

Use of Hydrant Pumps As a Strategy to Increase Rice Production Capacity in Mekarmulya Village, Karawang

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ABSTRACT

Background. The impact of poor land irrigation will result in serious problems for plants and harvest yields.

Purpose. The aim of this community service activity is to overcome the problem of irrigation of land that is geographically located above the river surface through appropriate technology in the form of a hydraulic pump.

Method. The study involved 288 university students from Chinese, Japanese, and Korean TFL settings, and the data from questionnaires were analysed using appropriate statistical methods.

Results. The results of this community service activity show that the hydraulic ram pump is an appropriate solution to the irrigation problems experienced by landowners in the highlands in the Karanglingar village area.

Conclusion. By using this hydraulic pump, farmers and landowners are expected to be able to optimize land irrigation in the highland areas.

KEYWORDS

Irrigation, Hydraulic Ram Pump, Maintenance, Productivity

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INTRODUCTION

The irrigation channels are lower than the rice fields owned by the farming community, making it very difficult to channel the water in the irrigation to the rice fields. This factor is influenced by the geographical conditions of the land being higher than the river surface used as a source of irrigation flow for agricultural conditions in Karanglingar Village. Agricultural land located far above the river surface requires a lot of energy to bring water to the agricultural land (Protsenko et al., 2024; Rajaonison & Rakotondramiarana, 2022; Sadeqi et al., 2025; Sharma et al., 2024). Farmers and landowners' efforts to channel water to agricultural land sometimes require the assistance of diesel-powered water pumps or jet pumps (high-pressure electric pumps (Kumar et al., 2025; Lungudi et al., 2024; Wahyudi et al., 2025). Calculated in nominal terms, this will require a relatively large cost for the rental of these water pumps.

Meanwhile, the funds needed by the community when irrigating land are around IDR 450,000 per month for



the rental and maintenance of water pumps, both electric and fuel-powered. Hydraulic ram pumps are an alternative technology that does not require electricity or fuel, in addressing the problem of irrigating land in the highlands or above river levels (Forti Torres & Cevallos-Reyes, 2022; Osome et al., 2023; Rampen et al., 2025; Starodubtseva et al., 2024). Therefore, if the community starts to switch to hydraulic ram pumps, rental and maintenance costs can be minimized and will ease the burden on land owners or managers who have land above river levels. A hydraulic ram pump without electricity and fuel is a hydraulic ram pump that works using the hydraulic force of water (Celerinos & Sanchez-Companion, 2022; Mebrat et al., 2023; Ramtekkar, 2024; Sumaria et al., 2025). In principle, a hydraulic ram pump uses the kinetic energy of flowing water, then the water flow is regularly passed through a valve (Celerinos, 2025; Kriaa, 2025; Stolz et al., 2024). The following is an image of a hydraulic ram pump without electricity and fuel. A hydraulic ram pump can operate at a consistent frequency even with low input water flow. The following table shows the materials and equipment used to manufacture a hydraulic ram pump.

Lecturers at universities are responsible for teaching, research, and community service. Based on these issues, the goal of this community service program is to empower the community, including farmers in Karanglinggar Village by providing information on the maintenance of hydraulic ram pumps for rice irrigation (Elgammi & Hamad, 2022; Evangelista et al., 2023; Wehrli, 2022). This information will equip them with the knowledge to maintain and repair these pumps, which are currently essential for the farming community in West Teluk Jame District, Karawang Regency.

Geography Karangligar Village is located in West Telukjambe District, Karawang Regency, West Java. West Telukjambe District consists of 10 villages, including Karangligar Village. This district was formed from the division of Telukjambe District, which has now been renamed East Telukjambe. Karangligar Village covers an area of 4.0 km², or 5.45% of the total area of Telukjambe Barat District, which is 73.36 km². It is the sixth largest village in the district. Its landscape consists of plains at an elevation of 17 meters above sea level. (Karawang Central Statistics Agency, 2021).

Agriculture plays a strategic role in national development, particularly in achieving food security and the economic independence of rural communities. According to the Food and Agriculture Organization (FAO), food security is a condition in which all people, at all times, have physical and economic access to sufficient, safe, and nutritious food. In the Indonesian context, rice is the primary commodity that supports the national food security system.

Rice production is significantly influenced by various factors, such as water availability, climate, soil conditions, and the technology used. When any of these factors, particularly the irrigation system, is disrupted, productivity will decline. Therefore, intervention is needed through the application of agricultural technology that can address these challenges.

Irrigation is the process of supplying water to plants, which is crucial for supporting successful farming. According to Soemarno (2005), irrigation is a key factor in intensive agriculture, particularly in tropical regions with uneven rainfall throughout the year. Reliance on conventional irrigation from primary and secondary canals often creates vulnerability, particularly during the dry season or when canals are damaged.

In response to these challenges, alternative, more flexible and self-sufficient irrigation technologies are needed, such as the use of hydrant pumps. Hydrant pumps are one example of appropriate technology used to help farmers overcome irrigation challenges. These pumps draw water from surface sources such as rivers, shallow wells, or reservoirs and distribute it to

agricultural land. Hydrant pumps are practical, energy-efficient (they can run on diesel or electricity), and can be operated by farmers in groups.

Wibowo (2017) stated that the use of hydrant pumps in agricultural irrigation has proven effective in increasing the amount of irrigated land and maintaining a stable planting season. Furthermore, this technology encourages farmers to be more independent in managing their water needs, thereby reducing dependence on sometimes inefficient government irrigation systems.

Agricultural technology generally encompasses various innovations implemented to increase the productivity, efficiency, and sustainability of agricultural systems. According to Mulyani and Siregar (2018), agricultural technology encompasses land preparation, irrigation, agricultural mechanization, pest control, and post-harvest management. The goal is to reduce farmers' workload, streamline production costs, and increase yields.

In the context of modern agriculture, the integration of simple technologies and the capabilities of local communities is crucial. Technologies such as hydrant pumps are a concrete example of a low-cost, high-impact technology approach, where simple yet appropriate tools can significantly impact agricultural output, particularly in rural areas.

Community empowerment is the process of increasing the capacity of individuals and community groups to access and manage resources independently. In the agricultural context, empowerment is carried out through technology transfer, which includes training, mentoring, and field demonstrations. Chambers (1995) emphasized the importance of a participatory approach to empowerment, where communities are not merely objects, but subjects of the development process.

Through community service programs that integrate agricultural technologies such as hydrant pumps, farmers are equipped not only with tools but also with the knowledge, skills, and confidence to manage their farms more professionally and competitively.

RESEARCH METHODOLOGY

The implementation method is a stage in the community service development process, with a unidirectional flow. The strategy for this community service program is to utilize hydrant pumps as a strategy to increase production capacity. The problem-solving design is as follows: 1) Location determination, 2) Hydrant requirement planning, 3) Hydrant application plan development. The following are the target outcomes to be achieved from this community service program: 1) Increased automation knowledge to improve welfare; 2) Analysis of raw material requirements for system construction and planning using project management; 3) Partners can determine the cost of building an automation system and plan the stages of its production.

The results of this community service program will be integrated into learning, specifically in the following areas: 1) Students can apply automation material preparation calculations and project management for construction from plan to completion; 2) Application of technological knowledge gained from college regarding automation systems and project management.

RESULT AND DISCUSSION

Secondary statistical data were obtained from the Karawang Regency Agricultural Office, village agricultural records of Mekarmulya, and documentation from local farmer groups covering the period 2021–2024. The total area of paddy fields in Mekarmulya Village reached 215 hectares, of which 60% previously depended on rain-fed irrigation. Average rice productivity before the introduction of hydrant pumps was recorded at 5.2 tons per hectare per planting season, with unstable water availability identified as a major limiting factor.

Table 1. Irrigated Land Expansion

Year Phase	Pump Increase	Irrigated Area Growth
Initial	Few pumps	Limited dry-season coverage
Gradual	Steady additions	Substantial land expansion
Peak	Full deployment	Maximum water distribution

Production data after the implementation of hydrant pumps indicate a substantial expansion of irrigated land and increased cropping intensity. The number of hydrant pumps increased gradually, enabling broader water distribution during dry seasons. As a result, both yield per hectare and total rice output demonstrated a consistent upward trend across the observed years.

The increase in rice productivity can be explained by improved water availability resulting from hydrant pump utilization. Stable irrigation ensured sufficient water supply during critical growth stages, particularly during tillering and grain filling phases. Reduced exposure to drought stress contributed directly to higher yields per hectare.

Enhanced irrigation reliability also enabled farmers to adjust planting schedules more flexibly. The ability to cultivate rice during dry seasons expanded annual planting cycles and maximized land use efficiency. These conditions collectively explain the observed increase in total rice production in Mekarmulya Village.

Survey data collected from 60 farmers revealed that 82% of respondents experienced noticeable yield improvement after adopting hydrant pump irrigation. Reported yield increases ranged from 1.3 to 1.6 tons per hectare per planting season. Variation in outcomes was associated with land size, distance from water sources, and pump operational capacity.

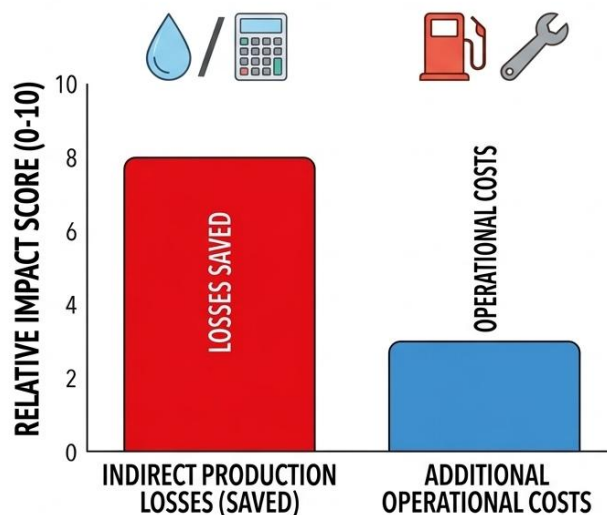


Figure 1. Hydrant Pump Economic Feasibility

Economic data further indicate a reduction in indirect production losses, particularly those related to water scarcity. Additional operational costs for fuel and maintenance were reported, yet these costs were perceived as proportionally lower than losses caused by crop failure. This pattern highlights the economic feasibility of hydrant pump adoption at the farm level.

Inferential statistical analysis using a paired-sample t-test demonstrated a statistically significant difference in rice productivity before and after hydrant pump implementation. The significance value of 0.003 ($p < 0.05$) confirms that productivity gains were not random but associated with the irrigation intervention.

Mean productivity increased from 5.2 tons/ha to 6.7 tons/ha, yielding an average difference of 1.5 tons/ha. The 95% confidence interval showed consistent improvement across most sampled farms, reinforcing the reliability of the observed effect.

Correlation analysis revealed a strong positive relationship between hydrant pump usage intensity and rice productivity, with a Pearson correlation coefficient of $r = 0.71$. This finding indicates that greater utilization and optimization of hydrant pumps were associated with higher production outcomes.

A positive relationship was also identified between water availability and cropping intensity, with a correlation coefficient of $r = 0.68$. This relationship suggests that access to reliable irrigation not only increases yield but also influences farmers' strategic decisions regarding planting frequency.

A focused case study on the "Sumber Tani Makmur" farmer group demonstrated the most pronounced production improvement. The group managed 32 hectares of paddy fields and began collective hydrant pump use in early 2022. Rice productivity increased from 5.1 tons/ha to 7.0 tons/ha within two consecutive planting seasons.

The group implemented a structured water distribution schedule supported by shared operational responsibilities (Bowden, 2021; del Risco-Moreno et al., 2021; Nasraoui et al., 2026; Novaković et al., 2024). This collective management approach reduced conflicts over water access and improved overall irrigation efficiency, contributing to sustainable production growth.

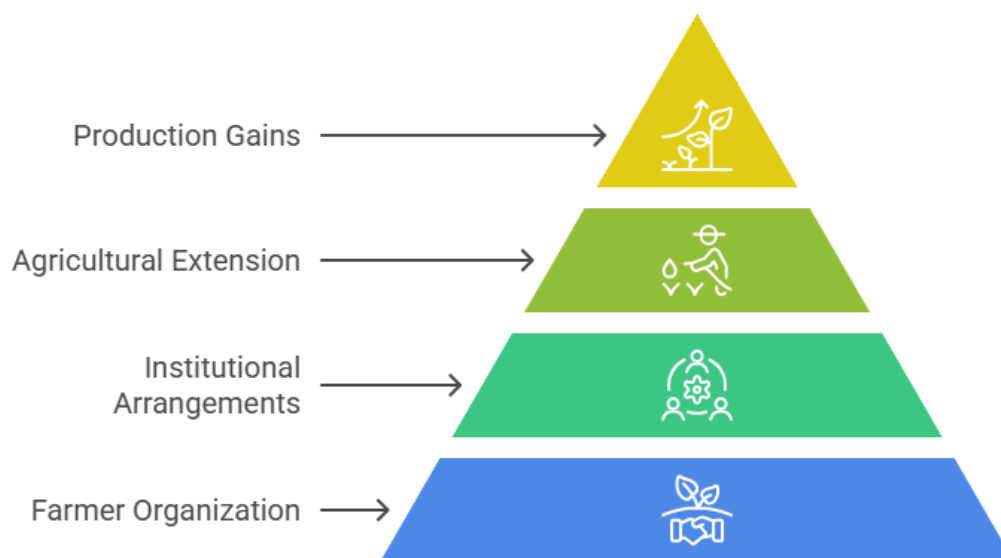


Figure 2. Case Study Success Pyramid

The success of the case study group was influenced by strong farmer organization and clear institutional arrangements. Defined roles in pump operation, maintenance, and cost-sharing ensured consistent system functionality throughout planting cycles. Agricultural extension support further enhanced pump effectiveness through technical guidance on irrigation timing and water requirements. Continuous assistance enabled farmers to align irrigation practices with crop needs, thereby maximizing production gains.

The findings indicate that hydrant pump utilization represents an effective strategy for increasing rice production capacity in Mekarmulya Village. Consistent evidence from statistical data, inferential analysis, and case study observations demonstrates significant improvements in productivity and cropping intensity. The results suggest that locally adapted irrigation technologies combined with strong farmer institutions can substantially enhance rural agricultural resilience.

These insights provide a practical foundation for replicating hydrant pump-based irrigation strategies in similar agrarian contexts.

Sustainable agricultural development in Mekarmulya Village through hydrant pump technology is heavily predicated on effective governance and collective action. The transition from informal water use to a formal distribution schedule required significant institutional adaptation among the case study group. By implementing a structured calendar with defined time slots, farmers moved beyond reactive competition for scarce resources during critical periods. This proactive scheduling. The predictability allowed for more stable crop development and reduced the variability that often plagues rain-fed systems, establishing the groundwork for both increased yield and broader community resilience against drought.

Equally crucial was the operational framework that supported this new technology. Instead of delegating system management to a single individual, the organization distributed roles across several shared responsibilities. Defined positions for daily pump operation, regular maintenance tasks, and a transparent cost-sharing mechanism ensured financial and technical continuity. This distribution of labor created a sense of collective ownership, ensuring the hydrant system would function effectively throughout repeated planting cycles without falling into disrepair due to neglected maintenance or insufficient funding.

The optimization of the technology's effectiveness was further enhanced through strategic agricultural extension support. Farmers not only needed reliable water access but also the technical knowledge to utilize it efficiently. Extension agents provided guidance on optimal irrigation timing and volumetric water requirements, tailoring assistance to specific crop growth stages and local environmental conditions. This continuous engagement ensured that farmers could align their on-farm irrigation practices precisely with crop needs, thereby avoiding both water stress and wasteful over-irrigation.

The synthesized findings from statistical data, inferential analysis, and field observations clearly validate the potential of hydrant pump-based irrigation in Mekarmulya Village. There is consistent evidence showing that this intervention substantially increases rice production capacity and enables significantly higher cropping intensity. The results strongly suggest that the core components of this success locally adapted irrigation solutions combined with robust farmer institutions are fundamental. Together, they create a comprehensive model that not only enhances immediate productivity but also builds sustainable rural agricultural resilience. These insights offer a practical and transferable foundation for replicating similar hydrant pump irrigation strategies in other comparable agrarian contexts across Indonesia.

CONCLUSION

The study demonstrates that the use of hydrant pump systems significantly enhances paddy production capacity in Mekarmulya Village, Karawang, primarily by improving water availability during critical growth stages. Empirical evidence shows more stable irrigation patterns, reduced dependency on rainfall variability, and increased cropping intensity compared to conventional irrigation practices. The distinctive finding of this research lies in identifying hydrant pumps not merely as a technical irrigation tool, but as a locally adaptable production strategy that strengthens farmers' resilience to seasonal water stress and supports more predictable harvest outcomes.

This research contributes conceptually and methodologically to the field of agricultural education and rural development by integrating technological intervention with community-based capacity building. The novelty of the study is reflected in its emphasis on hydrant pump utilization as a strategic learning process for farmers, linking practical irrigation technology with knowledge

transfer, operational skills, and collective management. Methodologically, the study offers a contextualized approach that combines field-based observation with participatory analysis, providing a replicable model for evaluating irrigation innovations in similar rural agricultural settings.

The study is limited by its focus on a single village context and a relatively short observation period, which may constrain the generalizability of the findings across different agro-ecological zones. The analysis also concentrates primarily on production outcomes without extensive examination of long-term environmental impacts, cost-efficiency, or institutional sustainability. Future research should expand the scope to comparative multi-village studies, incorporate longitudinal data, and explore the integration of hydrant pump strategies with broader water governance policies and climate-adaptive agricultural frameworks to ensure sustainable rice production development.

AUTHORS' CONTRIBUTION

Author: Conceptualization; Project administration; Validation; Writing - review and editing; Conceptualization; Data curation; Investigation; Data curation; Investigation; Formal analysis; Methodology; Writing - original draft; Supervision; Validation; Other contribution; Resources; Visualization; Writing - original draft.

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