CGIAR
SCIENCE FOR A FOOD-SECURE FUTURE

Technical Brief

Sunlight to Sustenance

Early implementation insights from a solar-grid lift system pilot in Nepal's mid-hills

Aashika Adhikari, Darshan Karki, Shisher Shrestha, and Jibesh Kumar K.C.

April 2026

Authors

Aashika Adhikari, Consultant - Climate Action Program, International Water Management Institute (IWMI), Kathmandu, Nepal

Darshan Karki, Regional Researcher - Social Scientist, IWMI, Kathmandu, Nepal

Shisher Shrestha, National Researcher - Renewable Energy, Water and Climate Change, IWMI, Kathmandu, Nepal

Jibesh Kumar K.C., Research Officer - Resilient Water Management and Livelihoods, IWMI, Kathmandu, Nepal

Acknowledgements

This activity was made possible through the support of the Indrawati Rural Municipality, Govinda Sapkota from the Community Development and Environment Conservation Forum (CDECF), and the active participation of Bisdeutar residents. It was initiated under the CGIAR Initiative on Nexus Gains and the CGIAR Initiative on Mixed Farming Systems and further supported by the CGIAR Climate Action Program and the CGIAR Policy Innovations Program. The authors gratefully acknowledge the contributions of the CGIAR Trust Fund contributors: https://www.cgiar.org/funders.

CGIAR Climate Action Program

The CGIAR Climate Action Program aims to drive science, innovation, and collaboration to transform food, land, and water systems for a climate-resilient, net-zero, and equitable future in Bangladesh, Cambodia, Côte d'Ivoire, Ethiopia, Honduras, India, Kenya, Nepal, Nigeria, Pakistan, Philippines, Senegal, Sri Lanka, Sudan, Tanzania, Zambia, and Zimbabwe.

CGIAR Policy Innovations Program

The CGIAR Policy Innovations Program strengthens markets, policies, and institutions through evidence-based research, capacity sharing, and innovative tools such as the AI-driven Policy Advisor to advance poverty reduction and food, land, and water security. It operates through Policy Innovation Hubs in Ethiopia, India, Kenya, Malawi, and Nigeria, with policy support across Bangladesh, Egypt, Pakistan, Sri Lanka, Rwanda, and other countries in the Global South.

Citation

Adhikari, Aashika, Darshan Karki, Shisher Shrestha, and Jibesh Kumar KC. 2026. "*Sunlight to Sustenance: Early Implementation Insights from a Solar-Grid Lift System Pilot in Nepal's Mid-Hills.*" International Water Management Institute.

Front cover photo: Community members witness the first water pumping during the commissioning of the solar lift system. (*photo*: Shisher Shrestha/IWMI)

Back cover photo: Researchers engage with the local lead farmer in Bisdeutar village to exchange knowledge and insights. (*photo*: Shisher Shrestha/IWMI)

Disclaimer

This publication has been prepared as an output of the CGIAR's Climate Action Program and the CGIAR Policy Innovations Program and has not been independently peer-reviewed. Responsibility for editing, proofreading, and layout, opinions expressed, and any possible errors lies with the authors and not the institutions involved.

Emerging Insights

The following preliminary insights have emerged from community engagement and implementation experience:

- Solar-grid lift system (SLS) can improve both domestic and irrigation water access. The pilot experience suggests that designing water-lifting systems as multiple-use systems (MUS) may better address combined domestic and irrigation needs in mid-hill communities.
- When working with marginalized and impoverished communities, it is more practical to request in-kind support in the form of services such as labor than expect financial contributions.
- Social mobilization is imperative to project success. It should continue in the post-installation phase until communities have fully adopted the technology and internalized its tangible benefits, such as increased income and savings.
- Technological interventions such as SLS should be accompanied by customized capacity-building support and complementary agricultural programs to provide an enabling environment to improve farm income after water access.
- In underserved communities, holistic water-access interventions act as a catalyst, improving water access while generating ripple effects on livelihoods, nutrition, disaster resilience, and community upliftment.
- Engaging with the local government since the project design phase of SLS is crucial for ensuring the project's sustainability and enhancing local agencies' responsibility towards it.
- Collaborating with multiple stakeholders in a project reduces the burden on a single institution, pools expertise, distributes responsibility, and contributes to long-term sustainability.

1. Background

In Nepal's mid-hills and mountains, climate change-induced challenges such as drying springs, altered rainfall patterns, and drought pose a direct threat to sustenance and livelihoods (Maharjan, 2024). Consequently, the need for reliable irrigation systems has become increasingly urgent.

The National Irrigation Policy 2023 recognizes lift irrigation systems as a solution for year-round irrigation in difficult terrains (MOEWRI, 2023). Building on this, Nepal's 16th periodic plan envisions providing year-round irrigation through lift systems to an additional 25,000 hectares of land in the hills and mountains by 2028/29 to enhance agricultural productivity (NPC, 2024). Despite this policy emphasis, the adoption and sustainability of lift irrigation remain limited.

Shrestha et al. (2026) found that sustainability issues stem from a flawed detailed feasibility study (DFS) and design, ownership concerns, operation and management challenges, absence of repair and maintenance funds, limited financial planning and lack of stakeholder engagement in the post-installation phase. To enhance sustainability, SLI interventions require rigorous demand and needs assessment before installation, site-specific feasibility and design accounting for local geography, topography, and hydrology, a formal water users' committee formation, robust operation and management mechanisms, and a dedicated repair and maintenance fund (Shrestha et al., 2026). For ensuring the long-term success of technical interventions, a shift toward market-linked approaches is needed, integrating irrigation with agricultural value chain development and engaging the private sector to create an enabling environment (Adamseged et al., 2025). However, developing agricultural value chains, addressing social challenges, and ensuring effective governance of SLI projects in remote terrains require context-specific, evidence-based approaches.

Building on the learnings from previous studies and pilots (Shrestha et al., 2026; Rauniyar et al., 2024) IWMI, in collaboration with Indrawati Rural Municipality (RM), installed an 8.25 kWp (kilowatt-peak) solar-grid lift system (SLS) that lifts more than 90,000 litres of water from underground daily to a height of 100 meters above the Indrawati river to a settlement of the indigenous Majhi community. In this ongoing pilot at Indrawati, IWMI is also experimenting with what constitutes an enabling environment for successful SLI projects using its intervention in Indrawati Rural Municipality (RM) as a case study. This technical brief presents early implementation insights and operational lessons to inform future research, implementation, and learning.

2. About the community

Bisdeutar, a village in Indrawati RM located around 50 km from Kathmandu, the capital city of Nepal, is home to 55 households, entirely inhabited by the Majhi community. In Nepal, the Majhi community is categorized as a highly marginalized indigenous group based on developmental indicators (NFDIN, 2022). To understand the community's demographic, socio-economic, agricultural, and household water use status, IWMI conducted surveys in two phases (July 2024 and April 2025). The first phase acquired the information to assess the solar lift system's feasibility, while the second phase, conducted after the solar installation, captured baseline information as well as the early outcomes of the interventions. Altogether, data collection included two rounds of household surveys, six focus group discussions (FGDs) with men, women, and youth, and five key informant interviews (KIIs). The key findings from the surveys are:

- **Socio-economic profile:** The total population of the village is 301 (49.5% men, 50.5% women). Over half the population has migrated for employment opportunities, education and better living conditions, reflecting limited local opportunities. Residents

rely on agriculture, daily wage labor (mainly sand mining), and foreign employment for their livelihood.

- **Agriculture:** The area consists of rainfed highlands, with terrain variation ranging from 8m to 192m above the riverbed, and irrigated lowlands near the river. The highlands, covering approximately 9.5 hectares, remain fallow for 5–6 months annually, and the lowlands are about 4.7 hectares. Maize, millet, linseed, and lentils are grown on highlands, while paddy, wheat, and potatoes are cultivated on lowlands. To date, 22.5% of the arable lowlands have been eroded by floods, increasing reliance on the dry highlands. Agricultural production is insufficient even for self-consumption. Water scarcity has hampered varied nutrition intake.
- **Water Access:** Residents depend on a small spring for drinking and cooking, while river water is used for bathing, laundry, and dishwashing. Spring water flow is subject to seasonal variability, and its location on a steep slope makes access difficult. Women shoulder the greater responsibility for household activities such as laundry and water collection, which require carrying heavy jars of water uphill. Women reported spending more than one hour on a round trip for water collection from the river. This intense drudgery limits women's opportunities for income-generation and affects personal well-being.
- **Market access:** The nearest markets, Siphaghat, Dolalghat and Kuntabesi are located approximately 13 km, 20 km, and 28 km from the village, respectively. River crossing is required, and during the monsoon, market access is often blocked due to floods and landslides.
- **Climate and disaster risk:** In the aftermath of the 2015 Nepal earthquake, all houses in Bisdeutar were destroyed, and 12 women and 2 children tragically lost their lives. The government considered resettling the village in response, but the plan never moved forward. Bisdeutar continues to battle too much water, resulting in landslides and floods during monsoon and too little water during the rest of the year. Climate-induced disasters such as drought, floods, and landslides have severely disrupted agricultural practices, reducing productivity, eroding arable lands, and destroying crops. These events have further hampered water supply, and damaged road connectivity, isolating the community from the market and other essential services.

Water scarcity has been a long-standing problem in the community. The village's location at the edge of the administrative boundary of Indrawati RM and a lack of year-round functional road access, appear to limit the engagement of state and non-state actors in providing solutions to its climate-vulnerable residents. Such geographical isolation compounded with an absence of dependable public transport, has further curtailed the community's ability to access government support to address their water-related problems.

3. Action research process in Bisdeutar, Indrawati Rural Municipality

IWMI continues to conduct a study in Bisdeutar, which started in 2024. The study investigates the organic processes after the establishment of an SLS project. The Figure 1 presented below illustrates the timeline of IWMI's engagement in interventions in Bisdeutar, which follows a participatory action research methodology.

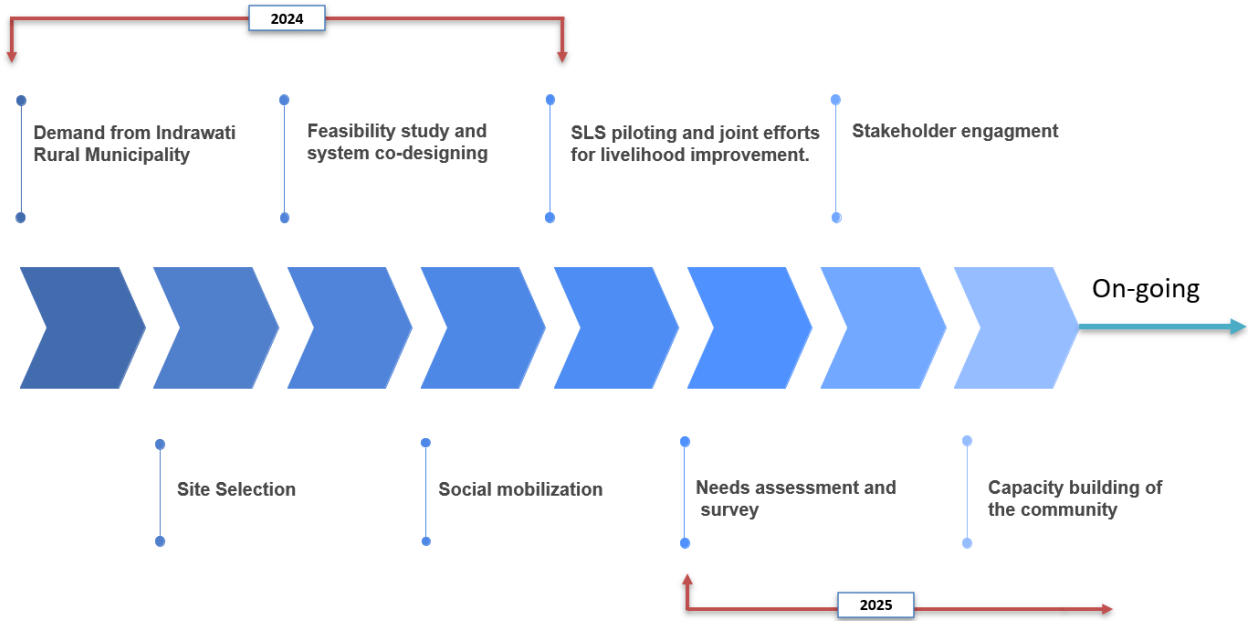

Figure 1: Timeline of IWMI's interventions and engagement in Bisdeutar, Indrawati Rural Municipality

Scoping visit and site finalization

Two scoping visits were conducted following a request from the municipality for pre-feasibility assessments in two of its wards. The assessments focused on gender equality and social inclusion, climate vulnerability, and financial considerations. Thirteen sites were evaluated and scored, after which three sites were selected. Bisdeutar emerged as a compelling site for intervention due to its geographical remoteness, the urgent need for water for irrigation, and the settlement of the highly marginalized groups. IWMI intentionally sought to address the connectivity-driven development bias of development projects in Nepal, where interventions tend to concentrate in accessible areas, by purposefully targeting a disaster-prone, socially marginalized settlement.

System co-design and installation

After a detailed feasibility study, the findings were shared with the municipality and the community, and their feedback was incorporated into the design. In response to the community's demand, the intervention was changed from the initially proposed irrigation system to a multiple-use system (MUS). The final design included a raised, capped borehole to prevent pump clogging and damage to the water intake during floods. Each household actively participated by contributing labor during the installation. The installed system comprises a 7.5 hp (horsepower) pump powered by an 8.25 kWp solar array with a grid option. It is designed to serve the domestic water needs of 55 households and irrigate around 5.5 hectares of land.

The grid connection was facilitated through the local government to address increasing water demand and ensure supply during non-sunny days and nighttime. This has doubled the

water discharge and enhanced system reliability. Such a co-design approach has strengthened community acceptance and improved the design's relevance.

Social mobilization

To promote sustained adoption of SLS technology, IWMI partnered with the Community Development & Environment Conservation Forum (CDECF), an NGO based in Indrawati Rural Municipality. CDECF facilitated IWMI's engagement with the Majhi community by forming a water users' committee and registering it at the municipality. Together, IWMI and CDECF worked to strengthen the committee's capacity in conducting regular meetings, documenting minutes, sharing information, and managing financial transactions. Regular follow-up visits are underway to provide necessary support.

Capacity building

Bisdeutar residents actively participated in the capacity-needs assessment survey, openly sharing their local challenges and needs (Figure 2). Alongside infrastructure development, needs assessment, and site-specific studies, IWMI, and CDECF, also conducted demand-driven training. Four community members, including one woman, were trained in basic operation and maintenance of the SLS system. Soil tests were also conducted, and soil improvement measures and potential high-value crops were recommended based on the agro-climatic conditions of Bisdeutar. Building on local knowledge of existing farming practices, IWMI and CDECF further suggested additional crops and fruits suited to the area. Drawing on learnings from IWMI's work on mixed-farming systems in the mid-hills of Nepal (Koirala et al., 2024) and based on the demands from the community, IWMI and CDECF designed and delivered a tailored capacity-building program to enhance existent agricultural practices.

Figure 2: Engagement of village residents in the capacity-needs assessment survey. [Photo by Aashika Adhikari]

Stakeholder engagement

Acknowledging that long-term sustainability and community development can be best achieved through collaboration among multiple stakeholders, IWMI has partnered with Indrawati RM, the water users' committee, and CDECF. Collectively, a repair and maintenance fund has been established with an initial contribution of 40% each from IWMI and Indrawati RM, and 20% from the users' committee. This fund is imperative for the system's repair and maintenance, and replacement of expensive components like pumps and controllers.

With support from IWMI, the community has strongly advocated their needs to local agencies. IWMI has further linked the community with an international NGO that implements drinking water and sanitation projects, to strengthen the drinking water component of the system. Furthermore, IWMI is also in talks with women rights NGOs to support women-centric programs in Bisdeutar.

4. Early outcomes of the interventions

The interventions have significantly enhanced both accessibility and availability of water in Bisdeutar village. The figure 3 shows the positive ripple effects observed in the community. The interim results are already visible from improved domestic water use and reduced women's workload to year-round irrigation for farmlands. Besides physical access, the interventions have fostered community proactiveness, increased preparedness, and enhanced safety against disasters. Collectively, early outcomes indicate potential contributions to daily life improvements, livelihood enhancement, and long-term community resilience. The visible impacts include:

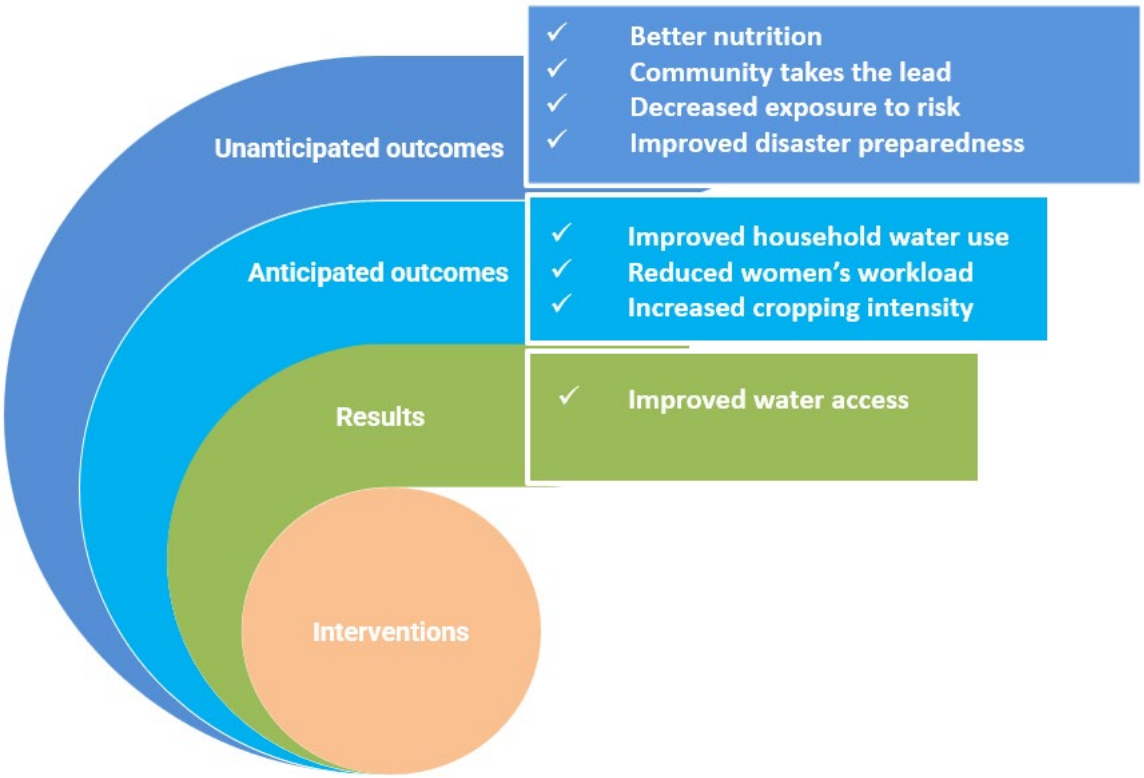

Figure 3:3 Interim impacts of the interventions in Bisdeutar, Indrawati Rural Municipality

Boosted cropping intensity

Bisdeutar cultivated mustard for the first time in the dry upland areas during the non-monsoon period after accessing water from the SLS, marking a shift toward year-round agriculture (Figure 4). Approximately 0.36 hectares of land have been brought under cultivation, yielding around 300 kg of mustard seeds. This harvest reduced household expenditure on edible oil, with some families reporting sufficiency for up to six months, while others found it adequate for the rainy season. Due to reliable water availability now, community members have recognized new opportunities for high-value crops such as tomato farming and mushroom cultivation, along with other options such as beekeeping. However, the limited distribution pipelines have constrained the expansion of irrigated land. With additional pipeline support, the irrigated area could increase up to 5.5 hectares.

Figure 4: Mustard cultivation after water access in the dry highland areas of Bisdeutar. [Photo by Shisher Shrestha]

Household water use and reduced drudgery

Water is now available closer to homes, and daily chores such as dishwashing, laundry, and bathing have become much easier. This has significantly reduced drudgery for women. As a woman with underlying health issues shared, "*I cannot walk much. Earlier, a round trip for laundry and bathing took 3–4 hours. Now, with water access near my home, it has made it easier and saved me time.*"

Better nutrition

With an extended kitchen gardening period beyond the monsoon season, the nutrition intake is expected to improve. As a woman expressed, *"Before, we could only grow vegetables*

during the monsoon. Now, with water availability, we can do kitchen gardening even in the dry season." Kitchen gardening generally supports homegrown produce for household cooking. It is now expected that villagers would have a varied and nutritious diet throughout the year.

Disaster preparedness and safety

Beyond physical water access, the intervention has enhanced community safety and is contributing to disaster preparedness. As a community member recalled, *"There was always fear while bathing in the river; we never knew when the water would suddenly rise. Now, there is no need to take that risk."* Similarly, an elderly man shared, *"Years ago, a fire broke out in the village. We had no water to extinguish it. Now, with water availability, we are hopeful we can respond better to such emergencies."*

Local government recognition and support

Previously, the village was often overlooked by the local government and other stakeholders, who perceived the community as unwilling to engage in agriculture. This socio-technical SLS initiative has altered this perception. The local government is now optimistic about agricultural development in Bisdeutar and is actively engaged in ensuring the sustainability of the SLS infrastructure. For the fiscal year 2025/26, the local government allocated NPR 50,000 (~USD 357) to the users' committee for the repair and maintenance of the system.

Community takes the lead

The interventions have played a catalytic role in uplifting the community. A notable shift has been observed. Previously, Bisdeutar residents rarely accessed subsidies, but now they are actively seeking government support. For instance, community members independently secured funds from the District Water Supply and Sanitation Division Office to improve the spring water supply. They are also actively seeking funds for a suspension bridge for better market access during the monsoon season.

5. Next steps

IWMI will seek to maintain periodic engagement with the local government and community, to observe longer-term outcomes and document emerging lessons. Continued observation will help generate evidence on the sustainability, local ownership, and longer-term effects of SLS, and inform future research and program design in similar contexts.

References

Adamseged, M. E., Abegaz, D. M., & Minh, T. T. (2025). Unveiling the potential: Is the private sector poised to revolutionize the solar irrigation market in Ethiopia? *Sustainable Futures, 9*, 100743. https://doi.org/10.1016/j.sftr.2025.100743

Gurung, H. (2021). Indigenous nationalities of Nepal: Profile report 2021. Government of Nepal, National Foundation for Development of Indigenous Nationalities.

Koirala, S., K.C., J., & Khadka, M. (2024). *Decentralized socio-technical innovation for sustainable intensification of mixed farming systems in Nepal's mid-hills*. https://hdl.handle.net/10568/172923

Maharjan, R. K. (2024). Impacts of climate change on farm-based livelihood: A study of Panchkhal. *Journal of APF Command and Staff College, 7*, 16–50. https://www.nepjol.info/index.php/JAPFCSC/article/view/66996

MOEWRI (Ministry of Energy, Water Resources and Irrigation). (2023). *National irrigation policy, 2080*. Government of Nepal.

NPC (National Planning Commission). (2024). *The sixteenth plan (Fiscal year 2024/25–2028/29)*. Government of Nepal.

Rauniyar, A., & Shrestha, S. (2024, September 2). *Community engagement and capacity-building needs in technology intervention*. International Water Management Institute. https://hdl.handle.net/10568/175910

Shrestha, S., Karki, D., Aryal, M., & Buchy, M. (2026). Unpacking the challenges of solar lift irrigation in Nepal's mid-hills: Toward a sustainable energy-water solution. In *Proceedings of the International Conference 2026 on Agricultural Engineering and Climate Smart Agriculture*. Nepalese Society of Agricultural Engineers.

CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land, and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centers/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org

To learn more about the science programs in the CGIAR Research Portfolio, please visit: https://www.cgiar.org/cgiar-research-portfolio-2025-2030

CGIAR

CLIMATE ACTION

POLICY INNOVATIONS