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Tepangin: An Appropriate Technology Solution for Improving Fertilizer Application Efficiency in Sumberwringin Village

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Abstract
Agricultural cultivation in Sumberwringin Village, Sukowono District, Jember Regency, Indonesia, continues to rely heavily on manual fertilizer application. This practice requires considerable time and labor and may result in uneven fertilizer distribution. Commercial fertilizer spreaders may improve efficiency but are often relatively expensive and less accessible to small- and medium-scale farmers. This community service programme developed and introduced Tepangin (Tebar Pupuk

Sumberwringin), a simple appropriate-technology fertilizer spreader made from locally available materials. The programme aimed to improve farmers' understanding of efficient fertilizer application and strengthen their ability to operate, maintain, and potentially reproduce the tool through farmer groups. Activities consisted of field problem identification, tool design and fabrication, preliminary testing, Business Model Canvas presentation, community socialization, field demonstration, hands-on practice, discussion, and evaluation. Farmers were directly involved in operating the tool and providing feedback on usability, comfort, fertilizer distribution, and potential improvements. The activity generated practical experience and strong participant engagement. Tepangin also created a potential pathway for collaboration among farmer groups, village government, students, and village-owned enterprises to support future production and maintenance. Tepangin represents a context-adapted innovation that may contribute to more efficient fertilizer application while strengthening local capacity for agricultural technology adoption.

Keywords: Appropriate technology, agricultural innovation, fertilizer application, farmer empowerment

Introduction

Sumberwringin Village, Sukowono District, Jember Regency, is an agricultural community in which farming is an important source of livelihood. The village has agricultural land used for several commodities, including rice, maize, tobacco, and other secondary crops. The uploaded manuscript describes agricultural cultivation in the village as still relying substantially on traditional methods, including manual fertilizer application. Manual application requires considerable time and physical effort and may produce an uneven distribution of fertilizer. These conditions create a practical need for a technology that can support farmers without imposing the financial and technical burden associated with more complex commercial machinery.

Fertilizer application is an important component of crop production because nutrients must be supplied in appropriate amounts and distributed in a manner that allows crops to use them effectively. Poor distribution can create variability within a field, with some areas receiving insufficient nutrients while other areas receive excessive amounts. From a farm-management perspective, fertilizer application also consumes labor that could otherwise be allocated to planting, crop maintenance, pest management, irrigation, harvesting, and post-harvest activities. For smallholder farmers, therefore, the efficiency of an application method is not only a technical issue but also an economic and labor-management issue.

Agricultural mechanization can help address labor-intensive operations, but

mechanization for smallholder farmers should be understood broadly. Appropriate technology does not necessarily mean sophisticated or automated equipment. Rather, the technology should match the users' economic capacity, technical skills, local resources, and working conditions. Indonesian literature on appropriate technology for small farmers emphasizes the importance of landholding size, local agroecosystems, availability of natural and human resources, and socioeconomic and cultural conditions in technology development [1]. This principle is relevant to Sumberwringin because commercial fertilizer spreaders may be less accessible to farmers with limited capital.

Technology adoption is also influenced by farmers' preferences and participation. Research on farmer preferences in Indonesia has shown that economic, sustainability, technical, and sociocultural considerations influence the selection of agricultural technologies [2]. Consequently, introducing equipment without understanding the users' needs may lead to low utilization after a community programme ends. Participatory development is more likely to generate a sense of ownership because farmers can contribute information about desired dimensions, capacity, weight, ease of operation, availability of materials, cost, and maintenance. The original Tepangin programme followed this principle through observation, interviews, and discussions with village officials and farmer groups before finalizing the design.

Recent Indonesian community-service programmes demonstrate continuing demand for simple fertilizer-spreading technologies. Yumeina and Hidayah described the development of a simple fertilizer spreader as an effort to provide accessible equipment for agricultural communities [3]. A recent programme in Gilirejo Village, Boyolali, introduced a simple fertilizer spreader made from PVC pipe for dryland farming, emphasizing affordability, ease of fabrication, reduced labor intensity, and improved fertilizer distribution [4]. Another programme in Panimbang introduced a solid fertilizer spreader made from recycled materials and presented it as an appropriate-technology response to physical workload and inefficiency in conventional fertilizer application [5]. These programmes provide a relevant context for Tepangin as a locally adapted innovation in East Java.

Appropriate technology programmes also show that equipment introduction is most useful when combined with training and mentoring. A 2026 community service programme in Garut introduced a rice-threshing machine through needs assessment,

equipment handover, technical training, hands-on practice, and evaluation [6]. A programme in Bengkalis used partner needs identification, technology design and fabrication, operational training, field assistance, and performance evaluation to strengthen farmers' ability to adopt agricultural technologies [7]. These examples indicate that successful technology transfer involves more than delivering equipment. Users need to understand the purpose of the technology, observe how it works, practice its operation, receive feedback, and develop the capacity to maintain it.

The same principle is evident in agricultural machinery programmes involving farmer groups. A University of Gadjah Mada community-service programme combined socialization, agricultural machinery handover, direct practice by farmer-group members, and planned follow-up activities [8]. An earlier programme in Kuta Dame introduced an automatic sprayer because farmers were still relying on manually operated equipment; the programme positioned appropriate technology as a response to limitations in existing practices [9]. These experiences reinforce the importance of practical demonstrations and user participation in agricultural innovation programmes.

Agricultural technology adoption also has a social and organizational dimension. Research on the Among Tani application in Batu City found that adoption of agricultural information technology occurs through stages and is influenced by farmer characteristics and crop-related vulnerability [10]. Although Tepangin is a physical rather than digital technology, the underlying lesson remains relevant: adoption is a process. Farmers need to observe an innovation, understand its relevance, discuss perceived advantages and constraints, and integrate it into existing routines. Farmer groups can provide an important platform for this process because they allow members to share experience, organize equipment use, and support peer learning.

The Tepangin prototype was developed using materials identified in the original manuscript as locally accessible, including PVC pipes of various sizes, adhesive, overshock components, PVC caps, and screws. Simple tools such as a grinder, saw, measuring tape, and drill were used in construction. The use of accessible materials can reduce dependence on specialized supply chains and may make repair or reproduction easier. It also creates an opportunity for farmer groups or BUMDes to participate in production and maintenance. Thus, Tepangin can be viewed not simply as a tool but as a potential local innovation system involving farmers, village institutions,

students, and educational partners.

The design philosophy of Tepangin is based on affordability, usability, and adaptability. Affordability is important because commercial equipment may be beyond the financial capacity of some farmers. Usability is essential because equipment that is difficult to operate will not be used consistently. Adaptability is necessary because field conditions, crop types, fertilizer characteristics, and user preferences vary. The original manuscript therefore describes a process involving field observation, interviews, discussion, design, testing, socialization, and hands-on practice. This process allows technical decisions to be connected to the actual working conditions of farmers.

The programme also incorporated a Business Model Canvas (BMC) as a planning and communication instrument. The BMC presentation to the Sumberwringin Village Government mapped the problem, proposed solution, intended users, resources, and potential development pathway. This stage is relevant to community-service sustainability because a student innovation should not end as a one-time demonstration. The BMC can help identify possible roles for farmer groups, village government, agricultural shops, construction-material suppliers, and BUMDes. Such institutional connections may facilitate future production, repair, distribution, and development of the device.

The 2026 Collaborative KKN programme therefore used a participatory sequence beginning with internal coordination and village coordination, followed by BMC presentation, farmer socialization, field demonstration, direct practice, and evaluation. This sequence positions the community as an active partner rather than a passive recipient. Farmers contributed contextual knowledge and feedback, while the KKN team contributed design, demonstration, and facilitation. The village government contributed institutional support. This collaborative structure is particularly relevant to appropriate technology because long-term use depends on local ownership and capacity.

At the same time, the current programme should be distinguished from a controlled engineering or agronomic trial. The source manuscript documents implementation activities and qualitative evaluation but does not provide standardized measurements of field capacity, distribution uniformity, fertilizer-dose accuracy, labor productivity, or crop yield. Therefore, claims that Tepangin definitively increases productivity or reduces fertilizer use cannot be made from the available evidence.

Instead, the programme should be understood as an initial technology-development and community-empowerment activity that establishes a foundation for subsequent quantitative evaluation.

The novelty of this community service lies in adapting a simple fertilizer-spreading device to the local context of Sumberwringin and integrating the technology with participatory planning, village coordination, farmer-group socialization, direct operation, and feedback. The intervention is not limited to the construction of a prototype; it also seeks to build local capacity to understand, use, maintain, evaluate, and potentially reproduce the tool. This combination of technical innovation and community empowerment is important for the sustainability of student-led agricultural technology programmes.

The purpose of this community service programme was to introduce Tepangin as an appropriate-technology solution for fertilizer application in Sumberwringin Village and to strengthen farmers' practical knowledge and capacity to use the tool. Specifically, the programme aimed to identify local fertilizer-application problems; introduce the design, function, and potential benefits of Tepangin; provide training and hands-on experience; obtain user feedback; and establish a foundation for continued development through farmer groups, the village government, and BUMDes.

Method

This community service programme used a participatory approach consisting of five stages: problem identification; design and fabrication; preliminary tool testing; socialization and hands-on training; and evaluation and follow-up. The activity was conducted in Sumberwringin Village, Sukowono District, Jember Regency, East Java, Indonesia, as part of the 2026 Collaborative KKN programme. The approach was selected because the problem and proposed technology were closely related to local agricultural practices and because the sustainability of a simple agricultural tool depends on user acceptance and local capacity.

The first stage was problem identification. The KKN team conducted field observation, interviews, and discussions with village officials and farmer groups. Observation focused on the existing fertilizer-application method, crops cultivated, field conditions, labor requirements, time required for manual application, and difficulties

experienced by farmers. Discussions were used to identify practical user requirements, including desired dimensions, fertilizer capacity, weight, ease of operation, availability of materials, production cost, and maintenance. The information obtained during this stage was used to establish the basic specifications of Tepangin.

The second stage involved design and fabrication. Tepangin was designed as a simple fertilizer-spreading device that could be made using materials available in or near the village. The source manuscript identifies PVC pipes of several sizes, adhesive, overshock components, PVC caps, screws, and supporting components. Construction used simple equipment such as a grinder, saw, measuring tape, drill, and hand tools. The design prioritized a simple mechanism and ease of operation so that farmers could understand the tool and, potentially, local groups could repair or reproduce it. Fabrication was conducted by the KKN team and followed by preliminary functional testing.

The third stage was preliminary testing. The prototype was tested at a designated agricultural location before community demonstration. Testing was intended to determine whether the fertilizer-flow mechanism functioned, whether the tool could be handled during field movement, whether the spreading pattern was observable, and whether adjustments were necessary. Because the original manuscript does not report standardized engineering measurements, the testing was treated as formative rather than as a comparative experiment. No quantitative superiority over manual fertilizer application is claimed in this article.

The fourth stage was socialization and training. Internal coordination among the KKN team was followed by coordination with the Sumberwringin Village Government concerning time, location, participants, and programme roles. On Friday, August 7, 2026, at 09:00 WIB, the team presented the Business Model Canvas and Tepangin concept to village officials. The presentation explained the local problem, proposed solution, target users, resources, implementation plan, and potential sustainability. Feedback and approval were obtained before farmer-group implementation.

On Tuesday, August 11, 2026, at 09:00 WIB, the team conducted socialization with the farmer group. The material covered the background of fertilizer-application inefficiency, the purpose and expected benefits of Tepangin, its working principle,

components, and operating procedure. The session used communicative explanation followed by a field demonstration. Demonstration began with fertilizer preparation and tool inspection, followed by explanation of the operating sequence and direct application in the agricultural field.

Participants were then given opportunities to operate Tepangin under KKN-team supervision. This hands-on practice allowed participants to experience the tool's weight, handling, movement, fertilizer loading, and spreading mechanism. Facilitators provided guidance on operation and safe handling and responded to questions during practice. Direct participation was also used to identify practical difficulties that might not be evident during classroom-style explanation.

The final stage was discussion and evaluation. Participants were invited to comment on ease of use, comfort, fertilizer distribution, perceived effectiveness, and problems encountered during practice. Feedback was treated as qualitative input for future design improvement. Documentation was collected throughout the activities as evidence of implementation and as material for reporting. The evaluation therefore emphasized implementation, participation, user experience, and improvement needs rather than statistical hypothesis testing.

The programme did not use a control group or standardized pre-post productivity measurement. Accordingly, the outcomes were assessed descriptively through completion of programme stages, direct participant involvement, practical experience, and qualitative feedback. Future evaluation should measure field capacity in hectares per hour, labor requirements, fertilizer-dose accuracy, distribution uniformity, operator fatigue, equipment durability, maintenance cost, user satisfaction, and willingness to continue using the device. Such measurements would provide stronger evidence for the technology's effectiveness and scalability.

Results

The Tepangin programme was implemented through preparation, village coordination, BMC presentation, farmer socialization, field demonstration, direct operation, and evaluation. Internal coordination among the Collaborative KKN students was used to finalize the programme concept, prepare the prototype, organize responsibilities, and prepare the BMC. Coordination with the Sumberwringin Village

Government helped align the programme with local conditions and establish institutional support.

The BMC presentation was conducted on Friday, August 7, 2026, at 09:00 WIB. The team introduced the Tepangin concept, explained the problem of manual fertilizer application, described the proposed technology, and discussed potential users, resources, implementation, and sustainability. The village government provided feedback and support before the programme was introduced to farmer groups. This process strengthened institutional coordination and helped position the innovation within the village context.

Farmer socialization was conducted on Tuesday, August 11, 2026, at 09:00 WIB. The activity explained the background of Tepangin, its expected benefits, working principle, components, and operating procedure. The explanation was followed by field demonstration. The team prepared fertilizer, inspected the device, demonstrated the operating sequence, and showed fertilizer spreading in the field. Participants then operated the tool directly with assistance from the KKN team.

The hands-on component was an important result of the activity because participants were not limited to receiving information. They experienced the operation of the device and could provide immediate feedback. The evaluation discussion addressed ease of operation, comfort, perceived effectiveness, fertilizer distribution, and possible constraints. The original manuscript reports that the feedback was used to identify strengths and weaknesses and to consider further development according to farmer needs.

The programme also generated a potential sustainability pathway. Farmer groups were identified as possible users and future managers of the tool, while the village government and BUMDes were identified as potential institutional partners for production, utilization, and further development. The activity therefore produced not only a prototype demonstration but also a collaborative framework for future implementation.

Because the original manuscript does not provide standardized measurements of labor time, field capacity, fertilizer distribution uniformity, fertilizer dose, or crop yield, the results should not be interpreted as proof of quantified productivity improvement. The strongest evidence from the activity concerns successful technology introduction, direct participant practice, community engagement, and identification of future improvement needs.



Picture 1. Tools about Tepangin

Discussion

The Tepangin programme demonstrates the relevance of a participatory appropriate-technology approach to a practical agricultural problem. The source manuscript identifies manual fertilizer application as time- and labor-intensive and potentially uneven. The programme responded with a simple tool made from locally accessible materials and embedded the innovation within a sequence of observation, design, demonstration, practice, and evaluation. This approach is consistent with the principle that agricultural technology should fit the economic, environmental, and social context of intended users [1]

The relevance of low-cost fertilizer mechanization is supported by recent Indonesian community-service activities. Simple fertilizer spreaders have been developed to address labor intensity and improve accessibility, including PVC-based designs and devices made from recycled materials [3,4,5]. These activities demonstrate that there remains a practical need for small-scale agricultural equipment that can be fabricated, operated, and maintained locally. Tepangin is consistent with this trend but adds a strong emphasis on village coordination and the potential role of farmer groups

and BUMDes.

Farmer participation is one of the main strengths of the programme. The original activity did not simply distribute a finished tool. It began with observation and discussion to identify user requirements, followed by direct operation by participants. This is important because technology adoption depends on perceived usefulness, affordability, usability, and compatibility with existing practices. Research on Indonesian farmers' technology preferences shows that economic and sustainability considerations are especially important [2]. A technology that is inexpensive but difficult to use may still fail, while a simple tool that farmers understand and can repair may have stronger practical acceptance.

The hands-on training model is also supported by recent agricultural technology programmes. Community service involving rice threshing equipment in Garut used needs assessment, technical training, hands-on practice, and evaluation [6]. A Bengkalis programme used a similar sequence of needs identification, design, fabrication, training, field assistance, and performance evaluation [7]. These examples suggest that the success of technology transfer depends on building user competence, not merely providing equipment. Tepangin's direct practice component therefore represents an appropriate strategy for the intended community.

The role of farmer groups is particularly important for sustainability. Shared equipment can be managed collectively, reducing the need for every farmer to purchase a separate tool. Experienced users can train new members, and the group can organize maintenance and storage. The original manuscript also identifies BUMDes as a potential partner in production and development. Such institutional arrangements can help move the innovation from a student project toward a community-managed technology. The UGM experience with agricultural machinery similarly shows the value of socialization, handover, direct practice, and continued mentoring [8].

The use of locally available PVC and simple construction components is potentially advantageous because it can reduce the cost and complexity of repair. However, local fabrication also creates technical questions. PVC components, joints, adhesive connections, and the fertilizer-flow mechanism need to withstand repeated loading, movement, moisture, and different fertilizer characteristics. These aspects were not systematically measured in the current activity. Future engineering tests should

therefore assess durability, failure points, maintenance requirements, and the service life of each component.

Fertilizer distribution uniformity is another important issue. The original manuscript states that Tepangin is expected to produce more even distribution than manual application, but it does not report quantitative distribution data. A visual impression of evenness is insufficient for a scientific claim. Future tests should collect fertilizer from multiple sampling points across a defined field width and calculate distribution uniformity or coefficient of variation. The tool should also be tested using fertilizers with different particle sizes and moisture characteristics. These measurements would provide objective evidence of the device's performance.

Labor efficiency should likewise be measured rather than assumed. A useful evaluation would compare the time required to cover a defined area using manual application and Tepangin, while recording the number of workers involved, number of refills, walking distance, and operator fatigue. A previous study comparing mechanical fertilizer spreading with manual application reported advantages of mechanical spreading in time, cost, and labor, although that study involved a different agricultural context [11]. Local testing is therefore needed before any similar conclusion is applied to Sumberwringin.

The BMC component is valuable because sustainability is a central issue in community-service innovation. Without a clear pathway for maintenance, production, and ownership, a prototype may remain unused after students complete their KKN placement. Presenting the BMC to village officials before farmer socialization allowed the programme to discuss potential users, resources, and future development. This may help connect the tool with village institutions and farmer organizations. Future programmes should formalize responsibilities for storage, maintenance, replacement materials, and additional production.

The programme also illustrates the importance of social acceptance. Farmers may evaluate technology not only by technical function but by comfort, convenience, compatibility with their routines, and perceived economic value. The discussion and evaluation after field practice provided a mechanism for capturing such feedback. This is consistent with research showing that technology adoption is influenced by social and organizational factors [2,10]. The farmer group can serve as a setting in which users

share experiences and reduce uncertainty for members who have not yet tried the tool.

Appropriate fertilizer application should also be linked to broader nutrient-management practices. A spreader can make application faster, but it does not determine whether the fertilizer rate, timing, and nutrient composition are agronomically appropriate. Future Tepangin programmes could therefore collaborate with agricultural extension personnel to integrate the tool with soil-fertility recommendations and balanced fertilization. This would ensure that improved mechanical efficiency does not simply facilitate the application of inappropriate fertilizer rates.

The current programme has several limitations. First, it did not include a controlled comparison between manual application and Tepangin. Second, the activity report does not provide standardized quantitative measurements of field capacity, distribution uniformity, labor savings, fertilizer-dose accuracy, or crop yield. Third, long-term durability and continued adoption were not monitored. Fourth, the available report does not provide complete participant characteristics. These limitations mean that the programme should be presented as an initial community-empowerment and technology-introduction activity rather than as proof of a statistically demonstrated increase in agricultural productivity.

These limitations provide a clear direction for future community service and research. A follow-up programme should conduct repeated field trials over several cropping cycles and compare Tepangin with manual application under standardized conditions. Outcomes should include time per hectare, labor requirements, fertilizer dose, distribution uniformity, operator fatigue, maintenance needs, construction cost, and user satisfaction. Economic analysis should estimate cost per hectare and compare the expected service life of Tepangin with commercial spreaders. Such data would strengthen the basis for decisions about replication in other villages.

The potential for replication is nevertheless encouraging. Recent Indonesian programmes continue to develop simple fertilizer spreaders and other agricultural appropriate technologies, indicating a persistent demand for affordable mechanization [3,4,5]. Tepangin can contribute to this field by documenting a locally developed approach in Sumberwringin. If subsequent testing confirms adequate performance and the design is refined based on farmer feedback, the technology could be adapted for other villages with similar labor and cost constraints.

The programme's broader contribution is therefore empowerment. The objective should not be limited to placing a tool in the village, but to developing the community's ability to understand, operate, maintain, evaluate, and improve the technology. The involvement of students, farmers, village government, and BUMDes creates an opportunity for reciprocal learning and local ownership. This is particularly appropriate for KKN because it links academic knowledge with practical community needs.

Overall, Tepangin represents a promising local innovation, but its strongest current evidence is evidence of feasibility and community engagement rather than quantified productivity impact. The participatory process, accessible materials, direct farmer practice, and institutional coordination are important strengths. The next step should be systematic measurement. By combining engineering evaluation, economic assessment, user feedback, and continued mentoring, the programme can determine whether Tepangin should be further refined and scaled. This evidence-based progression would strengthen both the scientific value and the community-service value of the innovation.

Conclusion

Tepangin (*Tebar Pupuk Sumberwringin*) is an appropriate-technology innovation developed to address the practical challenges of manual fertilizer application in Sumberwringin Village. The community-service programme successfully combined problem identification, prototype development, BMC presentation, socialization, field demonstration, direct farmer practice, and participatory evaluation. The activity strengthened practical exposure to the technology and established a potential pathway for continued development through farmer groups, the village government, and BUMDes. However, the available activity data do not support quantitative claims about productivity, labor savings, or distribution uniformity. Future programmes should conduct standardized field, engineering, and economic evaluations followed by iterative redesign and longer-term monitoring.

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Conflict of Interest

The authors declare no conflict of interest related to this community service activity or manuscript.

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