahan sempit di sekitar rumah secara lebih produktif.

102 responses



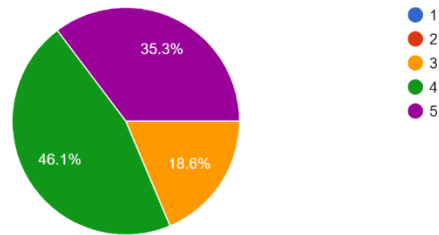
Taman Obat Keluarga (TOGA) bermanfaat dalam menyediakan obat tradisional bagi keluarga saya.

102 responses



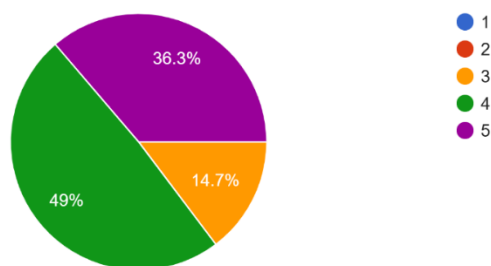
Budidaya hidroponik menghemat penggunaan air dibandingkan bercocok tanam secara konvensional.

102 responses



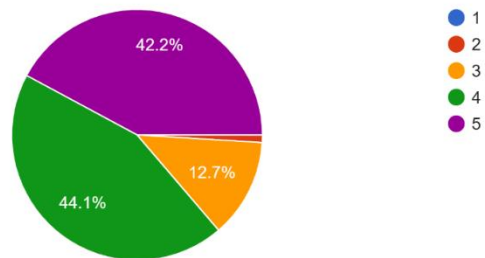
Hasil TOGA dapat menjadi alternatif pengobatan sederhana sebelum pergi ke fasilitas kesehatan.

102 responses



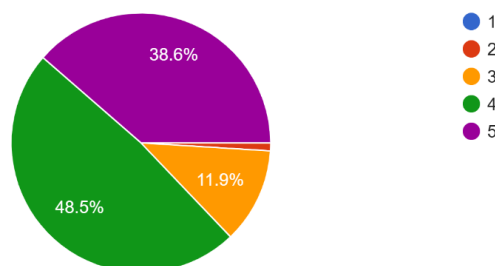
Program hidroponik dan TOGA meningkatkan solidaritas/gotong royong masyarakat desa.

102 responses



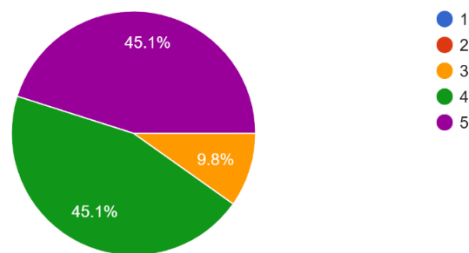
Budidaya hidroponik dan TOGA berpotensi menambah penghasilan keluarga saya.

101 responses



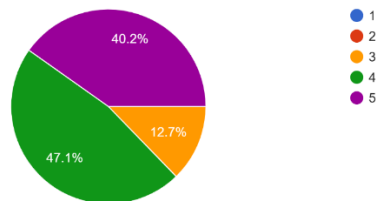
Saya merasa pengetahuan/pelatihan tentang hidroponik dan TOGA yang diberikan mudah dipahami.

102 responses



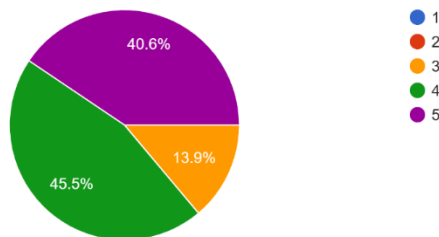
Produk sayuran hidroponik dan tanaman TOGA memiliki kualitas lebih baik dibandingkan produk di pasar tradisional.

102 responses



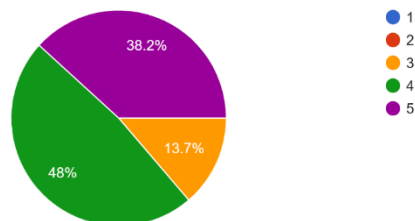
Saya bersedia terus mengembangkan hidroponik dan TOGA sebagai usaha berkelanjutan di rumah.

101 responses



Saya merasakan peningkatan ketersediaan sayuran segar sejak adanya budidaya hidroponik.

102 responses



**Figure 2.** Results of questionnaire.

Based on the results of a questionnaire involving 102 respondents in Ketimang Village, the data shows that the hydroponic program and Family Medicine Garden (TOGA) have had a significant positive impact and are in line with the research objectives.



### **Positive Impacts in Utilizing Narrow Land**

A total of 47.1% of respondents agreed and 42.2% strongly agreed that implementing a hydroponic system helps them utilize limited space around their homes more productively. This supports research findings that suggest hydroponic and TOGA innovations are effective solutions for cultivation in limited spaces, especially in densely populated areas. Utilizing home gardens as productive land offers dual benefits: food security and family health.

### **Health Benefits and Food Availability**

The questionnaire also demonstrated excellent acceptance of the program's health benefits. Fifty-one percent of respondents agreed and 39.2 percent strongly agreed that TOGA is beneficial in providing traditional medicine for families. This is supported by the finding that TOGA provides a variety of medicinal plants that are easy to maintain and use as traditional remedies for minor ailments at home. Furthermore, 49 percent of respondents agreed and 36.3 percent strongly agreed that TOGA products can be a simple alternative treatment before going to a health facility. This availability reduces the community's dependence on chemical drugs and health facilities that may be difficult to access.

Regarding food, 48% of respondents agreed and 38.2% strongly agreed that they experienced an increase in the availability of fresh vegetables since the introduction of hydroponic farming. Hydroponic systems allow for the production of nutritious, pesticide-free vegetables like bok choy, spinach, and kale, which can be harvested quickly and repeatedly.

### **Efficiency and Economic Opportunity**

The majority of respondents recognized the efficiency offered by this system. 46.1% agreed and 35.3% strongly agreed that hydroponic farming saves water compared to conventional farming. This data aligns with research findings that hydroponics can save up to 90% of water.

Economically, this program has the potential to increase household income. 48.5% of respondents agreed and 38.6% strongly agreed that hydroponic and traditional herbal cultivation has the potential to increase their family income. The harvest can be sold to supplement income, and derivative products such as herbal drinks or herbal powders can become superior village commodities.

### **Social and Sustainability Aspects**

The social aspect also showed positive results. 44.1% of respondents agreed and 42.2% strongly agreed that the program increased solidarity and mutual cooperation within the village community. This aligns with findings that the program strengthens social ties at the village level through mutual cooperation.

Furthermore, the program has potential for sustainability. 45.5% of respondents agreed and 40.6% strongly agreed that hydroponics and TOGA should be developed as sustainable home-based businesses. This demonstrates the community's commitment to continuing the program, supported by a strong understanding of the training provided.

45.1% agreed and 45.1% strongly agreed that the knowledge and training provided were easy to understand.

Overall, the results of this questionnaire strengthen the research findings that the integration of hydroponics and TOGA is not only effective in overcoming land limitations, but also successfully improves food security, health, and the community economy, as well as strengthening social cohesion.

### Challenges and Solutions

Some of the challenges in implementing hydroponics and TOGA in society include:

1. Lack of knowledge of special care for medicinal plants.
2. Limited community resources in providing hydroponic installations.
3. The need for regular monitoring of hydroponic plant nutrition.

The solution that can be implemented by the KKN-T group is through outreach to the surrounding community and proposing to schedule watering and monitoring of medicinal plants and hydroponics.

### CONCLUSION

**Fundamental Finding :** The implementation of a hydroponic system and a Family Medicinal Plant (TOGA) garden has proven to be an innovative and effective solution for utilizing limited land in the community of Ketimang Village, Wonoayu District, Sidoarjo Regency, providing dual benefits in the form of increased food availability, the provision of alternative medicines, and sustainable household economic opportunities, where hydroponics offers efficient use of water and nutrients and TOGA plays a crucial role in supporting public health through easily accessible traditional medicine. **Implication :** The success of this program depends heavily on training, mentoring, and collaboration within community groups to ensure sustainable plant implementation and maintenance, while a sustainable educational approach strengthens community capacity to optimally manage hydroponic and traditional medicine cultivation. **Limitation :** However, the effectiveness of the program still relies on the extent of community participation and consistency in applying the knowledge gained, meaning that without continuous guidance and adequate resources, long-term sustainability may face challenges. **Future Research :** Thus, future studies are encouraged to further explore scalable models of hydroponic and TOGA integration, measure long-term economic and health impacts quantitatively, and develop strategies for broader replication in other rural communities to strengthen economic resilience, family health, and the preservation of traditional healing culture at the village level.

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