Perceptions and Policy Implications of Water Pump Irrigation: Evidence from Rice Farmers in Indramayu, West Java

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Highlight

Pump-based irrigation significantly reduces water shortages and improves crop quality for over 90% of farmers in Indramayu, yet high operational costs impose financial strain on 41% of smallholders, highlighting the urgent need for targeted financial interventions and institutional support.

Abstract

This study evaluates farmer perceptions of pump-based irrigation in Indramayu Regency, West Java, addressing the problem of high operational costs and uncertain policy support, while focusing on its financial viability, agronomic benefits, and policy implications. We collected data from farmers as we used a quantitative. We found that pump irrigation can improve crop productivity, but it often burdens farmers financially. We have drawn on structured surveys of 147 rice farmers across Sindang, Lohbener, and Balongan subdistricts. Most respondents perceive water pump usage as financially manageable, with 72.6% rating market prices as moderately to highly affordable and 79.4% affirming operational costs are within their means. Moreover, 78.1% of farmers viewed maintenance expenses favorably, and 76.3% agreed that the investment is justified by the benefits received. However, concerns regarding additional financial burdens remain, with 41.1% expressing varying degrees of strain. Agronomically, 94.6% of farmers reported reduced water shortages during dry seasons, 98% observed improved crop quality, and 82.9% noted enhanced capacity to grow water-intensive crops. Despite these gains, only 50.7% felt more independent of government irrigation systems, indicating persistent infrastructural and financial constraints. The study employed the regulatory impact assessment framework and sustainability indicators to assess policy effectiveness and long-term viability. We underscored that the need for targeted interventions such as inclusive financing, technical support, and institutional strengthening can ensure equitable access and sustainable adoption of smallholder farming systems.

Keywords

Policy implications, farmers, rice, effectiveness.

Introduction

Indramayu Regency is a vital rice-producing region in Indonesia, plays a strategic role in supporting both Indramayu Regency, is a vital rice-producing region in Indonesia plays a strategic role in supporting both provincial and national food security (Sutardi et al., 2022).

With approximately 125,442 hectares of paddy fields and a recorded harvest of 1.2 million tons in October 2023, the area has substantial agricultural potential (Indonesia, B. S. 2025). However, limited access to irrigation water, especially during the dry season, remains a critical constraint on the productivity of the irrigation system. This challenge is compounded by deteriorating irrigation infrastructure and competing demands for water between agricultural and domestic uses. In response, the government prioritized the development of pump-based irrigation as a flexible and scalable solution. Coordinated pump irrigation programs have been launched through the Ministry of Agriculture's Emergency Food Response Task Force to improve water access, intensify cropping, and stabilize yields (Su, Q., & Singh, V. P., 2024).

Technical guidelines have been issued to support implementation, although oversight is led by the Agricultural Instrument Standardization Implementation Center of West Java. Pump irrigation is considered more adaptable

than permanent irrigation systems, offering farmers access to alternative water sources such as rivers and deep wells. However, the success of this policy hinges not only on technical deployment but also on its socio-economic responsiveness (Ward et al., 2025).

Drawing on OECD practices, this research applies a Regulatory Impact Assessment lens to evaluate farmer perceptions, usability, and affordability of PISs[1]. Key questions include how smallholder farmers assess the effectiveness of pump irrigation compared with traditional methods and whether the technology aligns with their financial capacity and agricultural needs (Sjaf, Arsyad, et al., 2022).

Pump-based irrigation in Indramayu Regency holds significant importance due to its direct impact on national food security and agricultural resilience (Budhi, G.S., & Aminah, M., 2009). Indramayu, as a leading rice-producing region in Indonesia, contributes substantially to both provincial and national rice supply chains, with more than 125,000 hectares of paddy fields and a harvest exceeding 1.2 million tons in October 2023 (Ariefiansyah, R., & Herman, R., 2023).

Persistent challenges in water availability, particularly during the dry season, threaten the productivity of the region. The deterioration of irrigation infrastructure and increasing competition for water resources highlight the need for adaptive technologies (O'Connell, 2017). Pump irrigation offers a strategic solution by providing farmers with access to alternative water sources and enabling more intensive land use. Its implementation, guided by national policy instruments and technical guidelines, demonstrates a governmental commitment to sustainable agricultural development (Streimikis, J., & Baležentis, T., 2020).

Evaluating this policy, it is necessary to assess its technical effectiveness and understand its socioeconomic impact on smallholder farmers. By examining farmer perceptions and affordability, this study aims to inform evidence-based policymaking and promote inclusive and responsive irrigation innovations to local needs. As a crucial rice-producing area in Indonesia, Indramayu Regency plays a significant role in supporting rice production at both the provincial and national levels. The regency possesses considerable potential for rice farming, with approximately 125,442 hectares of paddy fields available.

In October 2023, Indramayu achieved a rice harvest of 1.2 million tons. Data from the Food Security and Agriculture Office of Indramayu Regency indicate that the target for the expansion of planting area in 2024 is 12,887 hectares. During the second planting season (MT II/Gadu) in 2024, the planted area reached 102,258 hectares, while the harvested area was 24,468 hectares (Badan Pusat Statistik Kabupaten Indramayu, 2024, September 11).

The limited access to irrigation water, particularly in the dry season, is a significant obstacle to enhancing rice output in Indramayu, which often results in inadequate water supplies for farmland (Tirtalistyani & Kanwar, 2022). Damaged irrigation channels in various regions and competition for water resources between agricultural and domestic uses exacerbate this issue. The advancement of pump-based irrigation technology has been identified as a key solution to tackle these challenges. The technology allows farmers to access alternative water sources, such as rivers or deep wells, ensuring a consistent water supply for their agricultural lands (Saad & Gamatié, 2020).

The government, through the Ministry of Agriculture, has launched several initiatives aimed at aiding farmers in maintaining sustainable agricultural production to address the challenges of water availability. The Minister of Agriculture's Decree establishing a Pump Irrigation Task Force for Emergency Food Response is a notable initiative (Jamil, A., & Chairunnisya, R. A., 2023).

According to the World Bank Group. (2019), Governance in Irrigation and Drainage: Concepts, Cases, and Action-Oriented Approaches Practitioner's Resource, the task force is primarily responsible for five critical functions:

1. Developing and executing pump irrigation activities in accordance with set objectives.
2. Provide policy guidance to provincial-level field coordinators to ensure cohesive implementation.

1 In agricultural research (e.g., crop trials, soil studies, farmer surveys), PISs are documents given to farmers, workers, or community members before they participate in a study. They ensure participants understand the purpose, methods, risks, and benefits of the research.

3. Coordinating and overseeing the effectiveness and efficiency of pump irrigation activities.
4. Thorough monitoring is conducted to ensure program sustainability.
5. Reviewing the implementation process to identify successes and obstacles for future enhancements.

To ensure that the policy is carried out effectively, the Head of the Agricultural Instrument Standardization Implementation Center (BSIP) of West Java has been appointed as the responsible individual. Their duty is to enhance coordination, oversight, and collaboration among stakeholders so that the PIP can be successfully executed, contributing to increased rice productivity in the area.

At the national level, technical guidelines have been introduced for both piped and pump-based irrigation systems, in support of the Minister's policy, in addition to the rehabilitation of irrigation networks. These guidelines were developed by relevant Echelon I officials from the Directorate General of Agricultural Infrastructure and Facilities.

Indramayu Regency encompasses 125,442 hectares of rice fields, of which 84,684 hectares are designated as LP2B. The DKPP oversees 16 of the region's 99 priority programs, with five directly enhancing irrigation infrastructure. These include the development of tertiary irrigation networks across 108,000 hectares, the deployment of excavators for irrigation maintenance in 31 subdistricts, the construction of 1,000 deep-bore wells in rainfed areas, and the construction and revitalization of 100 water reservoirs. Additionally, efforts to eliminate water-related corruption are underway through the revitalization of the water user groups of P3A Mitra Cai farmers. Indramayu's agricultural landscape is supported by 311 Gapoktan and 2,824 farmer groups. National programs complement these efforts by providing seed and fertilizer subsidies, promoting mechanization, and providing technical support to boost rice, corn, and soybean production.

Ensuring sustainable rice production in Indramayu requires attention to environmental impacts and farmer capacity. Although productivity has improved, excessive fertilizer and pesticide use threaten long-term soil and water health. National policies now promote eco-friendly farming practices. Locally, the Indramayu Government supports rice production through institutional strengthening, farmer training, and infrastructure development, including irrigation and post-harvest facilities. Agricultural policies also aim to reduce post-harvest losses and enhance competitiveness through the development of downstream industries. However, land conversion remains a major challenge in maintaining planting areas. Farmer groups such as Gapoktan play a vital role in managing inputs and outputs, supported by the government, farmers, and private actors. Pump-based irrigation is increasingly adopted to address water shortages, aligned with national modernization efforts under the RPJMN 2020–2024 and the Alsintan program. Indramayu benefits from machinery assistance and legal mandates to improve access to irrigation. Farmer perceptions of pump-based systems shaped by technical, economic, and institutional factors are key to sustainable adoption and productivity gains.

The expansion of irrigation infrastructure and farmer group support has significantly strengthened Indramayu's agricultural base, yet sustaining rice production demands more than physical development. Environmental pressures, such as soil degradation from chemical overuse, and socio-institutional challenges, such as land conversion, require integrated responses. National and regional policies are increasingly focusing on sustainable practices, farmer empowerment, and technological modernization, particularly pump-based irrigation, to ensure long-term productivity. These efforts reflect a shift from infrastructure-led growth toward holistic agricultural resilience, where farmer perceptions, ecological stewardship, and institutional coordination play central roles.

The pump irrigation policy seeks to enhance water availability, particularly during dry seasons, and to facilitate rice intensification efforts in Indramayu Regency. Pump technology is viewed as a more adaptable and efficient alternative to permanent irrigation systems, which require more time and financial resources. With the assistance of pump irrigation, farmers are expected to increase cropping intensity, maximize land use, and ultimately improve rice yields. From a socio-economic viewpoint, this study presumes that the pump irrigation policy is flexible and responsive to the needs of its target users. However, to ensure its efficacy, a thorough evaluation that not only focuses on technical factors but also assesses social and economic implications is necessary. Drawing from the experiences of OECD member nations, policy evaluation uses the RIA approach.

Increasing rice production is a key national goal in achieving food security. The development of pump irrigation as a solution to irrigation water management issues in areas with agricultural potential but restricted access to

natural surface water is one strategic initiative being implemented. Nevertheless, the execution of this policy encounters several obstacles (Tumrani, S. A., Pathan, P. A., & Suleman, B. M., 2015).

1. How do smallholder farmers perceive the effectiveness and usability of pump-based irrigation systems compared with traditional irrigation methods in enhancing agricultural productivity?
2. What are the affordability and cost-effectiveness of PBI systems in relation to their financial capacity and agricultural benefits?

Literature Review

Pump-Based Irrigation and Agricultural Resilience in Indramayu Regency

Indramayu Regency holds a strategic position in Indonesia's food security landscape as one of the country's leading rice-producing regions, with more than 125,000 hectares of paddy fields and harvests exceeding 1.2 million tons in 2023 (Walker, S. 2024). Its contribution to both provincial and national rice supply chains has been widely recognized in earlier studies (Liu, L., Ross, H., and Ariyawardana, A. 2020). However, persistent challenges in water availability, particularly during the dry season, continue to constrain productivity. Scholars highlight that deteriorating irrigation infrastructure and competing demands for water between agricultural and domestic uses exacerbate these constraints (Elliott, J. et al. 2014).

In response, pump-based irrigation systems (PISs) have been promoted as adaptive technologies that provide farmers with flexible access to alternative water sources such as rivers and deep wells, thereby enabling more intensive land use and stabilizing yields (Pedro, R. N. 2012). The Ministry of Agriculture has institutionalized the approach through the Emergency Food Response Task Force, supported by technical guidelines and oversight from the Agricultural Instrument Standardization Implementation Center of West Java (Sarma, M. M., et al. 2025).

Governance frameworks, such as those outlined by the World Bank (2019), emphasize the importance of coordination, monitoring, and farmer participation in ensuring irrigation sustainability, while local institutions like Gapoktan and P3A Mitra Cai play a vital role in water resource management. Beyond technical deployment, scholars argue that the success of pump irrigation depends on its socio-economic responsiveness, particularly farmer perceptions of usability, affordability, and alignment with financial capacity (Anner, M., Pons-Vignon, N., & Rani, U., 2019). At the same time, environmental concerns such as soil degradation from excessive fertilizer and pesticide use highlight the need for sustainable practices (

Hossain, M. E.etal 2022). Overall, the literature underscores that pump-based irrigation in Indramayu is not only a technical solution to water scarcity but also a socio-economic and environmental intervention whose long-term success depends on integrated governance, farmer empowerment, and ecological stewardship. Although existing studies on pump-based irrigation systems (PISs) in Indramayu Regency have highlighted their technical potential to mitigate water scarcity, policy support through national modernization programs, and the role of local institutions in governance, the literature remains fragmented. Most research has examined technical efficiency, governance frameworks, or farmer perceptions in isolation, with limited empirical evidence on how these dimensions interact to shape long-term sustainability. Furthermore, while environmental concerns such as groundwater depletion and soil degradation are acknowledged, systematic assessments of ecological trade-offs remain scarce. Economic viability and equity issues, particularly the differential impacts on smallholders versus larger farmers, are also underexplored. Finally, despite climate variability being a critical driver of irrigation demand, few studies evaluate the adaptive capacity of PISs under future climate scenarios. This indicates a clear gap for integrated, longitudinal research that links technical performance, socio-economic responsiveness, governance effectiveness, and environmental sustainability to assess the resilience of pump irrigation as a holistic intervention in Indonesia's food security landscape.

RESEARCH METHOD

The research was conducted in Indramayu Regency, West Java, which serves as the designated area for policy implementation. Three subdistricts, Sindang, Lohbener, and Balongan to ensure the accuracy of data and information. These subdistricts were deliberately chosen because:

1. They received allocations for irrigation assistance.
2. The predominant population consists of rice farmers.
3. The regions are accessible and convenient for visits.

The study was conducted between October and November 2024.

Data Sources
This study employed a quantitative research design. Primary data were collected from 147 farmers who benefited from pump irrigation assistance in three subdistricts, selected through simple random sampling. Secondary data comprised geographic and demographic profiles, rice production statistics, and other farming-related datasets.

Data Collection Techniques
Primary data were gathered through structured questionnaires using a Likert scale to measure farmer perceptions, attitudes, and understanding of the Pump Irrigation Program (PIP).

Data Analysis Techniques
Quantitative data were analyzed using descriptive statistics (frequency, percentage, mean, and standard deviation) to summarize farmer perceptions. Likert-scale responses were tabulated to identify trends in financial viability, agronomic benefits, and policy implications. Inferential statistical techniques, such as correlation and regression analysis, were applied where relevant to examine relationships between farmer characteristics and their perceptions of pump irrigation.

RESULTS AND DISCUSSION

Balancing Infrastructure, Ecology, and Farmer Empowerment for Sustainable Food Security in Indramayu
Indramayu's story of agricultural resilience is one of people and communities working together to secure their future. Farmers have gained new strength through expanded irrigation networks, reservoirs, bore wells, and pump-based systems that make water more accessible, while local institutions like Gapoktan and farmer groups provide the social backbone that keeps production moving. Yet, behind these gains lie real challenges: soils and water strained by chemical use, and farmland lost to conversion. Policies now point toward more sustainable paths, eco-friendly farming, farmer training, stronger institutions, and better post-harvest systems, while modernization programs promote pump irrigation and mechanization. The heart of the finding is that Indramayu's resilience is not just about infrastructure or technology, but about balancing ecological care, empowering farmers, and ensuring institutions work hand in hand to sustain food security for generations.

Table 1. Balancing Growth and Sustainability: Agricultural Resilience Factors in Indramayu

Dimension	Key Points
Infrastructure Gains	Expansion of tertiary irrigation (108,000 ha), bore wells (1,000 units), reservoirs (100), pump-based irrigation adoption, and mechanization support.
Farmer Institutions	311 Gapoktan and 2,824 farmer groups manage inputs/outputs; supported by government, national programs, and private actors.
Challenges	Environmental: soil and water degradation from excessive fertilizer/pesticide use. Socio-institutional: land conversion reduces planting areas.
Policy Direction	Shift toward eco-friendly farming, farmer training, institutional strengthening, post-harvest loss reduction, and downstream industry development.
Modernization Focus	Pump-based irrigation promoted under RPJMN 2020–2024 and machinery program; adoption depends on farmer perceptions (technical, economic, institutional).
Main Finding	Indramayu's agricultural resilience is strengthened by infrastructure and farmer support, but long-term sustainability requires integrated strategies balancing ecological stewardship, farmer empowerment, and institutional coordination.

Source: Authors

Indramayu's agricultural resilience emerges from a blend of infrastructure expansion, strong farmer institutions, and evolving policy directions, yet it is tempered by persistent environmental and socio-institutional challenges. The region has benefited from significant gains such as the extension of tertiary irrigation networks across 108,000 hectares, the construction of reservoirs and bore wells, and the adoption of pump-based irrigation and mechanization support, while 311 Gapoktan and 2,824 farmer groups provide organizational strength in managing inputs and outputs with support from government and private actors. However, soil and water degradation from chemical overuse and land conversion, reducing planting areas, threaten sustainability. In response, policies now emphasize eco-friendly farming, farmer training, institutional strengthening, post-harvest loss reduction, and downstream industry development, with modernization programs like RPJMN 2020–2024 and Alsintan promoting pump irrigation as a strategic solution. Ultimately, the findings show that while infrastructure

and institutional support have bolstered resilience, long-term sustainability depends on integrated strategies that balance ecological stewardship, empower farmers, and ensure coordinated governance.

Balancing Efficiency and Sustainability: Farmers' Views on Pump Irrigation

Table 2 presents the results of a survey conducted among farmers in Indramayu District regarding the use of water pumps for agricultural irrigation. The statements reflect key dimensions of farmer experience, including ease of use, productivity, comfort, and technical challenges. Respondents rated their agreement on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree), offering insights into pump-based irrigation's practical and emotional impacts. The data serve as a foundation for participatory evaluation and scenario planning to enhance sustainable irrigation practices and farmer empowerment.

Table 2. Survey Statements on Irrigation Water Pump Utilization

No	Statement	Frequency (%)	1	2	3	4	5	Total
1.	Water pumps make it easier to irrigate my land than traditional methods.		1.4	0.0	0.7	67.1	30.8	100
2.	I feel more productive after using irrigation water pumps.		1.4	0.0	2.1	74.7	21.9	100
3.	Using water pumps increases my crop yields.		0.7	0.7	8.2	69.9	20.5	100
4.	I feel comfortable using water pumps for irrigation.		1.4	1.4	4.1	74.7	18.5	100
5.	I do not experience any technical difficulties in operating the water pump.		0.7	11.6	18.5	56.2	13.0	100

Resources: Created by Author 2025)

Scale Explanation: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Based on the survey conducted in Indramayu Regency, farmers generally express strong positive perceptions toward the use of water pumps for irrigation. The majority of respondents agreed that water pumps significantly ease the process of irrigating their land compared to traditional methods, with 67.1% agreeing and 30.8% strongly agreeing. Productivity gains are also widely acknowledged, with 74.7% of respondents agreeing and 21.9% strongly agreeing that they feel more productive after adopting PBI. In terms of crop yield, 69.9% and 20.5% agreed that water pumps help increase their harvests, respectively, although a small percentage (8.2%) remained neutral, possibly reflecting varied outcomes across farming contexts. Comfort in using the technology is evident, with 74.7% and 18.5% agreeing that they feel at ease operating the pumps, respectively. However, technical ease presents a more mixed picture: while 56.2% and 13.0% agree that they do not face operational difficulties, respectively, 30.8% report neutral or negative experiences, suggesting that some farmers may benefit from additional training or support. Overall, the data highlight the perceived value of water pumps in improving irrigation efficiency and productivity, while also pointing to areas for improvement in technical assistance and user support.

The survey results show that farmers find water pumps easier than traditional irrigation. Approximately 98% agree that pumps save time and labor. Most farmers reported higher productivity with pumps, with 96.6% giving positive feedback. Approximately 90% say that pumps help increase crop yields. Satisfaction with pump use is high, though 2.8% of patients report issues. Ease of operation shows mixed views: 69.2% are satisfied, but 30.8% face challenges. These challenges may stem from limited training or poor pump quality. Overall, farmers view pumps positively for efficiency and output. However, technical support and maintenance are required to ensure long-term use. A holistic approach that combines training, infrastructure, and policy is key to achieving sustainable adoption and farmer welfare.

Farmers' Views on Financial Aspects of Water Pump Use

Survey results on farmers' viewpoints concerning the cost-effectiveness and financial impacts of using water pumps for irrigation. Feedback was gathered based on five essential statements, each evaluated using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The percentages indicate the proportion of respondents who selected each option, providing insights into how farmers assess the expenses related to the purchase, operation, and maintenance of water pumps, as well as the perceived benefits of such an investment. This information is vital for evaluating the economic viability of irrigation through pumps and pinpointing areas where financial assistance or policy measures may be necessary to improve adoption and sustainability.

The table below displays the distribution of farmer responses to five evaluative statements regarding the affordability of PBI systems. Each statement was rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to capture perceptions across key cost dimensions: market price, operational expenses such as fuel or electricity, maintenance costs, perceived investment value, and financial burden.

The percentage distribution within each score category indicates the relative levels of agreement among the respondents, with each row totaling 100%. This structure facilitates a detailed understanding of cost-related acceptability from the user perspective. The highest concentration of agreement, 69.4% at score 4, relates to the perceived value of pump investment, indicating a strong alignment between expected benefits and financial outlay. In contrast, lower agreement levels regarding upfront affordability and maintenance costs highlight potential barriers to adoption that require further policy consideration.

These data provide an empirical basis for evaluating the economic feasibility of pump-based irrigation and designing targeted interventions to improve accessibility and sustainability in smallholder farming contexts.

Table 3. Price and Operational Costs in Indramayu Regency

No	Questionnaire Statement	Score 1 (%)	Score 2 (%)	Score 3 (%)	Score 4 (%)	Score 5 (%)	Total (%)
1	The price of water pumps available in the market is affordable.	8.2	14.4	31.5	41.1	4.8	100
2	The fuel or electricity costs to operate the water pump are within my means.	1.4	19.2	21.9	52.7	4.8	100
3	The maintenance and repair costs of water pumps are reasonable.	6.2	15.8	27.4	45.9	4.8	100
4	I feel that the investment in purchasing a water pump is worth the benefits received.	1.4	5.6	26.7	69.4	6.9	100
5	Additional expenses for water pumps do not overburden my finances.	6.8	9.6	24.7	56.2	2.7	100

Sources: Created by the author (2025)

The distribution of farmer perceptions regarding the affordability and operational costs of pump-based irrigation systems in Indramayu Regency is summarized. Five evaluative statements were assessed using a five-point Likert scale, with percentage values representing the proportion of respondents for each score. The findings show that most respondents consider investment in pump technology justified, with 69.4% agreeing and 6.9% strongly agreeing that the benefits outweigh the costs. Operational expenses, such as fuel and electricity, are generally perceived as manageable, with 52.7% of respondents agreeing. However, the perceptions of market price and maintenance costs are more varied. Approximately 22.6% of respondents disagreed or strongly disagreed that pump prices are affordable, and 22% expressed similar concerns about maintenance expenses. Additionally, while 56.2% agreed that additional expenditures do not place an excessive financial burden, 16.4% reported experiencing financial strain. These results suggest that although the perceived value and day-to-day affordability of pump use are generally positive, some farmers continue to face challenges in terms of initial investment and maintenance costs. Targeted policy interventions, such as subsidies, microfinance schemes, or community-based maintenance support, may be necessary to enhance equitable access and promote the long-term sustainability of pump-based irrigation technologies.

Table 4. Water Pump Work Effectiveness in Indramayu Regency

No	Statement	Score 1 (%)	Score 2 (%)	Score 3 (%)	Score 4 (%)	Score 5 (%)	Total (%)
1	The water pump operates efficiently and meets my land's irrigation needs.	0.7	3.4	4.8	83.6	7.5	100
2	The use of a water pump ensures a timely water supply during the planting season.	0.7	6.2	6.2	71.9	15.1	100
3	The water pump quickly distributes water across the entire field.	0.0	13.0	14.4	63.7	8.9	100
4	I rarely experience disruptions when using the irrigation water pump.	0.7	21.9	18.5	56.2	2.7	100

5	The water pump helps save time and labor during irrigation.	3.4	4.8	16.6	69.7	5.5	100

Sources: Created by the author (2025)

Presents farmer perceptions regarding pump-based irrigation system operational effectiveness in Indramayu Regency. The data are derived from five evaluative statements rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), capturing efficiency, timeliness, flow performance, reliability, and labor-saving potential. The results indicate a generally high level of satisfaction, particularly in terms of irrigation efficiency and timeliness, with 83.6% and 71.9% of respondents agreeing that the pump meets their land's water needs and delivers water punctually during the planting season, respectively. Similarly, 69.7% of respondents acknowledged that pump usage helps conserve time and labor. However, perceptions of reliability and flow speed show slightly more variation, with 21.9% expressing disagreement regarding operational disruptions and 27.4% remaining neutral or disagreeing about the pump's speed in distributing water. These findings suggest that while pump technology is broadly perceived as effective, targeted improvements in reliability and flow optimization may further enhance user experience and system performance.

Table 4 summarizes farmer perceptions regarding the practical benefits and ease of use of PBI systems in Indramayu Regency. The data are derived from five evaluative statements rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), capturing user experiences across the dimensions of comparative efficiency, productivity gains, yield improvement, operational comfort, and technical usability. The responses indicate a strong consensus on the advantages of pump irrigation over traditional methods, with 67.1% and 30.8% agreeing that pumps facilitate land irrigation more effectively, respectively. Similarly, 74.7% of the respondents reported increased productivity, and 69.9% acknowledged improvements in crop yields. Comfort in usage was also affirmed, with 74.7% expressing agreement and only 2.8% registering disagreement. However, technical usability showed slightly more variation: while 56.2% of respondents agreed that they encountered no operational difficulties, 30.1% remained neutral or disagreed, suggesting that some users may face challenges related to maintenance, training, or equipment quality. These findings underscore the perceived utility of pump technology in enhancing agricultural efficiency and highlight the need for continued technical support and capacity-building to ensure its inclusive and sustained adoption.

Table 4. Farmers' Views on Water Pump Usage in Indramayu Regency

No	Statement	Score (%)	1 Score (%)	2 Score (%)	3 Score (%)	4 Score (%)	5 Total (%)
1	Water pumps make irrigating my land easier than traditional methods.	1.4	0.0	0.7	67.1	30.8	100
2	I feel more productive after using irrigation water pumps.	1.4	0.0	2.1	74.7	21.9	100
3	Using water pumps increases my crop yields.	0.7	0.7	8.2	69.9	20.5	100
4	I feel comfortable using water pumps for irrigation.	1.4	1.4	4.1	74.7	18.5	100
5	I do not experience technical difficulties when operating water pumps.	0.7	11.6	18.5	56.2	13.0	100

Sources: Created by the author (2025).

The five statements were rated using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), capturing the dimensions of comparative ease, productivity, yield improvement, comfort, and technical operability. The data revealed overwhelmingly positive perceptions. For instance, 97.9% of the respondents agreed or strongly agreed that pump irrigation is easier than traditional methods, with only 2.1% expressing any level of disagreement. Similarly, 96.6% reported increased productivity, and 90.4% acknowledged improvements in crop yields following the adoption of pumps. These figures suggest that pump technology is widely recognized as a transformative tool for enhancing agricultural efficiency and outcomes.

Comfort in usage was also affirmed, with 93.2% of respondents expressing agreement or strong agreement. This indicates that the physical and operational aspects of pump use are well-accepted by farmers. However, technical usability showed slightly more variation: while 69.2% agreed or strongly agreed that they did not experience

operational difficulties, 30.8% selected scores 1–3, suggesting that a subset of users may face challenges related to maintenance, troubleshooting, or lack of training.

These findings underscore the dual narrative of pump adoption: while the technology is broadly embraced for its agronomic and ergonomic benefits, targeted technical support and capacity-building are needed to ensure inclusive and sustained use. Policy interventions such as localized training, user-friendly manuals, and community-based maintenance services could help bridge these usability gaps and enhance long-term impact.

Farmer Insights on the Use of Water Pumps for Irrigation: An In-Depth Survey Evaluation

A study examining the insights of farmers about water pump usage for irrigation highlights several key aspects reflecting their personal experiences with this technology. The following analysis is based on frequency responses to the following five primary statements:

1. Water pumps make land irrigation easier than traditional practices

A considerable majority of participants indicated that water pumps simplify the irrigation process compared with conventional methods. Specifically, 67.1% and 30.8% of respondents chose “agree” (4) and “strongly agree” (5), respectively, while only 1.4% opted for “disagree” (1 or 2). This outcome suggests that most farmers perceive tangible benefits in terms of time and labor efficiency when using water pumps.

2. Water pumps boost farmer productivity.

Many farmers reported an increase in productivity after they began using water pumps. This is evident, as 74.7% responded agree” (4) and 21.9% responded “strongly agree” (5). Only 3.5% of respondents gave neutral or unfavorable responses. These findings indicate that water pumps not only aid in irrigation but also enhance farming results, including better time management and improved agricultural practices.

3. Water pumps contribute to enhancing crop yields**.**

Of the respondents, 69.9% “agree” (4) that water pumps lead to greater crop yields, while 20.5% “strongly agree” (5). Only 9.6% of respondents provided neutral or negative responses (1, 2, or 3). This suggests a generally positive perception of the direct effects of water pumps on the harvest amount and quality.

4. Use of water pumps for irrigation.

Satisfaction levels regarding water pump operation were notably high. Approximately 74.7% of respondents chose “agree” (4) and 18.5% “strongly agree” (5), reflecting widespread ease of use. A small fraction (2.8%) selected “disagree” (1 or 2), likely attributable to technical difficulties or unfavorable circumstances regarding operational suitability.

5. Technical ease of water pump operation.

This aspect revealed comparatively lower satisfaction levels. While 56.2% selected “agree” (4) and 13.0% “strongly agree” (5), a significant 30.8% provided neutral or negative feedback, including 11.6% who responded with “somewhat disagree” (2). These numbers suggest that some farmers still face technical hurdles, possibly due to inadequate training or lower-quality pumps.

In general, the survey illustrates that farmers have a very positive view of using water pumps for irrigation, especially regarding irrigation simplicity, productivity improvements, and enhanced yields. Nonetheless, the reported technical difficulties indicate a need for increased support, such as the following:

1) Training initiatives targeted to improve technical knowledge
2) Maintenance assistance and access to spare parts to minimize downtime
3) Measures for quality control of pump distribution

4) These insights emphasize the need for a responsive, field-informed strategy for disseminating agricultural technology that combines technical, economic, and institutional support to promote sustainable usage and improved farmer well-being.

Table 5. Perceptions of the Benefits and Impacts of Water Pump Usage in the Indramayu Regency

No	Statement	Score 1 (%)	Score 2 (%)	Score 3 (%)	Score 4 (%)	Score 5 (%)	Total
1	The use of water pumps reduces the risk of water shortages during the dry season.	**0.7**	0.0	**4.8**	78.8	**15.8**	100
2	Water pumps help me grow crops that require more irrigation.	**0.0**	0.0	**17.1**	74.0	**8.9**	100
3	I have seen improvements in crop quality since the use of water pumps.	**0.7**	0.7	**0.7**	82.9	**15.1**	100
4	Water pumps extend the growing season or enable a second planting.	**3.4**	2.7	**23.3**	64.4	**6.2**	100
5	With the use of water pumps, I am more independent in irrigation and less reliant on government systems.	**6.8**	15.8	**26.7**	46.6	**4.1**	100

Sources: Created by Author 2025

Indramayu farmers generally perceive water pumps as highly beneficial for irrigation management, especially during dry seasons. A total of 94.6% of respondents agreed that pumps reduce the risk of water shortages, highlighting their importance in climate adaptation. Additionally, 82.9% of respondents believe that pumps enable the cultivation of water-intensive crops, expand planting options, and support diversification. Improvements in crop quality are also widely acknowledged, with 98% of farmers reporting positive changes since the adoption of PBI. While 70.6% agreed that pumps help extend the growing season or allow for a second planting, nearly 30% remained neutral or disagreed, suggesting variability in access or land suitability. Notably, only half of the respondents (50.7%) feel more independent from government irrigation systems, indicating that financial and technical constraints still limit full self-reliance, although pumps offer autonomy. These findings describe the need for integrated support combining infrastructure, training, and policy to ensure equitable and sustainable adoption of farming communities.

Captures the positive outcomes and lingering constraints.
Indramayu's agricultural strength arises from a combination of expanded irrigation facilities, organized farmer associations, and adaptive policy frameworks, though persistent ecological and institutional pressures remain. The development of tertiary irrigation covering 108,000 hectares, alongside reservoirs, bore wells, and pump-based systems, has enhanced water access and mechanization. At the same time, 311 Gapoktan and 2,824 farmer groups provide collective capacity to manage resources with support from both government and private stakeholders. National programs such as RPJMN 2020–2024 and machinery modernization initiatives highlight eco-conscious cultivation, farmer training, institutional reinforcement, and post-harvest efficiency, positioning pump irrigation as a pivotal innovation. Survey findings reveal strong approval: most respondents noted pumps simplify irrigation, improve productivity, and raise yields, while comfort in operation is widely acknowledged. Yet, technical challenges remain for a portion of farmers, pointing to the need for additional guidance and capacity building.

A majority believe investment in pump technology is worthwhile, with operational costs like fuel and electricity generally seen as manageable. However, concerns about purchase prices and maintenance expenses persist, with roughly one-fifth of farmers reporting affordability issues or financial strain. While many agree that expenditures do not impose excessive burdens, others highlight difficulties that could hinder equitable adoption. These insights suggest that although pump irrigation is valued for efficiency and productivity, sustainable implementation requires targeted support. Subsidies, microfinance options, and community-based maintenance schemes could help broaden access, ensuring that technological progress aligns with ecological stewardship, farmer empowerment, and coordinated governance to secure Indramayu's long-term agricultural resilience.

Farmer in Indramayu Regency highlight both the economic and functional dimensions of pump-based irrigation adoption. On the financial side, most respondents view investment in pump technology as worthwhile, with

nearly three-quarters agreeing that the benefits outweigh the costs, and operational expenses such as fuel and electricity are generally considered manageable. Yet, concerns remain regarding the affordability of purchase and maintenance, with around one-fifth of farmers reporting financial strain. These mixed views suggest that while day-to-day affordability is broadly positive, initial investment and upkeep continue to pose barriers for some households. Policy measures such as subsidies, microfinance programs, and collective maintenance schemes could help reduce these disparities and ensure more equitable access to pump technology.

At the same time, functional assessments reveal overwhelmingly favorable experiences with pump irrigation. Nearly all respondents reported that pumps ease irrigation compared to traditional methods, and the majority acknowledged gains in productivity and crop yields. Comfort in usage is widely affirmed, though technical operability shows greater variation, with about one-third of farmers indicating challenges in troubleshooting or maintenance. This dual narrative underscores that pump irrigation is both valued for its agronomic benefits and constrained by financial and technical hurdles. Addressing these issues through targeted training, user-friendly support systems, and community-based services would not only enhance usability but also reinforce long-term sustainability, ensuring that infrastructure investments translate into resilient agricultural outcomes.

Agricultural resilience is strengthened by infrastructure expansion, institutional support, and adaptive policies, yet it remains vulnerable to ecological and financial pressures. Farmer perceptions confirm that pump irrigation delivers significant benefits in productivity, yield, and ease of use, though affordability and technical challenges persist for a portion of users. Sustainable progress will depend on targeted interventions such as subsidies, microfinance, and localized training to ensure equitable access and effective utilization. Ultimately, balancing technological innovation with ecological stewardship and coordinated governance is essential to secure long-term resilience in Indramayu's farming systems.

DISCUSSION

Farmers in Indramayu generally perceive the financial aspects of water pump usage as manageable, although there is some variation across cost categories. Regarding market affordability, 72.6% of respondents rated water pump prices as moderately to highly affordable (scores 3–5), though 22.6% expressed concern, indicating room for price adjustments or subsidies. Fuel or electricity costs were viewed more positively, with 79.4% of respondents selecting scores of 4 or 5, suggesting that operational expenses are largely within the farmers' means. Maintenance and repair costs also received favorable responses, with 78.1% of respondents finding them affordable, though 22% remained neutral or concerned. Notably, 76.3% of farmers strongly agreed that the benefits received justify the investment in purchasing a pump, reflecting high perceived value. However, when asked about additional financial burdens, only 58.9% felt unburdened, and 41.1% expressed varying degrees of concern. These findings suggest that even if pump-based irrigation is widely accepted as cost-effective, targeted financial support, especially for upfront costs and unexpected expenses, could enhance equitable access and long-term adoption.

The most prominent finding is the strong consensus that water pumps significantly reduce the risk of water shortages during the dry season, with 94.6% of respondents selecting a score of 4 or 5. This underscores the vital role of the pump in climate adaptation and irrigation reliability. Additionally, 98% of farmers reported improvements in crop quality since adopting PBI, indicating a direct link between water access and agricultural outcomes. A substantial majority (82.9%) also agreed that pumps enable the cultivation of water-intensive crops, supporting diversification and improved land use. Although 70.6 % of the respondents felt that pumps help extend the growing season or allow for a second planting, the remaining 29.4% expressed neutral or negative views, suggesting that the benefits may vary depending on land conditions or pump capacity. Notably, only 50.7% of farmers felt more independent of government irrigation systems, revealing that full autonomy is still limited by financial, technical, or infrastructural constraints. These findings highlight the need for targeted interventions such as training, maintenance support, and inclusive financing to maximize the long-term benefits of PBI[2] and ensure equitable access across farming communities.

Several studies across different regions reinforce the findings of Indramayu regarding the financial viability and perceived benefits of PBI. In Ethiopia, Mebratu Negera et al. (2025) examined the impact of solar pumps and

[2] Pump-Based Irrigation (PBI) refers to irrigation systems that rely on mechanical pumps to draw water from groundwater or surface sources for agricultural use. PBI enhances water accessibility and crop productivity but requires adequate training, maintenance support, and inclusive financing to ensure long-term sustainability and equitable adoption across farming communities.

water harvesting ponds on smallholder farmers, revealing that most respondents found these technologies to be affordable, operationally efficient, and instrumental in improving crop income and food security. Similarly, Adhikari et al. (2025) analyzed irrigation pump ownership in Nepal's rice-wheat systems and found that pump access significantly reduced irrigation costs and increased yields, with farmers viewing the investment as worthwhile despite some technical challenges. In the Philippines, Jezra Deniega Dometita and Errol Gimeno De Castro (2025) explored the sustainability of solar-powered irrigation systems and reported that although maintenance and infrastructure gaps remained, farmers considered them cost-saving and effective. Their study emphasized the need for policy support to overcome financial and technical barriers.

Collectively, these affirm that while pump-based irrigation is broadly accepted as beneficial, its long-term success depends on affordability, technical support, and enabling policy environments, echoing the realities observed in Indramayu. The key advantage of this research is its ability to capture localized, farmer-driven insights into the financial and functional viability of PBI in Indramayu Regency. The study offers a nuanced understanding of affordability from the user's perspective by quantifying perceptions across multiple cost dimensions, purchase price, operational expenses, maintenance, and added financial burden. This bottom-up evidence is especially valuable for informing targeted policy interventions, such as subsidy design, credit schemes, and infrastructure support. Moreover, the research highlights the perceived agronomic benefits of pump usage, including improved crop quality, extended growing seasons, and reduced vulnerability to drought. These findings validate the relevance of pump technology in smallholder contexts and provide a foundation for scaling sustainable irrigation models that align with farmer priorities and local realities.

This research is limited by its reliance on self-reported perceptions, which may not fully capture the diversity of technical, economic, and geographic realities across farming communities in Indramayu. Although the findings reflect generally positive views on affordability and impact, they do not account for variations in pump performance, water availability, or long-term maintenance challenges across different subdistricts. Additionally, the survey does not disaggregate responses by farm size, income level, or access to institutional support, which could influence perceptions of cost-effectiveness and independence. The absence of longitudinal data also limits the ability to assess sustained outcomes over multiple planting seasons. Therefore, future research should incorporate field-based performance metrics, stratified sampling, and temporal analysis to better understand the nuanced barriers and enablers of pump-based irrigation adoption.

CONCLUCION

Pump-based irrigation in Indramayu Regency has emerged as a vital tool for strengthening sustainable rice production, with farmers reporting clear benefits in ease of use, productivity gains, and improved crop yields. While most respondents view the financial aspects of pump ownership and operation as manageable, concerns remain over upfront costs, maintenance, and occasional technical challenges, highlighting the need for targeted subsidies, affordable financing, and training support. The technology is widely recognized for reducing vulnerability to dry-season water shortages, improving crop quality, and enabling diversification, yet full independence from government irrigation systems is still constrained by financial and infrastructural factors. Taken together, these findings affirm that pump-based irrigation is both effective and valued by farmers, but its long-term success depends on integrated strategies that combine affordability, technical assistance, and inclusive policy frameworks to ensure equitable access, farmer empowerment, and ecological resilience across Indramayu's rice-farming communities.

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