Abdimas Umtas: Jurnal Pengabdian Kepada Masyarakat
LPPM-Universitas Muhammadiyah Tasikmalaya
Volume: 8, Issue: 4, October, 2025; pp: 2381-2391
E-ISSN: 2614 - 8544

Nethouse Technology for Potato Seed Production: Empowering Farmers in Sedaeng Village

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ABSTRACT

This Community Partnership Program (PKM) aimed to enhance the productivity, independence, and technical capability of the Laksmana Agrobisnis Farmer Group in Sedaeng Village, Tosari, Bromo, through the application of nethouse technology for potato seedling propagation. Before the intervention, seedling production was conducted manually on household terraces, yielding only around 2,500 G0 seedlings per season with inconsistent quality, high susceptibility to disease, and elevated production costs. The introduction of a 6×8 m permanent nethouse, accompanied by structured technical training and mentoring, resulted in a tenfold increase in productivity, producing approximately 25,000 G0 and 10,000 G1 seedlings per cycle. Production costs decreased substantially from Rp 77,500,000 to Rp 8,550,000, generating an estimated cost efficiency and measurable profits for the group. The program was implemented over eight months using a participatory and applicative approach that combined counseling, demonstration, and mentoring. Farmers developed practical competencies in propagation techniques, nutrient management, and pest control, enabling independent and sustainable seed production. Land utilization efficiency also improved, with 10,000 m² of farmland previously underutilized now fully cultivated with uniform, high-quality seedlings. Beyond technical achievements, the program fostered gender-inclusive participation, strengthened group collaboration, and enhanced the community's ability to adopt innovation in local agribusiness practices. Overall, this PKM program demonstrates that the adoption of nethouse technology is both technically feasible and socio-economically empowering. It improves production efficiency, reduces dependency on external seed sources, and fosters long-term sustainability among highland potato farmers. The successful implementation in Sedaeng Village serves as a replicable empowerment model for other potato-producing regions in East Java and similar highland communities across Indonesia.

ARTICLE INFO

Article History:
Submitted/Received: 22-09-2025
First Revised: 12-10-2025
Accepted: 15-10-2025
First Available online: 31 October 2025
Publication Date: 31 October 2025

Keyword :
Nethouse Technology
Potato Seedling Propagation
Farmer Empowerment
Sustainable Agriculture
Rural Innovation

https://doi.org/10.35568/abdimas.v8i4.7197

INTRODUCTION

Potato (*Solanum tuberosum L*.) is one of Indonesia's most important horticultural commodities and a vital source of income for highland farming communities, particularly in Tosari, Bromo. The crop plays a crucial role in supporting food security and the regional economy. However, the sustainability of potato cultivation is often constrained by the limited availability of high-quality seed tubers and the inefficiency of local seed production systems. In many smallholder settings, farmers still rely on traditional terrace-based propagation methods with low yields, inconsistent quality, and high susceptibility to disease. The Laksmana Agrobisnis Farmer Group in Sedaeng Village faces these same challenges, which have hindered their ability to achieve seed self-sufficiency and economic sustainability.

Sedaeng Village is a traditional Tengger Bromo cultural tourism village, located within the Bromo Tengger Semeru National Park (TNBTS) area. Alongside tourism, agriculture—particularly potato cultivation—remains the main economic activity of the local community. Since 2017, the Laksmana Agrobisnis Farmer Group, led by Joni, has specialized in potato seed propagation from the G0 to G3 generations. However, limitations in technology, infrastructure, and management have hindered optimal performance. G0 propagation has been carried out on house terraces using simple methods with minimal care, resulting in low productivity of only 2,500–3,000 seeds per cycle, compared to the 14,000–15,000 seeds required per hectare. As a result, the deficit must be covered by purchasing seeds from other farmers at high prices, which increases costs and reduces independence. The group's primary challenges include low motivation for independent seed propagation, limited availability and distribution of high-quality seeds, the absence of a nethouse facility, the high price of G0 seeds, reliance on low-quality recycled seeds, and a lack of knowledge regarding tissue culture technology for superior seed production.

The core purpose of this community service program (PKM) was to assist the Laksmana Agrobisnis group in producing G0 potato mini-seedlings that can later be developed into G1, G2, and G3 generations using a simple yet effective nethouse system. The specific problems identified in collaboration with the partner group include: (1) a lack of motivation to initiate independent G0 seed propagation; (2) the unavailability of adequate facilities for quality seed procurement and distribution; (3) the absence of a dedicated seedling structure, resulting in suboptimal seedling growth; (4) limited access to high-quality seeds; (5) the high cost of G0 seeds, which are often unaffordable for small farmers; (6) the widespread use of recycled seed tubers from previous harvests that are low in quality and disease-prone; and (7) the farmers' limited knowledge of modern seed production technology. These interrelated challenges have contributed to low productivity, poor seed uniformity, and recurring economic losses in the local potato farming system. The main expected output of this program was to improve the efficiency and quality of potato seed production through the application of nethouse-based propagation technology, combined with structured technical training and entrepreneurship mentoring. The intervention focused on facilitating the construction of a 6×8 m nethouse, introducing standardized propagation methods, and providing continuous guidance on business development and promotional strategies. This integrated approach was designed to accelerate the production process, improve seedling quality, and foster sustainable agribusiness capacity among local farmers.

The selection of nethouse technology over other alternatives was based on its suitability for Sedaeng's unique agroclimatic conditions, located within the Bromo Tengger Semeru National Park (TNBTS) area. This highland region is characterized by unpredictable weather, frequent strong winds, and fluctuating temperatures that threaten open-field propagation. The nethouse system offers multiple advantages: it protects plants from excessive sunlight, heavy rainfall, and insect infestation, while

https://doi.org/10.35568/abdimas.v8i4.7197

maintaining a stable microclimate conducive to healthy seedling growth. Its structural strength, flexibility, and cost-effectiveness make it a practical solution for small-scale farmers with limited resources. As supported by Balitbangtan (2021) and Rahmawati et al. (2022), nethouse cultivation increases seedling survival rates and reduces pathogen exposure, providing a sustainable foundation for seed independence initiatives.

This program aligns with the concept of appropriate technology for empowerment, as emphasized by Kusdyah (2021) and Slamet (2018), which highlights that rural technological interventions must be simple, adaptive, and empowering. By integrating nethouse construction, seedling management training, and entrepreneurship capacity-building, this PKM initiative aims to strengthen the autonomy of the Laksmana Agrobisnis group, reduce dependency on external seed suppliers, and establish a replicable empowerment model for other highland potato producers in East Java.

FIGURE 1. Joni - leader of the Laksmana Agrobisnis Farmers Group - in one of the managed cultivation plots

Nethouse technology is widely recognized as an effective semi-controlled cultivation system that helps optimize plant growth by protecting crops from excessive sunlight, heavy rainfall, pest attacks, and strong winds. It maintains stable temperature and humidity levels, creating a conducive environment for vegetative development (Balitbangtan, 2021). The use of nethouses has been proven to reduce pest and disease infestations and improve the viability of horticultural seeds (Slamet, 2018). In potato cultivation, the use of G0 seed derived from tissue culture yields healthier, more productive plants with higher growth rates (Wattimena, 2010). For highland regions such as Tosari, where weather patterns are unpredictable and environmental stresses are frequent, the nethouse system provides an adaptive and cost-effective solution for maintaining seedling quality and survival (Rahmawati et al., 2022).

Potato seed production in Indonesia is typically divided into four stages—G0, G1, G2, and G3—each requiring specific technical conditions to ensure genetic purity and optimal productivity. However, the availability of certified G0 seeds remains limited due to high costs, limited infrastructure, and insufficient knowledge among smallholder farmers (Kementerian Pertanian RI, 2022). Consequently, many farmers recycle low-quality harvested tubers, leading to degeneration, lower yields, and greater disease vulnerability (Sitorus & Ginting, 2020). These challenges underscore the urgent need for accessible propagation technology that enables small farmers to independently produce high-quality seeds. The nethouse, as an affordable and scalable structure, offers a practical pathway to address this gap and improve seed availability at the community level.

Empowering farmer groups through technological innovation is crucial for achieving production self-sufficiency and enhancing local resilience (Chambers, 1995). Empowerment initiatives that combine

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technology transfer with participatory education and mentoring foster greater independence, confidence, and innovation among farmers (Kusdyah, 2021). Within this framework, nethouse technology represents a model of appropriate technology—a system that is locally adaptable, affordable, and operable by small-scale farmers. As Rogers (2003) explains in his Diffusion of Innovations Theory, technology adoption depends on its perceived usefulness, ease of application, and compatibility with users' contexts. Therefore, participatory and adaptive technological approaches such as nethouse-based seed propagation are essential to promoting both technical and social empowerment.

Beyond technical interventions, the sustainability of seed propagation also depends on managerial competence and entrepreneurial motivation. Strengthening entrepreneurship encourages farmer groups to shift from subsistence-based to business-oriented agricultural practices (Howkins, 2001). The application of effective marketing and promotional strategies can enhance product value, improve competitiveness, and expand market reach (Kotler & Keller, 2016). Previous PKM programs have shown that combining simple technological innovation with entrepreneurship development significantly improves productivity, income generation, and group self-reliance (Kusdyah & Noercholis, 2023). This holistic approach ensures that empowerment is not only technical but also economic and organizational.

Despite increasing evidence of the benefits of controlled-environment cultivation, the practical application of nethouse-based potato seed propagation among smallholder farmers remains limited. Most previous studies have focused on large-scale greenhouse systems, leaving a gap in understanding community-managed and small-scale implementations. This PKM program addresses that gap by integrating nethouse technology with participatory empowerment and entrepreneurship training. It contributes both theoretically and practically to sustainable rural innovation, demonstrating how simple, adaptive technology can strengthen seed independence, improve productivity, and enhance the socio-economic resilience of farming communities in Indonesia's highland regions.

METHOD

This Community Partnership Program (PKM) employed a participatory, educative, and applicative approach to empower the Laksmana Agrobisnis Farmer Group in Sedaeng Village, Tosari, Bromo. The activities were conducted over eight months, from January to August 2024, through continuous collaboration between the PKM implementation team from Institut Asia Malang, agricultural extension officers, and the farmer group members. The participatory approach was emphasized to ensure that farmers were not merely recipients of technology but active contributors to problem identification, solution design, and implementation. This method allowed knowledge transfer to occur in both directions—between the academic facilitators and the local farmers—creating mutual learning and shared ownership of the program.

https://doi.org/10.35568/abdimas.v8i4.7197

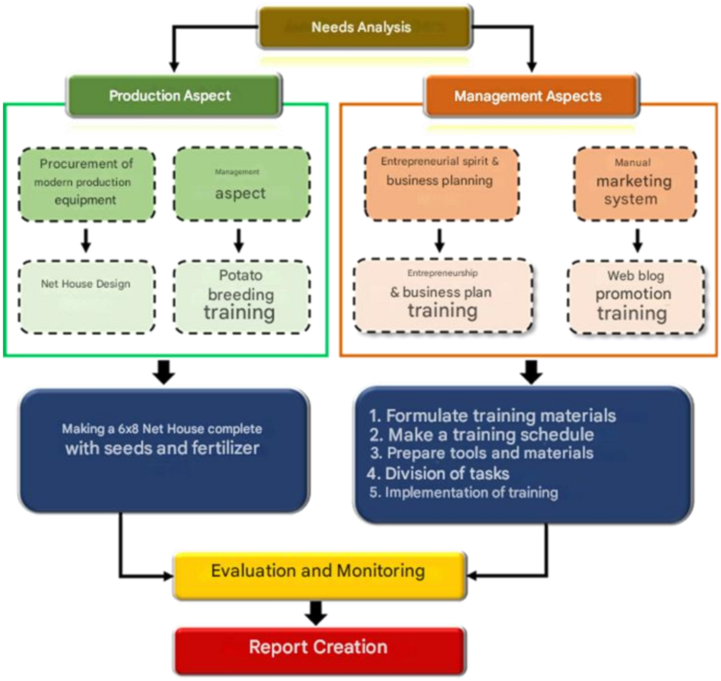

FIGURE 2. Implementation Flow

The primary participants were 10 active members of the Laksmana Agrobisnis group, consisting of eight men and two women who were directly involved in potato cultivation. They were selected based on their commitment to participate in training, their capacity to apply the acquired knowledge in their respective plots, and their role as representatives of the broader farming community in Sedaeng Village. The village is located at an altitude of approximately 1,600 meters above sea level within the Bromo Tengger Semeru National Park (TNBTS) area, where the weather is unpredictable, often affected by strong winds and irregular rainfall. This environment provided an ideal testing ground for nethouse technology, which was expected to improve the stability of seedling production conditions in such challenging climates.

Program implementation was carried out in five interrelated stages that aligned with the three main approaches.

- Counseling and Awareness Building - The initial phase introduced the concept of superior G0 potato seeds, emphasizing their role in productivity and disease prevention. Farmers participated in discussions to identify existing challenges and agree on collective objectives.
- Training and Knowledge Transfer - A series of workshops was conducted on G0 seed propagation techniques using tissue culture, planting media preparation, pest management, and irrigation systems. Additional sessions on entrepreneurship and farm management were also included to build business literacy.
- Nethouse Construction - A 6×8-meter simple nethouse was collaboratively designed and built by the PKM team and farmer members. The structure was equipped with UV-protective netting, ventilation, and an irrigation system suitable for highland conditions. This facility served as both a training site and a production unit for G0 seed propagation.
- Demonstration Plot and Field Practice - Demonstration plots were established on the farmer group’s land to facilitate hands-on learning. Members practiced propagation techniques under

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supervision, allowing them to apply training materials directly in real conditions.

- Entrepreneurship Mentoring and Evaluation - The final stage focused on strengthening business capacity through mentoring sessions on financial management, packaging, and product promotion strategies. Evaluation was conducted to assess improvements in production, cost efficiency, and farmer motivation.

Program evaluation combined quantitative and qualitative data collection methods to assess the overall effectiveness of the intervention. Quantitative data included changes in production capacity, cost efficiency, and quality improvement before and after the program. Qualitative data were gathered through direct observation, semi-structured interviews, and documentation, focusing on changes in participant motivation, skill levels, and group collaboration. Data triangulation was applied to ensure validity by cross-verifying information from the PKM team, field reports, and photographic documentation. Evaluation indicators were based on measurable progress in technical skills, economic outcomes, and empowerment levels among participants.

All activities were carried out under strict ethical considerations, ensuring voluntary participation and informed consent from all farmers. The PKM team maintained confidentiality of participant data and respected local customs and traditions of the Tengger Bromo community throughout the process. The program followed the ethical and community engagement standards of Institut Asia Malang, prioritizing inclusivity, transparency, and long-term community benefit.

RESULT AND DISCUSSION

The implementation of the Community Partnership Program (PKM) with the Laksmana Agrobisnis Farmers Group in Sedaeng Village produced substantial improvements in both technical and managerial aspects of potato seed propagation. Through the integration of nethouse technology, capacity building, and entrepreneurship mentoring, the program achieved significant outcomes that are measurable and replicable. The results are presented according to five dimensions: production performance, cost efficiency, management and organizational improvement, economic and social impact, and seed quality and productivity.

Production Performance

Before the PKM intervention, G0 potato seed propagation was performed using basic facilities located on house terraces. This method was highly susceptible to climatic fluctuations and pest attacks, yielding only approximately 2,500 G0 seeds per planting cycle. Following the construction of a 6 × 8 m nethouse, designed to accommodate 2,500 plantlets, the group successfully increased production capacity to approximately 25,000 G0 seeds per cycle. In addition, around 10,000 plantlets were prepared for field transplantation. This increase represents a tenfold improvement in productivity, enabling the farmers to meet internal seed requirements and supply excess seeds to neighboring farmers. The enhanced facility also allowed full utilization of approximately 10,000 m² of cultivated land, which was previously underutilized due to seed shortages.

Cost Efficiency

Before the intervention, the farmers' group relied heavily on purchasing external G0 seeds, incurring costs of approximately Rp 77,500,000 per production cycle, comprising Rp 62,500,000 for seed

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purchases and Rp 15,000,000 for planting materials. After the introduction of in-house propagation, total production costs decreased dramatically to Rp 8,550,000 per cycle, which included plantlet procurement, growing media, trays, nutrients, and fungicides. This cost reduction resulted in an efficiency gain of approximately Rp 68,950,000 per production cycle, representing a remarkable 88.9% reduction in operational expenditure. Such efficiency not only improved profit margins but also enhanced financial sustainability and reduced dependency on external seed suppliers.

Management and Organizational Improvement

The capacity-building component of the PKM program significantly improved the managerial competence of the farmers' group. Before the program, the group lacked systematic record-keeping and structured planning. Post-intervention, members successfully implemented basic production and financial recording systems, allowing for transparent cost tracking and profit analysis. They also adopted structured task distribution and established planting schedules based on both climatic conditions and market demand. These changes increased operational efficiency by an estimated 30%, while enhancing coordination, accountability, and decision-making within the organization. The improvement in management practices represents a crucial foundation for long-term sustainability.

Economic and Social Impact

The economic outcomes of the intervention were both immediate and substantial. The shift from seed dependency to self-production generated net profits of approximately Rp 68,950,000 per cycle, marking the first time the group achieved positive financial returns from seed propagation. The reduction in external purchases and the ability to market surplus seeds led to a 20–25% increase in group income. Socially, the program strengthened group cohesion and farmer participation. Members became more engaged in training activities, discussions, and collaborative decision-making. This sense of ownership and empowerment fostered higher motivation and confidence among farmers to continue independent innovation and collective problem-solving

Seed Quality and Productivity

The nethouse environment significantly improved the physiological quality of G0 seeds. The controlled microclimate reduced pest and disease incidence by approximately 40%, while the germination rate increased to 90–100%. The resulting G0 seeds exhibited greater uniformity, vigor, and disease resistance compared to the pre-program condition. The improvement in seed quality directly enhanced field productivity, allowing farmers to cultivate the full 10,000 m^2 of available farmland efficiently. The integrated system combining nethouse propagation and good management practices proved effective in achieving both quantitative and qualitative improvements in seed production

These results demonstrate that the combination of simple technology, such as net house construction, with continuous training and entrepreneurship development, can significantly improve production capacity and group independence. This aligns with findings from previous studies, which emphasize that technological innovation, supported by capacity building, enhances both productivity and sustainability of farmer groups.

https://doi.org/10.35568/abdimas.v8i4.7197

FIGURE 3. Entrepreneurship and marketing training session

TABLE 1. Key Performance Indicators

Aspect	Before	After	Improvement/Change
Propagation Facility	No nethouse; seed propagation conducted on house terraces	Permanent 6×8 m nethouse constructed; equipped for 2,500 plantlets	A controlled environment supports higher productivity
Seed Production Capacity	±2,500 G0 seeds per cycle	±25,000 G0 seeds per cycle	10× increase in production
Seed Production Cost	Rp 77,500,000 (purchased externally)	Rp 8,550,000 (self-produced)	Cost efficiency gain of Rp 68,950,000
Profit per Cycle	No profit (due to high external costs)	±Rp 68,950,000 net profit	Sustainable financial return achieved
Technical Knowledge	Limited understanding of propagation technology	Skilled in independent propagation using the nethouse and tissue culture techniques	Enhanced technical competence
Seed Availability	Dependent on external suppliers	Fully independent; available year-round	Achieved self-sufficiency
Seed Quality	Irregular, mixed-quality seeds with ~70% germination	Uniform G0 seeds with a 90–100% germination rate	+20–30% improvement in seed quality
Pest and Disease Incidence	High, frequent outbreaks	Reduced by approximately 40%	Improved plant health
Operational Management	No production or financial records	Implementation of systematic record-keeping	30% increase in work effectiveness
Land Utilization (10,000 m²)	Partial planting (limited by seed supply)	Fully planted (20,000 plantlets established)	100% land productivity achieved

Source: Primary field data, PKM Program (2025)

https://doi.org/10.35568/abdimas.v8i4.7197

CONCLUSION

The implementation of the Community Partnership Program (PKM) in Sedaeng Village has successfully empowered the Laksmana Agrobisnis Farmers Group through the integration of nethouse technology, participatory training, and entrepreneurship mentoring. The program produced tangible improvements across technical, managerial, and economic dimensions of potato seed propagation. Quantitatively, the PKM intervention increased G0 seed production capacity from approximately 2,500 to 25,000 seeds per planting cycle, achieving a tenfold improvement. Germination rates rose from 70% to 90–100%, and pest and disease incidence decreased by around 40%. The transition from external seed dependency to local production resulted in cost savings of about Rp 68,950,000 per cycle, with a corresponding increase in group income by 20–25%.

Qualitatively, the program enhanced farmers' technical knowledge, management capacity, and collective motivation. Members became more confident in managing production cycles, maintaining records, and implementing marketing strategies. The establishment of a simple 6×8 m nethouse provided a sustainable facility for year-round seed propagation, supporting the farmers' independence and resilience in the face of fluctuating market conditions. Despite its success, the study recognizes several limitations. The program's participants had diverse educational and technical backgrounds, which led to varying levels of understanding and performance during training and implementation. Moreover, the six-month project duration limited long-term observation of productivity trends and sustainability outcomes. Finally, the study involved a single farmer group, and while the results were positive, broader application and formal statistical validation are necessary to confirm replicability across different regions.

ACKNOWLEDGMENT

The authors would like to express their deepest gratitude to the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia for funding and supporting the implementation of this Community Partnership Program (PKM). Sincere appreciation is extended to Institut Asia Malang for providing guidance, facilities, and resources throughout the program. We are also grateful to the Laksmana Agrobisnis Farmers' Group for their active participation, cooperation, and commitment in every stage of the program. Their enthusiasm and willingness to innovate greatly contributed to the success and sustainability of the activities. Finally, we acknowledge the contributions of all team members, local stakeholders, and community partners whose dedication and collaboration made this program possible.

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