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Assistance in Implementing a Solar-Powered Ultrasonic Pest Repellent for the Sekar Murni Farmer Group, Semawot Village

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Abstract

Rat infestations remain a major challenge affecting rice productivity in rural agricultural areas. This community service program aimed to improve farmers' knowledge and technical skills in implementing a solar-powered ultrasonic pest repellent equipped with an automatic light sensor as a safer and more environmentally friendly alternative for rat control. The program involved 15 representatives of the Sekar Murni Farmers' Group in Semawot Village, Bojonegoro Regency, and was conducted through observation, outreach, hands-on training, and evaluation using pre-test, post-test, and participant satisfaction questionnaires. The average participant score increased from 53.2 to 86.6, with an N-Gain of 71.3%, indicating a high level of knowledge improvement. During field implementation, the device operated reliably under actual rice field conditions, and farmers informally reported reduced rat activity around the installation area, although these observations were not quantitatively verified. Participants also expressed positive acceptance of the technology because of its ease of operation and environmental safety. The integration of solar energy and automatic day-and-night operation distinguishes this program from previous community service initiatives. Overall, the program improved farmers' knowledge, encouraged initial technology adoption, and demonstrated the potential of sustainable pest management to support agricultural productivity.

Keywords: *solar-powered ultrasonic pest repeller; rice field rats; farmers' group; community service; agricultural technology*

Introduction

Agriculture plays a vital role in Indonesia's development and economy (Pratiwi, 2013; Setiani et al., 2021). Supported by its tropical climate, Indonesia

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produces various food crops, including rice, corn, soybeans, peanuts, and cassava (Arifandi et al., 2021). The agricultural sector contributes significantly to the country's Gross Domestic Product (GDP) and is the primary source of livelihood for most of the population. With a land area of approximately 1.9 million square kilometers, much of which is suitable for agriculture (Anggreani et al., 2023). Indonesia has considerable agricultural potential. However, crop productivity remains threatened by various challenges, particularly the rice field rat (*Rattus argentiventer*), which attacks rice from the nursery stage to harvest and causes substantial yield losses (Safitri et al., 2025). Besides consuming crops, rats damage plant roots, contaminate agricultural land, transmit diseases, and may ultimately lead to crop failure (Ratković et al., 2026).

The Sekar Murni Farmers' Group in Semawot Village, Sukosewu Subdistrict, Bojonegoro Regency, has also experienced persistent rat infestations. Semawot Village covers approximately 86.557 hectares and consists of one RW and four RT. with most residents relying on rice farming as their primary livelihood. Preliminary observations and interviews indicated that rat infestations frequently occur during the vegetative and grain-filling stages, reducing rice yields and increasing pest control costs. Although quantitative estimates of crop losses were unavailable, farmers consistently identified rats as one of the main constraints to agricultural productivity, consistent with previous studies reporting substantial yield losses and even crop failure due to rodent attacks (Azi Kurnawan et al., 2024; Raidar et al., 2023). Most farmers still rely on conventional pest control methods, such as poison, traps, and electric currents (Tijaniyah & Sabda Alam Arzenda, 2022), despite the serious safety risks associated with electrical methods in rice fields (Trianto & Ridwana, 2023). These conditions highlight the need for safer and more environmentally friendly pest management strategies.

With the advancement of agricultural technology, farmers can perform pest management more efficiently (Manurung et al., 2022). Electronic pest repellents are devices that use electromagnetic or ultrasonic waves to repel various insects and pests (Awal et al., 2025). Ultrasonic waves cause stress in insects and animals and are biologically safe for humans because they fall outside the human hearing range (Awal et al., 2024). Mice possess highly sensitive hearing to ultrasonic waves, with a hearing range spanning approximately 5–60 kHz (Choifin et al., 2023; Williams et al., 2008). To support continuous operation in agricultural fields, these devices can be powered by solar panels, which are well suited to Indonesia's abundant solar energy resources (Ariprihata et al., 2023; Aziz et al., 2025; Raidar et al., 2023).

Several previous studies have demonstrated the potential of ultrasonic technology as a safer and more environmentally friendly alternative for rodent pest control. Triyani et al. (2024) developed an ultrasonic and microcontroller-based rodent repellent capable of automatically generating repellent frequencies, while (Sihotang & Simbolon, 2024) designed an energy-efficient ultrasonic device suitable for open agricultural environments. Furthermore, Sihotang and Rizky (2025) reported that an ultrasonic and IoT-based rodent repellent system could reduce the intensity of rodent infestations in agricultural fields. These findings confirm the potential of ultrasonic technology as an effective and environmentally friendly solution for rodent control. However, previous studies have mainly emphasized prototype development and technical performance, with limited attention to farmers' knowledge, operational skills, equipment maintenance, and long-term technology adoption. Consequently, conventional pest control methods continue to dominate farming practices in many rural areas despite the availability of safer technological alternatives.

Although numerous studies have demonstrated the effectiveness of ultrasonic pest repellents, their adoption among farmers remains limited due to inadequate technical knowledge, limited training opportunities, and continued reliance on conventional pest control methods. Consequently, many farmers, including the Sekar Murni Farmers' Group in Semawot Village, have not fully utilized this technology despite its potential benefits. To address these challenges, this community service program provided outreach, practical demonstrations, and hands-on training to improve farmers' knowledge and technical skills in operating ultrasonic pest repellent devices as a safer and more environmentally friendly alternative for rat control (Pratiwi & Irayani, 2023). The novelty of this program lies in implementing a solar-powered ultrasonic pest repellent equipped with an automatic light sensor, combined with community-based assistance to support technology adoption in rural agricultural areas with limited electrical infrastructure, unlike previous studies that mainly emphasized hardware development or IoT-based monitoring (Vikri & Rokhmah, 2022). Through this approach, the program is expected to promote the sustainable adoption of environmentally friendly pest management practices and improve agricultural productivity in Semawot Village.

Methods

The community service program was implemented through four stages: observation and problem identification, outreach, training, and evaluation. The program involved 15 representatives of the Sekar Murni Farmers' Group, who were selected by the group leader based on their active involvement in rice farming and willingness to participate. These representatives were expected to disseminate the acquired knowledge and skills to other group members. The implementation flow is presented in Figure 1.

Figure 1. Flowchart of the community service activity implementation method

Observation and Problem Identification

The initial phase of the study involved direct observation of the rice fields and discussions with members of the Sekar Murni Farmers' Group. This was done to assess the situation and identify issues, including the state of agriculture, the severity of rat infestations, and the pest control methods currently used by farmers (Nurmalisa Lisdayana et al., 2026). The results of the observations showed that farmers were still using conventional methods to eradicate or repel rat pests.

Outreach on Ultrasonic Pest Repellent Technology

Before the device was implemented directly on farmers' fields, the research team conducted outreach activities through meetings with the local farming community (Adzkiya et al., 2025). The outreach activities were carried out through lectures and interactive discussions with members of the farmers' group. The material presented covered the types and impacts of rat pests on rice crops, the working principles of ultrasonic waves, the benefits of using ultrasonic pest repellents, the advantages of the device over conventional methods, and how to use the device safely and in an environmentally friendly manner. At this stage, participants were also educated on the importance of utilizing modern agricultural technology to improve the effectiveness of pest control.

Training on the Use of Equipment

The community service team provided hands-on training on installing, operating, placing, and maintaining the ultrasonic pest repellent devices. The devices emit ultrasonic waves at frequencies of 40–48 kHz, which disrupt rats' hearing and behavior while remaining inaudible to humans (Wahyuni & Ningsih, 2021). They are powered by a solar energy system consisting of a solar panel, charge controller, and a 12 V 10 Ah rechargeable lithium battery, enabling operation for more than 12 hours without sunlight. The devices are also equipped with an automatic light sensor for day-and-night operation and have an effective coverage distance of approximately 75 m in open-field conditions. Through this practical training, farmers were expected to operate and maintain the devices independently.

Activity Evaluation

The effectiveness of the community service program was evaluated using two instruments. The first consisted of pre-test and post-test assessments covering five indicators: understanding of rat infestation impacts, safe pest control methods, ultrasonic technology, device operation, and the benefits of ultrasonic pest repellent devices. The second consisted of a participant satisfaction questionnaire containing six statements evaluated using a four-point Likert scale (Strongly Agree, Agree, Neutral, and Disagree).

Both instruments were developed based on the outreach objectives and materials and underwent expert review by two academic members of the community service team to ensure content validity, clarity, and consistency before implementation. Pre-test and post-test data were analyzed using the Normalized Gain (N-Gain) method because it measures improvements in participants' knowledge while considering their initial level of understanding. Satisfaction questionnaire responses were analyzed descriptively using response percentages (Budiardi et al., 2025). Qualitative observations recorded through field notes during outreach and training were also analyzed descriptively to complement the quantitative findings. To measure the effectiveness of the activities in a more standardized manner, the Normalized Gain (N-Gain) was calculated using the formula:

$$N - Gain = \frac{(Post-Test\ Score - Pre-Test\ Score)}{(Maximum\ Score - Pre-Test\ Score)} \quad (1)$$

The N-Gain values were classified as high ($g \geq 0.70$), moderate ($0.30 \leq g < 0.70$), and low ($g < 0.30$), following the categorization proposed by Hake (1998), which continues to be widely adopted in recent educational research (Tasripin et al., 2024). This community service program did not include a control group or long-term monitoring. Therefore, the findings primarily reflect immediate improvements in participants' knowledge, satisfaction, and initial technology adoption rather than long-term impacts on rat infestation control (Pratomo et al., 2025).

Results and Discussion

A community service program entitled "Assistance in the Implementation of Ultrasonic Pest Repellents for the Sekar Murni Farmers' Group in Semawot Village" was conducted on May 26, 2026, with the participation of members of the Sekar Murni Farmers' Group. Figure 2 depicts the community service activity carried out in collaboration with the Sekar Murni Farmers' Group. The activity aimed to enhance farmers' knowledge and skills in utilizing ultrasonic wave-based pest repellent technology as a safer and more effective alternative for rat pest control.

Figure 2. Community service activities with the Sekar Murni farmers' group

There were 15 participants in the community service activity, all of whom were representatives of the Sekar Murni Farmers' Group in Semawot Village, Sukosewu Subdistrict, Bojonegoro Regency. The selection of the 15 participants was made in coordination with the farmers' group leadership to ensure the effectiveness of the mentoring process. The program consisted of an awarenessraising phase, training on the use of tools, and an evaluation using pre- and post-tests as well as a participant satisfaction survey.

Implementation of Outreach Activities

The activity began with an awareness session for members of the Sekar Murni Farmers' Group on the impacts of rat infestations on rice production and the importance of applying modern technology for pest control. As shown in Figure 3, Mr. Muhammad Jauhar Vikri, M.Kom., delivered a presentation covering the impacts of rat infestations, the risks of conventional pest control methods, the principles of ultrasonic technology, and the safe and effective use of ultrasonic pest repellent devices. Through this outreach activity, participants were expected to gain a better understanding of safer and more environmentally friendly alternatives for rat pest management.

Figure 3. Demonstration of a pest repellent device

Ultrasonic pest repellents provide a safer and more environmentally friendly alternative because they do not rely on chemicals or open electrical circuits. The devices emit high-frequency sound waves that disrupt rats' hearing and behavior, encouraging them to leave the rice fields. During the outreach session, participants asked whether the ultrasonic waves could affect humans, livestock, or beneficial animals, as well as about the device's effectiveness in open-field conditions and its operation during cloudy weather. These questions reflected participants' limited prior knowledge of ultrasonic technology, which was addressed through explanations of the device's operating principles, safety, and practical advantages.

Figure 4. Assistance with the implementation of pest repellents

Figure 4 shows the training session on the use of the ultrasonic pest repellent, during which the community service team explained the device components, operating principles, installation, operation, and maintenance. Participants also received hands-on demonstrations to activate and use the device. The ultrasonic pest repellent emits sound waves at frequencies of 40–48 kHz, which disrupt rats' hearing and behavior, helping to reduce rat activity in rice fields. During the training, participants observed the device operation, asked questions, and discussed its application in their fields. By the end of the session, most participants were able to independently install, operate, and maintain the device. Although some initially experienced minor difficulties in positioning the solar panel and connecting the battery system, these issues were resolved through repeated demonstrations and direct guidance.

Figure 5. Installation of the solar-powered ultrasonic pest repellent in the rice field

As shown in Figure 5, the ultrasonic pest repellent was successfully installed and operated under actual rice field conditions. The solar-powered system supplied sufficient energy for continuous operation, while the automatic light sensor enabled autonomous operation according to ambient light conditions. Direct field observations confirmed stable device operation throughout the implementation period, indicating that the proposed technology is technically feasible for field application. Participating farmers also informally reported reduced rat activity around the installation area, suggesting the device's potential effectiveness under field conditions; however, these observations were not quantitatively verified. Compared with conventional pest control methods that rely on poison or electric traps, the ultrasonic device provides a safer and more environmentally friendly alternative because it operates without chemicals and is powered by solar energy. However, this community service program did not quantitatively evaluate reductions in rat populations, crop damage, or rice productivity; therefore, the present findings primarily demonstrate the technical feasibility and initial acceptance of the technology rather than its long-term biological effectiveness.

Pre-Test and Post-Test Results

To assess participants' understanding, pre-test and post-test evaluations were conducted involving 15 participants. The pre-test measured participants' initial knowledge before the outreach activities, while the post-test assessed their understanding after the mentoring program. The evaluation covered the impacts of rat infestations, safe pest control methods, ultrasonic technology, device operation, and the benefits of ultrasonic pest repellents for environmentally friendly pest management.

Table 1. Participants' pre-test and post-test results

Assessment Indicator	Pre-Test Score	Post-Test Score
Understanding the Impact of Rats	72	90
Knowledge of safe pest control methods	58	87
Understanding Ultrasonic Wave Technology	45	88
Ability to use tools	42	83
Understanding the Benefits of Ultrasonic Devices	49	85
Average	53.2	86.6

Based on the pre-test and post-test results in Table 1, participants' average score increased from 53.2 to 86.6, indicating improved understanding after the community service activities. To determine the effectiveness of the outreach and mentoring program, the improvement was further analyzed using the Normalized Gain (N-Gain) based on the average pre-test and post-test scores, as follows:

$$N - Gain = \frac{(86.6 - 53.2)}{(100 - 53.2)} = \frac{33.4}{46.8} = 0.713 \quad (2)$$

$$N - Gain = 0,713 \times 100\% = 71,3\% \quad (3)$$

Based on the average pre-test and post-test scores, the N-Gain value was 0.713 (71.3%), indicating a high level of learning improvement according to the adopted classification. These findings indicate that the outreach and mentoring activities effectively improved participants' knowledge of ultrasonic pest control and device operation. Participants already had relatively good initial knowledge of the impacts of rat infestations, as reflected by the highest pre-test score (72). In contrast, understanding of ultrasonic technology, device operation, and its benefits was relatively low before the program. The largest improvement was observed in understanding ultrasonic technology, which increased from 45 to 88, followed by participants' ability to operate the device, which increased from 42 to 83. These improvements were mainly attributed to the combination of theoretical explanations and hands-on demonstrations that allowed participants to directly observe and operate the device. Meanwhile, understanding of the impacts of rat infestations showed the smallest improvement because participants were already familiar with this issue through their farming experience.

The improvement in participants' knowledge and their positive responses toward the ultrasonic pest repellent indicate an encouraging level of initial technology acceptance. According to agricultural innovation diffusion theory, farmers are more likely to adopt new technologies when they understand the benefits, perceive the technology as easy to use, and have opportunities to observe and practice its application directly. Therefore, the combination of theoretical outreach and hands-on demonstrations in this program not only improved participants' knowledge but also increased their confidence in applying ultrasonic pest control as an alternative to conventional methods.

Overall, the community service activity successfully enhanced the knowledge and skills of members of the Sekar Murni Farmers' Group in Semawot Village regarding the application of safer, more effective, and environmentally friendly pest control technologies. These findings demonstrate that combining theoretical outreach with practical demonstrations effectively improved both participants' conceptual understanding and technical skills. However, the present evaluation only measured short-term learning outcomes immediately after the training. Further monitoring is required to determine whether these knowledge gains lead to sustained behavioral changes in pest management practices. Although behavioral changes were not formally evaluated, several participants stated their intention to adopt the ultrasonic pest repellent as an alternative to poison and electric traps during future planting seasons, indicating positive initial acceptance of the technology.

Figure 6. Completing the questionnaire

In addition to the pre-test and post-test, Figure 6 shows that the activity was also evaluated through the distribution of a questionnaire to gauge participant satisfaction with the implementation of the community service activity.

Table 2. Results of the participant satisfaction survey

Assessment Indicator	Strongly Agree	Agree	Enough	Disagree
The informational materials are easy to understand	8	6	1	0
Easy-to-use pest repeller	8	6	1	0
Useful mentoring activities	10	5	0	0
Ultrasonic technology is safer than conventional methods	11	4	0	0
The device has the potential to help reduce the rat population	8	6	1	0
Participants are interested in using the device	9	5	1	0

Based on the questionnaire results presented in Table 2, the majority of participants responded positively to the community service activities. For the indicator "Ultrasonic technology is safer than conventional methods," 11 out of 15 participants (73.3%) strongly agreed and 4 participants (26.7%) agreed. These results indicate that participants considered ultrasonic technology to be a safer alternative to conventional pest control methods such as poison, traps, and electric currents commonly used in rice fields.

Similarly, for the indicator "Useful mentoring activities," 10 participants (66.7%) strongly agreed and 5 participants (33.3%) agreed. Most participants also agreed that the outreach materials were easy to understand and that the ultrasonic pest repellent was relatively easy to operate. These findings suggest that participants' satisfaction was primarily influenced by the practical training sessions, the simplicity of device operation, and the perceived benefits of the technology as a safer alternative to conventional rat control methods.

Overall, participants responded positively to all aspects of the community service program, and no participants expressed disagreement with any assessment indicator. However, one participant selected a neutral response for several indicators, including the clarity of the outreach materials, ease of device operation, the potential effectiveness of the device, and willingness to use it. Based on informal discussions after the training, the participant preferred to observe the device under actual field conditions before making a final evaluation. This indicates that farmers' acceptance was influenced not only by the quality of the training but also by their confidence in the device's long-term performance under actual farming conditions. This suggests that although the technology was generally well accepted, some farmers remained cautious and required practical experience before forming a definitive opinion. Overall, the program increased participants' awareness of environmentally friendly pest control and strengthened their acceptance of ultrasonic technology.

Nevertheless, this community service program was limited to 15 representatives from a single farmer group and evaluated only short-term improvements in knowledge and participant satisfaction without a control group or long-term monitoring. Future community service programs should involve larger participant groups, include a control group where feasible, and conduct longer field monitoring with quantitative measurements of rat populations, crop damage, and rice productivity to better evaluate the long-term effectiveness of ultrasonic technology.

Conclusion

The community service program on the use of ultrasonic pest repellents for the Sekar Murni Farmers' Group in Semawot Village successfully improved participants' knowledge and understanding of ultrasonic-based rat control. Participants' average score increased from 53.2 in the pre-test to 86.6 in the post-test, with an N-Gain of 71.3%, indicating a high level of learning improvement. Participants also showed positive acceptance of ultrasonic pest repellents as a safer and more environmentally friendly alternative to conventional pest control methods. To enhance the sustainability and broader adoption of this technology, universities should continue providing technical assistance and periodic training, while agricultural extension services and local government agencies should facilitate technology dissemination and field implementation. Future programs should include long-term monitoring of rat populations, crop damage, and rice productivity to evaluate the practical effectiveness of ultrasonic pest repellent technology under real farming conditions.

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