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Empowering PokTan ViCi 10 farmers in Ciomas Rahayu Village through hydroponic and aquaponic cultivation systems

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ABSTRACT

The Villa Ciomas RW 10 Farmer Group (PokTan Vici 10), actively engaged in urban farming in Ciomas Rahayu Village, Bogor, West Java, has been utilizing a small plot of land located next to the Cisindangbarang River. Their urban farming area already includes a small fishpond but lacks aquaponics equipment. The community service team aims to enhance the utility of the urban farming facilities by installing aquaponics equipment, providing workshops on basic hydroponics and aquaponics knowledge, exploring its business potential, and offering hands-on hydroponics and aquaponics cultivation practice. Throughout the program, the team also conducts monitoring and guidance to ensure successful implementation and address any challenges encountered during the training program. The hydroponic/aquaponics equipment installation was successful; however, nutrient supply from the fishponds only was initially suboptimal, prompting the addition of hydroponic nutrients. Hydroponic techniques were also introduced for vegetable cultivation. Based on a questionnaire analysis conducted before and after the training, the program positively impacted participants, significantly enhancing their knowledge and aquaponic skills (Wilcoxon signed-rank test, $p<0.05$). In conclusion, the aquaponics equipment was successfully installed, and participants gained foundational knowledge and skills in aquaponics, enabling them to independently manage aquaponics systems through to harvest. Looking ahead, the community members plan to explore business opportunities in selling hydroponics/aquaponics products.

Keyword: Aquaponic, Farming Group, Hydroponic, Urban Farming

ABSTRAK

Kelompok Tani Villa Ciomas RW 10 (PokTan Vici 10) yang aktif dalam pertanian perkotaan di Desa Ciomas Rahayu, Bogor, Jawa Barat memanfaatkan area kecil sebagai lahan yang terletak di samping sungai Cisindangbarang. Area pertanian perkotaan yang mereka miliki tersebut sudah dilengkapi oleh kolam ikan kecil namun masih belum memiliki perangkat akuaponik. Tim pengabdi bertujuan meningkatkan nilai guna pemanfaatan fasilitas pertanian perkotaan di Villa Ciomas RW 10 dengan melakukan instalasi perangkat hidroponik dan akuaponik, memberikan pelatihan seputar pengetahuan dasar hidroponik dan akuaponik, peluang bisnisnya, serta praktik langsung budidaya hidroponik/akuaponik. Dalam pelaksanaannya tim juga melakukan pemantauan dan pembimbingan untuk memastikan keberhasilan serta penanganan kendala yang dihadapi selama program pelatihan. Instalasi perangkat akuaponik berlangsung dengan baik, namun dalam pelaksanaannya nutrisi dari kolam ikan belum optimal sehingga dicoba ditambahkan nutrisi hidroponik. Selain itu dilakukan juga teknik hidroponik untuk produksi tanaman sayuran. Berdasarkan analisis kuesioner yang diberikan di awal dan akhir pelatihan diperoleh hasil bahwa kegiatan ini berdampak positif, meningkatkan pengetahuan dan keterampilan warga (Wilcoxon signed-rank test, $p<0.05$). Dapat disimpulkan melalui kegiatan ini perangkat akuaponik berhasil diinstalasi, warga mendapatkan pengetahuan dasar dan bisa menjalankan teknik akuaponik hingga pemanenan. Di masa yang akan

datang warga berencana untuk mengeksplorasi peluang bisnis penjualan hasil hidroponik/akuaponik.
Keyword: Akuaponik, Hidroponik, Kelompok Tani, Pertanian Urban

1. Introduction

The rapid development of urban areas has impacted the reduction of agricultural land. With the increase in economic and residential developments in urban areas, changes in land use have also escalated. Land that was once used for agricultural purposes has been converted into residential zones. As large plots of land in urban areas become scarce, utilizing yards has emerged as a viable option to support agricultural development in these regions. The use of urban yards is closely tied to efforts to achieve communal food security, beginning on a small scale at the household level. One way to utilize urban yards is by implementing aquaponic cultivation systems.

Atma Jaya Catholic University of Indonesia has conducted several community service programs at RW10 Ciomas Rahayu Village, Bogor, West Java. Previously, a tempeh-making training program led to the successful establishment of Kampung Tempe Ciomas (Ciomas Tempeh Village), which has become a local tourist attraction. Besides tempeh-making and mushroom farming, Ciomas Rahayu Village also has the Villa Ciomas RW 10 farmer group (PokTan Vici 10), which actively engages in urban farming. They maintain a small pond with two compartments, each measuring 1.69 × 4.10 m², used for rice or fish farming (Figure 1). This pond, located near the community hall by the Cisindangbarang River, is equipped with a pump that draws water from the river to the ponds (Figure 2). Currently, the pond contains tilapia, catfish, fish feces, and fish pellets left over, which can serve as nutrient sources for hydroponic plants [1].

The installation of an aquaponics system will add significant value to this facility. To achieve this, this community service program aimed to install aquaponics equipment, conduct workshops on basic aquaponics knowledge, explore its business potential, and provide hands-on practice in aquaponics cultivation. The target participants for the aquaponic farming techniques training were the members of the Villa Ciomas (Vici) Farmer Group (PokTan) RW 10. Most of these members are retired, so aquaponics farming can provide them with daily activities. The vegetables harvested from this activity can be consumed by the participants or sold, contributing to household income and enhancing food security, especially within their families [2].

Figure 1. PokTan Vici 10's fishpond serves as a source of nutrients for aquaponic plant cultivation.

2. Methods

This community service activity was conducted from April 19 to August 2, 2024. The program began with an initial location survey to plan the aquaponics design and installation. Seedling preparation was carried out by the community service team at Atma Jaya Catholic University of Indonesia, BSD Campus. Seeds were sown in water-soaked rockwool. After seedlings showed two or three new leaves, rock wool was ready to be transferred to the net pot and put inside the hole of the hydroponic device. About 400 fingerling of 7 cm pangasius catfish (local name: ikan patin) were stocked to the aquaponic setup. The aquaponic installation, initial aquaponic trials, workshops, and hands-on activities took place at the Ciomas Rahayu Village RW10's Hall in Bogor. Following the initial trial, the team deliver workshops, covering the science of aquaponics, aquaponics techniques, and related business opportunities (Figure 2). Members of farmer group and several residents participated in hands-on hydroponics practice during the workshops. The community service team

consistently monitored the activities throughout the cultivation process, ensuring that the implementation of hydroponic and aquaponic systems progressed effectively and addressing any challenges encountered along the way.

Figure 2. Workshop e-flyers. Workshops were held twice during the community service.

To evaluate the program, a pre-test was conducted at the beginning and a post-test at the end (Table 1), along with a workshop feedback survey. Data from the pre-and post-test assessments, both overall and for each question, were analyzed statistically using the Wilcoxon signed-rank test, with $p<0.05$ considered to indicate a significant difference.

Table 1. Rubric for respondents' understanding levels for pre and post-test evaluation

Level of Understanding	Description	Score
Not understand at all	Has no understanding of the topic; unable to explain concepts or apply information.	1
Understand a little bit	Has minimal understanding; can identify basic concepts but struggles to explain or apply them.	2
Understand quite enough	Has a fair understanding; can explain main concepts but needs guidance to apply them.	3
Understand	Has a good understanding; able to explain and apply most concepts with minor guidance.	4
Understand entirely	Has a thorough understanding; able to fully explain and independently apply all concepts.	5

3. Results and Discussion

During the implementation of this community service program, the aquaponic system was successfully designed and installed. The farmer group assisted the community service team with the first round of trials, which included aquaponics installation, fish fingerling stocking, plant seedling transfer, maintenance and troubleshooting, and fish and hydroponic plant cultivation. Result of each activity was described as follow.

3.1. Design and installment of aquaponic devices

Following the initial survey, the aquaponics system was designed as follows: the device consisted of four

UPVC pipes, each ¾ inch in diameter and 4 meters in length. The pipes were arranged at a slight incline to allow water to flow from top to bottom. Each pipe contained 13-14 holes to hold net pots filled with rockwool, which were planted with seedlings. Water from the fishpond was channeled into the hydroponic device using a pump connected to the pipes, supplying nutrients to the plants from fish waste and fish food leftovers (Figure 3).

Figure 3. Aquaponic device installment (left), The right side of the fishpond, where a pump had been installed to deliver water to the aquaponics device (right).

3.2. First aquaponic trial and troubleshooting

Pangasius fish was chosen as this species is well-suited to the conditions of the system and can contribute to nutrient cycling [3]. Many other aquaponics set up and research were done using pangasius fish [4], [5], [6], [7]. Multispecies vegetables which have been sowed previously were also planted on the device, including water spinach, spinach, and lettuce. The fish provided essential nutrients for the plants through their waste, supporting the growth of the vegetables while also benefiting from the filtered water provided by the hydroponic system [8]. This integrated approach allowed for a sustainable cultivation process that maximized the use of both aquatic and plant resources.

Figure 4. Drip line irrigation using AB mix, which was slowly dripped into the hydroponic apparatus. A five-liter container with an adjustable valve was used. The AB mix inside the container was regularly checked and refilled as needed.

During the first aquaponic trial, the growth of hydroponic vegetables was suboptimal. Nutrition itself from the fishpond was unable to supply an adequate nutrient to the hydroponic system (TDS 108 ppm, pH 7.3). TDS of aquaponics which can support optimal plant growth is about 200-400 ppm since nutrients is generated in continuous matter [9]. It was also found that, fish were harvested routinely by the community without stocking new fish to the fishpond during the trial. Team decided to add drip line irrigation to the aquaponic system as a troubleshooting. A total of 150 mL AB mix was diluted into 2.5 L solution and delivered via drip line irrigation (Figure 4). After the addition of nutrient, total dissolved solid was increased significantly, however it still could not compensate the previous suboptimal growth of hydroponic plants. There was another major issue, the fishpond produced too much sludge that interfere with the pump and the water circulation. An additional solid removal device such as microscreen drum filter would be beneficial [10]. At the end, aquaponic system was

converted to hydroponic by using nutrition solely from AB mix solution. Considering the readiness of the facilities and the socio-cultural characteristics of the residents, the team decided to focus on hydroponics training, which is relatively easier to implement.

3.3. Workshop and hands-on training

Workshop included presentations on the following topics: Introduction to Hydroponics (Dr. Yasinta Ratna E. Wulandari) (Figure 5), Tips and Tricks for Plant Cultivation with Hydroponic and Aquaponic Techniques (Dr. Rory Hutagalung, DEA.), AB Mix Preparation and Nutrient Measurement (Dr. Listya U. Karmawan), and Business Opportunities for Plant Cultivation with Hydroponic Techniques (Yanti, Ph.D.). Each topic was delivered by a different speaker in 30-minute sessions. On average, all speakers received a participant satisfaction score of 4.77 out of 5.

Figure 5. Workshop on the topic of Introduction to Hydroponics, presented by Dr Yasinta Ratna R. Wulandari.

The second workshop, which featured hands-on training, was attended by 13 residents of RW10 Ciomas Rahayu Village, including members of the farmer group, along with four speakers and two student assistants from Atma Jaya Catholic University of Indonesia. The hands-on training included harvesting hydroponic vegetables from the first trial, preparing hydroponic nutrients, measuring and adjusting the pH and TDS of the hydroponic solution, setting up the hydroponic system, and transferring plants into the hydroponic installation (Figure 6). Additionally, the team monitored the participants throughout the cultivation and maintenance process, offering guidance and constructive feedback to ensure successful implementation. By the end of the activity, the farmer group had successfully grown hydroponic plants, which were harvested and enjoyed by the farmer group and residents.

Figure 6. Villager learning how to measure using pH (yellow colored device, held by villager using white shirt) and TDS Meter (gray colored device, held by villager using blue shirt).

3.4. Evaluation of community service using statistical data analysis

The total score for each evaluation question was aggregated and analyzed. A total of 13 residents from RW 10, Ciomas Rahayu Village, participated in the evaluation to assess their understanding of plant cultivation using aquaponic and hydroponic techniques. The analysis revealed that all participants demonstrated a marked

improvement in their comprehension of the concepts following the workshop. This enhancement in understanding was consistent across all ten evaluation questions (Figure 5, Table 2).

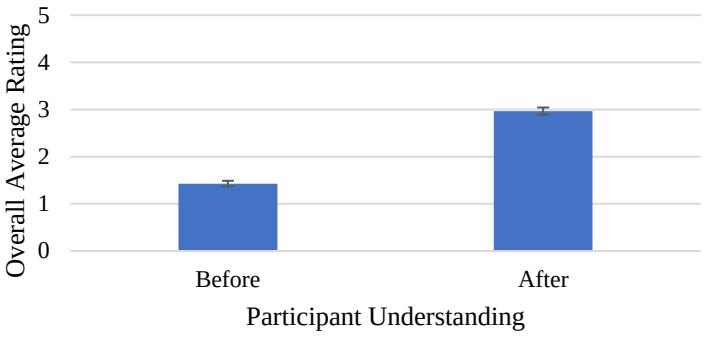

Figure 7. Overall average rating of participant knowledge before and after workshop and hands on aquaponics and hydroponics activity.

The results indicated a significant improvement in residents' knowledge following the training ($p<0.05$, Wilcoxon signed-rank test). Specifically, participants' understanding of aquaponics and hydroponics systems (questions 1–4) and plant care and cultivation using hydroponic techniques (questions 5–10) showed a marked increase after the workshop compared to their pre-workshop levels (Table 2).

Table 2. Results of the wilcoxon signed rank test analysis of RW 10 Ciomas Rahayu Village residents' knowledge.

No	Evaluation questions	Testing period	Min	Max	Mean ± SD	*p-Value**
1	Knowledge on the basic concepts of hydroponics	Before training	1	4	1,61 ± 0.86	< 0,00
		After training	2	4	3,0 ± 0,81	
2	Knowledge on the basic concepts of aquaponics	Before training	1	3	1,69 ± 0,85	< 0,00
		After training	2	4	3,07 ± 0,86	
3	Knowledge of the nutrients and media used in hydroponics/ aquaponics	Before training	1	3	1,46 ± 0,66	< 0,00
		After training	2	4	2,84 ± 0,68	
4	Knowledge of the tools used in hydroponics/aquaponics	Before training	1	3	1,46 ± 0,66	< 0,00
		After training	2	4	3,07 ± 0,86	
5	Knowledge of plant care and maintenance	Before training	1	3	1,46 ± 0,66	< 0,00
		After training	2	4	3,07 ± 0,64	
6	Ability to set up/place hydroponic/aquaponic devices	Before training	1	3	1,46 ± 0,66	< 0,00
		After training	2	4	3,0 ± 0,57	
7	Ability to make and adjust TDS/pH of hydroponic/aquaponic media	Before training	1	3	1,30 ± 0,63	< 0,00
		After training	1	4	2,84 ± 0,89	
8	Ability to sow seeds and transfer plants to devices	Before training	1	3	1,38 ± 0,65	< 0,00
		After training	2	4	2,92 ± 0,75	
9	Ability to care and maintain hydroponic/aquaponic plants	Before training	1	3	1,46 ± 0,66	< 0,00
		After training	2	4	3,0 ± 0,70	
10	Ability to harvest crops from hydroponic/ aquaponic devices	Before training	1	3	1,46 ± 0,66	< 0,00
		After training	2	4	3,0 ± 0,70	

*Wilcoxon Signed Rank Test = 0,05

4. Conclusions

The urban farming facilities in RW 10 Ciomas Rahayu Village were enhanced by the installed aquaponics and hydroponic equipment. Members of the farmer group and residents demonstrated increased knowledge of hydroponics and aquaponics, including business potential. While the aquaponics system still requires improvement, the farmer group and residents successfully practiced hydroponic techniques, covering steps from preparation to harvesting. The results of the workshop showed a significant improvement in residents' knowledge following the training, with a p-value of < 0.05, as analyzed using the Wilcoxon signed-rank test. Moving forward, it is hoped that the farmer group and residents of Ciomas Rahayu Village can leverage these aquaponics and hydroponics systems to develop profitable ventures, turning their agricultural activities into sustainable sources of income.

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