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Application of Drip Irrigation System on Vanilla Cultivation

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ABSTRACT

Background: The research in Jogoyudan Village, Lumajang District, identifies a significant gap in community income, land utilization, and entrepreneurial skill development, which is addressed through a community empowerment program focusing on vanilla cultivation training. The primary research gap highlighted is the low community income, underutilized yard spaces, and inadequate training and workshops to improve entrepreneurship skills among residents. These challenges are critical in a community where agriculture is dominant but lacks diversification and modern cultivation techniques.
Contribution: This community service aims to improve knowledge of cultivating vanilla and making drip irrigation. Through this activity, it is hoped that the community will get additional income from the vanilla cultivation business.
Method: This study includes pre-training, training, and post-training. The training employs socialization regarding vanilla cultivation techniques and drip irrigation. The next step is the direct practice of planting and pollinating vanilla as well as the practice of assembling drip irrigation. In this activity, 25 people were selected as training participants.
Results: This service program shows increased knowledge of vanilla cultivation and drip irrigation by 38%.
Conclusion: The training participants can independently cultivate vanilla and create drip irrigation in the yard. This activity received an excellent response from the training participants regarding facilitators, facilities, presenters, and. Participants were very enthusiastic and enthusiastic about cultivating vanilla in their yards.

INTRODUCTION

Jogoyudan Village is located in the Lumajang District, Lumajang Regency, and has an administrative area of 445 ha. The topography of Jogoyudan village consists of low to medium

plains (between ± 0 – 500 ASL). Jogoyudan Village Regency has an average annual rainfall of 1758 mm/year and a tropical climate. Based on the Schmid and Ferguson classification, the climate is classified as type D. The lowest temperature was 14 degrees Celsius in August, while the highest temperature was 36 degrees Celcius in April [1].

Jogoyudan Village has 6,320 residents, and the majority (25.48%) of residents work as farmers. According to the Central Statistics Agency [2], land use in Jogoyudan Village is divided into three: agricultural land, yard land, and buildings. The area of rice fields in Jogoyudan Village is 158 Ha, dry land is 87, and yards is 80 Ha [3]. Agricultural commodities in Jogoyudan village include rice, corn, cassava, peanuts, green beans and soybeans. Rice plants are rarely planted in Jogoyudan due to limited water availability and damaged irrigation channels [4]. The existing rice fields rely only on rainwater, so other efforts are needed to optimize the land in Jogoyudan Village.

Other problems found in this village are firstly relatively fertile yard land has not been managed optimally, so it has become idle land, secondly many primary and secondary irrigation channels are damaged [5], [6], thirdly post-harvest handling of agricultural products is not optimal, and [7]; fourthly, there is still a lack of training, workshops, and activities to improve entrepreneurial skills for village residents [8].

Yard land that has not been managed optimally is a big problem, considering that this area has fertile volcanic soil, which supports the development of several cultivated plants. Damaged irrigation channels need to be repaired considering the high rainfall, which needs to be optimized. Post-harvest handling that is not optimal also significantly impacts farmers' income. Training and workshops are also essential to increase farmers' capacity, especially regarding agricultural technology development.

The topographic location and altitude of Jogoyudan village have great potential for vanilla cultivation. Vanilla can be planted in empty yards around people's homes or on agricultural land. Vanilla (*Vanilla planifolia*) is a plant from the Orchidaceae family whose fruit has high economic value [9]. Vanilla is a high-value agricultural commodity, easy to cultivate, and can be planted in yards [10]. Vanilla plants can grow well in tropical areas at 0-1,200 meters above sea level. The ideal rainfall for vanilla is around 1,000-2,000 mm/year, with temperatures between 20-30°C [3]. Vanilla plants require shade with light levels between 30-50% [11]-[13]. The topography and climate conditions of Jogoyudan Village meet the requirements for the growth of vanilla plants, so the cultivation of this plant has good potential.

Cultivating vanilla plants is relatively easy to do. Vanilla plants can be developed in two ways, namely generatively or through seeds and vegetatively, namely using stem cuttings, but vanilla plants are easier to acquire through cuttings. Cuttings are a commonly used method for propagating vanilla plants. Good cuttings come from mother plants that are fertile and healthy, have dense leaves, dense stem segments, large stem circumference, and have never flowered or fruited. Taking cuttings should be done at the beginning of the rainy season. The cuttings are usually 1 m or more, with around 7-8 segments. The longer the cuttings are planted, the faster they flower [14]. Vanilla has quite good and stable market prospects. The price of vanilla is between 300 to 600 thousand rupiah per kg of dry vanilla [15], [16]. Vanilla can be used for various food products, beverages, cosmetics, perfumes, and other applications.

A vanilla plant is a plant that is sensitive to lack or excess water. Dry soil conditions (water content below the limit/depletion) will cause the plants to wilt and eventually die. And vice versa, soils containing lots of water will cause poor soil aeration and be unfavorable for root growth. As a result, plant growth will be thin and stunted [17]. Vanilla planting should be done on flat

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ground, not soggy or muddy. The soil suitable for planting vanilla is loamy and sandy with a neutral to slightly acidic acidity level [18]. The technology that can be used to overcome these problems is drip irrigation [10].

Drip irrigation is a way of providing water by dripping water through pipes around the plants. Drip irrigation is low-pressure and can be adjusted precisely in volume and target. The efficiency of irrigation water can be optimized using drip irrigation [19]. Drip irrigation technology has been used for the cultivation of plants such as vanilla, chili, citrus, and others [10], [20], [21].

The primary research gap lies in the underutilization of fertile land and inefficient water management, especially in high-value crop cultivation like vanilla. Despite favorable climatic conditions and fertile volcanic soil, the village's agricultural land, particularly yard land, is not optimally utilized, and the damaged irrigation infrastructure further exacerbates this issue. Additionally, the villagers have a significant gap in post-harvest handling.

This study aims to increase the community's ability to cultivate vanilla and make drip irrigation. The research contributes to the potential for vanilla cultivation, a crop well-suited to the village's climate and topography, suggesting it as a viable economic activity. It also proposes the adoption of drip irrigation as a solution to the prevalent water management challenges. This proposed study aims to improve agricultural practices by addressing the villagers' knowledge and skill gap. This research offers a comprehensive approach to enhancing agricultural productivity in Jogoyudan Village through strategic crop selection, improved water management, and capacity building.

METHOD

This service program was conducted in the Jogojudan Village, Lumajang District, Lumajang Regency (Figure 1) in May-June 2023. This activity was attended by 25 participants from the Jogoyudan Village and the Lumajang Regency area. The implementation of this activity is divided into three stages: pre-training, training, and post-training (Figure 2). The result of this program is an appropriate technology in the form of a drip irrigation design that supports the growth of vanilla plants so the community can cultivate and develop vanilla commodities in their yards as an alternative solution for empowering the community's economy.

The pre-training stage is the preparation stage for the service team before implementing a program. At this stage, 25 people were selected as training participants. The demo plot location for the irrigation system installation was at Mr. Wawan's yard (one of the joined participants). Figure 3 shows the construction of drip irrigation system. Making drip irrigation begins with estimating the need for pipes, faucets, stick drippers, and other materials. Irrigation development starts with installing a digital automatic timer on the water reservoir. At this stage, watering is set to be carried out two times at 06.00 and 15.00, each lasting 30 minutes.

Next is the implementation of construction, which is the structure of pipes, hoses, and dripper sticks (refer to Figure 4). After the installation, a check is carried out to determine the system's readiness. If the assessment shows good results, the reservoir is ready to be filled with water. Through trials, the system is introduced to actual working conditions [22]. The prototype layout and series of drip irrigation tools can be seen in Figure 5.

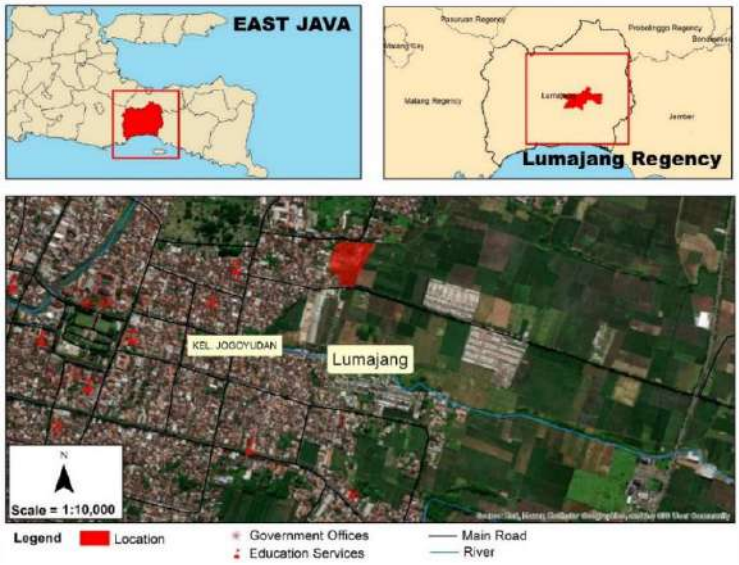

Figure 1. Service location

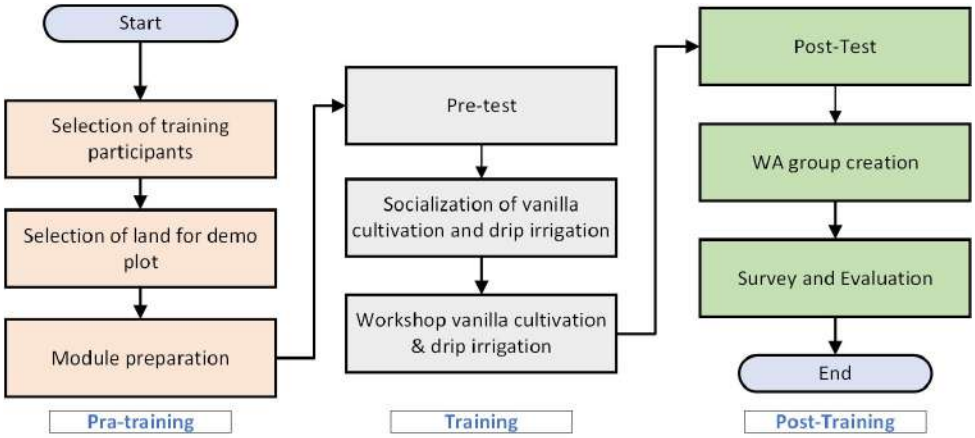

Figure 2. Method of community service

(a) (b)

Figure 3. Drip irrigation system (a) automatic timer installation (b) soil excavation for irrigation pipelines

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Figure 4. Drip irrigation assembly

Figure 5. Drip irrigation system prototype

The second stage is training, a core stage of this program. Before the exercise, a pre-test was conducted to measure participants' knowledge of vanilla cultivation and drip irrigation. Training activities are divided into socialization, hands-on vanilla cultivation, and drip irrigation practice. The training phase lasted for two meetings, and each session lasted two hours. The first meeting discussed vanilla cultivation techniques and making drip irrigation (Figure 6). In this outreach activity, the service team invited an expert and vanilla practitioner to provide knowledge to the training participants. In contrast, the speaker came from the service team for expertise related to drip irrigation. The service team also prepared modules for the participants as learning media (Figure 7).

(a) (b)

Figure 6. Program implementation (a) vanilla cultivation (b) drip irrigation training

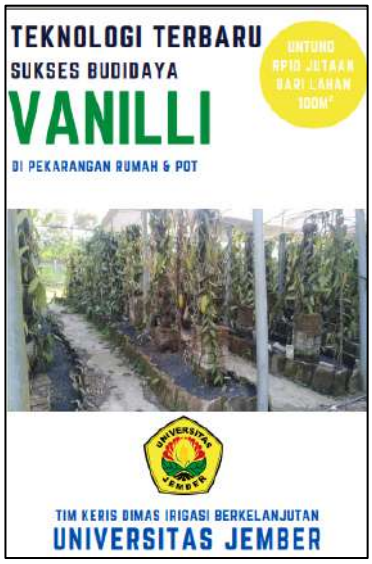

Figure 7. Booklet of vanilla cultivation and drip irrigation system

In the second meeting, hands-on practice and comparative studies were carried out in vanilla plantations. The participants cultivated vanilla in this activity, from land preparation to planting. After planting, participants were invited to go to a vanilla garden that was ready to produce and then carry out the pollination process on the vanilla (Figure 8).

(a) (b)

Figure 8. The participants cultivated vanilla
(a) vanilla planting plot demonstration (b) vanilla pollination

The third stage is the post-training stage, the stage after implementation of the training program. Post-training includes evaluation and monitoring of training participants. The participant monitoring process is done by creating a WhatsApp group to facilitate coordination and answer questions about drip irrigation cultivation and installation. The evaluation process uses a post-test and survey to determine the participants' knowledge and satisfaction. The survey results were then analyzed descriptively and quantitatively using Kirkpatrick's analysis [23].

The evaluation materials include Facilitators, Facilities, Speakers, and Materials. The program's facilitator is a dedicated team that handles pre- and post-training training. The facilitator, called a program committee, has provided facilities for the participants during the

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program. Facilities are the materials used and needed by the participants. The facilities provided in this program are learning modules, cultivation materials, irrigation system materials, and the Whatsapp group. The presenter is the person who provides material for the participants because of their experience and knowledge, which is sufficient to teach the trainees. The presenters are experts and practitioners with expertise in vanilla cultivation for ten years. The material is the learning reference material for the participants [24].

The four items used as evaluation material are assessed using a numerical scale. The numerical scale used in this program can be shown in Table 1. The questionnaire results were then presented in a percentages by dividing the number of participants who chose the numerical scale assessment evaluation by the number of participants who filled out the satisfaction survey, then multiplied by 100.

Table 1. Evaluation score scale

Scale	Explanation
1	Very Bad
2	Bad
3	Good
4	Very Good

RESULTS AND DISCUSSION

1. Evaluation of community empowerment programs

Table 2 shows participants' average level of understanding about vanilla cultivation and drip irrigation before training of 54.43%. After the participants received a solicitation and practiced cultivating vanilla and drip irrigation, the average level of understanding increased to 93.14%. There is an increase in knowledge of 38.71%.

Table 2. The increase in participants' understanding

Question Number	Average Value		
	Before Training	After Training	Percentage of improvement
1	50	100	50
2	58	100	42
3	58	88	30
4	40	92	52
5	60	92	32
6	40	100	60
7	64	100	36
8	56	80	24
9	44	84	40
10	64	92	28
11	72	100	28
12	32	88	56
13	48	88	40
14	76	100	24
Average	54.43	93.14	38.71

2. Satisfaction of the facilitator

Figure 9 shows the participant's satisfied reactions to the program's facilitator. Based on the survey results, it was found that the training participants were delighted (83%) with the service of the facilitator (service team) in implementing the activity. Facilitators are good at implementing community service programs. The reasons for the participants choosing a very

satisfactory score were 1) effective and efficient in preparing the event timeline; 2) easy to get along with (humble); 3) fast response; 4) good at controlling events; and 5) good time management.

The training participants were delighted, especially with time management, where the facilitator carried out the program according to a predetermined timeline. Participants feel satisfied because many similar activities are often rescheduled suddenly. Participants responded very satisfactorily to the facilitator because of the selection of appropriate speakers and the provided facilities.

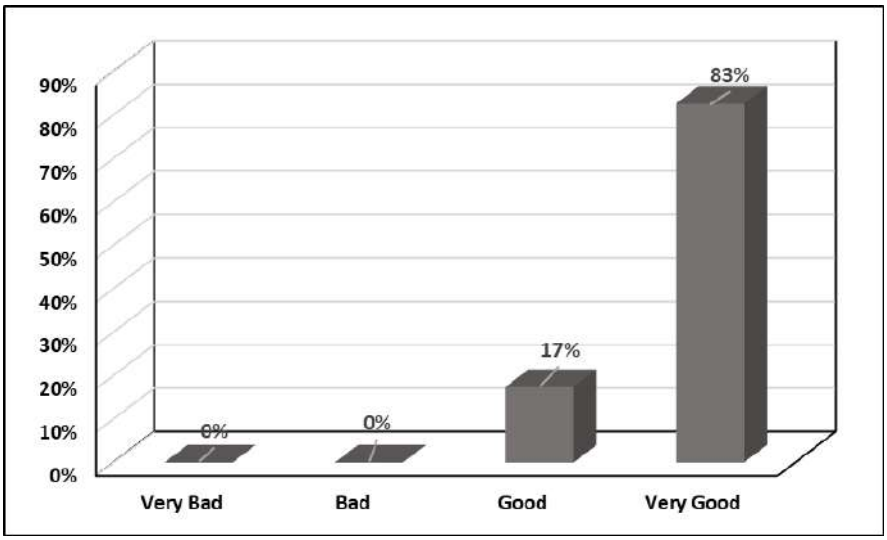

Figure 9. Participant satisfaction with the facilitator

3. Satisfaction with facilities

Figure 10 shows the participants' satisfied reactions to the facilities provided during the program. The survey results found that the training participants were delighted (92%) with the facilities provided. The facilities provided in this program are learning modules, cultivation materials (vanilla seeds and fertilizer), irrigation system materials, vehicles for comparative studies, and a Whatsapp group for coordination and consultation. The training participants were satisfied because the modules provided were complete, informative, and easy to understand. Each participant was also given seeds and fertilizer for vanilla plants according to the area of the participant's yard. The service team also prepared accommodation for a comparative study of flowering vanilla plants to try pollination, causing participants to feel delighted with the facilities provided.

Participants also provide input to the facilitator, especially in inadequate training facilities, in this case, related to the absence of chairs during the training. The suggestions and feedback given by the participants to the facilitator were correct. The team of devotees designed the training to be held outside the room so they could practice directly after delivering the material. But in this case, it can be input for the team so that they will continue to provide chairs during training even though it is held outside the room.

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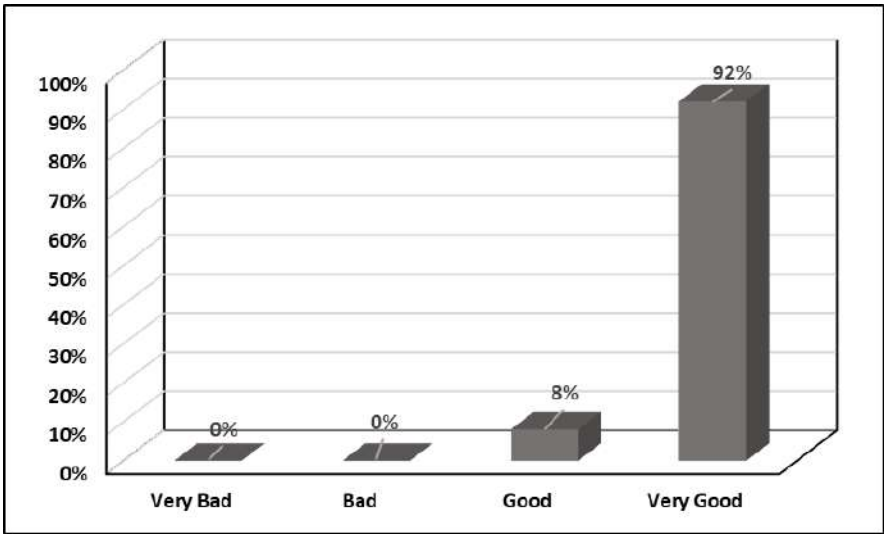

Figure 10. Participants' satisfaction with the facilities

4. Satisfaction with the speaker

Figure 11 shows the participants satisfied reactions to the speaker during the activity. The survey found that the training participants were delighted (88%) with the appointed speakers. In this activity, two speakers were Fathorossi, S.E., M.M., an expert and practitioner of vanilla cultivation, and Prof. Dr. Indarto, S.TP., DEA., IPU as an irrigation expert. The participants chose the value of being very satisfied with the designated speakers because of the easy-to-understand and interactive way of delivering knowledge during the activity. The presenters also use outdoor learning methods that are fun for the participants. In addition, the presenters were also responsive and good at delivering material during the training and responding to participant questions in the Whatsapp group.

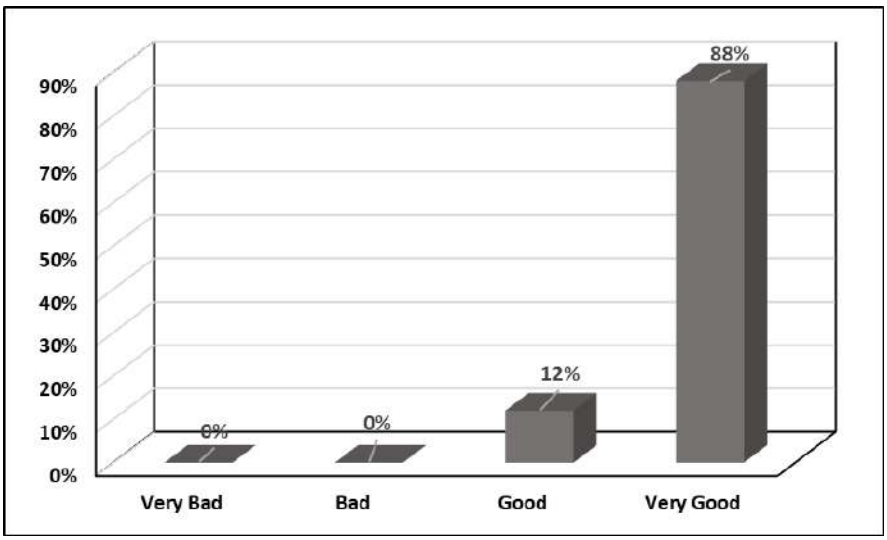

Figure 11. Participants' satisfaction with the speakers

5. Provided knowledge satisfaction

Figure 12 shows the participant's satisfied reactions to the provided knowledge during the activity. The survey found that the training participants were delighted (76%) with the supplied knowledge. It can be concluded that the provided understanding is excellent and relevant in

answering the problems in the community. The provided modules are complete, from soil processing techniques, seed selection, land preparation, and harvesting to post-harvesting of vanilla. In addition, there is also a technical guide to assembling simple drip irrigation, complete with pictures and tables, to make it easier for participants in the drip irrigation installation process.

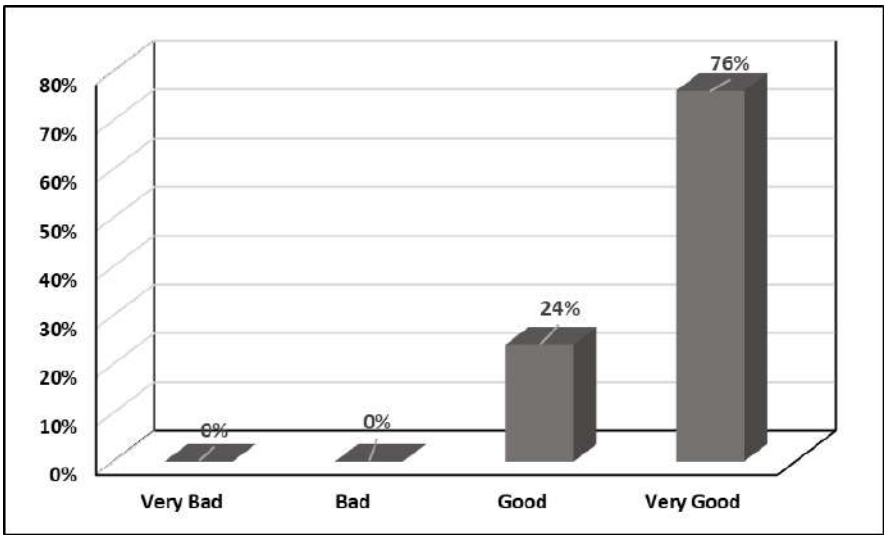

Figure 12. Participants' satisfaction with the material

6. Usefulness of the program

Figure 13 is the participant's response to the program's usefulness level. Based on the survey results, it is known that the activities carried out are helpful (100%) in solving problems in the community. In this case, the percentage of participants who chose practical and very useful, respectively, is 20% and 80%. The benefits of this activity are increasing the community's soft skills in vanilla cultivation and drip irrigation installation. This activity also increases community networks in vanilla marketing. In addition, this activity is also one of the additional income for the community.

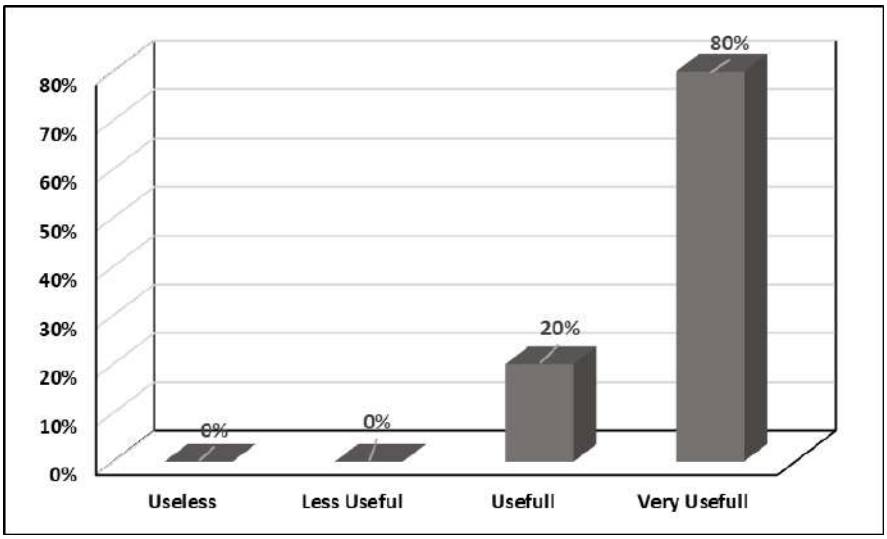

Figure 13. The usefulness of the program

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7. Program Sustainability

Figure 14 show the participant's response to the program's continuation. Based on the survey results, it was found that all participants (100%) were ready to implement the effects of the training in their yards. This service program can increase community motivation to earn additional income by planting vanilla in their home gardens using a drip irrigation system.

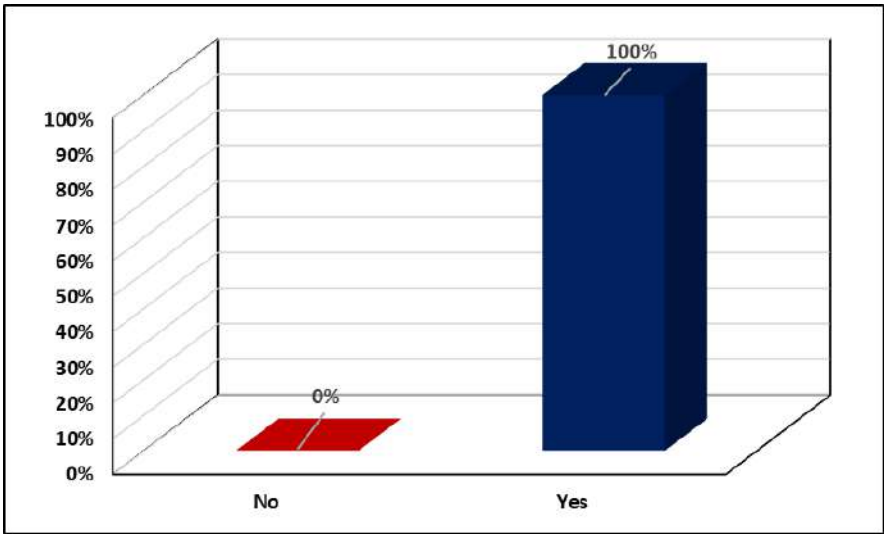

Figure 14. Program sustainability level

These results highlight the success of a community service program focused on vanilla cultivation and drip irrigation training in Jogoyudan Village. It emphasizes the effectiveness of direct training and practice in enhancing participants' skills and knowledge [25], [26]. This program was designed to address several local challenges: low community income, underutilized yard land, and a lack of training in entrepreneurship skills. The introduction of vanilla cultivation, a high-value agricultural commodity, was identified as a potential solution to increase community income. The program aimed to empower participants by providing them with the necessary skills and knowledge to cultivate vanilla and implement drip irrigation systems in their yards.

The success of the program is primarily attributed to its hands-on training approach. This method involved direct, practical experiences in vanilla cultivation and the installation of drip irrigation systems. Such hands-on training is crucial in agricultural learning as it allows participants to engage actively with the material, understand the practical aspects of cultivation, and gain firsthand experience. Research indicates that direct practice can significantly improve knowledge retention and skill acquisition compared to theoretical learning alone. This experiential learning approach likely increased participants' confidence and competence in vanilla cultivation and drip irrigation, which are essential skills for enhancing agricultural productivity and sustainability.

The increase in skills and knowledge among participants is a vital outcome, suggesting that they are now better equipped to cultivate vanilla independently and efficiently use water resources through drip irrigation. This empowerment is expected to lead to improved agricultural outputs, increased income, and overall community development in Jogoyudan Village. Participants' enthusiastic responses and willingness to apply these skills in their own yards also indicate the program's relevance and effectiveness in addressing the community's needs.

CONCLUSION

The successful outcome of the training program in Jogoyudan Village demonstrates a significant advancement in local agricultural practices, particularly in the cultivation of vanilla and the implementation of drip irrigation systems. This enhancement in skills and knowledge among the participants is expected to lead to improved agricultural productivity, higher income levels, and overall community development. The positive feedback from participants about the quality of training, including the facilitators' expertise and the material's relevance, underscores the program's effectiveness in meeting the community's needs. For future research, it would be beneficial to conduct a longitudinal study to assess the long-term impacts of this training on the economic well-being of the participants and the wider community

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References

[1] S. R. Barkunan, V. Bhanumathi, J. Sethuram, “Smart sensor for automatic drip irrigation system for paddy cultivation,” *Computers & Electrical Engineering*, vol. 73, pp. 180-193, 2019, https://doi.org/10.1016/j.compeleceng.2018.11.013.

[2] K. Shi, T. Lu, W. Zheng, X. Zhang, L. Zhangzhong, “A review of the category, mechanism, and controlling methods of chemical clogging in drip irrigation system,” *Agriculture*, vol. 12, no. 2, p. 202, 2022, https://doi.org/10.3390/agriculture12020202.

[3] E. H. Sharu, M. S. A. Razak, “Hydraulic performance and modelling of pressurized drip irrigation system,” *Water*, vol. 12, 8, p. 2295, 2020, https://doi.org/10.3390/w12082295.

[4] T. Iftikhar, H. Majeed, M. Waheed, S. S. Zahra, M. Niaz, A. A. AL-Huqail, “Vanilla,” In *Essentials of Medicinal and Aromatic Crops*, pp. 341-371, 2023, https://doi.org/10.1007/978-3-031-35403-8_14.

[5] I. G. K. Adiputra, I. W. Winaja, I. M. Sumarya, “Vegetative growth of vanilla cuttings after addition of weed clippings mulch under 2 climatic condition, wet and dry seasons,” In *IOP Conference Series: Earth and Environmental Science*, vol. 399, no. 1, p. 012084 2019, https://doi.org/10.1088/1755-1315/399/1/012084.

[6] L. Thomas, S. A. V. Srinivasan, K. N. Babu, “Cost and demand ecosystem of vanilla production In India: Current trends and economic prospects,” *International Journal of Innovative Horticulture*, vol. 9, no. 1, pp. 52-55, 2020, http://dx.doi.org/10.5958/2582-2527.2020.00007.X.

[7] K. M. Mafie, “Vanilla Husbandry and Fish Farming in Meru district, Arusha-Tanzania,” *Appropriate Technology*, vol. 6, no. 2, pp. 88-93, 2020, https://doi.org/10.37675/jap.2020.6.2.88.

[8] N. P. Mohanty, D. Singh, A. Hota and S. Kumar, "Cultivation of Cash Crops under Automated Greenhouse using Internet of Things (IoT)," *2019 International Conference on Communication and Signal Processing (ICCSP)*, pp. 0235-0239, 2019, https://doi.org/10.1109/ICCSP.2019.8697930.

[9] W. W. W. Kandegama, R. M. P. J. Rathnayake, M. B. Baig, M. Behnassi, “Impacts of climate change on horticultural crop production in Sri Lanka and the potential of climate-smart agriculture in enhancing food security and resilience,” In *Food Security and Climate-Smart Food Systems: Building Resilience for the Global South*, pp. 67-97, 2022, https://doi.org/10.1007/978-3-030-92738-7_5.

10.12198/spekta.v4i2.8407

[10] A. Bandyopadhyay, D. K. Ghosh, B. Biswas, M. H. Parameswarappa, J. Timsina, "Fertigation effects on nutrient use efficiency, energy productivity, and economics of coconut (cocos nucifera L.) cultivation in the eastern indo-gangetic Plains of South Asia," *International journal of fruit science*, vol. 20, no. sup3, pp. S1483-S1494, 2020, https://doi.org/10.1080/15538362.2020.1812016.

[11] R. K. Jain, B. Gupta, M. Ansari and P. P. Ray, "IOT Enabled Smart Drip Irrigation System Using Web/Android Applications," *2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT)*, pp. 1-6, 2020, https://doi.org/10.1109/ICCCNT49239.2020.9225345.

[12] S. Miran, M. Tamoor, T. Kiren, F. Raza, M. I. Hussain, J. T. Kim, "Optimization of standalone photovoltaic drip irrigation system: A simulation study," *Sustainability*, vol. 14, no. 14, p. 8515, 2022, https://doi.org/10.3390/su14148515.

[13] Y. H. Modhvadiya, M. V. Jalu, "Effect of environmental parameter on soilless cultivation in polycarbonate greenhouse," *The Parma Journal*, pp. 1841-1849, 2023, https://www.thepharmajournal.com/archives/2023/vol12issue12S/PartX/S-12-12-296-395.pdf.

[14] Q. Guo, G. Huang, Y. Guo, M. Zhang, Y. Zhou, L. Duan, "Optimizing irrigation and planting density of spring maize under mulch drip irrigation system in the arid region of Northwest China," *Field Crops Research*, vol. 266, p. 108141, 2021, https://doi.org/10.1016/j.fcr.2021.108141.

[15] B. M. Kumar, T. K. Kunhamu, "Nature-based solutions in agriculture: A review of the coconut (Cocos nucifera L.)-based farming systems in Kerala,"the Land of Coconut Trees"," *Nature-Based Solutions*, vol. 2, p. 100012, 2022, https://doi.org/10.1016/j.nbsj.2022.100012.

[16] M. Núñez, M. Finkbeiner, "A regionalised life cycle assessment model to globally assess the environmental implications of soil salinization in irrigated agriculture," *Environmental Science & Technology*, vol. 54, no. 6, pp. 3082-3090, 2020, https://doi.org/10.1021/acs.est.9b03334.

[17] K. D. Alotaibi et al., "Date palm cultivation: A review of soil and environmental conditions and future challenges," *Land Degradation & Development*, vol. 34, no. 9, pp. 2431-2444, 2023, https://doi.org/10.1002/ldr.4619.

[18] M. O. G. Al-Salami, N. J. R. Alhasnawi, "Effect of Water Stress and Selenium Spraying on Vegetative and Yield Indicators of Garlic Allium sativum L," In *IOP Conference Series: Earth and Environmental Science*, vol. 1262, no. 5, p. 052042, 2023, https://doi.org/10.1088/1755-1315/1262/5/052042.

[19] R. A. Prabaninggar, E. R. Sasmita, E. Wahyurini, "In Vitro Micro-Cutting Of Vanilla (Vanilla Planifolia Andrews.) In Different Naa And Bap," *Techno LPPM*, vol. 7, no. 1, pp. 027-036, 2021, http://jurnal.upnyk.ac.id/index.php/teknoslppm/article/view/5429.

[20] R. Tao, J. Li, S. Yu, B. Hu, N. Ling, G. Chu, "Abundant rather than rare fungi perform a vital role in maintaining the growth of continuous cropped cut chrysanthemum," *European Journal of Soil Biology*, vol. 116, p. 103489, 2023, https://doi.org/10.1016/j.ejsobi.2023.103489.

[21] Y. Hu, M. F. Resende Jr, A. Bombarely, M. Brym, E. Bassil, A. H. Chambers, "Genomics-based diversity analysis of Vanilla species using a Vanilla planifolia draft genome and Genotyping-By-Sequencing," *Scientific reports*, vol. 9, no. 1, p. 3416, 2019, https://doi.org/10.1038/s41598-019-40144-1.

[22] A. T. Mosquera-Espinosa et al., "In vitro evaluation of the development of Fusarium in vanilla accessions," *Agronomy*, vol. 12, no. 11, p. 2831, 2022, https://doi.org/10.3390/agronomy12112831.

[23] D. L. Kirkpatrick and J. D. Kirkpatrick, "Implementing teh Four Levels A Practical Guide for Effective Evaluation of Training of Programs," *California: Berrett Koehlerr Publisher*,

vol. 16, 2009, https://www.bkconnection.com/static/Implementing-the-Four-Levels-EXCERPT.pdf.

[24] J. J. Bello-Bello, S. Schettino-Salomón, J. Ortega-Espinoza, J. L. Spinoso-Castillo, "A temporary immersion system for mass micropropagation of pitahaya (Hylocereus undatus)," *3 Biotech*, vol. 11, no. 10, p. 437, 2021, https://doi.org/10.1007/s13205-021-02984-5.

[25] P. Bakshi, M. Singh, K. Kour, M. Iqbal, R. Kumar, Sarita, "Horticulture: A key for Sustainable development," In *Innovative Approaches for Sustainable Development: Theories and Practices in Agriculture*, pp. 169-190, 2022, https://doi.org/10.1007/978-3-030-90549-1_11.

[26] E. Astuti, N. Sugihartini, Z. Zainab, and P. R. Novitasari, "Community Service Based on A Training Method for Making Liquid Hand Sanitizers to Prevent The Spread of COVID-19 in Tegalsari Kulon Progo," *SPEKTA (Jurnal Pengabdian Kepada Masyarakat: Teknologi dan Aplikasi)*, vol. 4, no. 1, pp. 107–116, 2023, https://doi.org/10.12928/spekta.v4i1.7821.

10.12198/spekta.v4i2.8407