



Solar-Powered Insect Trap Lamp to Support Food Security for Vegetable Farmers at BBPP Lembang, Bandung

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ABSTRACT

The excessive use of chemical pesticides in vegetable cultivation has negative impacts on both the environment and human health. This community service activity aimed to introduce and implement a solar-powered insect trap (solar light trap) as an environmentally friendly alternative for pest control. The program was carried out in collaboration with the Sugih Mukti Farmers Group under the guidance of BBPP Lembang, Bandung. The applied methods included training, joint assembly of the device with students, as well as demonstration and handover of the tool to farmers. The results showed that this technology received positive responses from the farmers and has the potential to reduce pesticide use. Furthermore, the tool's effectiveness was monitored to support a scientific publication. This activity represents a concrete step in applying appropriate technology to improve the quality of environmentally friendly agriculture.

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A. INTRODUCTION

Agriculture is a strategic sector in maintaining national food security; however, it faces various challenges such as climate change, environmental degradation, and attacks from plant pests and diseases (particularly insect pests) The use of synthetic pesticides has become the primary solution for farmers in controlling pests, but it potentially generates negative impacts on the environment and human health . In addition, pesticide residues left on crops can contaminate soil and water as well as induce pest resistance.

According to data from the Ministry of Agriculture, pesticide use has increased by an average of 4–6% per year in horticultural commodities such as vegetables. Indiscriminate use of pesticides has led to a decline in insect biodiversity, including natural predators of insect pests. Therefore, environmentally friendly and sustainable pest management approaches are required, one of which is the use of light traps for insect control.

A light trap is a device that uses a light source to attract insects into a trap without chemical substances. This technology has been proven effective in controlling populations of certain insects, such as *Noctuidae* and *Aphididae*, and it can be widely applied in organic farming. In practice, light traps can be combined with renewable energy such as solar panels, thus supporting the principles of energy efficiency and sustainability.



Solar panels are one of the renewable energy sources that have been widely used in modern agricultural systems, especially in areas with limited access to electricity. The use of solar panels as a power source for insect trap systems offers advantages in terms of efficiency, portability, and energy independence. This technology is highly relevant for application in agricultural areas such as Lembang–Bandung, which has high solar radiation potential and significant needs for pest control in horticultural crops.

The Agricultural Training Center (BBPP) Lembang, as a national agricultural education hub, has farmer groups that are actively engaged and open to appropriate technological innovations. Collaboration between higher education institutions and BBPP Lembang in the form of community service programs is expected to provide concrete solutions in technology transfer, farmer empowerment, and the enhancement of environmentally friendly agricultural practices .

This activity aims to implement solar-powered light trap technology for farmer groups under BBPP Lembang, as well as to measure its impact on reducing insect pest populations in vegetable farming areas. Through a participatory approach and hands-on training, this program is expected not only to transfer technology but also to raise farmers' awareness of the importance of sustainable agriculture.

B. METHODS

This community service activity employed a participatory and problem-solving approach, developed through the synergy between academics, students, and farmer groups. The methodological stages were systematically carried out, starting from the identification of partner needs to training and tool evaluation.

The implementation method consisted of the following stages:

1. Survey and Problem Identification

The team conducted field visits to the *Sugih Mukti* Farmers Group to understand land characteristics, types of cultivated crops, and pest problems faced by farmers. This activity was also used to determine the design of the device that best suited field conditions.

2. Design and Fabrication of the Device

Based on the survey results, the team designed a portable and weather-resistant light trap powered by solar panels. The assembly was conducted in two locations: Jakarta for the electronic components and Bandung for final assembly and testing.

3. Training and Technical Assistance

A two-day training program was conducted, covering:

- Theoretical materials on renewable energy and solar panel conversion,
- Demonstrations on assembly and installation of the device,
- Simulations on maintenance and troubleshooting.

4. Field Implementation

Two units of the light trap were installed at strategic locations in the partner's farming area. The placement of the devices was determined based on pest distribution and the need for nighttime lighting.

5. Handover and Initial Monitoring

The devices were symbolically handed over to the head of the farmers' group,



accompanied by official handover documents. The activity continued with initial observation and performance recording of the devices.

6. Effectiveness Monitoring Plan

Monitoring activities were carried out by recording the number of insects trapped over one month to evaluate the effectiveness of the devices.

C. RESULTS AND DISCUSSION

The initial stage of the activity began with a field survey in April 2025 at the agricultural area of the *Sugih Mukti* Farmers Group, Cikole Subdistrict, Lembang, West Bandung. The survey was conducted to identify land conditions, farmers' needs, and the potential for implementing insect trap technology. The results showed that pest attacks, such as caterpillars and nocturnal insects (*Noctuidae*), were among the main challenges in vegetable cultivation, particularly mustard greens, cabbage, and lettuce.

Based on interviews with the head of the farmers' group, it was found that farmers were still highly dependent on chemical pesticides, which were applied routinely every 5–7 days. This raised concerns about pesticide residue impacts and the high cost of production. Some farmers also reported limited knowledge of more environmentally friendly pest control alternatives. In addition, restricted access to electricity in the fields at night was identified as another obstacle to using conventional energy-based devices.

These findings formed the basis for the team to design a solar-powered light trap device that could effectively capture insect pests while being energy-independent and environmentally friendly. The survey results were also used to determine the device design, installation sites, and educational strategies for the farmers.

The community service program was subsequently implemented as planned, including the design and assembly of the devices in collaboration with students of the MTTE Study Program at PNJ, reinforcing both educational aspects and academic involvement. Five units of light traps were successfully installed on the partner's farmland, with placement determined based on farmers' and agricultural extension officers' recommendations to cover the most pest-prone planting areas.

Farmers showed strong enthusiasm for this innovation. The two-day technical training provided a comprehensive understanding of the device's working principles, solar panel maintenance, and how to interpret the insect capture patterns. The hands-on demonstration served as an effective medium of knowledge transfer, as it included direct field practice.

The presence of representatives from the West Bandung Regency Food and Agriculture Agency and BBPP Lembang underscored institutional support for this appropriate technology innovation. During the official handover ceremony, collaborative commitment between the university and local institutions was reaffirmed to ensure program sustainability.

However, several technical challenges were encountered, including:

- **Difficult field access**, particularly during the rainy season, which complicated the mobilization of devices. This was resolved by hiring local motorcycle taxis (*ojek*).
- **Delays in shipping specific components** (such as PCBs) from abroad, required schedule adjustments. The team mitigated this by sourcing components in parallel from two cities (Jakarta and Bandung).
- **Separate assembly and deployment locations**, which made logistics more complex, but this was overcome by renting cargo transport services.



As part of the evaluation of the technical training, the implementation team conducted pre-tests and post-tests with participants from the *Sugih Mukti* Farmers Group. The objective was to measure improvements in participants' understanding of solar energy, the use of the light trap device, and its maintenance and function in pest control.

The test instrument consisted of 10 multiple-choice questions covering three aspects:

1. Basic knowledge of renewable energy (solar panels),
2. Technical understanding of the light trap device,
3. Device maintenance and troubleshooting.

Comparative Analysis of Pre-Test and Post-Test Results

The evaluation of pre-test and post-test outcomes is an essential step in assessing the effectiveness of a training program. By comparing these results (Fig.1), it is possible to determine the extent to which the training has succeeded in improving participants' understanding and skills. This analysis includes a comparison of average scores, data variability, statistical test results, and an in-depth interpretation of the observed trends.

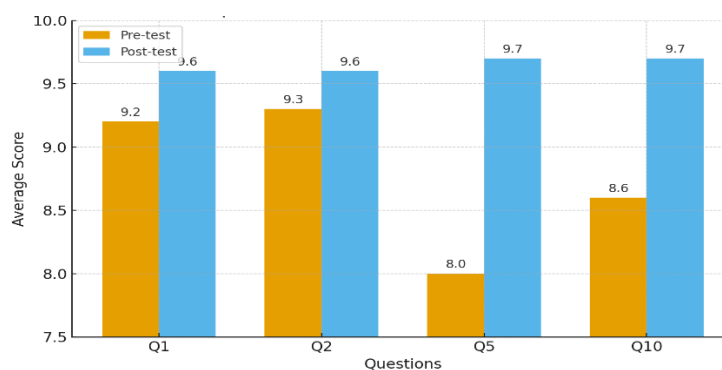


Figure 1. The visual comparison of pre-test vs. post-test scores

Participants already had a strong understanding before training. The post-test shows a slight increase (from ~9.2–9.3 to 9.6), meaning the training reinforced knowledge but did not drastically change it (Question 1 and Question 2 \geq 9.2 pre-test). These topics had a weaker initial understanding. Post-test results show a more notable increase (up to 9.7), indicating that training effectively improved comprehension where it was most needed, from Questions 5 and 10 (lower baseline: 8.0–8.6). Despite average increases, the wide standard deviation suggests uneven improvements across participants; some improved greatly, while others showed little change. From a practical standpoint, the training succeeded in raising knowledge levels, especially on weaker topics. However, the lack of statistical significance means that results should be interpreted cautiously, and follow-up training with larger samples is recommended.

The pre-test was conducted before the training to measure participants' initial knowledge. Based on the data analysis, the average pre-test scores for fifteen questions ranged from 8.0 to 9.5. This indicates that the majority of participants already had a fairly good baseline understanding of the tested material.



Some questions, such as Question 1 and Question 2, recorded relatively high average scores (around 9.2–9.3). This suggests that the topics assessed in these items were already well understood by participants even before the training began. Conversely, several questions received lower average scores, such as Question 5 and Question 10, which ranged from 8.0 to 8.6. These differences indicate that although most participants had a solid basic knowledge, there were still areas that required further reinforcement.

In addition to the averages, the standard deviation of the pre-test scores ranged between 17 and 21, reflecting considerable variation among participants. In other words, while some participants demonstrated high levels of understanding, others showed relatively low comprehension. This condition highlights the need for adaptive training strategies that can effectively address the varying levels of participants' knowledge.

The post-test was conducted after the training to evaluate the direct impact of the activity. The analysis showed that the average post-test scores ranged from 9.0 to 9.7. Score improvements were observed in almost all questions. For example, Question 2, which initially had a score of 8.6 in the pre-test, increased to 9.6 in the post-test, while Question 10 rose from 8.08 to 9.7.

Some questions that had already scored high in the pre-test, such as Question 1, also showed improvement, although relatively small (from 9.26 to 9.60). This indicates that the training not only benefited participants who initially had lower levels of understanding but also reinforced the knowledge of those who were already proficient in the material.

However, the standard deviation of the post-test scores remained in the same range as the pre-test (around 17–21). This suggests that variation in participants' understanding persisted. Although the average scores improved, individual differences remained considerable.

When compared directly, the post-test results demonstrate a positive trend:

- The average scores increased in almost all questions, with the most notable improvements found in questions with lower pre-test scores.
- The variation in scores remained high, indicating that although the training successfully raised the overall average understanding, equal comprehension among participants was not fully achieved.

However, based on the results of the paired *t*-test, these improvements were not statistically significant. The *p*-values for all questions were greater than 0.05, meaning there is no strong statistical evidence that the observed increases were not due to chance. This can be attributed to several factors:

1. A limited sample size, making it difficult for small differences to reach statistical significance.
2. High variability among participants, which caused the data to be more dispersed.
3. The short duration of the training resulted in impacts that were not large enough to be statistically detectable.

Nevertheless, from a practical perspective, the increase in average scores still carries important value. In the context of training, positive changes in scores, even if not statistically significant, still indicate a meaningful improvement in participants' understanding. From the analysis, several important interpretations can be drawn:



a. Positive Impact of the Training

The increase in average scores from pre-test to post-test indicates that the training successfully enhanced participants' understanding. Participants who initially had lower scores tended to show greater improvement, particularly in questions related to fundamental concepts explained during the training.

b. Heterogeneity of Participants

The high variation in scores reveals gaps in participants' knowledge levels. This suggests that the training methods should be designed to accommodate diverse levels of understanding. For instance, participants with higher comprehension could be provided with advanced materials, while those with lower comprehension should receive reinforcement of basic concepts.

c. Need for Further Evaluation

Since the observed improvement was not statistically significant, follow-up evaluations are necessary to determine whether the training has a clearer long-term impact. For example, administering a follow-up test a few weeks after the training could help measure knowledge retention.

D. CONCLUSION

Overall, the comparison of pre-test and post-test results shows a trend of improved participant understanding after the training, although the increase was not statistically significant. The pre-test indicated that participants possessed fairly good but varied baseline knowledge, while the post-test demonstrated an overall improvement in understanding, particularly on topics that were initially weaker. Nevertheless, the variation among participants remained high, which should be taken into account when designing future training programs. The fact that the improvement was not statistically significant does not imply that the training failed; rather, it highlights the need for strategic adjustments to maximize the effectiveness of future training initiatives.

For improvement in future activities, several points should be considered: Increase Training Intensity. The duration and depth of the training materials should be enhanced, particularly on topics that had lower pre-test scores., Use Interactive Learning Methods, Practice-based approaches, group discussions, and simulations can strengthen participants' understanding and reduce gaps in comprehension among individuals, Provide Differentiated Training Materials, Materials should be tailored to participants' levels of understanding, for example, by offering separate classes for basic and advanced learners., Conduct Follow-Up Post-Tests: Administer additional post-tests a few weeks after the training to measure participants' knowledge retention and evaluate long-term effectiveness. Improve Evaluation Instruments: Revise questionnaire items to make them more sensitive in detecting smaller but meaningful changes in knowledge. Increase Participant Numbers. With a larger sample size, statistical analyses will be more accurate and have greater power to detect significant differences.



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F. AUTHOR CONTRIBUTIONS

List the contributions of all team members to the community engagement activities and the article writing process. Activity implementation: NS, YG, ATA, IS, AD, PO, Article preparation: PO, MKD, Impact analysis: PO, NS, IS, Results presentation: MKD, MD Article revision: PO.

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