

Decentralized Socio-Technical Innovation for Sustainable Intensification of Mixed Farming Systems in Nepal's Mid-Hills

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The [Mixed Farming Systems Initiative](#) aims to provide equitable, transformative pathways for improved livelihoods of actors in mixed farming systems through sustainable intensification within target agroecologies and socio-economic settings.

Through action research and development partnerships, the Initiative will improve smallholder farmers' resilience to weather-induced shocks, provide a more stable income and significant benefits in welfare, and enhance social justice and inclusion for 13 million people by 2030.

Activities will be implemented in six focus countries globally representing diverse mixed farming systems as follows: Ghana (cereal–root crop mixed), Ethiopia (highland mixed), Malawi: (maize mixed), Bangladesh (rice mixed), Nepal (highland mixed), and Lao People's Democratic Republic (upland intensive mixed/ highland extensive mixed).

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Cover photo: A farming family in Aiselukharka, Khotang, sells fresh vegetables grown in their kitchen garden from their home. (Source: IWMI)

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Background

In Nepal, over 80% of farming households own less than one hectare of land, with most plots fragmented into smaller sections. As a result, farmers practice Mixed Farming Systems (MFS)—growing cereals, vegetables, and fruits, alongside raising livestock and practicing agroforestry for food and other materials (K.C. and Neupane, 2024)¹. The MFS integrates crops and livestock, where manure supports crop growth and crop residues feed livestock. Water resources are essential to these systems. However, the lack of focus on improving MFS in the context of climate change has led to declining agricultural productivity and increased migration, as people search for better opportunities elsewhere (Neupane and Koirala, 2023)². This has placed a heavier work burden on women, who are now forced to take on more responsibilities in their households and communities. Although women play a crucial role in farming, they have limited access to resources and information for sustainable practices and water management (FAO, 2019)³.

The needs of farmers practicing MFS are also overlooked by prioritizing commercial farming through providing subsidies to promote mono-cropping, the use of herbicides, and improved crop varieties. Policies, institutions, and technologies are also designed for adult male farmers giving less attention to the needs, challenges, and priorities of women and elderly farmers. Further, inadequate investment, infrastructure, agro-advisory tools, underdeveloped markets, labor shortage, climate-induced risks, and weak agriculture governance foster challenges to MFS. As a result, farmers' interest in agriculture is decreasing whilst attracting them to non-agriculture sectors (Koirala and Neupane 2023)⁴.

This indicates a pressing need to rethink the existing agriculture system. In the context of growing labor migration, feminization of agriculture, and increased fallow land, the crop-water-livestock-based MFS can be a vital strategy. It has the potential to enhance the current farming practices by utilizing the same quantity of natural resources and employing effective crop management, water security, and animal husbandry techniques. With policy, program, and technological interventions, MFS may provide an important opportunity to upscale agroecological innovations and improve the livelihoods of resource-poor farmers (Neupane and Koirala, 2023)².

In this backdrop, the International Water Management Institute (IWMI) and the International Maize and Wheat Improvement Centre (CIMMYT) co-designed and implemented with local governments and farmers the CGIAR Initiative on Mixed Farming Systems in Gurbhakot Municipality, Surkhet district and Halesi Tuwachung Municipality, Khotang district (Figure 1). These mid-hill regions of Nepal were selected as they are prone to drought. The three-year research project, 2022-2024

¹ K. C., J., Neupane, N. (2024). Sustainable formulae for mixed farming in Middle Hills of Nepal. Kathmandu, Nepal: Kantipur Daily News Paper. <https://hdl.handle.net/10568/163141>

² Neupane, N., Koirala, S. (2023). Reviving Nepal's agriculture: mixed farming can boost Nepal's income, food security and resilience to climate change. The Kathmandu Post

³ FAO. (2019). Country gender assessment of agriculture and the rural sector in Nepal, Kathmandu, Nepal: Food and Agriculture Organization of the United Nations (FAO).

⁴ Koirala, S. and Neupane, N. (2023). Breaking barriers in agriculture: implementing and scaling innovations in mixed farming systems is possible only with inclusive policies. The Kathmandu Post: <https://hdl.handle.net/10568/132662>

aimed to intensify sustainable agriculture by helping farmers diversify risks, optimize labor, improve water efficiency in farming and boost productivity while protecting the environment. It has also promoted women and elderly friendly innovations, strengthened entrepreneurship skills for women and smallholder farmers, and expanded networks through Multi-Stakeholder Agriculture Knowledge Hubs.

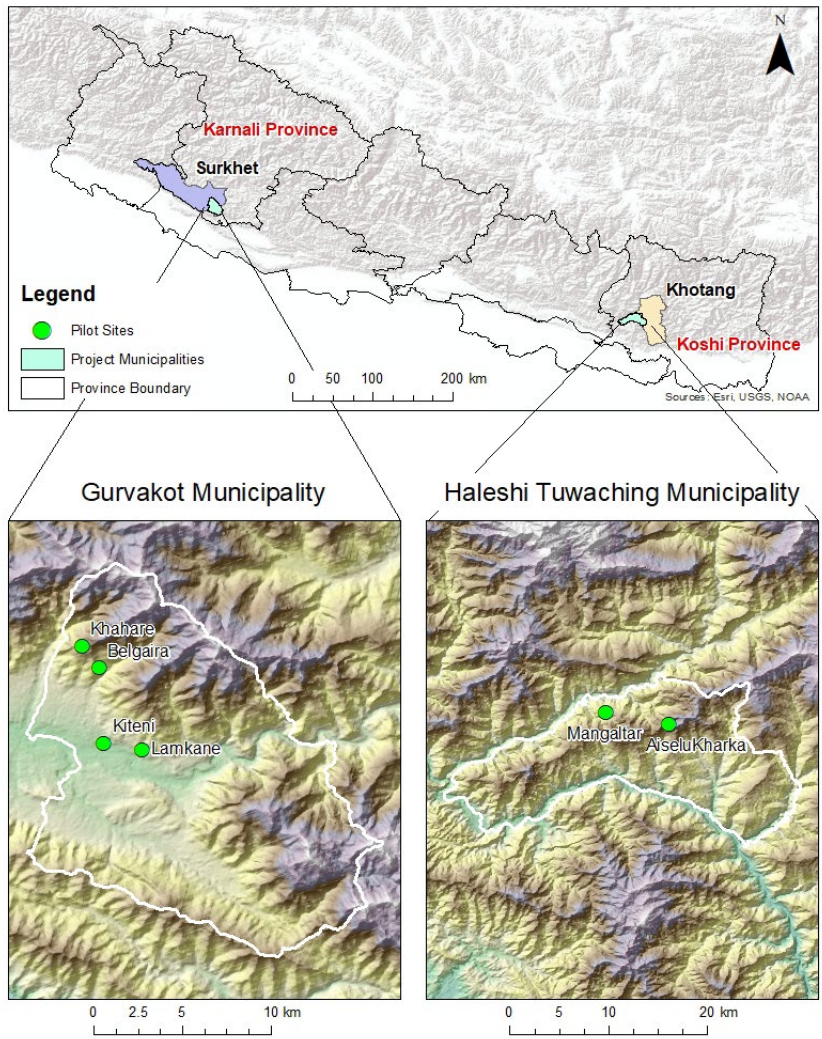


Figure 1: Location map of MFS research sites in Nepal

This technical brief summarizes the process, outcomes, and lessons from these innovations, offering insights for future scaling.

Mixed Farming Systems in the Mid-hills of Nepal

Small landholdings coupled with water scarcity, remoteness, limited access to information, knowledge, technological innovations, and lack of inclusivity in agricultural interventions result in low productivity of the farming systems in the Mid-hills. Women are becoming the future of farming in the mid-hills as men move from agricultural occupation to jobs and education in cities and

foreign countries. Meanwhile, policies, institutions, and technologies in Nepal continue to focus primarily on men, neglecting the needs and challenges faced by women (FAO, 2019³).

Possible entry points for potential socio-technical innovations to improve the hill-MFS were identified and elaborated based on interactions with stakeholders as well as by carrying out a Descriptive Design of Farming Systems⁵ exercise in the MFS research areas. Sketching the Nepal's MFS in the mid-hills and reflecting on the key interactions between the main system components highlighted the importance of water on agricultural productivity and the need of diversifying field crops production with fodder crops to benefit livestock production (see Figure 2).

Through multiple interactions with local governments at the research site, social innovations like the Multi-Stakeholder Agricultural Knowledge Hub (*Krishi Chautari*) were identified as tools to help farmers adopt and scale technical innovations, such as water-efficient technologies and fodder, forage, and fruit cultivation.

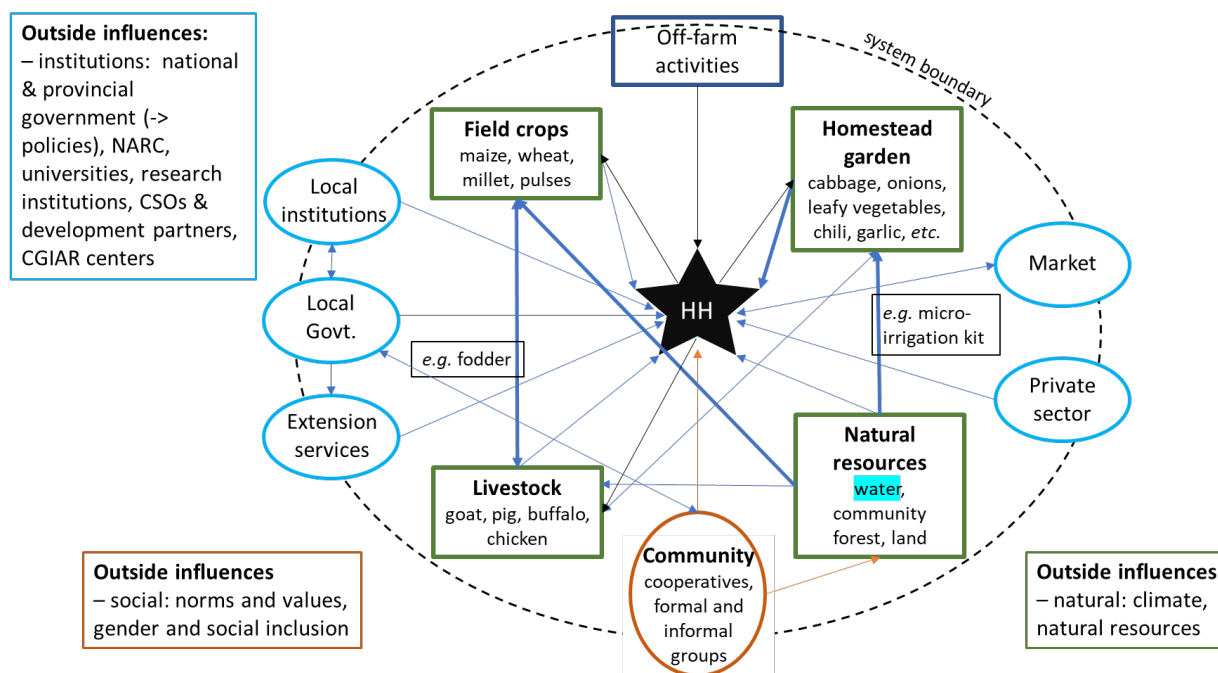


Figure 2: Sketch of the mixed farming system in the Mid-hills of Nepal. Green squares represent the key farming components; circles display the key drivers; and arrows show the interactions between components/drivers; N.B: the key interactions between components (entry points) are highlighted by bold arrows and some examples of interventions given in black boxes (e.g. fodder; e.g. micro-irrigation kit). (adapted from Neupane et al. 2023)⁶.

⁵ Frija, A., Alary, V. and Idoudi, Z. (2023). Tool for Descriptive Design of Farming Systems: Components, Priorities, and Sociotechnical Packages towards Sustainable Intensification of Mixed Crop Livestock Systems. Ibadan, Nigeria: IITA. <https://hdl.handle.net/10568/135982>

⁶ Neupane, N., Koirala, S., Karki, D., Khadka, M., Shrestha, N., K.C., J., Pandit, A., Cheesman, S., Frija, A. (2023). Harmonization of Work Packages in Mixed Farming: A descriptive design of farming systems components, priorities, and sociotechnical packages towards sustainable intensification. Report. Oyo State, Nigeria. International Institute of Tropical Agriculture. <https://hdl.handle.net/10568/135864>

Short Description of the Socio-Technical Innovations

Water system integration into the MFS

The mixed farming systems in Nepal's mid-hills predominantly rely on rain-fed agriculture, with limited irrigation access in most areas (Gurung et al., 2019)⁷. Water scarcity significantly hampers crop production, especially during the dry season, leaving fields fallow from November to April in both municipalities (K.C. et al. 2024)⁸. Many households cultivate vegetable gardens near their homes, depending on the availability of water. However, this water scarcity also impacts the availability of fodder and forage, reducing livestock productivity. Stakeholders in these regions have emphasized the need for efficient irrigation technologies as a crucial intervention to maximize the use of limited water resources, enhance agricultural productivity, and alleviate women's labor burdens. The efficient water use technologies implemented in the study sites aim to address water scarcity and boost agricultural productivity, particularly for homestead gardens.

Key Objectives:

1. Promote climate-smart and women-friendly irrigation technologies to address water scarcity.
2. Optimize water utilization to enhance agricultural productivity and crop yields.
3. Reduce the drudgery associated with irrigation tasks, particularly for women farmers.
4. Ensure irrigation for homestead farming and dry-season agriculture.
5. Empower smallholder farmers, including women, disadvantaged farmers, and marginalized groups.

With drought and water shortages threatening livelihoods and food security in Nepal's mid-hill ecosystems, the innovation integrates micro-irrigation and multi-use water practices to improve water efficiency and crop yields, especially in dry seasons. These climate-smart, women-friendly technologies benefit smallholder farmers, including marginalized groups like Dalits and the poor. In July 2023, 179 participants (107 women, 72 men) received training on micro-irrigation and efficient water use practices, leading to the distribution of 70 drip irrigation kits and 113 sprinkler kits, prioritizing disadvantaged farmers. Regular support has been provided on the installation and operation of the kits to the treatment farmers in coordination with the respective municipality and ward offices.

Local scale multi-stakeholder agricultural knowledge hub (*Krishi Chautari*)

The Multi-Stakeholder Agriculture Knowledge Hub (MSAKH) is an innovation aimed at fostering collaboration among local and municipal stakeholders to address agricultural challenges, share experiences, and promote sustainable mixed farming systems. Its goals include empowering farmers, especially women, Dalits, and marginalized groups, improving their access to resources, and advocating for policy changes.

⁷ Gurung, A., Adhikari, S., Chauhan, R., Thakuri, S., Nakarmi, S., Ghale, S., Dongol, B. S., & Rijal, D. (2019). Water crises in a water-rich country: Case studies from rural watersheds of Nepal's mid-hills. <https://doi.org/10.2166/wp.2019.245>

⁸ K.C., J., Kafle, S., Cheesman, S., Koirala, S., Neupane, N., Shrestha, N., Gathala, M.K. & Khadka, M. (2023). Interventions to sustainably improve the mixed farming systems of the Nepali Mid-hills. CGIAR research initiative on Mixed Farming Systems. Mexico, CIMMYT and Colombo, Sri Lanka: IWMI. <https://hdl.handle.net/10568/139232>

Key Objectives:

1. Inclusive Participation: Engage diverse local stakeholders in dialogue, decision-making, and activity implementation.
2. Knowledge Sharing: Serve as a hub for both indigenous and scientific agricultural knowledge and practices.
3. Advocacy: Promote policy updates that support smallholder farmers and MFS.
4. Capacity Building: Offer training and awareness programs tailored to stakeholders' needs.
5. Monitoring and Coordination: Track agricultural activities and encourage alignment across institutions.
6. Scalability: Facilitate the expansion of MFS through advocacy and resource mobilization.

With these objectives in March 2024, four MSAKHs- one each was established in Ward 6 and 7 of Halesi Tuwachung Municipality, and Ward 12 and 14 of Gurbhakot Municipality, in the presence of the research team, social mobilizers, municipality staff, and ward chairpersons. The MSAKH were formed comprising multiple stakeholders, including farmers, agro-entrepreneurs, local elected representatives and officials, financial institutions, community-based organizations (CBOs), and private entities such as cold storage operators, collectors, processors, and retailers. Among these, some stakeholders—such as farmers, ward representatives, cooperatives, and agro-vets—have become regular members. Apart from these stakeholders, IWMI and CIMMYT researchers and social mobilizers are also engaged in facilitating the hubs.

Methods Employed for Selecting Innovations

We adopted the decentralized and local stakeholders driven approaches to identify, co-design, test and adopt these two innovations.

A scoping visit and interaction with local stakeholders

The MFS research team from IWMI and CIMMYT visited Surkhet district in Western Nepal and Khotang district in Eastern Nepal in 2022 to understand the contexts, demand and needs of stakeholders on agriculture and scope out potential sites for participatory action research on MFS. The scoping visit identified Gurbhakot municipality in Surkhet and Halesi Tuwachung municipality in Khotang for the MFS research.

Socio-technical situation analysis and need assessment of farmers

In November and December 2022, researchers from IWMI and CIMMYT, along with representatives from the Nepal Agricultural Research Council and the Department of Agriculture, visited two MFS research sites. They engaged with elected officials, extension officers, agro-vets, small-scale agri-entrepreneurs, and members of farming households, including youth and women. Through focus group discussions and semi-structured interviews, they assessed agricultural needs and priorities, specifically for hill MFS. This activity helped identify both challenges and opportunities for piloting technical interventions aimed at sustainably intensifying MFS practices in the research areas.

Prioritizing farmers' needs

During the April 2023 visit, farmers selected the top three interventions based on their interests and needs. In both areas, most farmers prioritized improving water availability through water conservation practices, such as multiple water use systems, mulching, and drip and sprinkler irrigation. After discussions with farmers and reflections among researchers, the team identified the following innovations for piloting:

1. Improved water use efficiency in mid-hill mixed farming through micro-irrigation practices.
2. Enhanced fodder and forage in mid-hill smallholder systems to boost livestock productivity, reduce soil erosion, and restore degraded lands.
3. Increased household nutrition and income diversification by promoting high-value fruit trees in smallholder systems.
4. Establishment of multi-stakeholder platforms for information and knowledge exchange to promote MFS practices.

Micro-irrigation and improved fodder/fruit interventions were piloted with 125 farmers across two districts, including 76 women farmers.

Capacity Building of Farmers and Stakeholders

Between 2022 and 2024, several activities were conducted to enhance farmers' technical knowledge, awareness, and skills regarding MFS innovations application. Eight capacity-building activities, including a study visit, workshop, and online seminar for mayors and agricultural staff on the systems approach to mixed farming, were organized. These activities covered various MFS topics such as efficient water use technologies, soil health, mulching, micro-irrigation, multiple water use systems, conservation agriculture, and gender and social inclusion in MFS practices. A total of 454 participants (about 60% women), including local policymakers, farmers, and agricultural staff, benefited from these efforts. On-site demonstrations and training on micro-irrigation, business planning, and entrepreneurship helped encourage women farmers to engage in the learning activities.

Results of the Innovations

While data analysis on the impacts of these innovations is ongoing, field observations and interactions with farmers who have adopted MFS innovations show improvements in crop yields and the exchange of information on innovative practices (challenges and solutions) through the knowledge hubs.

- Farmers are integrating various components of farming systems at the farm level, including goats, poultry, piggery, fodder, forage, lentils, millet, vegetables, and micro-irrigation (Koirala et al., 2024).⁹

⁹ Koirala, S., Mponela, P., Kafle, S., K.C., J., Khadka, L., Koirala, P., & Khadka M. 2024. Scaling strategy workshop: Assessing challenges and opportunities for scaling socio-technical innovations in Mixed Farming Systems of Nepal's Mid-Hills. IWMI. <https://hdl.handle.net/10883/35404>

- With knowledge and skills in on-farm water conservation and micro-irrigation technologies like drip irrigation, farmers participating in the MFS pilot are increasing vegetable production during the dry season. They are also able to sell surplus vegetables in local markets, boosting both food security and household income.
- "Earlier, we only had water for agriculture during the rainy season, leaving farming land barren for the rest of the year. However, on-site training on MFS taught us how to use even a small amount of water effectively for farming. With the increased motivation, we believe that by working together in the community, we can take current agriculture to the next level and succeed in commercial farming." A male farmer, Kiteni, Surkhet, November 2024.
- A female farmer from Aiselukharka, Halesi Tuwachung-7, Khotang, said that she is able to produce twice as much as last year's vegetable production despite the significant dry period in 2024 utilizing drip irrigation. A farmer's family in Lower Aiselukharka has iterated that they can produce vegetables up to three times a year using micro-irrigation technologies. Farmers are using vegetable residues to feed cattle, which is also increasing the use of organic manures in agricultural fields (K.C. and Neupane, 2024¹⁰).
- With the introduction of micro-irrigation technologies and related training on efficient water use practices, home kitchen gardens in pilot households are now filled with green vegetables. Despite fragmented agriculture plots, utilizing small drip kits, farmers were able to produce 30 - 100 kg of vegetables per household, mostly during the dry period, between October 2023 and July 2024.
- Access to irrigation kits, hands-on training, continuous support and monitoring and establishing model farms to raise awareness have a significant influence on the adoption of micro-irrigation technologies. 45 percent of farmers, among treatment farmers, were able to practice micro irrigation practices efficiently.
- Halesi Tuwachung and Gurbhakot municipalities have incorporated evidence and information from the MFS research into their annual planning processes and have prioritized promoting MFS interventions in their constituencies.¹¹ The mayor of Gurbhakot municipality expressed the relevance of MFS research findings to connect farmers in agricultural production, despite persistent challenges of youth migration (November 2024).

Key Lessons of the Innovations

- Farmers can benefit from selling surplus agricultural produce such as vegetables and livestock products if they are supported by markets, value addition of produce, reliable transport, and communication systems.
- Crop-water-livestock-forage based mixed farming systems can support food and nutrition security of smallholder farming households.

¹⁰ K. C., J., Neupane, N. 2024. Sustainable formulae for mixed farming in Middle Hills of Nepal. Kathmandu, Nepal: Kantipur Daily News Paper. <https://hdl.handle.net/10568/163141>

¹¹ Neupane, N., K.C., J., Kafle, S., Koirala, S., Shrestha, N., Shrestha, S., Khadka, M., Cheesman, S., and Rai, S. 2024. Some suggestions on Mixed Farming System to be included in the Programs and Plans of Agriculture Sector of Halesi Tuwachung Municipality for the Fiscal Year 2081/2082. Report. Nepal: International Water Management Institute (IWMI). <https://hdl.handle.net/10568/152170>

- Micro-irrigation solutions (drip, sprinkle, and innovative irrigation), rainwater harvesting, soil and water conservation practices can support to improve water use efficiency in agriculture.
- The innovation is expected to inspire farmers in non-piloted areas to adopt the technologies. The role of local governments, private sector, and development projects in scaling the tested water solutions is critical.
- The local stakeholders have acknowledged knowledge hubs as a valuable platform for sharing agricultural knowledge, negotiating fair prices, and accessing government subsidies.
- Female farmers have expressed being benefitted from the knowledge sharing, and capacity strengthening programs initiated by the hubs. Some of the female farmers from Gurbhakot Municipality also stated that prior to their involvement in MSAKH, they had never been part of such process where their agriculture related needs were discussed.
- Mayors and ward chairs in the study areas view the hub positively, believing it can inspire farmers and foster collaboration to address shared agriculture related challenges. Other wards within the municipalities without MSAKH have shown interest in replicating the hub.

Social mobilizers have played a critical role in the hub's success, but their temporary involvement requires a planned transition to ensure the hub's sustainability.

Future Priorities

- Conduct policy and market assessments, along with evidence-based advocacy, to create an enabling environment for scaling up and out micro-irrigation practices in the water-scarce municipalities of the mid-hills of Nepal.
- Identify and engage champions from different stakeholders (e.g. policymakers, planners, private sector, communities, etc.) to develop and implement action plans for scaling innovations aligning with government's policies.
- Strengthen engagement with local government, enabling them for evidence-based policy development and investment to scale tested socio-technical innovations such as water security for food security.
- Many farmers, including female and Dalit farmers, still lack technical knowledge in the installation, maintenance, and effective use of micro-irrigation systems. Training shall be provided through local farmers who have received such training, with MSAKH members taking the lead role. Additionally, linking farmers to market intermediaries and cooperatives will be a key focus. Training on value additions of local products is also necessary.
- A clear governance structure for the MSAKH should be developed and formally endorsed by its members.
- Hub members require a broad range of skills, including networking, coordination, fundraising, data and information management, monitoring and evaluation, and leadership. Given the current skills gap, targeted training programs should be implemented to strengthen the hub's capabilities and functionality.

- In all knowledge hubs, male members have predominantly assumed leadership positions, while female members in many areas have been hesitant to take on executive roles. Challenges such as fear of increased workload, lack of confidence, and difficulties attending training due to travel constraints have been identified for women farming taking leadership roles. This highlights the need for targeted capacity-building programs, such as self-esteem-building workshops, mentoring opportunities, and technical skills training to empower women and other disadvantaged groups to assume leadership positions.
- Encourage the regular involvement of municipalities in MSAKH activities to serve as a bridge between farmers and the private sector, until farmers are able to independently negotiate for their benefits.