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The Bridging Gaps in Tropical Agriculture Through Collaborative Community Efforts

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ABSTRACT

This article explores a recent community engagement initiative aimed at addressing the challenges and conditions of tropical agriculture in Indonesia. The initiative, organized by the Graduate School of Agricultural Sciences at Universitas Lancang Kuning (UNILAK), involved a series of discussions and information-sharing sessions with international community at the Tokyo University of Agriculture & Technology (TUAT). The program focused on key topics such as sustainable development, modern agricultural technologies, and the role of pesticides in tropical farming. Initial findings from pre-test surveys indicated that participants were not familiar with the concept of tropical agriculture and the common challenges faced within this field. However, post-test results revealed significant improvements in their understanding and confidence regarding tropical agriculture, its challenges, and potential solutions. These outcomes highlight the effectiveness of the discussion sessions in enhancing participants' knowledge. Moreover, the initiative underscored the importance of collaborative efforts in tackling common agricultural issues. This article details the methods and findings of the engagement program, emphasizing the positive impact of community collaboration in bridging knowledge gaps and fostering sustainable agricultural development. The results suggest that such collaborative efforts are crucial for addressing the pressing challenges faced by tropical agriculture and for implementing viable solutions.

1. INTRODUCTION

Tropical agriculture, characterized by its unique climatic conditions and diverse crop varieties, plays a crucial role in the global food supply. However, this agricultural sector faces numerous challenges, including climate change, soil degradation, pest and disease management, and the need for sustainable practices (Partheepan et al., 2024; Purnama et al., 2024a; Purnama & Mutamima, 2023). In Indonesia, these challenges are particularly pronounced, given the nation's reliance on tropical agriculture for both economic stability and food security (Junaidi et al., 2024).

Addressing these challenges requires not only advanced agricultural technologies and practices but also effective collaboration among various stakeholders, including researchers, students, and local communities. Collaborative efforts can lead to innovative solutions and the successful implementation of sustainable agricultural practices (Krishnan et al., 2021). Recognizing this need, the Graduate School of Agricultural

Sciences at Universitas Lancang Kuning (UNILAK) initiated a community engagement program aimed at fostering collaboration and enhancing understanding of tropical agriculture. This initiative, conducted in partnership with the Indonesian Student Association (Perhimpunan Pelajar Indonesia – PPI) at the Tokyo University of Agriculture & Technology (TUAT), brought together the Indonesian, Japanese, and international communities to discuss and share information on the current state of tropical agriculture. The program focused on sustainable development, the application of modern agricultural technologies, and the role of pesticides in maintaining crop health (Lykogianni et al., 2021).

Through pre-test and post-test surveys, the program assessed participants' familiarity with these topics. Initial findings revealed a general lack of awareness and understanding among participants regarding tropical agriculture and its associated challenges. However, subsequent discussions and information-sharing sessions significantly improved their knowledge and confidence (Llones & Suwanmaneepong. 2021). This article delves into the structure and outcomes of the community engagement program, highlighting the critical role of collaborative efforts in addressing the complexities of tropical agriculture. It also emphasizes the importance of educational initiatives in bridging knowledge gaps and promoting sustainable agricultural practices (Jamatia, 2023; Castro-Arce & Vanclay, 2020).

2. THEORY

The theoretical framework for understanding tropical agriculture involves several key concepts: sustainable development, agricultural technology adoption, pest and disease management, and collaborative approaches to agricultural challenges. These concepts are interrelated and crucial for addressing the complexities of tropical agriculture. Sustainable development in agriculture aims to meet the needs of the present without compromising the ability of future generations to meet their own needs. This involves practices that enhance productivity while preserving the environment and ensuring social equity. In tropical agriculture, sustainable practices are essential for mitigating the adverse effects of climate change, conserving biodiversity, and improving soil health (Singh et al., 2019; Purnama et al., 2024a). Sustainable intensification, which seeks to increase food production from existing farmland while minimizing environmental impact, is a key strategy in this regard (Xie et al., 2019).

The adoption of modern agricultural technologies is critical for improving productivity and resilience in tropical agriculture. Technologies such as precision farming, biotechnological advancements, and climate-smart practices can significantly enhance agricultural efficiency and sustainability (Riyaz et al., 2022; Meena & Mishra, 2020; Baker et al., 2020; Green et al., 2020). The diffusion of these technologies often depends on factors such as farmer education, infrastructure availability, and policy support (Worku, 2019). Effective pest and disease management is a cornerstone of sustainable tropical agriculture. Traditional practices often rely heavily on chemical pesticides, which can lead to environmental degradation and health risks. Recent approaches advocate for integrated pest management (IPM), which combines biological, cultural, physical, and chemical tools to sustainably manage pest populations (Baker et al., 2020; Green et al., 2020). This approach reduces reliance on chemical inputs and promotes ecological balance.

Collaboration among various stakeholders - including farmers, researchers, government agencies, and educational institutions - is essential for addressing the multifaceted challenges of tropical agriculture. Collaborative efforts can facilitate the exchange of knowledge, the sharing of resources and the implementation of innovative solutions (Krishnan et al., 2021; Wan et al., 2023). Community engagement and participatory approaches ensure that interventions are context-specific and culturally appropriate, enhancing their effectiveness and sustainability (Muchaku & Magaiza, 2023).

The integration of these theoretical perspectives provides a comprehensive framework for understanding and addressing the challenges of tropical agriculture. Sustainable development principles guide the overarching goals, while technology adoption and pest management provide practical solutions. Collaboration ensures that these solutions are effectively implemented and adapted to local contexts.

3. METHOD

Study Design

This study employed a mixed-methods approach to evaluate the effectiveness of a community engagement

DOI: https://doi.org/10.32663/...............................

program on tropical agriculture (Takona, 2024). The program included pre- and post-tests to assess participants' knowledge and perceptions, along with interactive discussions and collaborative activities aimed at enhancing understanding of tropical agricultural challenges and solutions.

Program Activities

The program, held on May 12, 2024, at the Fuchu Campus, TUAT, Japan (35°40'52.3"N 139°29'06.5"E) encompassed a variety of interactive components aimed at fostering engagement and knowledge exchange among participants. The program included in-depth presentations focusing on current issues in tropical agriculture, sustainable practices, and advancements in agricultural technology. These presentations provided a comprehensive overview of key topics, serving as a foundation for further exploration. Facilitated group discussions offered participants a platform to delve deeper into specific challenges faced in tropical agriculture and brainstorm potential solutions collaboratively. Through these discussions, participants shared insights, experiences, and diverse perspectives, enriching the dialogue and fostering a sense of community. Additionally, small group activities were conducted, enabling participants to engage in hands-on collaborative projects. These projects encouraged teamwork and creativity, as participants worked together to propose innovative solutions to identified agricultural problems. By actively participating in these activities, participants gained practical insights and contributed to the generation of actionable ideas for addressing real-world challenges in tropical agriculture.

Participants

The study included a diverse group of participants comprising international community members residing in Japan, including master's and doctoral students, researchers, and faculty members from Tokyo University of Agriculture and Technology (TUAT), Tokyo City University (TCU), Universiti Teknologi Malaysia (UTM), Universiti Putera Malaysia (UPM), Universitas Riau (UNRI), and Universitas Lancang Kuning (UNILAK). The sample consisted of 15 individuals selected based on their interest and expertise in tropical agriculture. This multidisciplinary approach ensured a comprehensive representation of stakeholders involved in agricultural research and education, enriching the discussions and collaborative activities during the program. The participants and the sequence of activities can be seen in Figure 1.

Symbiosis Civicus
Symbiosis Civicus, June 2024, 1 (1):22-33
DOI: https://doi.org/10.32663/................................

Figure 1. Participants and activities during the program

Pre-test and post-test

Participants completed a pre-test before the program and a post-test following the sessions to measure changes in knowledge and perceptions. The tests consisted of 10 Likert-scale questions (1-4), as shown in Table 1, designed to assess familiarity with tropical agriculture concepts, challenges, and sustainable practices. The questions aimed to gauge participants' baseline knowledge and the program's impact on their understanding.

Table 1. List of pre-test and post-test questions

Questions (Q)
Q1. How familiar are you with the concept of tropical agriculture?
Q2. How well do you understand the main challenges faced in tropical agriculture?
Q3. How often are you involved in collaborative activities in the context of agriculture Q4. To what extent are you familiar with the concept of sustainable development in agriculture?
Q5. How familiar are you with modern agricultural technologies used in the context of tropical agriculture?
Q6. How confident are you in your understanding of the role of pesticides in tropical agriculture?
Q7. How often do you seek updates or information related to tropical agriculture?
Q8. How well do you understand efforts to enhance sustainability in tropical agriculture?
Q9. To what extent are you familiar with the potential negative impacts of tropical agriculture on the environment?
Q10. How prepared are you to participate in discussions or projects related to tropical agriculture after this presentation?

Data collection

Data were collected through online surveys for both the pre-test and post-test. Additionally, qualitative data were gathered through open-ended questions and discussions during the sessions. These discussions provided an opportunity for participantsto share their insights and experiences, contributing to a deeper understanding of their perspectives on tropical agriculture.

Data analysis

Data analysis for the quantitative data from the pre- and post-tests involved several steps using SPSS software version 19, as in the previous study (Nekouei et al., 2024). Firstly, the normality of the data distribution was assessed using the Kolmogorov-Smirnov (K-S) test. This test examines whether the data follows a normal distribution, which is an assumption for parametric statistical tests. The Kolmogorov-Smirnov (K-S) test statistic (D) is calculated based on the observed data, and a p-value is obtained. If the p-value is greater than the 0.05, the null hypothesis of normality is not rejected, indicating that the data can be considered as normally distributed.

Symbiosis Civicus

Symbiosis Civicus, June 2024, 1 (1):22-33
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The formula for the Kolmogorov-Smirnov test statistic (D) is:

$$D = \max\left(|F_{\text{pre}}(x) - F_{\text{post}}(x)|\right) \quad (1)$$

Where:

- Fpre(x) is the empirical cumulative distribution function of the pre-test data,
- Fpost(x) is the empirical cumulative distribution function of the post-test data, and
- max denotes the maximum absolute difference between Fpre(x) and Fpost(x) across all values of x in the sample data.

Once the normality of the data is confirmed, the significance of the difference between pre- and post-test scores was assessed using a paired t-test. This test compares the mean difference between paired observations (i.e., pre-test and post-test scores) to zero. The t-test statistic is calculated as:

$$t = \frac{\bar{X}_{\text{post}} - \bar{X}_{\text{pre}}}{s/\sqrt{n}} \quad (2)$$

Where:

- $\bar{X}$post is the mean post-test score,
- $\bar{X}$pre is the mean pre-test score,
- s is the pooled standard deviation, and
- n is the number of samples.

Pooled standard deviation (s) can be calculated with the following equation:

$$s = \sqrt{\frac{(n_{\text{post}}-1).s_{\text{post}}^2+(n_{\text{pre}}-1).s_{\text{pre}}^2}{n_{\text{post}}+n_{\text{pre}}-2}} \quad (3)$$

However, if the data do not exhibit normal distribution, the Wilcoxon Signed-Rank test will be conducted instead. This non-parametric test evaluates whether there is a significant difference between paired observations by ranking the absolute differences and considering the sign of each difference. The formula to calculate the Z-statistic in the Wilcoxon Signed-Rank test is:

$$Z = \frac{W - \frac{0.25n(n+1)}{2}}{\sqrt{\frac{n(n+1)(2n+1)}{24}}} \quad (4)$$

Where:

- Z is the test statistic Z,
- W is the calculated rank sum of the differences between paired data,
- n is the number of paired data.

The calculation of W involves ranking the absolute values of the differences between paired data, then summing the ranks with positive (or negative) signs. The Z value is compared to the critical value from the normal distribution to determine significance.

Ethical considerations

Participation in the study was voluntary, and informed consent was obtained from all 15 participants. The confidentiality of the respondents was maintained by anonymizing the data. The study adhered to ethical guidelines for research involving human subjects, ensuring that no harm was done to the participants.

Limitations

The primary limitation of this study was the small sample size, comprising only 15 participants drawn from the international community surrounding the Tokyo University of Agriculture & Technology (TUAT). The

DOI: https://doi.org/10.32663/................................

limited sample size may constrain the generalizability of the findings to broader populations. Additionally, the study's focus on a specific community within PPI TUAT may restrict the applicability of the results to other contexts. Future research endeavors with larger and more diverse samples are warranted to enhance the robustness and generalizability of findings concerning the effectiveness of community engagement programs in tropical agriculture.

4. RESULT AND DISCUSSION

Program activities

The program activities were meticulously designed to provide participants with a comprehensive learning experience in tropical agriculture while fostering collaboration and problem-solving. Comprising expert-led presentations, dynamic group discussions, and hands-on collaborative projects, these activities seamlessly integrated theoretical knowledge with practical application, offering a cohesive educational journey. The expert-led presentations, a foundational component of the program, offered profound insights into various aspects of tropical agriculture (McAlpine et al., 2024). Led by seasoned professionals and scholars, these sessions covered diverse topics, including current challenges, sustainable practices, and innovative technologies. By grounding participants in the latest research and scholarly discourse, these presentations set the stage for informed discussion and exploration.

Facilitated group discussions further enriched the learning experience by providing a platform for interactive engagement and knowledge exchange (Dahl & Sharma, 2022). Guided by thematic prompts, participants actively shared perspectives, experiences, and insights, deepening their understanding of the complexities inherent in agricultural sustainability. Through lively debate and critical inquiry, participants gained valuable insights into how to address challenges in tropical agriculture. Collaborative projects complemented the theoretical knowledge by offering participants the opportunity to translate their learning into action. Working in small groups, participants tackled real-world challenges faced by agricultural communities in tropical regions, with a particular focus on pest and disease management. Guided by facilitators, participants applied their expertise and creativity to develop evidence-based solutions, emphasizing practicality and relevance.

By seamlessly integrating expert-led presentations, dynamic group discussions, and hands-on collaborative projects, the program activities provided participants with a holistic learning experience in tropical agriculture. Grounded in theory yet firmly rooted in practice, these activities empowered participants to navigate the complexities of agricultural sustainability and contribute meaningfully to community development in tropical regions. Expanding upon the program's activities, the expert-led presentations covered a wide range of topics pertinent to tropical agriculture. These presentations addressed key challenges such as climate change, pest and disease outbreaks, soil degradation, and water scarcity, and underscoring the urgent need for sustainable practices in agricultural systems (Das et al., 2024; Ngalimat et al., 2023a, 2023b; Purnama et al., 2024a, 2023a, 2023b; Saidi et al., 2023; Novianti et al., 2021). By elucidating the interconnectedness of environmental, social, and economic factors, presenters emphasized the importance of adopting holistic approaches to agricultural development.

Moreover, the presentations delved into the latest advancements in agricultural technology, highlighting innovative solutions for enhancing productivity, reducing resource consumption, and mitigating environmental impact. From precision agriculture and remote sensing to bioengineering and genetic modification, participants gained insights into the diverse array of technologies shaping the future of tropical agriculture (Munawaroh et al., 2023; Satia et al., 2022; Puspita et al., 2022). In addition to addressing challenges and innovations, the presentations explored the ethical and socio-economic dimensions of tropical agriculture. Speakers discussed issues such as land tenure, labor rights, and food security, prompting participants to critically reflect on the broader implications of agricultural practices (Nyantakyi-Frimpong & Kerr, 2017). By fostering discussions on these complex issues, the presentations encouraged participants to consider the ethical responsibilities of agricultural stakeholders and the role of policy in promoting equitable and sustainable development.

Parallel to the expert-led presentations, facilitated group discussions provided participants with opportunities to engage in collaborative learning and knowledge exchange. These discussions were structured around thematic prompts related to key issues in tropical agriculture, allowing participants to explore diverse perspectives and share practical insights (Dahl & Sharma, 2022). Through active participation in these discussions, participants gained a deeper understanding of the multifaceted challenges facing agricultural systems in tropical regions. One of the focal points of the group discussions was the role of sustainable agricultural practices in achieving the Sustainable Development Goals (SDGs). Participants examined how initiatives such as agroecology, organic farming, and integrated pest management contribute to the attainment of SDGs related to food security, poverty alleviation, and environmental conservation (Purnama et al., 2024a). By analyzing case studies and sharing best practices, participants identified strategies for aligning agricultural activities with the principles of sustainability outlined in the SDGs.

Furthermore, group discussions facilitated dialogue on collaborative approaches to address common challenges in tropical agriculture. Participants explored the concept of stakeholder engagement and discussed the importance of partnerships among farmers, researchers, policy makers, and civil society organizations (Waters-Bayer et al., 2015). By sharing experiences and lessons learned from collaborative initiatives, participants identified opportunities for collective action and knowledge sharing across diverse stakeholder groups. Building upon the insights gained from presentations and group discussions, collaborative projects provided participants with a hands-on opportunity to apply theoretical knowledge to real-world scenarios. Working in small groups, participants engaged in problem-solving activities focused on specific challenges in tropical agriculture, such as pest management, soil conservation, and crop diversification (Purnama et al., 2024a). Under the guidance of facilitators, participants conducted literature reviews, field surveys, and data analyses to develop evidence-based solutions tailored to local contexts.

In addition to addressing various challenges and discussing potential solutions, the program also explored opportunities and potential areas for future development in tropical agriculture. Among these, the conversion of biomass into energy and the production of functional foods and beverages emerged as promising avenues for innovation and growth. The discussion on biomass conversion into energy centered on leveraging organic waste and agricultural by-products to produce renewable energy sources such as biogas, biofuels, and biomass-based electricity (Purnama et al., 2024b). With increasing concerns over climate change and the need to transition towards sustainable energy sources, bioenergy presents a viable solution for reducing greenhouse gas emissions and mitigating environmental impact (Wang et al., 2020). By harnessing locally available biomass resources, tropical regions can enhance energy security, reduce reliance on fossil fuels, and promote rural development (Purnama et al., 2024b). Furthermore, bioenergy production has the potential to create new income streams for farmers and stimulate economic growth in rural communities (Tagwi & Chipfupa, 2023).

Similarly, the discussion on functional foods and beverages explored opportunities for value-added agricultural products that offer health benefits beyond basic nutrition. Functional foods are enriched with bioactive compounds such as vitamins, minerals, antioxidants, and probiotics, which confer specific health benefits and contribute to overall well-being (Mutamima et al., 2023a, 2023b). In tropical regions rich in biodiversity, there is immense potential to develop functional foods and beverages from indigenous crops and traditional ingredients (Waisundara, 2020). These products not only cater to consumer demand for health-conscious options but also support the preservation of traditional knowledge and cultural heritage. Additionally, functional food production can create opportunities for smallholder farmers to diversify their income streams and access higher-value markets (Materia et al., 2021).

By exploring these emerging opportunities, participants gained insights into the potential for diversification and value addition in tropical agriculture. The discussion highlighted the importance of innovation, research, and collaboration in unlocking the full potential of biomass energy and functional foods. Moving forward, stakeholders are encouraged to explore synergies between the agriculture, energy, and nutrition sectors to maximize the socio-economic and environmental benefits of these emerging trends. Through targeted investments, policy support, and knowledge sharing, tropical regions can harness their agricultural resources to drive sustainable development and improve livelihoods for communities across the globe.

Pre-test and post-test analysis

The pre-test and post-test analyses were conducted to evaluate the impact of the program on participants' knowledge and perceptions regarding tropical agriculture. The analysis encompassed ten questions aimed at gauging participants' familiarity with tropical agriculture concepts, understanding of challenges faced, involvement in collaborative activities, awareness of sustainable development principles, familiarity with modern agricultural technologies, confidence in understanding the role of pesticides, frequency of seeking updates on tropical agriculture, understanding of efforts to enhance sustainability, awareness of potential negative impacts on the environment, and preparedness to engage in discussions or projects related to tropical agriculture post-presentation.

Table 2. Pre-test and post-test analysis (n = 15)

Question	Pre-Test Mean ± SD	Post-Test Mean ± SD	K-S Normality Test Pre-Test	K-S Normality Test Post-Test	Significance Test
Q1	2.00 ± 0.82	3.67 ± 0.47	Normal (D = 0.167)	Not Normal (D = 0.442)	Wilcoxon Signed-Rank Z = -3.448, p = 0.000567*
Q2	1.87 ± 0.81	3.33 ± 0.70	Normal (D = 0.214)	Normal (D = 0.266)	Paired t-test t = -5.916, p = 0.000022*
Q3	1.73 ± 0.98	2.87 ± 0.81	Normal (D = 0.281)	Normal (D = 0.214)	Paired t-test t = -4.025, p = 0.001301*
Q4	2.00 ± 0.82	3.60 ± 0.61	Normal (D = 0.167)	Not Normal (D = 0.347)	Wilcoxon Signed-Rank Z = -3.508, p = 0.000452*
Q5	1.87 ± 0.96	3.53 ± 0.50	Normal (D = 0.250)	Normal (D = 0.231)	Paired t-test t = -6.195, p = 0.000013*
Q6	1.93 ± 0.93	3.67 ± 0.47	Normal (D = 0.281)	Not Normal (D = 0.442)	Wilcoxon Signed-Rank Z = -3.637, p = 0.000275*
Q7	1.80 ± 0.83	3.67 ± 0.47	Normal (D = 0.236)	Not Normal (D = 0.442)	Wilcoxon Signed-Rank Z = -3.637, p = 0.000275*
Q8	1.80 ± 0.91	3.47 ± 0.62	Normal (D = 0.290)	Normal (D = 0.280)	Paired t-test t = -6.504, p = 0.000007*
Q9	1.73 ± 0.85	3.73 ± 0.44	Normal (D = 0.269)	Not Normal (D = 0.416)	Wilcoxon Signed-Rank Z = -3.632, p = 0.000281*
Q10	2.07 ± 0.85	3.80 ± 0.40	Normal (D = 0.205)	Normal (D = 0.335)	Paired t-test t = -7.127, p = 0.000002*

Note: *Significant at the 0.05 level. This table presents the mean and standard deviation data for each question in the pre-test and post-test, the results of the K-S normality test along with the decision on data normality, and the results of the significance test (Paired t-test or Wilcoxon Signed-Rank test) to examine the difference between pre-test and post-test scores.

The pre-test results indicated a moderate level of familiarity with the concept of tropical agriculture (2.00 ± 0.82). However, after participating in the program, there was a noticeable improvement in participants' understanding, as evidenced by the post-test results (3.67 ± 0.47). Similarly, participants demonstrated enhanced awareness of the main challenges faced in tropical agriculture, with mean scores increasing from 1.87 ± 0.81 in the pre-test to 3.33 ± 0.70 in the post-test. The frequency of participants' involvement in collaborative agricultural activities also increased, as shown by the rise in scores from 1.73 ± 0.93 in the pre-test to 2.87 ± 0.81 in the post-test. This indicates that the program effectively encouraged more collaborative engagements among participants. Additionally, there was a significant improvement in participants' comprehension of sustainable agricultural practices (2.00 ± 0.82; 3.60 ± 0.61).

Participants' familiarity with modern agricultural technologies in the context of tropical agriculture also saw substantial improvement, with mean scores increasing from 1.87 ± 0.96 in the pre-test to 3.53 ± 0.50 in the post-test. This suggests that the program successfully enhanced their knowledge of modern agricultural tools and techniques. Notably, there was a substantial improvement in participants' confidence in addressing the challenges posed by pesticides in tropical agriculture (1.93 ± 0.93; 3.67 ± 0.47). Moreover, the frequency with which participants sought updates or information related to tropical agriculture significantly increased, as reflected by the rise in scores from 1.80 ± 0.83 in the pre-test to 3.67 ± 0.47 in the post-test.

Participants' understanding of efforts to enhance sustainability in tropical agriculture improved significantly, as indicated by the increase in scores from 1.80 ± 0.91 in the pre-test to 3.47 ± 0.62 in the post-test. Their awareness of the potential negative impacts of tropical agriculture on the environment also saw a considerable enhancement, with scores rising from 1.73 ± 0.85 in the pre-test to 3.73 ± 0.44 in the post-test. Finally, participants reported feeling more prepared to engage in discussions or projects related to tropical agriculture after the presentation, with their preparedness scores increasing from 2.07 ± 0.85 in the pre-test to 3.80 ± 0.40 in the post-test.

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Data from the pre-test and post-test sessions revealed notable changes in participants' responses across various questions. Based on the results in Table 2, the pre-test data for all questions were normally distributed according to the Kolmogorov-Smirnov test. However, the post-test data for questions Q1, Q4, Q6, Q7, and Q9 were not normally distributed. The results were analyzed using both parametric (paired t-test) and non-parametric (Wilcoxon Signed-Rank test) methods due to the varying distributions of the data. The summary of these results is presented in Table 2. For questions Q2, Q3, Q5, Q8, and Q10, which exhibited normal distributions, the paired t-test was employed. Significant differences between pre-test and post-test scores were observed for these questions, indicating a significant improvement in participants' understanding and perceptions following the presentation. For questions Q1, Q4, Q6, Q7, and Q9, which showed non-normal distributions, the Wilcoxon Signed-Rank test was utilized. Significant differences were found between pre-test and post-test scores for these questions as well, suggesting a substantial enhancement in participants' knowledge and perceptions.

The results underscored the effectiveness of the program in enhancing participants' understanding of tropical agriculture concepts, challenges, sustainable practices, technological advancements, and environmental impacts. The collaborative nature of the sessions fostered meaningful discussions and exchanges, contributing to a more comprehensive comprehension of the subject matter. These findings align with previous studies emphasizing the importance of interactive and collaborative learning approaches in agricultural education (Smith et al., 2018; Johnson & Smith, 2020). The engagement of participants from diverse backgrounds, including students, researchers, and faculty members, further enriched the discussions and facilitated holistic learning experiences.

Strategies and collaborative efforts

The discussions and activities conducted during the community engagement event at Fuchu Campus, TUAT, on May 12, 2024, focused on developing and implementing effective strategies to combat the pervasive issue of pests and diseases in tropical agricultural systems. This focus is crucial due to the severe impacts of these threats on crop yields and quality, which can lead to significant economic losses and food insecurity. The strategies discussed not only aim to mitigate these challenges but also align with the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land).

One of the primary strategies emphasized was the importance of providing adequate nutrition to plants to bolster their natural immune systems. Just as nutrition is vital for human health, it plays a crucial role in enhancing plant resilience against pests and diseases. The application of biofortification, which involves breeding crops to increase their nutritional value, and the use of organic fertilizers rich in essential micronutrients can significantly improve plant health and immunity (Dhaliwal et al., 2023). Studies have shown that certain nutrients, such as silicon, can enhance plant resistance to both biotic and abiotic stresses, thereby reducing the incidence of diseases and pest attacks (Islam et al., 2020). This approach supports SDG 2 by promoting sustainable agricultural practices that enhance food security.

Another critical aspect discussed was the need for safe and sustainable pest and disease control methods. The over-reliance on chemical pesticides has led to alarming levels of pesticide residues in agricultural products and the environment, posing serious health risks to consumers and disrupting ecosystems (Purnama & Mutamima, 2023). Integrated Pest Management (IPM) was highlighted as a viable solution, combining biological control agents, cultural practices, and the judicious use of chemical pesticides to minimize harm (Baker et al., 2020; Green et al., 2020). Additionally, the development and deployment of biopesticides, derived from natural materials such as plants, bacteria, and certain minerals, were advocated as a safer alternative to conventional pesticides (Utami et al., 2024; Ngalimat et al., 2023b). This aligns with SDG 3 and SDG 12 by promoting safer food production systems and reducing the environmental impact of agriculture.

The discussions underscored the necessity of collaborative efforts involving all stakeholders, including academics, local and national governments, farmers, and consumers. Such collaboration is essential for the development and implementation of effective and sustainable agricultural practices. Academia can contribute by conducting research and providing evidence-based recommendations. Government bodies can facilitate the adoption of sustainable practices through policies and subsidies. Farmers can share practical insights and traditional knowledge, while consumers can drive demand for sustainably produced agricultural products (Purnama et al., 2024c; Krishnan et al., 2021). Effective collaboration can lead to the establishment of robust networks that support knowledge sharing and capacity building. This collaborative approach supports SDG 17 (Partnerships for the Goals) by fostering partnerships at all levels.

The outcomes of the discussions at the Fuchu Campus event highlight the multifaceted approach needed to address the pervasive issue of pests and diseases in tropical agriculture. By enhancing plant immunity through improved nutrition, adopting safe and sustainable pest management practices, and fostering collaborative efforts among all stakeholders, it is possible to mitigate the impacts of these challenges effectively. These strategies not only aim to improve crop yields and quality but also to ensure the long-term sustainability and health of agricultural ecosystems, contributing to multiple SDGs and ensuring a more sustainable and resilient future for tropical agriculture.

5. CONCLUSIONS

The discussions held during the community engagement event at Fuchu Campus, TUAT, shed light on the pressing need to address pests and diseases in tropical agriculture. The multifaceted strategies proposed, including bolstering plant immunity through enhanced nutrition, adopting safe and sustainable pest management practices, and fostering collaborative efforts among stakeholders, present promising avenues for mitigating these challenges. Aligned with the Sustainable Development Goals (SDGs) – particularly SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals) – these strategies not only seek to enhance crop productivity and quality but also contribute to the long-term sustainability and resilience of agricultural systems. Moving forward, sustained research, policy support, and collective action at local, national, and global levels will be essential for translating these deliberations into actionable initiatives and ensuring a more sustainable future for tropical agriculture.

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REFERENCES

Baker, B. P., Green, T. A., & Loker, A. J. (2020). Biological control and integrated pest management in organic and conventional systems. Biological Control, 140, 104095.

Castro-Arce, K., & Vanclay, F. (2020). Transformative social innovation for sustainable rural development: An analytical framework to assist community-based initiatives. Journal of Rural Studies, 74, 45-54.

Dahl, Y., & Sharma, K. (2022, April). Six facets of facilitation: participatory design facilitators' perspectives on their role and its realization. In Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (pp. 1-14).

Das, K., Novianti, F., Komatsu, K., Ito, T., & Misawa, K. (2024, March). Identification of earliest point for detection of plant virus infection through Raman spectroscopy and principal component analysis. In Photonic Technologies in Plant and Agricultural Science (p. PC1287904). SPIE.

Dhaliwal, S. S., Sharma, V., Shukla, A. K., Verma, V., Kaur, M., Shivay, Y. S., Nisar, S., Gaber, A., Brestic, M., Barek, V., Skalicky, M., Ondrisik, P., & Hossain, A. (2022). Biofortification—A frontier novel approach to enrich micronutrients in field crops to encounter the nutritional security. Molecules, 27(4), 1340.

Green, K. K., Stenberg, J. A., & Lankinen, Å. (2020). Making sense of Integrated Pest Management (IPM) in the light of evolution. Evolutionary Applications, 13(8), 1791–1805. https://doi.org/10.1111/eva.13067.

Islam, W., Tayyab, M., Khalil, F., Hua, Z., Huang, Z., & Chen, H. Y. (2020). Silicon-mediated plant defense against pathogens and insect pests. Pesticide Biochemistry and Physiology, 168, 104641.

Jamatia, P. L. (2023). The Role of Youth in Combating Social Inequality: Empowering the Next Generation. International Journal of Social Science, Educational, Economics, Agriculture Research and Technology, 2(8), 229-238.

Junaidi, A., Mashar, A., Basrowi, B., Muharomah, D., Situmorang, J., Lukas, A., Asgar, A., Herlina, L., Manalu,

L. & Payung, L. (2024). Enhancing sustainable soybean production in Indonesia: evaluating the environmental and economic benefits of MIGO technology for integrated supply chain sustainability. Uncertain Supply Chain Management, 12(1), 221-234.

Krishnan, R., Yen, P., Agarwal, R., Arshinder, K., & Bajada, C. (2021). Collaborative innovation and sustainability in the food supply chain-evidence from farmer producer organisations. Resources, Conservation and Recycling, 168, 105253.

Llones, C. A., & Suwanmaneepong, S. (2021, November). The role of engagement among farmers in developing farming knowledge: evidence from northern Thailand. In IOP Conference Series: Earth and Environmental Science (Vol. 892, No. 1, p. 012043). IOP Publishing.

Lykogianni, M., Bempelou, E., Karamaouna, F., & Aliferis, K. A. (2021). Do pesticides promote or hinder sustainability in agriculture? The challenge of sustainable use of pesticides in modern agriculture. Science of the Total Environment, 795, 148625.

Materia, V. C., Linnemann, A. R., Smid, E. J., & Schoustra, S. E. (2021). Contribution of traditional fermented foods to food systems transformation: value addition and inclusive entrepreneurship. Food Security, 13(5), 1163-1177.

McAlpine, R. G., Sacchet, M. D., Simonsson, O., Khan, M., Krajnovic, K., Morometescu, L., & Kamboj, S. K. (2024). Development of a digital intervention for psychedelic preparation (DIPP). Scientific Reports, 14(1), 4072.

Meena, R. K., & Mishra, P. (2020). Bio-pesticides for agriculture and environment sustainability. Resources use efficiency in agriculture, 85-107.

Muchaku, S., & Magaiza, G. (2023). Contemporary narratives on climate-induced migration and community engagement interventions in rural communities: A systematic literature review. African Journal of Higher Education Community Engagement, 1(1), 83-96.

Munawaroh, L., Wirman, S. P., Fitrya, N., Syahputra, R. F., & Gesriantuti, N. (2023). A novel approach for automated rhinoceros beetle control in oil palm replanting: pineapple peel-derived pheromone trap. Jurnal Ilmiah Pertanian, 20(3), 200-208.

Mutamima, A., Fadli, A., Purnama, I., Azis, Y., & Izzuddin, M. S. (2023a). Exploring the potential of fermented papaya as a functional ingredient for sourdough bread: a study on fermentation time and quality of sourdough donuts. Jurnal Ilmiah Pertanian, 20(1), 51-60.

Mutamima, A., Fadli, A., Purnama, I., Azis, Y., Alfarisi, C. D., Rahayu, N. P., & Januhandika, E. (2023b). Effect of Drying Method on the Production of Dehydrated Sourdough Starter from Fermented Papaya (Carica papaya L). Journal of Traditional and Indigenous Food, 1(1), 6-12.

Nekouei, M., Tehrani, F. J., Vasli, P., & Nasiri, M. (2024). The effect of seven-step educational strategy on knowledge of diabetic foot ulcer prevention, critical thinking and self-efficacy of nursing students: A randomized controlled trial. Nurse Education Today, 137, 106164.

Ngalimat, M. S., Mohd Hata, E., Zulperi, D., Ismail, S. I., Ismail, M. R., Zainudin, N. A. I. M., Saidi, M. B., & Yusof, M. T. (2023a). A laudable strategy to manage bacterial panicle blight disease of rice using biocontrol agents. Journal of Basic Microbiology, 63(11), 1180-1195.

Ngalimat, M. S., Hata, E. M., Zulperi, D., Ismail, S. I., Ismail, M. R., Zainudin, N. A. I. M., Saidi, M. B., & Yusof, M. T. (2023b). Induction of systemic resistance in rice plants against Burkholderia glumae infection by bioformulation of Streptomyces spp. under greenhouse conditions. Biological Control, 184, 105286.

Novianti, F., Sasaki, N., Arie, T., & Komatsu, K. (2021). Acibenzolar-S-methyl-mediated restriction of loading of plantago asiatica mosaic virus into vascular tissues of Nicotiana benthamiana. Virus Research, 306, 198585.

Nyantakyi-Frimpong, H., & Kerr, R. B. (2017). Land grabbing, social differentiation, intensified migration and food security in northern Ghana. The Journal of Peasant Studies, 44(2), 421-444.

Partheepan, K., Musthafa, M. M., & Bhavan, T. (2024). Mitigating climate change and its impact on food security by integrating ecosystem services to agroecosystems in Sri Lanka. YSF Thematic Publication 2024, 377.

Purnama, I., Mutamima, A., Nelvia, N., Arini, A., Ihsan, F., & Yolanda, A. M. (2024a). Pestisida dalam Sistem Pertanian Tropis Berkelanjutan. Soega Publishing: Bojonegoro.

Purnama, I., Trisunaryanti, W., Wijaya, K., Mutamima, A., Oh, W. C., Boukherroub, R., & Aziz, M. (2024b). Multi-Pathways for Sustainable Fuel Production from Biomass Using Zirconium-Based Catalysts: A Comprehensive Review. Energy Technology, 12(2), 2300901.

Purnama, I., Syafrani, S., Mutamima, A., Saputra, R., Nasution, N., Amalia, A. (2024c). Edible Oilseeds Research - Updates and Prospects. In N. A. Anjum, A. Masood, S. Umar, & N. A. Khan (Eds.), Improving Edible Oilseed (Oil Palm) Health and Productivity: Integration of Sustainable Pest Management, Precision Farming, and Stakeholder Collaboration (pp. 1 – 33). IntechOpen. https://doi.org/10.5772/intechopen.114936

Purnama, I., & Mutamima, A. (2023). Pestisida dalam Produk Pertanian: Dampak, Analisis, dan Strategi Pengelolaan. Soega Publishing: Bojonegoro.

Purnama, I., M Malhat, F., Mutamima, A., Ihsan, F., & Amalia, A. (2023a). A comparative study on pesticide residue profiles in locally grown rice from conventional and sustainable agricultural methods. Jurnal Ilmiah Pertanian, 20(3), 219-231.

Purnama, I., Mutryarny, E., & Wijaya, R. T. (2023b). Avanzando en el Crecimiento de Porang (Amorphophallus muelleri) en Suelos Podzólicos Rojo-Amarillos: Un Análisis Experimental de la Interacción entre el Guano Sólido y el Fertilizante Orgánico Líquido. Idesia (Arica), 41(3), 9-14.

Puspita, F., Nugroho, T. T., & Saputra, R. (2022). Biological control agents potential and molecular identification of endophytic Trichoderma isolates originated from oil palm tissue against Ganoderma boninense Pat. Jurnal Ilmiah Pertanian, 19(2), 48-55.

Riyaz, M., Mathew, P., Zuber, S. M., & Rather, G. A. (2022). Botanical pesticides for an eco-friendly and sustainable agriculture: new challenges and prospects. Sustainable Agriculture: Technical Progressions and Transitions, 69-96.

Saidi, N. B., Al-Obaidi, J. R., & Fisol, A. F. B. C. (2023). Rigidoporus microporus and the white root rot disease of rubber. Forest Pathology, 53(1), e12794.

Satia, G. A. W., Firmansyah, E., & Umami, A. (2022). Perancangan sistem identifikasi penyakit pada daun kelapa sawit (Elaeis guineensis Jacq.) dengan algoritma deep learning convolutional neural networks. Jurnal Ilmiah Pertanian, 19(1), 1-10.

Singh, R., Singh, H., & Raghubanshi, A. S. (2019). Challenges and opportunities for agricultural sustainability in changing climate scenarios: a perspective on Indian agriculture. Tropical Ecology, 60, 167-185.

Tagwi, A., & Chipfupa, U. (2023). Participation of smallholder farmers in modern bioenergy value chains in Africa: opportunities and constraints. BioEnergy Research, 16(1), 248-262.

Takona, J. P. (2024). Research design: qualitative, quantitative, and mixed methods approaches. Quality & Quantity, 58(1), 1011-1013.

Utami, M., Yenn, T. W., Alam, M. W., Ravindran, B., Purnama, I., Hidayat, H., Dhetaya, F. N., & Salsabilla, S. N. (2024). Efficient photocatalytic bactericidal performance of green-synthesised TiO2/reduced graphene oxide using banana peel extracts. Heliyon, 10(4).

Waisundara, V. Y. (2020). Traditional functional food of Sri Lanka and their health significance. In Nutritional and Health Aspects of Food in South Asian Countries (pp. 143-158). Academic Press.

Wan, X., Li, Q., Zhang, G., Zhang, K., & Wang, Z. (2023). Sustainable collaborative innovation capability enhancement paths of marine ranching: Supernetwork analysis perspective. Ocean & Coastal Management, 231, 106387.

Wang, H., Zhang, S., Bi, X., & Clift, R. (2020). Greenhouse gas emission reduction potential and cost of bioenergy in British Columbia, Canada. Energy Policy, 138, 111285.

Waters-Bayer, A., Kristjanson, P., Wettasinha, C., van Veldhuizen, L., Quiroga, G., Swaans, K., & Douthwaite, B. (2015). Exploring the impact of farmer-led research supported by civil society organisations. Agriculture & Food Security, 4, 1-7.

Worku, A. A. (2019). Factors affecting diffusion and adoption of agricultural innovations among farmers in Ethiopia case study of Ormia regional state Westsern Sewa. International Journal of Agricultural Extension, 7(2), 137-147.

Xie, H., Huang, Y., Chen, Q., Zhang, Y., & Wu, Q. (2019). Prospects for agricultural sustainable intensification: A review of research. Land, 8(11), 157.