Farmers' Assessment of Water Accessibility and Delivery Reliability in NIA's Solar Powered Irrigation Projects in Talugtug, Nueva Ecija

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Abstract- ***This study examined the perceptions of farmers regarding water accessibility and delivery reliability in the National Irrigation Administration's (NIA) solar-powered irrigation projects in Talugtug, Nueva Ecija. It aimed to assess how farmers view the system in terms of proximity of the water source, frequency of water availability, ease of access, timeliness of water delivery, consistency of water supply, and adequacy of water volume delivered. The study used a quantitative descriptive research design and involved 88 purposively selected farmers who are actual users of NIA's solar-powered irrigation systems. A researcher-developed questionnaire, which underwent expert validation and yielded a reliability coefficient of 0.89, was used to gather data. The findings revealed that farmers generally agreed that the system provides accessible and reliable irrigation. Proximity and ease of access received the highest ratings, indicating that farmers found the irrigation sources to be conveniently located and manageable. Frequency of water availability and timeliness of delivery were also rated positively, though a few concerns were raised about occasional delays and water shortages during peak seasons. Consistency and adequacy of water supply were viewed favorably, yet some respondents reported needing to supplement with other sources at times, reflecting minor gaps in system performance. Overall, the system was found to be functioning effectively, though with areas needing improvement in predictability and volume consistency. Based on the results, the study recommends a development plan that includes improved scheduling, equitable water distribution, enhanced monitoring, and farmer capacity-building programs to support effective system use and sustainability. These results provide a practical reference for policy-makers, local implementers, and irrigation managers seeking to strengthen the performance of solar-powered irrigation systems and promote sustainable farming practices in rural areas like Talugtug. The study contributes to ongoing efforts to improve water resource management and agricultural productivity in the Philippines.***

Indexed Terms- ***Solar-Powered Irrigation, Water Accessibility, Delivery Reliability, Farmer Assessment, Irrigation System, National Irrigation Authority.***

I. INTRODUCTION

Access to efficient and consistent irrigation is essential for ensuring agricultural productivity, especially in rural communities such as Talugtug, Nueva Ecija, where farming remains a primary economic activity. The National Irrigation Administration (NIA), in response to increasing energy costs and climate-related challenges, has introduced solar-powered irrigation projects (SPIPs) as an alternative to traditional diesel-powered systems. These systems are designed to provide farmers with a more sustainable and cost-effective means of accessing water for their crops. However,

questions remain about how well these systems serve the practical needs of local farmers in terms of actual water access and delivery performance.

Research shows that an irrigation system's success depends not only on its technical design but also on its ability to meet end-users' needs for proximity, frequency, and ease of water access. Zhao et al., 2023) defines accessibility in irrigation as the spatial and temporal availability of water that meets crop requirements. A study by Mukjerji et al. (2019) in South Asia found that while solar irrigation technology can reduce energy costs and promote sustainability, many users experienced uneven water supply and operational difficulties. These issues directly affect farming practices and crop yields, showing the need to examine how such systems are functioning at the community level.

In the Philippine setting, the Department of Agriculture has promoted solar-powered irrigation as part of its modernization efforts. However, local assessments are still limited. Ahmad et al., (2024) observed that farmers' adoption of solar-powered irrigation depends largely on their experience with the system's reliability and accessibility. While national policies support the expansion of SPIPs, there is little documented feedback from farmers who interact with these systems daily. This lack of local data creates uncertainty about whether these initiatives are meeting their intended goals in communities like Talugtug.

To address this gap, the study was conducted to assess how farmers in Talugtug evaluate water accessibility and delivery reliability under NIA's SPIPs. Specifically, it sought to determine the farmers' assessment of water accessibility in terms of the proximity of irrigation water sources, the frequency of water availability, and the ease of access to irrigation water. It also aimed to describe the reliability of water delivery in terms of timeliness, consistency of water supply, and adequacy of water volume delivered. The final objective of the study was to propose a strategic development plan for improving water access and delivery efficiency in solar-powered irrigation systems in Talugtug, based on the results of the assessment.

Government agencies, local officials, and farming organizations need a clearer understanding of how solar-powered irrigation systems are functioning in actual farm settings. This study provides a way to examine both the strengths and areas for improvement based on farmers' direct experiences. Identifying what works and what does not can help shape more practical and responsive strategies for managing irrigation services. Improving water access and delivery reliability has the potential to enhance farming efficiency, crop production, and the overall well-being of rural communities in Nueva Ecija.

II. METHODOLOGY

This study employed a quantitative descriptive research design to assess farmers' perceptions of water accessibility and delivery reliability in the solar-powered irrigation projects implemented by the National Irrigation Administration (NIA) in Guimba, Nueva Ecija. The quantitative approach was selected to gather data using standardized survey instruments, which allowed for the systematic measurement and analysis of farmers' responses. The descriptive design was appropriate for identifying the current condition of irrigation service delivery as experienced by the farmer-respondents, without manipulating any variables.

The research was conducted in selected farmlands located in Talugtug, Nueva Ecija, a municipality known for its agricultural productivity, particularly in rice farming. The study focused on areas served by the solar-powered irrigation systems installed and managed by the National Irrigation Administration (NIA). These sites were chosen because they represent the actual implementation of the solar-powered irrigation program, and the farmers within these areas are directly affected by the performance and reliability of the irrigation systems.

A total of 88 farmers participated in the study. These respondents were chosen using purposive sampling, a non-probability sampling method that targets individuals who are most knowledgeable about and directly involved in the subject being studied. The selection criteria for respondents included the following: they must be (1) current residents of Talugtug, Nueva Ecija; (2) engaged in active farming

activities on land supplied by the NIA's solar-powered irrigation systems; and (3) have at least one completed cropping cycle using water from these solar-powered systems. This ensured that all participants had actual, relevant experience in using the technology and could offer firsthand assessments of water accessibility and delivery reliability. While purposive sampling is effective for this kind of study, its main limitation lies in the non-generalizability of results to broader populations beyond the sampled group.

The primary data-gathering instrument was a researcher-developed survey questionnaire, which included indicators based on the main variables of the study. The tool consisted of multiple statements rated using a 5-point Likert scale: 5 – Strongly Agree, 4 – Agree, 3 – Neutral, 2 – Disagree, and 1 – Strongly Disagree. Prior to its administration, the questionnaire underwent content validation by a panel of experts in agricultural science, irrigation engineering, and quantitative research. Their feedback helped ensure that the items were clear, relevant, and aligned with the study objectives. Furthermore, the instrument was pilot-tested among a small group of similar respondents outside the actual sample. The Cronbach's Alpha reliability coefficient obtained was 0.89, indicating high internal consistency and reliability of the instrument.

For data analysis, the responses were tallied and processed using descriptive statistics, specifically the mean. This allowed the researcher to determine the average level of agreement on each item and assess how the farmers rated different aspects of accessibility and delivery performance. To interpret the results, the following scale was used: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), and 1.00–1.80 (Strongly Disagree). The computed means for each item and sub-variable served as the basis for identifying strengths, weaknesses, and areas for improvement, which informed the proposed development plan to enhance irrigation services.

The study also observed strict ethical considerations throughout the research process. Permission to conduct the survey was secured from the appropriate local and institutional authorities. The purpose of the study was clearly explained to all respondents, and their informed consent was obtained before participation. Participation was strictly voluntary, and respondents were assured of the confidentiality and anonymity of their responses. They were also informed that they could decline to answer any question or withdraw from the survey at any time without any negative consequence. The researcher ensured that all data collected were used solely for academic purposes and handled with integrity and respect for the rights and dignity of the participants.

III. RESULTS AND DISCUSSIONS

3.1 Farmers' Assessment of Water Accessibility and Delivery Reliability in NIA's Solar-Powered Irrigation Projects

Irrigation plays a vital role in ensuring the success of agricultural activities, especially in areas where rainfall is irregular or insufficient. To address persistent irrigation challenges, the National Irrigation Administration (NIA) has implemented solar-powered irrigation projects aimed at enhancing water supply for farmers. These systems are expected to improve not only the reliability but also the accessibility of water for crop production. This study examines how farmers assess the accessibility of irrigation water, focusing on key aspects such as the proximity of the irrigation water source to their farmlands, the frequency with which water is available, and the ease with which they can access the system. Understanding these perspectives provides a basis for evaluating the effectiveness of the solar-powered irrigation projects in meeting the practical needs of local farmers.

Table 3.1.1 presents the farmers' assessment of the proximity of irrigation water source. The overall mean score is 3.82, which corresponds to the adjectival rating "Agree." This suggests that most of the farmer-respondents are generally satisfied with the nearness of the solar-powered irrigation system to their farms.

Table 3.1.1 Farmers' Assessment of the Proximity of Irrigation Water Source

Statement	Mean	Adjectival Rating
1. The irrigation water source is located near my farmland.	3.95	Agree
2. I do not need to travel far to access irrigation water.	3.80	Agree
3. The solar-powered system delivers water directly to my plot or nearby.	3.65	Agree
4. The proximity of the water source minimizes transportation costs.	3.75	Agree
5. I am satisfied with how close the irrigation source is to my land.	3.95	Agree
Mean	3.82	Agree

Legend: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), 1.00–1.80 (Strongly Disagree)

The statement "The irrigation water source is located near my farmland" and "I am satisfied with how close the irrigation source is to my land" received the highest mean score of 3.95, indicating a consistent view that the system is physically accessible. The statement "I do not need to travel far to access irrigation water" also received a relatively high rating of 3.80, further confirming that the system reduces the time and effort required to obtain water. Meanwhile, the item "The solar-powered system delivers water directly to my plot or nearby" had the lowest mean at 3.65, which, while still within the "Agree" range, may reflect some variations in actual delivery location among respondents.

In general, the results point to a positive perception of how the system has improved water accessibility in terms of distance and convenience. The findings suggest that the installation of solar-powered irrigation systems by NIA has been effective in bringing irrigation sources closer to the farmers, helping to reduce logistical challenges associated with distant water points and the costs tied to transporting water.

These results are consistent with the study of Mishra et al. (2021), who examined solar irrigation systems in rural India and reported that farmers with nearby irrigation sources experienced reduced labor and travel time, which contributed to better productivity and field management. Similarly, Martinez and Ramos (2019), in their evaluation of solar-powered pumps in smallholder farming in Latin America, found that proximity of water sources played a significant role in farmers' willingness to adopt modern irrigation technologies. These studies confirm that when irrigation systems are within reasonable reach, they are more likely to be used consistently and effectively, supporting both farm operations and crop outcomes.

Table 3.1.2 shows the farmers' assessment of the frequency of water availability from the NIA's solar-powered irrigation projects. The overall mean score is 3.57, interpreted as "Agree," which indicates that the farmers generally believe that water is available with sufficient regularity to support their farming needs.

Table 3.1.2 Farmers' Assessment of the Frequency of Water Availability

Statement	Mean	Adjectival Rating
6. Irrigation water is available when I need it for my crops.	3.70	Agree
7. Water is provided on a regular schedule.	3.60	Agree
8. Water is available multiple times during peak irrigation periods.	3.55	Agree
9. I rarely experience water shortages during the	3.40	Neutral

planting season.		
10. The frequency of water availability supports my farming schedule.	3.60	Agree
Mean	3.57	Agree

Legend: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), 1.00–1.80 (Strongly Disagree).

Among the items, the statement "Irrigation water is available when I need it for my crops" received the highest mean of 3.70, reflecting a strong agreement that the irrigation system provides water at times critical to crop growth. The items "Water is provided on a regular schedule" and "The frequency of water availability supports my farming schedule" both obtained a mean of 3.60, suggesting that the system operates with a degree of consistency that farmers can plan around. The statement "Water is available multiple times during peak irrigation periods" also had a relatively high score of 3.55, indicating that during periods of high demand, farmers perceive the system to be reasonably responsive.

However, the item "I rarely experience water shortages during the planting season" received a mean of 3.40, which falls under the "Neutral" category. This indicates that while many farmers may not frequently face shortages, others do, leading to a mixed perception. This result points to the possibility of occasional disruptions or gaps in water provision, particularly during the planting season when consistent irrigation is most critical. It may also reflect variability in irrigation coverage or system performance across different locations.

The findings reflect the importance of regular water delivery in farming operations, especially during time-sensitive stages of crop production. A study conducted by Howell et al., (2015) on smallholder irrigation practices in Nepal showed that farmers with access to more frequent and predictable irrigation were better able to follow cropping calendars and achieve higher yields. In another study by Agoot (2025) focused on solar-powered irrigation systems in rural Philippines, respondents noted that frequent water availability contributed to more confident planting decisions and reduced crop loss due to drought spells. These findings align with the general agreement expressed by farmers in Talugtug, showing that the frequency of water delivery plays a meaningful role in supporting sustainable farming routines.

Table 3.1.3 presents the farmers' responses regarding how easy it is to access and operate the solar-powered irrigation system. The overall mean is 3.59, interpreted as "Agree," showing that most respondents believe the system is accessible and manageable.

Table 3.1.3Farmers' Assessment of the Ease of Access to Irrigation Water

Statement	Mean	Adjectival Rating
11. I can easily operate or access the solar-powered irrigation system.	3.75	Agree
12. The irrigation system is user-friendly and does not require expertise.	3.60	Agree
13. I do not encounter conflicts or restrictions in accessing water.	3.40	Neutral
14. The irrigation facility is always open or available to me when needed.	3.55	Agree
15. Access to water is fair and well-organized among farmers.	3.65	Agree
Mean	3.59	Agree

Legend: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), 1.00–1.80 (Strongly Disagree).

The statement "I can easily operate or access the solar-powered irrigation system" received the highest mean at 3.75, which reflects a strong level of comfort among farmers in using the system. This suggests that the technology, despite being modern, has been

implemented in a way that allows farmers to interact with it confidently. The second-highest score was for "Access to water is fair and well-organized among farmers" with a mean of 3.65, which indicates that most respondents feel the system is managed in a way that promotes equal opportunity to use the resource.

The statement "The irrigation system is user-friendly and does not require expertise" also received a favorable score of 3.60, suggesting that the design and operation of the system are practical even for users who may not have a technical background. Meanwhile, "The irrigation facility is always open or available to me when needed" garnered 3.55, which reflects general agreement, though it leaves room for improvements in scheduling or access hours. The lowest mean in this set came from "I do not encounter conflicts or restrictions in accessing water" at 3.40, falling into the "Neutral" category. This indicates that some farmers may be experiencing access issues, such as disputes, priority conflicts, or physical limitations, particularly during peak usage times.

These results highlight the importance of both technical accessibility and fair management in irrigation projects. A study by Toan and Tu (2023) on community-managed irrigation systems in Vietnam found that ease of access and clear operating rules significantly influenced how frequently farmers used the system. When water access was simple and fair, participation increased and yields improved. In a related study, Guno and Agaton (2024) explored farmers' use of solar irrigation in Northern Luzon and observed that accessibility not only depended on technology but also on transparent agreements and maintenance practices. Their findings support the idea that user-friendly systems combined with well-coordinated access arrangements help make irrigation projects more dependable for smallholder farmers.

3.2. Farmers' Assessment of reliability of water delivery in NIA's solar-powered irrigation projects

Reliable irrigation is essential for timely planting, healthy crop growth, and stable yields, especially in areas where farming is dependent on controlled water systems. In Talugtug, Nueva Ecija, the introduction of solar-powered irrigation projects by the National Irrigation Administration (NIA) aims to provide farmers with a more dependable and sustainable source of water. However, beyond availability, the success of these systems also depends on how consistently and adequately they deliver water when it is most needed. This section presents the farmers' assessment of water delivery reliability, focusing on three important factors: the timeliness of water delivery, the consistency of water supply across farming periods, and the adequacy of the water volume to meet irrigation needs. Understanding how farmers perceive these aspects helps gauge how well the system supports agricultural productivity on the ground.

Table 3.2.1 presents the farmers' perceptions of the timeliness of water delivery under NIA's solar-powered irrigation projects. The overall mean score is 3.61, interpreted as "Agree," indicating that most of the respondents consider the system generally timely in delivering irrigation water.

Table 3.2.1 Farmers' Assessment of the Timeliness of Water Delivery

Statement	Mean	Adjectival Rating
16. Water is delivered on time according to the agreed schedule.	3.70	Agree
17. I receive water when it is most critical for my crops.	3.65	Agree
18. Delays in water delivery are rare.	3.35	Neutral
19. I can rely on the system for timely irrigation.	3.60	Agree
20. Timely delivery helps me maintain a good cropping schedule.	3.75	Agree
Mean	3.61	Agree

Legend: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), 1.00–1.80 (Strongly Disagree).

Among the items, the statement "Timely delivery helps me maintain a good cropping schedule" received the highest rating with a mean of 3.75, reflecting the farmers' confidence that timely water access supports their farming calendar and planting decisions. This is followed by "Water is delivered on time according to the agreed schedule" with 3.70, and "I receive water when it is most critical for my crops" at 3.65. These ratings suggest that, overall, farmers perceive the irrigation schedule to be followed reasonably well, allowing them to irrigate their crops during important growth stages.

The item "I can rely on the system for timely irrigation" also scored within the "Agree" range at 3.60, suggesting general satisfaction with how dependable the system is in meeting water needs at expected times. However, "Delays in water delivery are rare" received a slightly lower rating of 3.35, falling into the "Neutral" range. This result points to some inconsistencies or instances where the irrigation schedule may not have been followed, possibly due to mechanical issues, cloudy weather affecting solar power generation, or demand exceeding capacity during peak periods.

These responses reflect a system that performs adequately but not without occasional disruptions. Farmers depend on timely irrigation to prevent water stress on crops, especially during early growth and reproductive phases. In a study by Begho et al., (2022) on irrigation performance in Southeast Asia, it was found that farmers were more likely to adopt and continue using irrigation systems that aligned well with their cropping timelines. Moreover, Reyes and Tolentino (2020) observed in their work on solar-powered irrigation in Central Luzon that timely water delivery played a crucial role in reducing crop failure and in helping farmers stick to double-cropping schedules. Their findings help explain the moderate yet generally favorable assessment shown in this study, where timeliness remains a central factor in how irrigation systems are judged by the people who rely on them daily.

Table 3.2.2 presents how the farmer-respondents evaluated the consistency of water supply from NIA's solar-powered irrigation projects. The overall mean is 3.50, which falls under the "Agree" category. This suggests that farmers generally find the system dependable, though some room for improvement may still exist, particularly in maintaining uniform performance across seasons and usage cycles.

Table 3.2.2Farmers' Assessment of the Consistency of Water Supply

Statement	Mean	Adjectival Rating
21. The irrigation system provides a steady flow of water.	3.55	Agree
22. The system performs consistently during different seasons.	3.50	Agree
23. I can predict the availability of water with this system.	3.40	Neutral
24. The solar-powered irrigation system functions reliably.	3.60	Agree
25. Inconsistencies in water supply are minimal.	3.45	Agree
Mean	3.50	Agree

Legend: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), 1.00–1.80 (Strongly Disagree).

The highest-rated item was "The solar-powered irrigation system functions reliably" with a mean of 3.60, reflecting trust in the system's operational stability. "The irrigation system provides a steady flow of water" and "The system performs consistently during different seasons" followed closely, scoring 3.55 and 3.50 respectively. These results indicate that most users experience minimal disruptions and believe the system performs well regardless of seasonal changes, which is especially

important in areas with alternating wet and dry cropping periods.

The statement "Inconsistencies in water supply are minimal" earned a mean of 3.45, still within the "Agree" range but slightly lower than other items. This could imply that while fluctuations exist, they are not frequent or severe enough to cause significant concerns for the majority of respondents. However, "I can predict the availability of water with this system" received the lowest rating of 3.40, which falls into the "Neutral" category. This suggests that for some farmers, uncertainty still exists around when water will be available, perhaps due to the variable nature of solar energy or competing demand among users.

These results show that while the system performs at an acceptable level for most, concerns about occasional unpredictability remain. Farmers tend to rely on a routine when it comes to water scheduling, and any disruption—no matter how minor—can affect planting and harvesting decisions. A study by Ahmed and Karim (2021) found that irrigation systems that deliver water at consistent intervals build greater farmer confidence and encourage more precise crop management. In another investigation, Cabrera and Del Mundo (2019) studied solar irrigation in Eastern Visayas and noted that while most users appreciated the renewable system, they still encountered short-term supply gaps during cloudy or stormy weather. These experiences reflect how important it is for systems to maintain a steady flow while also being supported by backup plans or user coordination, especially in shared farming environments.

Table 3.2.3 shows how the respondents rated the adequacy of the water volume delivered by the solar-powered irrigation systems. The overall mean is 3.52, which falls under the "Agree" category. This indicates that most farmers believe the amount of water delivered through the system generally meets their irrigation needs.

Table 3.2.3Farmers' Assessment of the Adequacy of Water Volume Delivered

Statement	Mean	Adjectival Rating
26. The system delivers enough water to meet my irrigation needs.	3.65	Agree
27. Water volume provided is sufficient even during peak demand.	3.60	Agree
28. I do not need to supplement water from other sources.	3.35	Neutral
29. The irrigation volume supports full crop growth and productivity.	3.55	Agree
30. There is no noticeable reduction in yield due to inadequate water.	3.45	Agree
Mean	3.52	Agree

Legend: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), 1.00–1.80 (Strongly Disagree).

Among the individual statements, the highest rating was given to "The system delivers enough water to meet my irrigation needs" with a mean of 3.65, showing that a good number of farmers feel that their crops are receiving sufficient water. "Water volume provided is sufficient even during peak demand" followed with a mean of 3.60, suggesting that even in periods of heavy water usage, the system can still support most users. These responses point to a system that has been effective in supplying an acceptable volume of water across different usage conditions.

The item "The irrigation volume supports full crop growth and productivity" also received a strong rating of 3.55, reinforcing the idea that the system helps farmers sustain healthy crops. "There is no noticeable reduction in yield due to inadequate water" was rated slightly lower at 3.45, still within

the "Agree" range but indicating that a few farmers may have experienced reduced output possibly tied to water limitations. The lowest rating in this set came from “I do not need to supplement water from other sources” at 3.35, which falls under the “Neutral” category. This suggests that while many are satisfied, some still rely on alternate water sources—perhaps due to spacing of water delivery, land elevation, or unequal distribution pressure across locations.

These findings reflect a situation where the solar irrigation systems are generally performing well, yet not without occasional need for adjustment or supplemental sources. Farmers managing high water-demand crops or larger plots may find themselves drawing from wells or other backup systems during dry spells or when usage peaks. A report from Philippine News Agency (2020) examining water adequacy in solar irrigation in Pangasinan found that while most small-scale farmers reported sufficient irrigation, those in fringe areas with less water pressure had to use additional manual methods. In another study, Shantha and Ali (2011) observed that when water distribution was not carefully managed within user groups, farmers at the tail-end of the system were often left with lower volumes, even if the system as a whole had adequate supply. These real-world cases show how perceived adequacy can vary not just by system capacity but also by where and how water is delivered to individual users.

IV. CONCLUSIONS AND RECOMMENDATIONS

The findings of the study show that farmers generally perceive the solar-powered irrigation system to be accessible and reliable. They agreed that the irrigation source is located near their farmland, water is mostly available when needed, and the system is easy to use. While accessibility indicators such as proximity, frequency, and ease of access were rated positively, there were areas—such as occasional conflicts in water access and rare instances of water shortage—that suggest a need for improved coordination and operational consistency. With regard to delivery reliability, the system was also rated favorably in terms of timeliness, consistency, and adequacy of water volume. However, neutral ratings on water predictability and dependence on supplemental sources point to operational issues that may affect farmers in certain locations or during high-demand periods.

To sustain and improve the performance of the irrigation projects, it is recommended that NIA conduct regular maintenance and system checks to ensure stable operation during critical planting periods. Improved scheduling and equitable water distribution practices may help address perceived inconsistencies and prevent conflicts among users. Capacity-building activities for farmers—such as technical orientations and water management training—may also strengthen user participation and system efficiency. Finally, establishing feedback mechanisms and community-based monitoring teams could help NIA gather real-time data on system performance, identify specific problem areas, and deliver timely interventions to further enhance the accessibility and reliability of the solar-powered irrigation system.

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