Vokatek: Journal of Research and Community Service
E-ISSN: 2986-0105 P-ISSN : 2985-8402
Vol. 4, No. 3, December 2026
https://journal.diginus.id/VOKATEK/index

Empowering the Baji Minasa Farmer Group through Solar-Powered Water Pump Implementation for Sustainable Irrigation

Sudarmanto Jayanegara[1*], Hartini Ramli[2], Raodah[3], Fahri Anwar[4], Achmad Romadin[5]
[12345]*Universitas Negeri Makassar, Indonesia*

Corresponding e-mail : sudarmanto@unm.ac.id

ARTICLE INFO

Keywords:

Farmer Group;
Irrigation Pump;
Pangkep;
PKM;
Solar Panels

Article History

Received:
September 28, 2026
Revised:
October 26, 2026
Accepted:
October 31, 2026

ABSTRACT

This community engagement program aimed to empower the Baji Minasa Farmer Group through the implementation of solar-powered water pumps to support sustainable irrigation. The program was conducted in Tondong Tallasa Village, Pangkep Regency, South Sulawesi, Indonesia, involving 24 farmers. Program outcomes were evaluated before and after implementation using six indicators: energy management knowledge, pump operation, equipment maintenance, irrigation efficiency, agricultural productivity, and farmer group independence. The assessment results showed improvements across all indicators. The results showed an improvement across all six community empowerment indicators following the implementation of the program. Energy management knowledge increased from 35.07% to 89.93%, pump operation from 29.86% to 87.85%, equipment maintenance from 25.00% to 81.94%, irrigation efficiency from 45.14% to 89.93%, and agricultural productivity from 50.00% to 85.07%. Farmer group independence also demonstrated an increase, from an estimated 39.93% to 87.85%. Overall, the average achievement increased from 37.50% before the program to 87.09% afterward, representing an improvement of 49.59 percentage points. The greatest improvement among the five indicators with calculated scores was observed in pump operation, with an increase of 57.99 percentage points, followed by equipment maintenance at 56.94 percentage points. The results suggest that the program contributed to strengthening the technical capacity and independence of farmer groups. However, the increase in the agricultural productivity assessment score does not necessarily demonstrate an actual increase in crop yields, as direct production measurements were not reported. Overall, the implementation of solar-powered water pumps has the potential to strengthen farmer capacity and support more sustainable agricultural water management.

This is an open access article under the CC BY-SA license

To cite this article:
Jayanegara, S., Ramli, H., Raodah, Anwar, F., & Romadin, A. (2026). Empowering the Baji Minasa Farmer Group through Solar-Powered Water Pump Implementation for Sustainable Irrigation. *Vokatek: Journal of Research and Community Service, 4*(3), 59–67. https://doi.org/10.61255/vokatek.v4i3.1890

INTRODUCTION

Pangkajene and Islands Regency (Pangkep) is a regency in South Sulawesi Province covering an area of approximately 1,112.29 km^2, comprising 13 districts (*kecamatan*), 65 villages (*desa*), and 38 urban villages (*kelurahan*) (DPM-PTSP South Sulawesi Province). The local economy is dominated by the agriculture, forestry, and fisheries sectors, which constitute the largest contributors to the regency's Gross Regional Domestic Product (GRDP). This situation highlights the strategic role the agricultural sector plays in supporting the local economy and community welfare (BPS Pangkep: 2024).

Specificall in Tondong Tallasa District, data from Statistics Indonesia (BPS) for Pangkep Regency indicate that agriculture and plantation farming are the dominant sectors. Agricultural activity in the district relies heavily on rice fields located in Bantimurung Village, a key source of agricultural land in the area. Bantimurung Village spans approximately 2,642 hectares—comprising 340 hectares of rice fields and 2,302 hectares of dry land—thereby offering significant potential for the development of sustainable agricultural enterprises (BPS Tondong Tallasa Pangkep: 2025).

Complementing this potential, agricultural management in Bantimurung Village is supported by active farmer institutions. According to Pangkep Regent Decree Number 93 of 2023 regarding the designation of farmer group associations in Bantimurung Village, Tondong Tallasa District, there are 32 active farmer groups. One of these is the Baji Minasa Farmer Group, which plays a direct role in managing agricultural land and improving the welfare of local farmers. This group plays a strategic role in coordinating cultivation activities, strengthening cooperation among farmers, and serving as a platform for implementing government programs and agricultural innovations at the village level.

The Baji Minasa Farmer Group consists of 24 farmers and is led by Natsir; it is based in Bantimurung Village, Tondong Tallasa District. The group is committed to enhancing its members' welfare through sustainable agricultural management. Cultivating an area of approximately 11 hectares, the group primarily grows paddy rice using a twice-yearly planting cycle. Drawing on their experience and extensive knowledge of local farming practices, the Baji Minasa Farmer Group serves as a strategic partner in adopting agricultural technologies and innovations to boost productivity and ensure agricultural sustainability in Bantimurung Village.

Despite possessing significant land potential, the Baji Minasa Farmer Group faces challenges regarding irrigation water supply. Land irrigation currently relies on rainfall, while during the dry season, farmers must use conventional pumps to draw water from a river located at a lower elevation. These conditions result in high energy demands and operational costs, suboptimal water distribution, and limited planting windows. Consequently, land productivity and farmer income have not been maximized.

As a solution, this Community Service (PKM) program implements a solar-powered water pumping system to facilitate irrigation that is more efficient, economical, environmentally friendly, and sustainable. The use of solar panels is expected to reduce reliance on conventional energy sources while lowering pump operating costs. The technology implementation also aims to ensure equitable water distribution, enabling farmers to optimize their cropping patterns and productivity.

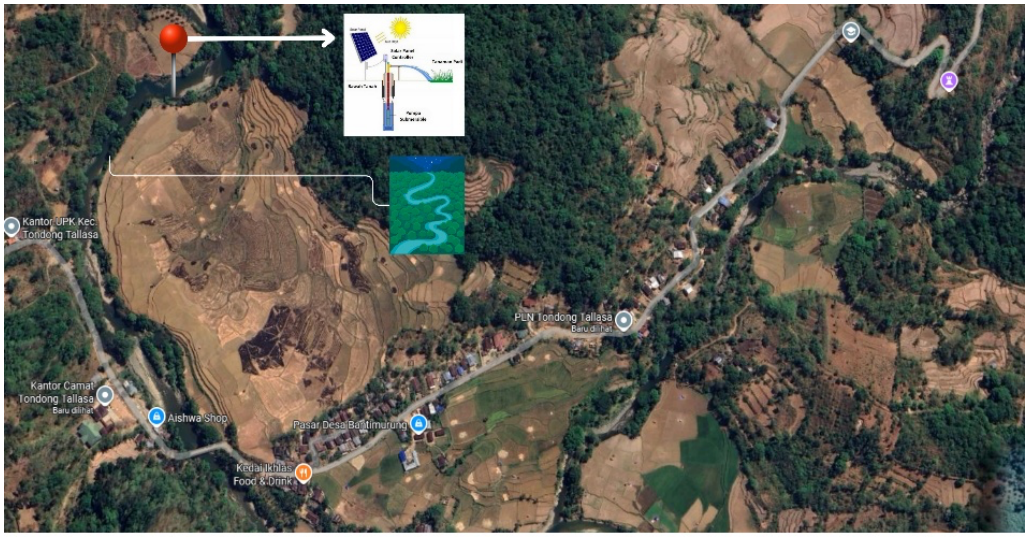


Figure 1. Conditions and situation of the partners' rice farming areas

The program was designed not merely to install solar-powered water pumps but also to strengthen the technical capacity and self-reliance of the Baji Minasa Farmer Group. Although the implementation of solar-powered irrigation technology can improve access to water for agricultural activities, its long-term effectiveness also depends on farmers' ability to operate and maintain the equipment independently and manage irrigation resources efficiently. Therefore, an important challenge extends beyond technology provision to ensuring that farmers can sustain its use after the program ends. The program addresses this challenge through an integrated empowerment approach that combines the implementation of solar-powered water pumps with training in pump operation and maintenance, as well as strengthening farm management capacity. Its contribution lies in assessing changes in farmers' knowledge and operational capabilities, irrigation efficiency, and group

independence before and after implementation, rather than evaluating equipment installation alone. Improvements in rice productivity and reductions in production costs are expected benefits that require further validation through direct measurements. Digital-based marketing is considered a complementary strategy for increasing the market reach and economic value of agricultural produce; however, it should be included as a program component only when its implementation and outcomes are documented and evaluated.

METHOD

The community service program was implemented using a structured, participatory approach involving the Baji Minasa Farmer Group in Tondong Tallasa Village, Pangkep Regency, South Sulawesi, Indonesia. The program aimed to improve farmers' capacity to utilize solar-powered water pumps for agricultural irrigation and strengthen the group's operational independence. The implementation consisted of five stages: (1) initial coordination and assessment of partner needs (Socialization); (2) outreach and training on solar energy management and pump operation; (3) installation and implementation of solar-powered water pump technology; (4) technical assistance, equipment maintenance training, and program evaluation; and (5) development of strategies to sustain technology use and farmer group independence.

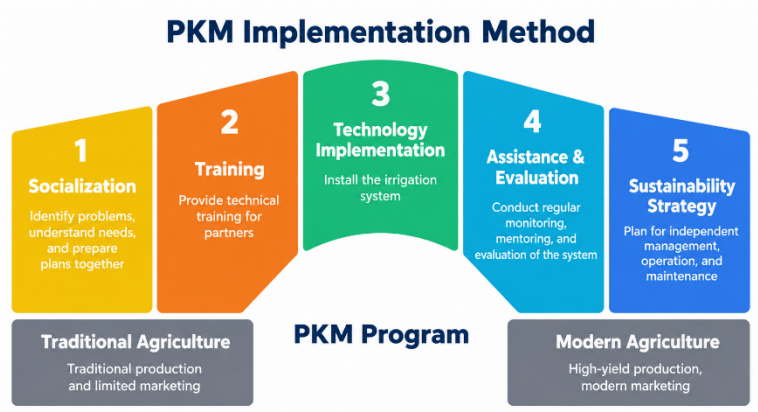


Figure 2. Workflow of the PKM activity implementation method

In the execution of this Community Partnership Program (PKM), close collaboration with the Baji Minasa Farmer Group serves as the primary foundation for every stage of implementing the proposed solutions. The partners play an active role—not merely as beneficiaries, but also as field implementers involved from the very beginning of the project. During the socialization phase, the farmer group facilitates initial meetings and discussions to identify core challenges, establish priority needs, and reach a consensus on the action plan. This stage aims to build a shared understanding and commitment, while simultaneously fostering a social environment conducive to the adoption of the technology.



Figure 3. Initial outreach visit with the farmer group following confirmation of funding

The training and capacity-building phase is designed to strengthen the technical knowledge and practical skills of the Baji Minasa Farmer Group in operating and maintaining a solar-powered irrigation system. The training is facilitated by the project team, with responsibilities distributed according to each member's area of expertise. The team leader, who specializes in mechanical engineering, provides instruction on the installation, operation, and maintenance of the solar-powered water pumping system. A team member with a background in agricultural engineering explains irrigation water management and its application in farming activities, while a team member specializing in industrial engineering provides guidance on monitoring, visualization, and control systems.

The training is conducted over a four-month period across three separate visits, encompassing theoretical understanding, practical application, and hands-on exercises. The training curriculum covers solar-powered pump system components, pump operation, routine maintenance, troubleshooting, and irrigation water management. Participant attendance is recorded for each session to document their level of engagement.



Figure 4. Farmer group participation

During the technology implementation phase, the project team and the Baji Minasa Farmer Group installed four solar-powered irrigation pumps supported by 2 × 550 Wp photovoltaic panels. The system installation included panel mounting, supporting components, and performance testing. Technical documentation covered pump specifications, total dynamic head, measured water discharge, daily operating duration, controller configuration, pipe dimensions, and irrigation coverage.



Figure 5. Technology is applied

The mentoring and evaluation phase encompasses the monitoring of the solar-powered irrigation system, alongside the collection of feedback from the Baji Minasa Farmer Group. The evaluation is conducted during the final visit—specifically the third visit—to assess the system's operation, irrigation performance, and the capacity of the partners involved. Technical performance is documented through records such as water discharge measurements and operational logs. The

evaluation results serve to identify areas for improvement and support the long-term operational sustainability of the implemented technology. Only completed evaluations with verified results are included in the reporting; the specific performance of the pump itself is excluded from this assessment, which focuses instead on the flow of water from the river to the rice fields.



Figure 6. Mentoring and evaluation

The sustainability of the program is underpinned by the Baji Minasa Farmer Group's commitment to independently manage and maintain the solar-powered irrigation system, as well as to continue operating the marketing website. The partners' contributions—providing the site, labor, and local resources throughout the project—serve as a strong indicator of the program's long-term viability. Furthermore, the program's success is bolstered by the proposing team's research expertise in energy conversion, electrical systems, agricultural management, and the development of web-based and IoT systems.

Through a systematic implementation method and active support from the partners, this program is expected not only to directly address irrigation and marketing challenges but also to foster sustainable socio-economic transformation within the farming community.

RESULTS AND DISCUSSION

The evaluation results indicate that the Community Partnership Program (PKM) implemented through the introduction of solar-powered irrigation pumps has successfully enhanced the empowerment of the Baji Minasa Farmer Group. Prior to the program, the farmers faced limitations in understanding solar energy technology, operating and maintaining pumps, and managing irrigation, as they were previously reliant on fuel-powered pumps.

Table 1. Assessment Instrument

Skor	Kategori penilaian
1	Very Poor
2	Poor
3	Good
4	Very Good

Each indicator is assessed through 3 questions. Thus:

- Number of participants: 24.
- Number of indicators: 5.
- Questions per indicator: 3.
- Maximum score per indicator: 24 × 3 × 4 = 288.
- Maximum score for all indicators: 1,440.

Table 2. Recapitulation of score calculations

Indikator	Maximun Skore	Minimun Skore	Before (%)	After (%)	Results (%)
Solar energy knowledge	288	101	35,07	259	89,93
Pump operation	288	86	29,86	253	87,85
Equipment maintenance	288	72	25,00	236	81,94
Irrigation management	288	130	45,14	259	89,93
Agricultural productivity	288	144	50,00	245	85,07
Farmer group indepence	288	115	39,90	253	87.85
Average	288	108,00	37,50	250,83	87,09

The formula for calculating the percentage of assessment scores from a questionnaire or evaluation instrument for 24 participants is as follows:
Calculation formula:

$$\boldsymbol{P = \frac{Total\ average\ score}{maximum\ total\ number\ of\ participants} \times 100\ \%}$$

The evaluation involved 24 members of the Baji Minasa Farmer Group and covered six community empowerment indicators. The results demonstrated improvements across all indicators following program implementation. Energy management knowledge increased from 35.07% before the program to 89.93% afterward, representing an improvement of 54.86 percentage points. Pump operation skills increased from 29.86% to 87.85%, with an improvement of 57.99 percentage points. Equipment maintenance capabilities improved from 25.00% to 81.94%, representing an increase of 56.94 percentage points. Similarly, irrigation efficiency increased from 45.14% to 89.93%, an improvement of 44.79 percentage points. Agricultural productivity increased from 50.00% to 85.07%, corresponding to an improvement of 35.07 percentage points. Furthermore, farmer group independence increased from 39.93% to 87.85%, representing an improvement of 47.92 percentage points. Overall, the average assessment score increased from 37.50% before the program to 87.09% after implementation, representing an improvement of 49.59 percentage points. Among the six indicators, pump operation recorded the greatest improvement (57.99 percentage points), followed by equipment maintenance (56.94 percentage points) and energy management knowledge (54.86 percentage points). These findings indicate positive improvements in participants' technical knowledge, operational skills, equipment maintenance capabilities, irrigation management, agricultural productivity, and organizational independence.

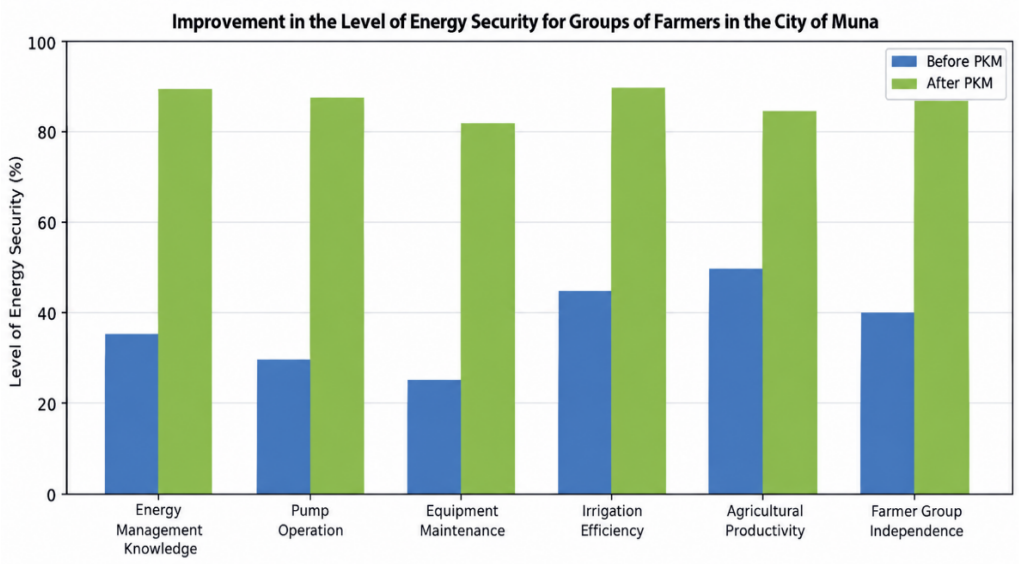


Figure 7. Evaluation bar chart from partner Baji Minasa

Furthermore, the group's self-reliance in managing the technology increased from 40% to 87% (an increase of 47 points), demonstrating that the farmers are now capable of operating and maintaining the system with greater independence.

Overall, the average empowerment assessment score increased from 37.50% before the program to 87.09% after implementation, representing an improvement of 49.59 percentage points. This value was calculated using the unweighted arithmetic mean of the six assessment indicators. The findings demonstrate improvements in farmers' assessed knowledge and technical skills, equipment maintenance capabilities, irrigation management efficiency, agricultural productivity indicators, and farmer group independence. However, these improvements in assessment scores should not be interpreted as direct evidence of increased crop yields or household income without supporting production and economic measurements.

The technology implemented through this Community Partnership Program (PKM) consists of a solar-powered irrigation pump system designed to meet the water requirements of the Baji Minasa Farmer Group. The system comprises photovoltaic panels as the primary energy source, a water pump, a network of pipes, and supporting operational components. The installation was carried out in collaboration with the farming community to facilitate access to irrigation water by harnessing solar energy.

The solar-powered irrigation system currently in place is being used to support peanut cultivation on the farmers' land. This temporary application was chosen because the land had already been allocated for ongoing agricultural activities before the PKM (Community Partnership Program) team became involved. Following the peanut harvest, the farmers plan to switch to rice cultivation, which is expected to benefit from the existing irrigation system. Previously, irrigation efforts faced operational challenges related to the use of diesel-powered pumps. Consequently, this installed system serves as an alternative to conventional, fossil-fuel-based irrigation technology, offering the potential to reduce reliance on fossil fuels and lower operational irrigation costs. However, the actual improvements in energy efficiency, water distribution, and operational cost savings have not yet been quantified. Further evaluation is required, involving measurements of water discharge, irrigation volume, operational duration, energy consumption, and fuel expenditures. Therefore, the potential for increased agricultural productivity and higher farmer income is viewed as a prospective benefit that warrants further assessment through crop production and economic data.



Figure 8. The results of the technology implementation have been used for crop irrigation

The implementation of this solution goes beyond the provision of physical hardware; it also enhances the farmers' capacity to independently operate, maintain, and manage the technology, ensuring its sustainable use to support increased agricultural productivity.

The evaluation results indicate that the Community Partnership Program (PKM) implemented through the introduction of solar-powered irrigation pumps—has successfully enhanced the empowerment of the Baji Minasa Farmer Group. Prior to the program, the farmers faced limitations in understanding solar energy technology, operating and maintaining pumps, and managing irrigation, as they were previously reliant on fuel-powered pumps.

CONCLUSIONS

The Community Partnership Empowerment Program (PKM) implemented for the Baji Minasa Farmer Group successfully introduced solar-powered irrigation technology as an alternative energy solution to support agricultural water management. The program combined the implementation of appropriate renewable energy technology with farmer capacity-building activities, including training in energy management, solar-powered pump operation, equipment maintenance, irrigation management, and strengthening farmer group independence. Evaluation results involving 24 members of the farmer group demonstrated improvements across all six empowerment indicators. The average assessment score increased from 37.50% before program implementation to 87.09% afterward, representing an improvement of 49.59

AKNOWLEDGMENT

We extend our deepest gratitude and appreciation to the Institute for Research and Community Service (LP2M) of Universitas Negeri Makassar (UNM) for their support and facilitation of this community service initiative.

We also express our thanks to Mitra Baji Minasa, the Head of Tondong Tallasa Village, the entire community of Tondong Tallasa Village, and the students who participated actively, provided support, and collaborated throughout the implementation of this program. It is our hope that the synergy and collaboration established here will continue, providing lasting benefits to the community specifically by enhancing the well-being and self-reliance of the people of Tondong Tallasa Village.

AUTHOR CONTRIBUTION STATEMENT

All five authors contributed to the implementation and preparation of this community service article. Sudarmanto Jayanegara contributed to the conceptualization, project coordination, methodology, investigation, and manuscript drafting. Hartini Ramli contributed to the agricultural aspects, partner training, field investigation, and data collection. Raodah contributed to the technical implementation, system monitoring, and data validation. Fahri Anwar contributed to data analysis, visualization, and manuscript review. Achmad Romadhin contributed to supervision, project evaluation, and critical revision of the manuscript. All authors have reviewed and approved the final version of this manuscript.

REFERENCES

Statistics Indonesia (Badan Pusat Statistik) of Pangkajene and Kepulauan Regency. Development of Business Sector Category A (Agriculture, Forestry, and Fisheries) in Relation to the Gross Regional Domestic Product (GRDP) of Pangkajene and Kepulauan Regency, 2020–2024. 2025

BPS-Statistics Indonesia, Pangkajene dan Kepulauan Regency. In 2024, the economy of Pangkajene dan Kepulauan Regency grew by 5.00 percent. 2025.

Statistics Indonesia of Pangkajene and Kepulauan Regency. Tondong Tallasa District in Figures 2025.

Jayanegara S, Ramli H, Misbahuddin AF, Aqsha I, Rifuqi DM. Empowerment of the Ati Maci'nong farmer group to revitalize rice paddy irrigation systems using solar-powered pumps in support of a green economy. Jurnal Abdimas Patikala. 2025;5(2):1861–1870.

Syahid M, Salam N, Piarah W, Djafar Z, Jalaluddin, Tarakka R, et al. Utilization of Solar-Powered Water Pumps for Agricultural Irrigation Systems. J Tepat (Applied Technology for Community Service). 2022;5(1):102–7.

Darmawan FA, Aqsha I, Hambali A. Implementation of Solar-Powered Irrigation Pump Technology for Rice Paddies in Parambambe Village, Takalar Regency, South Sulawesi. SEMAR (Journal of Science, Technology, and Arts for Society). 2023;12(1):54.

Jayanegara S. Performance Testing of a Laboratory-Scale Crossflow Turbine for Power Generation. Patria Artha Technol J. 2023;7(1).

Jayanegara S, Rifqie DM, Hidayat A. Optimization of Electrical Energy Sources for Egg Tray Drying Machines Using Thermoelectric Generator Modules. 2023;4(November):64–9.

Jayanegara, Sudarmanto, Zuryati Djafar, Zulkifli Djafar, Nasaruddin Azis WHP. The Characterization of Thermoelectric Generator in Utilizing the Heat Waste of the Biomass Egg Drying Machine. EPI Int J Eng [Internet]. 2020;3(1):30–3. Available from: https://cot.unhas.ac.id/journals/index.php/epiije/article/view/844.

Jayanegara S, Muhsin Z, Husda BR, Anwar B. Thermoelectric generator performance as a power generator in a portable stove. *Journal of Science and Engineering*. 2025;8(2):139–146.

Jayanegara S, Wiranda M, Kamaluddin. Thermoelectric generator demonstration on stove as alternative energy. Journal of Embedded System Security and Intelligent Systems (JESSI). 2025;6(1).

Ramli H, Rofifah ANH, Saripa, Hafiza N, Jaya MA, Rusdiaman M, Adam MA, Fadilah A, Fardan M. Design of a web-based food recipe information system using economical ingredients. Journal of Vocational, Informatics and Computer Education. 2023;1(1).