Understanding barriers and opportunities for scaling sustainable and inclusive farmer-led irrigation development in Nepal

Manohara Khadka, Labisha Uprety, Gitta Shrestha, Thai Thi Minh, Shambhawi Nepal, Manita Raut, Shashwat Dhungana, Sumona Shahrin, Timothy J. Krupnik, Petra Schmitter

CSISA

Cereal Systems Initiative for South Asia

Funded by

USAID FROM THE AMERICAN PEOPLE

BILL & MELINDA GATES foundation

Partners

CIMMYT International Maize and Wheat Improvement Center

IFPRI

IRRI

IWMI

CSISA COVID-19 Resilience Activity Partners

iDE

Understanding barriers and opportunities for scaling sustainable and inclusive farmer-led irrigation development in Nepal

Manohara Khadka[1], Labisha Uprety[1], Gitta Shrestha[1], Thai Thi Minh[1], Shambhawi Nepal[1], Manita Raut[1], Shashwat Dhungana[1], Sumona Shahrin[2], Timothy J. Krupnik[2], Petra Schmitter[1,3]

[1.]International Water Management Institute (IWMI), CGIAR, Lalitpur 44600, Kathmandu, Nepal

[2.]International Maize and Wheat Improvement Center (CIMMYT), CGIAR, Lalitpur, Kahtnamdu, 44700, Nepal

[3.]The World Bank, MSN MC10-1007, 1818 H St NW, Washington, DC 20433, United States.

Cereal Systems Initiative for South Asia

The CSISA Nepal Covid-19 Response and Resilience Activity

Intensive cropping systems that include rice, wheat and/or maize are widespread throughout South Asia. These systems constitute the main economic activity in many rural areas and provide staple food for millions of people. Therefore, enhancing the yield and productivity of cereal production in South Asia is therefore of great concern. Simultaneously, issues of resource degradation, declining labor availability and climate variability pose steep challenges for achieving the goals of improving food security and rural livelihoods.

The Cereal Systems Initiative for South Asia (CSISA) was established in 2009 with a goal of benefiting more than 8 million farmers by the end of 2023. The project is an exemplary sample of One CGIAR in action, and is led by the International Maize and Wheat Improvement Center (CIMMYT) and implemented jointly with the International Food Policy Research Institute (IFPRI), the Inernational Water Mangement Institute (IWMI) and the International Rice Research Institute (IRRI). Operating in rural 'innovation hubs' in Bangladesh, India and Nepal, CSISA works to increase the adoption of various resource-conserving and climate-resilient technologies, and improve farmers' access to market information and enterprise development. CSISA supports women farmers by improving their access and exposure to modern and improved technological innovations, knowledge and entrepreneurial skills. CSISA works in synergy with regional and national efforts, collaborating with myriad public, civil society and private-sector partners.

CSISA's Goals

- Facilitate the widespread adoption of resource-conserving practices, technologies and services that increase yields with lower water, labor and input costs.
- Support mainstreaming innovations in national-, state- and district-level government programs to improve long-term impacts achieved through investments in the agricultural sector.
- Generate and disseminate new knowledge on cropping system management practices that can withstand the impacts of climate change in South Asia.
- Improve the policy environment to facilitate the adoption of sustainable intensification technologies.
- Build strategic partnerships that can sustain and enhance the scale of benefits accrued through improving cereal system productivity.

With a new investment in the CSISA program, the USAID Mission in Nepal is supporting CSISA to rapidly and effectively respond to the threats posed by the Covid-19 crisis that undermine the recovery and sustained resilience of farmers in the FtF Zone of Nepal. This Activity includes Texas A&M University, Cornell University, and International Development Enterprises (iDE) as core partners. Activities involve two inter-linked Objectives that address CSISA's strengths in core areas needed to assist in Covid-19 response and recovery over an18 month period (From July 2020- December 2021). The ultimate goal of the CSISA Covid-19 Resilience Activity is to develop mechanisms to support longer-term resilience among smallholder farmers and the private sector – with emphasis empowering youth and overcoming challenges faced by women headed farm households. At the same time, the Activity is assisting in efforts to increase smallholder farmers' understanding of, and capacity to protect themselves, from Covid-19. This is achieved through the dissemination of awareness raising messages on public health and by increasing economic opportunities for return migrants, smallholder farmers, and by encouraging resilience-enhancing irrigation.

Sugested citation: Khadka, M., Uprety, L., Shrestha, G., Minh, T.T., Nepal, S., Raut, M., Dhungana, S., Shahrin, S., Krupnik, T.J., Schmitter, P. 2021. Understanding barriers and opportunities for scaling sustainable and inclusive farmer-led irrigation development in Nepal. The Cereal Systems Initiative for South Asia (CSISA). Kathmandu, Nepal.

Cover photo: Nabin Baral

Printed in Nepal. Published in 2021.

Acknowledgement: This work was supported by the Bill and Melinda Gates Foundation and USAID through the Cereal Systems Initiative for South Asia (CSISA). The views and opinions in this document are those of the authors and do not necessarily reflect the Gates Foundation or USAID and shall not be used for advertising purposes.

Table of Contents

TABLES

FIGURES

ANNEXES

Executive Summary

Nepal has abundant water resources, but over 60% of irrigable lands owned by smallholder farmers don't have irrigation access. Many smallholder farmers and women farmers lack water for agriculture, drinking, sanitation, and other domestic uses. Nepal's Tarai region is considered as an area with huge potential for surface and groundwater-based irrigation development. But the drivers and constraints for scaling of irrigation development remain poorly understood.

This study therefore aimed at assessing opportunities, and barriers for scaling sustainable and inclusive farmer-led irrigation development in the Feed the Future Zone of Influence (FtF ZoI) region in Western Tarai from a qualitative social science perspective. Irrigation development does not take place in a vacuum, irrigation practices are continuously shaped and reshaped by a multi-faceted range of drivers stretching from farmer's livelihoods and aspirations, via economic arrangements of different scales including supporting sectors and markets, to the political economy of water resources management and international trade arrangements. Making irrigation work, therefore requires the application of an integrated lens for analysis to understand and pinpoint critical bottlenecks in the rural innovation systems for irrigation development and management. To achieve this, the research has looked at six key interconnected dimensions that influence scaling of irrigation development in Nepal's diverse societies, livelihoods, and political economy:

- Lasting drivers in the FtF ZoI and Covid-19 related impacts and responses
- Policy environment, including governance
- Agricultural value chains
- Irrigation equipment and service supply chain
- Public and private sector interventions in water resources and agricultural development
- Gender and social inclusion in policies, agricultural value chains, irrigation equipment supply chains and public and private sector interventions

The research broadly based on extensive review of scientific and grey literature, including over 50 policy and programs documents of the governments and development partners in Nepal, 16 telephone interviews with the private sector, farmer group associations and agricultural cooperatives, provincial officials and policymakers, and reflections of stakeholders on the opportunities and challenges of the water sector to capitalize on the power of water in national development planning.

The recognition of water management and irrigation development being crucial to the country's agricultural and economic growth provides an opportunity of the new federal PPP legislations to stimulate private sector investment in irrigation supply chains, agricultural value chains (VCs) and also multiple use water systems. However, the current policy frameworks remain biased towards large-scale infrastructure and economic growth instead of inclusive growth. Hence, subsidies for agro-inputs are not pro-poor and women friendly and largely fall in the hands of better-off farmers. Furthermore, the overlapping roles and responsibilities across the three levels of government and sectoral line ministries complicates the role out of agricultural and water management interventions in the water-agricultural and energy sector. Hence, the lack of coordination among ministries and stakeholders has led in the past to poor scaling of available irrigation and agricultural technologies.

For many of the agricultural VCs, access to timely and quality fertilizer remains a serious bottleneck. Furthermore, poor access to roads and transport facilities, lack of (cold) stores and poor market linkages result in post-harvest losses. Similar challenges in the irrigation supply chains are observed. The reliance of imported raw material for domestic manufacturing significantly increases costs as well as the unreliable land ports and road conditions which hamper the importation of equipment. This together with the political instability with neighbour countries results in steep price increases of irrigation equipment such as pumps. Transportation and market disruptions because of Covid-19 aggravated the situation leading to price surges for vegetables and equipment, declined harvests of wheat and reduced income for farmers as well as remittances from migrant workers. Given the fast-growing local demand of agriculture and irrigation equipment there is an opportunity to strengthen local manufacturing companies. The USD 6.6. billion under the Green Recovery Plan in building resilience to climate, Covid-19 and other shocks provides an opportunity to strengthen agri-businesses and local manufacturing of equipment in a pro-poor and inclusive way, creating jobs for women, returning migrants and youth affected by Covid-19. Especially the recent Industrial Enterprise-related policies and acts on VCs, PPPs, business and finance give priority to smallholders, youth, tenant and marginal farmers. Multi-stakeholder partnerships which provide services support and strengthen the capacity of female extension agents, entrepreneurs will be key given the cultural norms in the Tarai which restrict interaction between women and men outside kinship circles.

For farmer-led irrigation development to thrive, there is a need to address issues of land tenancy as these prohibit borehole investments and electricity access and stability. As tenancy rights are barely protected, investments in borewells under an irrigation service scheme are less likely to happen if formal tenancy contracts are absent. Introducing shared solar irrigation pump (SIP) systems and wells supporting a sharing equipment-rental market at community level might be an alternative. However, upfront investment costs in SIPs remain relatively high and the 60% subsidy programs fail to reach the poor and the most vulnerable. Limitations to the inclusive subsidy schemes are the requirement of a land ownership certificate, a recommendation letter from the local government and

a minimum land size of 1 ha, preventing smallholder farmers, women and youth from reaping the benefits of SIP. Although not implemented in Nepal, a group approach to subsidy mechanism for SIP access by smallholder and the poor farmers would be potential action research to conduct. As irrigation development remains predominantly infrastructure focused the implementation of gender and inclusive principles has been relatively limited when it comes to irrigation development and in particular the role out of financing mechanisms, irrigation supply chains and services and VCs. However, women are emerging as role models and entrepreneurs leading 30% of firms including agri-businesses. There is an opportunity to use private-sector extension to overcome some of the current challenges in human capacity and knowledge on Gender Equality and Social Inclusion (GESI) in governmental institutions tasked to implement irrigated agricultural programs. Mainstreaming GESI in the private sector by partnering with I/NGOs could offer an opportunity to achieve GESI outcomes at the project-implementation level as women's social networks are key to technology adoption.

Learning from these insights the following five objectives are essential to *improve incomes, nutrition, health, knowledge in the FtF ZoI through sustainable and inclusive scaling of FLI development:*

- *Enable a supportive policy and institutional environment and governance mechanisms for the scaling of sustainable and inclusive FLI development along irrigated agricultural value chains through both public and private investments.:* This includes supporting an environment for private sector partnership, domestic agro-irrigation input manufacturers, regulation of markets for cheap Indian agriculture, fertilizer agri-businesses and strengthening of technical and human capacity in sanitary and Phyto-sanitary implementation; revision of fertilizer and subsidy policies and strengthening of GESI tools and transformative approaches.
- *Capitalize upon private sector investment into irrigation equipment and input supply chains:* Develop financing modalities that help de-risk private sector investment to entire frontier markets especially micro-irrigation, bottom of pyramid market financing. Strengthen scaling partnerships between private sector, local governments, operating Technical and vocational education Training (TVET) institutions. Support domestic manufacturers and create an enabling environment for more domestic agro and irrigation input businesses to grow (e.g. revising raw material taxes those required for irrigation equipment, engaging with private sector to establish input factories). Invest in essential infrastructures such as cold stores and collection centers to enable stallholder produces to effectively reach bigger markets.
- *Enhance adaptive interventions to support small-scale irrigation and farmer-led irrigation development:* It is essential to emphasize that scaling FLI development requires bundles of irrigation technologies, agronomic practices, extension services, financial and market services as well as corresponding actions to reach scale of the locally driven, bottom-up, effective and efficient climate smart agriculture, sustainable water resources use and gender and social inclusion. Implement best-fit of bundled irrigation and agronomic practices with financial and market services, cold storage and entrepreneurial activities to enhance return of investment for smallholder farmers and agri-businesses and lower investment risk. Support scaling of solar-powered irrigation pumps (SIPs) technologies for water access for multiple use, including WASH in areas with unreliable electricity access. Addressing access of poor women, smallholders and vulnerable groups requires innovative end-user financing which could include farm-equipment leasing, group-distribution models or integration of irrigation investment with agricultural-related inputs. Support local governments to pilot and implement frameworks for decentralized water and land management as a sustainable solution to water security, environmental conservation and equitable development outcomes. This also includes the training of local services providers for operation and maintenance.
- *Supporting collaborative scaling ecosystem in responding to dynamics and driving changes needed for scaling FLI development:* Establish inclusive and sustainable financing ecosystem for public and private sector investment. Promote 'multi-stakeholder partnerships approach for scaling' to strengthen resource leverage, harmonized irrigation investment, market system development, evidence-based policymaking and knowledge development, and local capacity building. Strengthen partnerships with research organizations as a knowledge broker to address information and innovation gaps to support the niche, reach and accelerate functions of scaling is essential. This also includes capacity building of sectoral staff, water user associations and farmers collective to promote climate smart agricultural development.
- *Transform the irrigation and agricultural development system:* Systemic barriers that hinder transformative changes in the irrigation, private sector and agricultural value chain sectors can be addressed through the facilitation of inclusive policy processes at the local, provincial and federal levels on inclusive and sustainable FLI development scaling approaches. This will require contextual evidence-based policy and programs explicitly addressing discriminatory norms, attitudes and practices that exclude women and disadvantaged groups participating from decision making processes at layers. This also demands equal recognition of social science and gender perspectives and expertise in planning water resource development. Gender responsive budgeting should be embedded in the theory of change and monitoring activities, and capacity development of the government, CSOs and private sector on multi-use water resources management. Create and operate multi-stakeholder dialogue (MSD) platforms, dialogues, and knowledge forum (national and subnational level) which connects private sector actors, government, cooperatives and association of water user groups to discuss barriers and opportunities for scaling small-scale/farmer-led irrigation. Investment into Research for Development (R4D) programs to design, implement and learn from 'sustainable and transformative irrigation development in the FtF ZoI is essential to develop local capacity on inclusive agri-businesses, and strengthen local policy implementation.

Abbreviations and Acronyms

ADB	Asian Development Bank
ADS	Agriculture Development Strategy
AEPC	Alternative Energy Promotion Center
AMIS	Agency Managed Irrigation System
CBS	Central Bureau of Statistics
CIDA	Canadian International Development Agency
Covid-19	Coronavirus Disease 2019
CSISA	Cereal Systems Initiative for South Asia
CSO	Civil Society Organization
DED	Department of Electricity Development
DoA	Department of Agriculture
DHM	Department of Hydrology and Meteorology
DoLI	Department of Local Infrastructure
DP	Development Partner
DWRI	Department of Water Resources and Irrigation
DWSS	Department of Water Supply and Sewerage
FAO	Food and Agriculture Organization of the United Nations
FECOFUN	Federation of Community Forestry Users, Nepal
FEDWASUN	Federation of Drinking Water and Sanitation Users in Nepal
FLI	Farmer-led Irrigation
FMIS	Farmer-managed Irrigation System
FtF ZoI	Feed the Future Zone of Influence
FY	Fiscal Year
G2G	Government-to-Government
GDP	Gross Domestic Product
GESI	Gender Equality and Social Inclusion
GESI WG	Gender Equality and Social Inclusion Working Group of IDPG in Nepal
GoN	Government of Nepal
GWRDB	Groundwater Resource Development Board
HH	Household
iDE	International Development Enterprises
IDPG	International Development Partners Group
IFAD	International Fund for Agricultural Development
IMP	National Irrigation Master Plan
INGO	International Non-governmental Organization
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
JMIS	Joint Managed Irrigation System
LDPE	Low-density Polyethylene
LGOA	Local Government Operation Act, 2017
M ha	Million Hectares
MFI	Monetary Financial Institution
MoALD	Ministry of Agriculture and Livestock Development
MoEWRI	Ministry of Energy, Water Resources and Irrigation
MoF	Ministry of Finance
MoFAGA	Ministry of Federal Affairs and General Administration
MoITFE	Ministry of Industry, Tourism, Forests and Environment Provincial
MoLMAC	Ministry of Land Management, Agriculture and Cooperatives
MoLESS	Ministry of Labor Employment and Social Security
MoLRCPR	Ministry of Land Reform, Cooperatives and Poverty Reduction
MoPID	Ministry of Physical Infrastructure Development (Provincial)
MoPIT	Ministry of Physical Infrastructure and Transport
MoSD	Ministry of Social Development (Provincial)

MSD	Multi-stakeholder Dialogue
MT	Metric Tons
MUS	Multiple-use Water System
MUWRM	Multiple-use Water Resources Management
NACCF	Nepal Agricultural Cooperative Central Federation
NACF	Nepal Agricultural Cooperative Federation
NARC	Nepal Agricultural Research Council
NDC	Nationally Determined Contribution
NEA	Nepal Electricity Authority
NFGF	National Farmers Group Federation, Nepal
NGO	Non-governmental Organization
NIFUWAN	National Irrigation Federation of Water User's Association, Nepal
NIT	Non-conventional Irrigation Technology
NNRFC	National Natural Resources and Fiscal Commission
NPC	National Planning Commission
NPR	Nepalese Rupees
NTI	Non-traditional Technology-based Irrigation
O/M	Operation and Management
PMEP	Prime Minister Employment Program
PPP	Public-Private Partnership
PS	Private Sector
PVC	Polyvinyl Chloride
REED	Rural Economy and Enterprise Development
RETS	Renewable Energy Test Station
SAPPROS	Support Activities for Poor Producers of Nepal
SDC	Swiss Agency for Development and Cooperation
SDGs	Sustainable Development Goals
SFACL	Small Farmer Agriculture Cooperative Limited
SFCL	Small Farmer Cooperative Limited
SIMI	Smallholder Irrigation Market Initiative
SIP	Solar-powered Irrigated Pump
SKBBL	Sana Kisan Bikas Laghubitta Bittiyasanstha Limited
SMEs	Small and Medium Enterprises
SNG	Subnational Government (includes Provincial and Local Government)
SPS	Sanitary and Phytosanitary
SSI	Small-scale Irrigation
SIID	Sustainable and Inclusive Irrigation Development
STW	Shallow Tube Well
TVET	Technical and Vocational Education and Training
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VAT	Value Added Tax
WASH	Water, Sanitation and Hygiene
WB	World Bank
WECS	Water and Energy Commission Secretariat
WRM	Water Resources Management
WNRM	Water and Natural Resources Management
WRI	Water Resources and Irrigation
WRRDC	Water Resources Research and Development Center
WSS	Water Supply and Sanitation
WUA	Water Users Association
WUG	Water Users Group
YETI	Youth Employment Transformation Initiative

1. Introduction

1.1. Research context

Nepal is a water-abundant country but is not using water optimally and efficiently to secure livelihoods and environmental sustainability (Biggs et al., 2013, Bharati et al., 2014). Less than a tenth of available water resources are harnessed for productive uses (IWMI, 2020). Harnessing the potential of water for food and nutrition security, health and a clean environment is a key development opportunity. Nepal's Tarai region is viewed as having huge potential for surface and groundwater-based irrigation development. Only about 22% of the available recharged groundwater is utilized annually. The estimated available balance of 6.9 billion cubic meters (BCM) could be pumped to irrigate 613,000 hectares (ha) of rain-fed agricultural land in the region, with a potential direct economic gain of USD 1.1 billion annually, resulting in expansion of energy-based small and medium enterprises and local job markets (Nepal et al., 2021). It is likely that the development of the relatively underutilized groundwater resource in the Feed the Future Zone of Influence (FtF ZoI) will support regional agricultural and industrial development, the national economy and sociocultural and livelihood changes (Sharma et al., 2020).

The FtF ZoI is socioeconomically and culturally diverse. Indigenous peoples (Janajatis) comprising ethnic groups such as Tharus, Magar, Majhi and Tamang are the dominant social group (38.15%), followed by Chhetri (30.16%), Brahmin (11.11%) and marginalized groups (Dalit[1]- 12.76%, Muslim - 6.81%, Madheshi other castes - 0.5%, Badi - 0.25% and others 0.26%) (**Annex 1-1**). Over 70% of the Janajatis are Tharu who live in the Bardiya, Dang and Kailali districts of the FtF ZoI. Furthermore, youth and people with disabilities comprise around 39% and 4% of the total population respectively (CBS 2011). Despite the Government of Nepal's (GoN) recent focus on youths in policies and programs, the majority of young people continue to aspire to migrate to cities, India and Gulf countries. In the FtF ZoI, men constitute 95% of those who migrate (MoLESS, 2020).

Over 50% of the population in the FtF ZoI are smallholder farmers with less than 0.5 ha of land or are landless and rely on rain-fed agricultural and seasonal migration as sources of income. Women make up over 70% of the total workforce in agricultural production (UN Women, 2015). However, smallholders, including tenant and women farmers, lack water access and irrigation technologies (Pant and Thapa, 2017, Leder et al., 2019), despite availability of water resources. Their access to water is likely to be further impacted by the projected change in hydrology and streamflow caused by climate change (Pandey et al., 2020), which will eventually affect food security and livelihoods. The Covid-19 pandemic has worsened the lives and livelihoods of smallholders, the poor, women and girls (Shrestha and Leder, 2020). More women (46%) than men (28%) lost jobs during the lockdown. Those most affected were agricultural daily wage earners, small-scale agricultural entrepreneurs, food and vegetable suppliers and private firms (UNDP, 2020). Ensuring water access and efficient water use technologies for irrigation, drinking, sanitation and other livelihood activities could help build resilience to shocks such as Covid-19, especially for women, resource-poor farmers and disadvantaged groups (Raut and Rajouria, 2020, Shrestha and Leder, 2020). However, insufficient attention paid to the local socioeconomic context, the wider enabling environment and governance aspects of irrigation as well as greater focus on large physical infrastructure and engineering-centered approaches are systemic barriers to scaling farmer-led irrigation (FLI) (Awasthi et al., 2016, Bharati and Uhlenbrook, 2020, Harou JJ et al., 2020, Clement et al., 2012). These barriers can be addressed when irrigation development is designed and implemented in an inclusive and sustainable way, along with multi-actor engagement for irrigation planning, decision-making and investment (Clement et al., 2012, Minh et al., 2020, Harou JJ et al., 2020).

Moreover, while groundwater-based irrigation is limited and affected by various policy, institutional, investment and governance challenges (Sugden et al., 2020, Minh et al., 2021, Urfels and Foster, 2020), regional and global studies warn that expansion of groundwater-based markets could lead to overexploitation and result in imbalance in the hydrological system (Grey and Sadoff, 2007, Pavelic, 2013, Villholth, 2013, World Bank, 2020a, Shah, 2014). The challenge is to promote growth and poverty alleviation through irrigation scaling while ensuring environmental sustainability, social inclusion and equity (ibid). The extent to which FLI and small-scale irrigation (SSI) can be sustainably scaled, and gender equality, social inclusion and equity outcomes achieved, has not been systemically analyzed in Nepal.

Accelerating irrigation development is also shaped by Nepal's new governance system. The country moved to a federal governance system following the promulgation of the Federal and Republic

[1] Dalits are artisan caste groups in Nepal. They are highly excluded and marginalized on the basis of informal institutions such as 'caste hierarchy, economic, political and cultural exclusionary practices in Nepal. They live with the lowest of the Human Development Index and multi-dimension poverty' (UNDP 2009). Dalit women in the FtF ZoI are discriminated against and marginalized on the basis of gender intersected with other social relations such as caste, language, region, economic status, markets and social networks (telephone interview with an MP, February 12, 2021, province 5).

Constitution on September 20, 2015 and subsequent elections for the three levels of government in 2017. For the first time in Nepali politics, large numbers of women were elected as lawmakers at all levels of government (federal - 33.5%, provincial - 34.4%, local - 41%) (ECN 2017). This is a significant political change, as women made up only 6% of the parliament in the previous system (Uehara, 2019). Their participation in water policymaking and decision-making is essential for transforming the water sector and achieving inclusive development outcomes (Khadka et al., forthcoming). Moreover, policy frameworks, functions, functionaries, roles and responsibilities between and among layered government and sectoral agencies change when the governance structure changes (De Stefano and Garrick, 2018). This has implications for water resources use and management. With a federal system in place, the GoN announced an ambitious vision of achieving USD 12,100 per capita income per year by 2044, along with a reduction in people living in multidimensional poverty from 28.7% in 2019 to 6% by 2030 and 3% by 2044 (NPC, 2019). The 15th Plan, 2019/20 -2023/24, recognizes the roles of agriculture, water resources and the energy sectors in economic growth and social development. Efficient, sustainable, equitable and inclusive groundwater access and irrigated agricultural value chains (VC), if promoted in the FtF ZoI (hereafter referred to interchangeably as Western Tarai), can support the government in achieving its national vision.

However, there is no systemic analysis of how federalism has changed policies, functions, power and functionaries/institutions in the water, agricultural and energy sector and to what extent government policies and programs have supported the promotion of SSI technologies and irrigated agricultural VCs that enable smallholders, women farmers and marginalized groups to improve their livelihoods and income. Neither is there an analysis of what the systemic barriers are that hinder the scaling of inclusive and sustainable irrigation development. This study aims to fill that gap and to support policymakers and decision makers, development partners (DPs) and private sector actors to make informed investment decisions that build resilience to climate change and other global challenges such as Covid-19. Investment in sustainable and inclusive water access, conservation and efficient use for agriculture development, along with political empowerment of women in the water sector and technical approaches to water development are needed in a country where political transformation is taking place.

1.2. Research objective and structure of the report

The overall objective of this research is to assess opportunities for and systemic barriers to sustainable and inclusive irrigation development that can increase resilience and generate income for smallholder farmers in districts in the FtF ZoI affected by Covid-19. The research consists of an integrated analysis of the enabling and disabling environment for scaling irrigation (**Figure 2-1**). This includes policy enabling, governance structures and institutional changes in the federal context for managing water resources, dynamics of irrigated agricultural VCs and irrigation supply chains, public and private sector interventions in irrigation development, including multi-actor engagement, with gender equality and social inclusion (GESI) being cross-cutting to ensure recommendations for irrigation development that are inclusive and sustainable.

An analysis of the enabling/disabling environment is essential when aiming to improve water access and scale irrigation technologies and services that are critical for promoting profitable, inclusive and resilient irrigated agricultural VCs while ensuring sustainable use of groundwater in the FtF ZoI. The study is guided by the following key questions:

- What are new drivers and responses (e.g., Covid-19) in Nepal that would impact irrigation scaling?
- What characterizes policy environments for promoting SSI that are sustainable, profitable and beneficial to women and smallholder farmers?
- What characterizes agricultural VCs in which irrigation are embedded?
- What characterizes irrigation supply chains that provide different technologies and equipment for irrigation development?
- What are public-private sector interventions for scaling irrigation technologies and development under federalism?
- What are the systemic barriers and opportunities for making irrigation development sustainable, gender and socially inclusive and smallholder-centric in the federal context?

The report has 11 sections. The first three sections provide the background to the study, the analytical framework, the socioeconomic and livelihood strategies of people in the FtF ZoI and how different people have been impacted by the Covid-19 pandemic. The policy environment influencing irrigation scaling under the federal system, and the dynamics of irrigated agricultural VCs and irrigation supply chains are discussed in sections five, six and seven. The public and private sector interventions and actor linkages for scaling irrigation are discussed in sections eight. The last two sections discuss the challenges and opportunities for scaling and some recommendations.

2. Analytical Framework

2.1. Defining sustainable and inclusive irrigation development in Nepal

Scholars (Ansari and Pradhan, 1991, Merrey, 2018, Merrey et al., 2007, Suhardiman et al., 2017) argue that irrigation development is more than a technical intervention and adheres to sociopolitical drivers. Sustainable and inclusive irrigation scaling therefore needs to focus on reducing poverty, increasing equity and gender equality and enhancing ecosystem services. Nepal's sociocultural, economic and food production systems are diverse and dynamic, and water resources management (WRM) policies and practices need to consider this diversity and complexity (Clement et al., 2012, Leder 2019, Suhardiman et al., 2017). As water scientists and policymakers point out (Harou JJ et al., 2020), managing water requires multi-sectoral action, as water is connected to multiple users and uses, including health, sanitation, irrigation, hydropower, enterprises and ecosystems. Water management also connects themes such as governance, equity, climate change, gender, inclusion, economic development and natural resources management, which requires a holistic approach (Harou JJ et al., 2020, Pahl-Wostl, 2020, Bharati and Uhlenbrook, 2020, Joshi and Nicol, 2020). Therefore, transformation is needed in water resources development (WRD) policy, planning and implementation that allows policymakers and water stakeholders to conceptualize and operationalize irrigation development and scaling mechanisms beyond the classical engineering-economic approaches (Harou JJ et al., 2020, Clement et al., 2012). Keeping these perspectives in mind, we define sustainable and inclusive irrigation development in Nepal as:

> *those efforts in the water/irrigation and agricultural sectors that recognize the structural issues of poverty, inequality, human development and water stress and focus on the need for an action, a process and a set of desired outcomes – in short, a way of developing the sector – that results in positive change in the livelihoods of smallholder farmers, women and marginalized groups, and will not reinforce existing inequality and marginalization (adapted from IDPG GESI WG, 2017).*

The main objective of scaling sustainable and inclusive irrigation development in the Nepalese context is, therefore, to enhance food security, income, human capital and inclusion and to amplify the voices of women and smallholder farmers in the water sector by enhancing their access to water, irrigation technologies, VCs, knowledge, resources and capabilities (e.g., finance, skills, awareness,) as well as improving public sector policies, governance systems and scaling interventions (Minh et al., 2021 and IWMI, 2021, Loon et al, 2020). The key questions for systemic scaling are thus: what should be scaled, where, when, by how much, for whom, by whom and why (Woltering et al., 2019, p. 4). This means that scaling irrigation development should not have negative effects on social (gender and social equality, power relations, equity, resilience, and inclusiveness), environmental (use and quality of natural resources and climate change) and governance (inclusion, voice and influence).

2.2 Analytical framework

Understanding barriers and opportunities that influence sustainable and inclusive irrigation development in Nepal requires a comprehensive analysis of the current agriculture and irrigation systems as well as the multiple contexts in which these systems are embedded. We therefore adapted the tools for analyzing the enabling environment (Minh et al., 2021, IWMI, 2021) to the context of sustainable and inclusive irrigation development in Nepal as well as to the Covid-19 pandemic. **Figure 2-1** illustrates the analytical framework, which has six dimensions: the long-lasting drivers and Covid-19-related impacts and responses, policy environment, agricultural VC, irrigation equipment and service supply chain, public and private interventions in WRD and gender equity and social inclusion (GESI).

2.2.1. Covid-19-related impacts and responses

Nepal is highly vulnerable to natural disasters and climate change impacts. However, the impacts of such stressors are unequal (Gentle and Maraseni, 2012, Huynh and Resurreccion, 2014). New drivers such as Covid-19 can affect smallholder farmers, women and marginalized groups disproportionately (UNDP, 2020, Pradhan et al., 2021). The pandemic's gendered dynamics can also reinforce existing gender and social inequality, if response mechanisms are not GESI-sensitive (UN Women, 2020). At the same time, the pandemic offers an opportunity for sustainable transformation of Nepal's economy, natural resources management and people's livelihoods (Pradhan et al., 2021). In the FtF ZoI – the food basket of Nepal (Sharma et al., 2020) – the pandemic can positively influence irrigation development targeted at the most affected populations and groups. This will eventually help to build their resilience when irrigated services reach them and they are connected to markets for high-value crops. Pro-poor and gender-responsive irrigation interventions in the wake of Covid-19 can also boost agriculture's contribution to the gross domestic product (GDP), which declined from 50% in 1990 to 27% in 2017 (Tractebel Engineering GmbH, 2019). We analyze: i) the impact of Covid-19

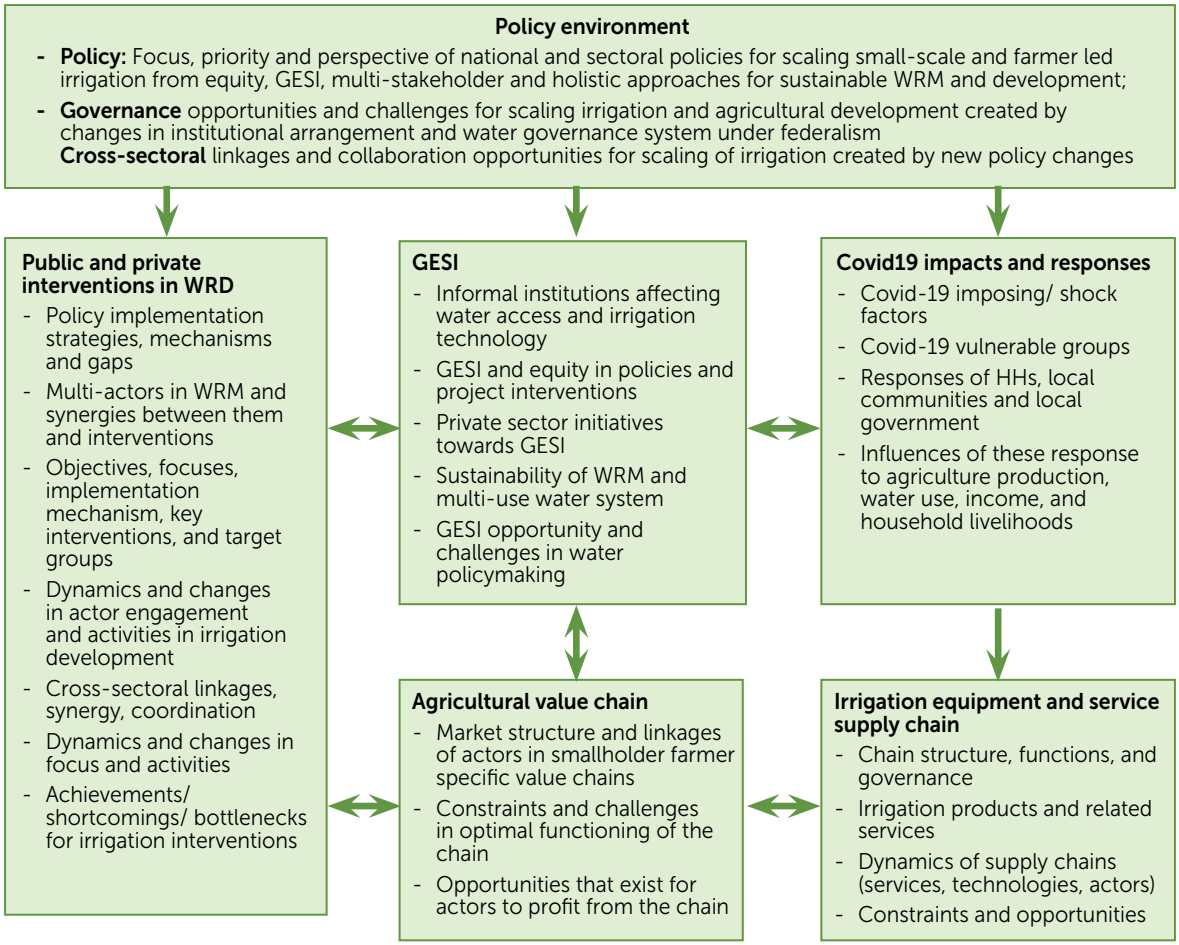


Figure 2-1. Analytical framework for scaling irrigation development in Nepal (adapted from Minh et al. 2021, and IWMI, 2021).

on vulnerable groups; ii) responses of households, local communities and governments (e.g., immediate, new policy and program directions); and iii) influence of these responses on agricultural production, multiple-use water systems (MUS) for irrigation, drinking water, sanitation and hygiene (WASH) and gainful employment and household livelihoods.

2.2.2. Policy environment

A policy environment refers to policy frameworks, institutional arrangements and governance systems that shape national development (Minh et al., 2021). A policy framework is key to scaling programs and approaches (Minh et al., 2021, IWMI, 2021, Loon et al., 2020). Whether it supports inclusive and sustainable irrigation development depends on perspectives and approaches to addressing irrigation issues articulated in the framework. These include not only irrigation or WRM systems but also equity issues around water access, institutional mechanisms and inclusion/exclusion of actors (state and non-state) in shaping water and agricultural policy and development interventions (Suhardiman et al., 2018). Water resources access, management and uses require more than classical economic and engineering approaches and need to be contextually relevant to the socio-economic conditions (Merrey et al., 2007, Clement et al., 2012, Biggs et al., 2013, Pradhan, 2016, Pradhan and Belbase, 2018). In addition, Nepal's federal system has resulted in administrative, fiscal, judicial and legislative powers and autonomy to be devolved to local level governments (Sharma, 2020). Therefore, we look at policy frameworks, institutional arrangements and governance to: i) assess the focus, priority and perspectives of Nepal's national and sectoral policies influencing small-scale and farmer-led irrigation development; ii) identify policy agenda and approaches for equity, gender and social inclusion, and sustainable WRM and irrigated agricultural development; and iii) identify the barriers and opportunities for scaling created by new policy changes and governance structures.

2.2.3. Agricultural value chains

An agricultural VC refers to the mapping of a product's passage from the field to final consumption involving several actors and activities; each stage is to have 'added value' to the product (FAO, 2010). This exercise helps better understand existing linkages and potential constraints that affect

actors' capacities to effectively generate profit for themselves. The analysis of opportunities for and barriers to promoting agricultural VCs as a key dimension for scaling will include: i) assessing the structure and linkages of actors in smallholder-centric VCs; ii) constraints and challenges to the optimal functioning of the chain; and iii) opportunities that exist for actors to profit from the chain.

2.2.4. Irrigation equipment and service supply chains

Easy and sustainable access to irrigation equipment and services by farmers facilitates their access to water, technologies and knowledge of multiple uses of water as well as markets (GC, 2020, IWMI, 2020). Farmers largely rely on the private sector to access technological innovations and irrigation services. Therefore, insights into irrigation equipment supply chains can highlight the main actors (such as key players in manufacturing, import/wholesale, distribution and retail as well as end-user farmers) and their interactions. These insights also offer the opportunity to better understand how the private sector engagement could be leveraged in favor of smallholder farmers. Further, many farmers, especially smallholders, the poor and women farmers, are not reached by these actors because of their lack of access to information, credit and social networks as well as procedural complexities and accessibility (Winther et al., 2018, GC and Hall, 2020). Scaling of irrigation services and technologies therefore needs to consider equity and inclusion in the way farmers, especially the poor, women and marginalized groups, have access to resources and services required for technology access and adoption. In the analysis of irrigation equipment and service supply chains, we focus on i) supply chain structure, functions and governance; ii) irrigation products and related services; iii) supply chain dynamics (e.g., services, technologies, actors); and iv) constraints and opportunities for actors, especially the private sector, farmers and their associations.

2.2.5. Public and private sector interventions in irrigation development

Public and private sector interventions refer to a wide range of scaling activities at the policy implementation level. These include public sector development programs/projects, multi-stakeholder engagement, processes and learning, research and knowledge development, private sector investment, partnerships, and capacity development tools and approaches (IWMI, 2021). Collaboration and partnership among stakeholders (government, civil society, I/NGOs, private sector, local and research institutions, water users associations and farmers) are key to implementing policies for irrigation scaling (Loon et al., 2020, Minh et al. 2021, IWMI 2021). Multi-actor engagement (Minh et al. 2020) can support implementation of national policies through an integrated irrigation development program that includes water, energy, agricultural VCs, irrigation technologies and services, investment, inclusion and capacity development. The development priorities and interests of national and international actors also shape intervention approaches and focus (Khadka, 2010). In the analysis of public and private sector interventions in irrigation development, we explore: i) diverse actors and their roles in scaling irrigation development; ii) dynamics in approaches to and focus of interventions by the GoN and DPs in irrigation development, and if the interventions intend to promote SSI/FLI; iii) market system development, collective action and the financing ecosystem; and iv) new program directions in response to emerging drivers such as Covid-19 and climate change.

2.2.6. Gender equality and social inclusion (GESI)

Studies on gender and technology show that the capacity of smallholder, women and tenant farmers to access and adopt agricultural technologies and knowledge is influenced by their limited access to and control over water, technologies, credit and information as well as limited participation in technology-related decision-making and planning (Winther et al., 2018, van Koppen, 2002, Tiwari, 2010, Upadhyay et al., 2005), which eventually impacts the gender and social outcomes of scaling technology. Systemic barriers that enable or hinder the poor, women and marginalized groups from accessing and sustainably using technologies are linked to formal and informal institutions (IDPG GESI WG, 2017). Formal institutions, such as laws, policies, guidelines, programs, and informal institutions, such as social and gender norms, beliefs, worldviews, social capital and social power relations, influence inclusion/exclusion outcomes and equitable access to resources, opportunities, information and space for meaningful participation by women and people with limited voices, power and networks (Shrestha et al., 2018a, Shrestha and Clement, 2019a, Udas et al., 2019, Khadka, 2009, Leder et al., 2019, Sugden et al., 2020). GESI, as an approach to and outcome of development, is therefore key to scaling sustainable and inclusive irrigation development. We analyze: i) informal and formal institutions/system-specific barriers and opportunities for access to and adoption of technologies by the poor, smallholder farmers, women, youth and disadvantaged groups amid the evolving socioeconomic and political situation in the country; and ii) development interventions that enable women to enter or benefit from irrigated agricultural VCs and irrigation supply chains.

3. Methodology

3.1. Data sources for analyzing six themes of scaling

This report is based on an extensive qualitative review of scientific literature, official documents, project/program reports, gray literature and online learning forums related to the six themes of irrigation scaling presented in the analytical framework. The documents reviewed ranged from national and provincial policies, guidelines and project documents, to blog posts, newspaper articles, scientific articles and reports (**Table 3-1**). Nepalese documents were translated into English. We reviewed over 50 GoN policies, including federal-level sectoral ministries (water, forest, agriculture, climate change, environment, trade, land, poverty reduction, GESI, youth and employment), province 5 and 7 government policies and program/project documents and websites (**Annex 3-1**). The review focused on the elements presented in Table 3-1, applying the scaling framework on sustainable and inclusive irrigation development in Nepal presented in Figure 2-1.

Telephone interviews, webinars, stakeholder consultations and transcribing interviews with provincial and local government authorities on agricultural development aired on national television and radio completed the literature review. The research team attended and reflected on stakeholder discussions on the water resources bill (October 12, 2020), webinars on 'Covid-19 and WASH', 'GESI and Covid-19' and the 'roles and barriers of women entrepreneurs in Nepal'. We also attended virtual conferences on pathways to scaling, federalism and natural resources management, and gender, migration and irrigation governance held between July and December 2020. We reviewed expert opinions in Nepali newspapers about the challenges federalism presents to the water and natural resources sector. We conducted telephone and online interviews (10 men and 3 women) with private sector stakeholders to better understand irrigation equipment supply chains, on which there is limited research in the Nepali context. Stakeholders interviewed include solar companies, pump importers, drip irrigation kit and sprinkler manufacturers, electric/diesel/petrol pump vendors, local agro-vets, agriculture cooperatives and a farmers' federation. In addition, we interviewed four provincial officials to confirm the web-based analysis of provincial policies on water and agriculture. The preliminary findings of the analysis were presented at three stakeholder workshops organized by the CSISA project, and stakeholder input was extremely important for confirming the findings.

3.2. Data analysis and validation

In seeking to understand the challenges and opportunities brought about by Covid-19, we considered different segments of the population and their vulnerability, associated impacts on gender and social inequality in the FtF ZoI as well as the coping and response mechanisms of people and governments. The webinars on Covid-19 and GESI organized by the co-chairs of the IDPG GESI Working Group and Gender in Humanitarian Action (GiHA), which is coordinated and facilitated by UN

Table 3-1. An overview of secondary and primary data.

Type of data/collection tool	n	Information/topics
GoN policies	50	National development vision, approaches, irrigation development, WRM, energy, trade, taxes, land use, climate change adaptation, agriculture, GESI, public-private partnership (PPP), policy implementation strategies, institutional mechanisms, roles and power of three levels of government, and roles of government line ministries
Provincial policies	8	Covid-19 responses, irrigation technologies, agricultural value chains, GESI, programs and budgets
Development project reports (project design documents, factsheets, evaluation reports)	29	Irrigation, value chains, GESI, sustainability, equity, subsidy, PPP, multi-stakeholder participation, solar energy, farmer-led irrigation, multiple-use water management, governance barriers, project implementation modalities, federalism, capacity gaps
Telephone and online interviews with private sector actors	13	Mapping the irrigation equipment supply chain and better understanding of agricultural cooperatives and microfinance
Telephone interviews with provincial officials and policymakers	4	Confirmation of provincial policies and programs on irrigation, challenges and opportunities federalism has created for decentralized irrigation
Multi-stakeholder workshops	3	Presentation and validation of preliminary analysis and additional ideas on sustainable and inclusive irrigation that the analysis missed
Gray literature (blogs, newspaper articles, webinars, unpublished reports, presentations)	>50	Subsidies, governance, GESI, Covid-19, changes brought about by federalism, political inclusion, capacity development, knowledge system, PPP
Journal articles (international and national)	>200	Scaling factors, GESI, WRM and irrigation governance, PPP, value chain approaches, climate change, MUS, livelihoods, migration, Covid-19 impacts

Women, provided powerful confirmation of our findings. We used gender, equity and inclusion perspectives to analyze vulnerability and response mechanisms to the pandemic.

In analyzing policies, we first created an inventory presenting the sector-specific policy data in a systematic tabular format (for example: goal, objectives, strategies, water solutions including SSI, gaps and challenges, conflicts/contradictions between policies, private sector provision, equity, gender equality and inclusion provision, etc.). We then divided the policy review into five clusters: i) water, irrigation, energy; ii) environment, climate change, natural resources; iii) agriculture, land; iv) trade, tax and PPPs; and v) national development framework including poverty reduction, GESI and youth empowerment. We then conducted a cross-sectoral analysis, looking at the complementarity and contradictions between policies for scaling irrigation development. The policy analysis was then linked to the analysis of public and private sector interventions, agricultural VCs, irrigation supply chains and GESI as interconnected factors for scaling irrigation development in Nepal.

In researching private actors in irrigation and agriculture, we scrutinized their linkages and interdependencies using agricultural VCs and mapping irrigation equipment supply chains. The main questions investigated concerned how the overall chains functioned, and what barriers need to be addressed and opportunities explored to enhance the position of private actors and smallholders in these chains. The analysis of public and private sector interventions in irrigation development was based on a review of around 30 projects and impact evaluation reports.

Some of these reviews/design documents were commissioned by DPs such as the United States Agency for International Development (USAID), the World Bank, the International Fund for Agricultural Development (IFAD), the Swiss Agency for Development and Cooperation (SDC), the Japan International Cooperation Agency (JICA) and the Asian Development Bank (ADB). The primary focus of the review was to understand how smallholder farmers and farmer-led irrigation infrastructure are integrated into irrigation and agricultural projects. We reviewed project goals, focus of interventions/components, modality of partnerships, irrigation technologies, beneficiaries, geographical focus and approaches considered to ensure sustainability, equity and inclusion of development interventions.

As GESI was cross-cutting, all data collected was thematically arranged and rearranged as per the emerging and identified patterns. With regard to investigating GESI barriers and enablers to SSI scaling, the review focused on key questions such as how GESI has been conceptualized in policies and documents; what key GESI barriers the documents are trying to address; what strategies have been adopted for successful implementation of GESI objectives; what lessons were learned from the implementation; how gendered norms and barriers as well as other challenges and constraints were addressed and enabled transformation. The factors (barriers and opportunities) influencing scaling sustainable and inclusive irrigation development were then identified based on the analysis of the six aspects of scaling. They were arranged and rearranged based on the concepts/ideas emerging from the analysis of scaling elements. The recommendations for scaling of sustainable and inclusive irrigation development were drawn from the barriers and opportunities analysis.

4. Drivers of and Responses to Sustainable and Inclusive Irrigation Development

4.1. Long-lasting drivers

4.1.1. Ethnicity, class, social relations and land ownership

The FtF ZoI is highly diverse, with more than 90 caste and ethnic groups with varying livelihood strategies, socioeconomic status, gender and social relations (CBS, 2014). This diversity must be considered when designing water resource and irrigation development (Clement et al., 2012, Leder et al., 2017). As **Table 4-1** shows, 11% of the total households in the country with more women than men are located in the FtF ZoI. Over 30% of the total population is young people aged between 10 and 24. Large numbers of children and women experience malnutrition.

Historically, social relations, privilege and hierarchies based on gender, caste, ethnicity, class and region are the predominant informal institution being practiced. This dynamic shapes people's access to different livelihood assets, opportunities and irrigation technologies (Gurung et al., 2020). A unique class relation exists in western Nepal due to skewed landholdings and poverty. Most of the farmers, who are indigenous to Western Tarai, are smallholder and tenant farmers who work for large landholders (advantaged caste groups who migrated from the Hills to Tarai in the 1960s). The deeply entrenched 'Kamaiya' system of bonded labor[2] in agriculture is still practiced in the region, even though it was officially abolished in 2002. The Tharu ethnic group, who are landless or land poor, work for the land rich in an exploitative patron-client relationship. The former become bonded by a loan received from the latter in return for providing labor for farming and domestic activities (Giri, 2010, Panta and Thapa, 2017). Likewise, Dalits (especially Mushahars), who are also landless and extremely poor, provide landowners with labor for ploughing and domestic work under the 'Haliya' system.

Land entitlement opens pathways to resources and opportunities that are essential for high agricultural performance. To begin with, land entitlement is the sole proof of being a farmer in Nepal, which in turn provides access to finance, inputs, tools and services. Land entitlement is also a basic requirement for applying for any kind of government subsidy, including irrigation equipment (Bastakoti et al., 2017, Pandey et al., 2020a). Furthermore, land entitlement facilitates trust, reciprocity and negotiation pathways in agrarian economies. Land ownership is lowest

[2] An individual enters debt bondage when their labor is demanded as a means of repayment of a loan, or of money given in advance. Usually, people are tricked or trapped into working for no pay or very little pay (in return for such a loan), in conditions that violate their human rights. Importantly, the value of the work done by a bonded laborer is greater than the original sum of money borrowed or advanced (Anti-Slavery International cit. Giri 2004: 1 in Giri, 2010).

Table 4-1. Socioeconomic characteristics of people in the FtF ZoI.

Socioeconomic characteristics	Description
No. of households (HHs) and population size in Nepal (according to the 2011 census)	HHs = 5,423,297; population = 26.5 million
No. of households	Banke = 94,773, Bardiya = 83,176, Dang = 116,415, Kailali = 142,480, Kanchanpur = 82,152, Kapilvastu = 91,321
Population by gender (%)	Male = 1,590,452 (48.65%); female = 1,678,913 (51.35%)
Population by caste and ethnicity (%)	Janajatis = 38.15, Chhetri = 30.16, Brahmin = 11.11, Dalits = 12.76, Muslims = 6.81, Madheshi other caste = 0.5, Badi = 0.25, other = 0.26
Food security status in the FtF ZoI	Banke = marginal deficit, Bardiya = surplus, Dang = marginal surplus, Kailali = severe deficit, Kanchanpur = surplus, Kapilvastu = deficit
Stunting among children under 5 years (%)	Banke = 40-49, Bardiya = 40-49, Dang = 40-49, Kailali = 40-49, Kanchanpur = 30-39, Kapilvastu = 30-39
Wasting among children under 5 years (%)	Banke = 15-19, Bardiya = 15-19, Dang = 5-9, Kailali >= 20, Kanchanpur = 10-14, Kapilvastu = 10-14
Underweight among children under 5 years (%)	Banke = 30-39, Bardiya = 30-39, Dang = 20-29, Kailali = 20-29, Kanchanpur = 20-29, Kapilvastu >= 40
Major languages	Nepali, Tharu, Avadhi, Bhojpuri, Maithili, Magar
Young people (10-24 years)	Banke = 34.42, Bardiya = 35.6, Dang = 34.91, Kailali = 35.91, Kanchanpur = 35.67, Kapilbastu = 32.74
Land ownership (% of total landowners)	Men's ownership of land = 96%; women's ownership of land = 3.7%
Household managed by gender (% of total HHs in the region)	Female-headed household = 16%; male-headed household = 84%

Source: Census, 2014, Census 2011, Sharma et al., 2020, Suhardiman et al., 2020, Pandey et al., 2019.

among Madheshi Dalits and Muslims (Gurung et al., 2020). The landless are directly excluded from accessing irrigation services and benefits because they do not own land in the irrigated command area. Thus, they are never direct beneficiaries of the sector, as the distribution of irrigation water is land based, making irrigation development inherently biased against the landless and land poor (ADB et al., 2012). Class, gender, caste, ethnicity and other identity-based social relations influence the irrigated agricultural production and livelihood strategies of women, Dalits, Janajatis, Muslims and other disadvantaged groups.

4.1.2. Agriculture-based livelihood strategies

There is a close relationship between agriculture, SSI and gender relations in the FtF ZoI. In Nepal, over two-thirds of the population directly depend on agriculture for their livelihood/employment (FAO, 2019). Women constitute the major workforce in farming, including forestry and fishery activities (76.7%), compared to men (54.6%) (UN Women, 2015). The average landholding size per household is 0.68 ha, and over 50% of farmers are smallholders cultivating land usually less than 0.5 ha (Tractebel Engineering GmbH, 2019).[3] Most lands are in the name of male members of a household (over 80%). Only 19.7% of households have land in a woman's name (CBS, 2011). The figure is even lower in the FtF ZoI as only 3.1% women own land (Rijal, 2017). Access to micro-irrigation technologies has provided opportunities for women farmers to diversify their crops and earn a living. Access to simple, low-cost and less labor-intensive irrigation technologies by women farmers has resulted in improved food security, nutritional intake and economic opportunities at the household level (Upadhyay et al., 2005). In particular, multiple-use water system technologies close to the homestead empower women to earn a cash income from vegetable farming as well strengthen their social networks (Pant et al., 2006).

In the FtF region, much of the population are smallholder and tenant farmers. Some 73.4% of landholdings are less than 1 ha and account for 39.1% of the agricultural lands, while 24.8% of agricultural landholdings larger than 1 ha operate over 60% of the cultivated lands (CBS, 2013). About 16% of the households are headed by women and around 61.1% of the agricultural lands are rain-fed. However, less than 6% of farmers own improved agricultural equipment (Pandey et al., 2019). Only 3.3% of households surveyed in western Nepal received services following climate-induced disasters (ibid). An effective agricultural strategy will directly benefit small commercial farmers and could substantially raise the productivity of subsistence farmers, whereas the impact on the landless and near landless will be mostly through employment effects generated by irrigated agricultural VCs (Tractebel Engineering GmbH, 2019). Scaling irrigation equipment and services would help diversify irrigated agriculture production in the Tarai, where less than 50% of farmers have year-round irrigation access (ICIMOD, 2017).

Farmers grow both winter and summer crops (**Table 4-2**). Major cities such as Dang, Surkhet and Dhangadi in the FtF ZoI are rapidly urbanizing and have a high preference for organic food crops (Tractebel Engineering GmbH, 2019). Hotels and restaurants in the road corridors demand indigenous crops (e.g., buckwheat and barley) and livestock products. Increased demand for water resources and limited access to irrigation is a challenge for production. Diversified market-oriented crop cultivation along with access to low-cost irrigation technologies and market linkages would create more livelihood options in the region.

4.1.3. Off-farm livelihood strategies

Off-farm activities such as migration, wage labor, formal and informal jobs and small and medium enterprises (SMEs) are the main livelihood strategies in the FtF ZoI (Panta and Thapa, 2017). Official data shows that people migrate to India, Malaysia and Gulf countries; 95% of them are men (MoLESS, 2020). Projecting the data from returnee migrants during the Covid-19 pandemic shows that people

Table 4-2. Main crops produced and marketed in the FtF ZoI districts.

	Summer crops					Winter crops			
Districts	Paddy	Maize	Millet	Buck-wheat	Vegetables	Wheat	Barley	Vegetables	Lentils
Banke	√	√	-	-	√	√	√	√	√
Bardiya	√	√	-	-	√	√	√	√	√
Dang	√	√	√	√	√	√	√	√	√
Kailali	√	√	√	√	√	√	√	√	√
Kanchanpur	√	√	-	-	√	√	√	√	√
Kapilbastu	√	√	-	-	√	√	√	√	√

Source: 1) MOAD, FAO & WFP 2013. Crop Situation Update: A Joint Mission of 2012 Summer Crops and Outlook of 2012/13 Winter Crops. https://documents.wfp.org/stellent/groups/public/documents/ena/wfp256520.pdf. Kathmandu, Nepal: Ministry of Agricultural Development (MOAD), Food and Agriculture Organization, World Food Program.
2) Web searches.

[3] The Agricultural Development Strategy 2015-2035 has classified farmers into three groups comprising 20% small commercial farmers (with 1 to 5 ha and above of land); 27% subsistence farmers (with 0.5 to 1 ha of land); and the landless and near landless (less than 0.50 ha) comprising about 53% of the rural population (MoAD, 2016).

from province 5 migrate mostly to Gulf countries (42.2%) followed by India (37%), Malaysia (17.8%) and other countries (3%). Their counterparts in province 7 migrate largely to India (90.3%) followed by Malaysia (7.4%), Gulf countries (2.2%) and other (0.1%). Agriculture's contribution to GDP declined from 50% in 1990 to 27% in 2017, despite the country's huge potential for economic growth through irrigated agriculture (DWRI, 2019).[4] Sustainable agriculture-based livelihoods could be achieved by improving access to micro-irrigation technologies, markets, credit and technical skills by those left behind, especially women and returnee migrant youths (Clement et al., 2015). The Covid-19 pandemic has reinforced existing poverty, inequality, gender marginalization and unequal power relations, as discussed below. Irrigation scaling programs have significant potential to improve the resilience of those impacted by the pandemic.

4.1.4. Gender norms, relations and patriarchal values and practices

Gender norms deeply entrenched in patriarchal ideology and unequal power relations are systemic barriers to women and girls accessing public services. In the Tarai region, gender discrimination and inequality are particularly pervasive. Madheshi women and girls experience lower human development and a high incidence of gender-based violence compared to their counterparts in the Hills and Mountains regions and compared to Madheshi men and boys (UNDP, 2009). Women and girls in the Tarai also face different layers of exclusion based on gender, caste, ethnicity, class, region and language-based social relations (Bennett et al., 2008). Among Madheshi women, Dalits, Muslim and Tarai Janajati experience high levels of poverty and marginalization. In most cases, women rely on men for activities such as ploughing, transporting irrigation pipes, operating irrigation equipment and even irrigating the fields. This has broader implications, particularly for women farmers without men in the household. These women suffer from both economic and psychological stress (Shrestha et al., 2018a).

Further, **patriarchal values and practices** are the main barriers preventing women from fully engaging in on-farm and off-farm livelihood activities (Udas et al., 2019). Although traditional gender roles are shifting, and women are beginning to get involved in local markets, they face a triple work burden in terms of productive, reproductive and community activities. In addition, increasing pressure on natural resources as a result of climate change has added stress to women's time poverty. A study on nutrition-sensitive agricultural interventions and gender dynamics shows how both in the Kailali and Baitadi districts in western Nepal, workload and time constraints influenced women's choice of crops (Kjeldsberg et al 2017). Women chose simple, less time-demanding crops and decided to limit the amount of production, given the anticipated time involved in market-related activities. This is one of the reasons why women mainly engage in subsistence farming close to their home. Distance to markets and poor infrastructure and transportation create an additional time burden (ibid).

Mobility in many cultures is seen as a means to control women's sexuality and maintain women's subordinate position. Freedom of mobility is lowest among Muslim women and Madheshi Dalits (Gurung et al., 2020). Restricted or limited mobility influences women's access to information and knowledge about technology and relevant innovations. For example, among specific groups such as the Muslims and Madheshi, women in general practice *purdah* or *ghumto* (female seclusion) and interact less with the outside world, particularly men. Women outside the home must be accompanied by a male relative. Women from these communities also have fewer opportunities for education because of restricted mobility (FAO, 2019, JICA, 2013). Under such circumstances, interaction with male irrigation tech distributors, extension officers, agricultural suppliers, market off-takers or project staff could bring shame, dishonor and even result in family conflict as expressed by an interview with a female respondent from the Small Farmer Cooperative Limited:

> *"It is not easy to involve women from remote areas in the western and far-western region. Social norms limit women's mobility, they face questions from family members. Even if we convince them to join, they are not active. We are trying to collaborate with local leaders to enhance women's participation in cooperatives"* (telephone interview, October 8, 2020).

Deeply embedded gender norms and division of responsibilities between men and women, do not favor women as irrigators or technology users. Irrigation technologies and services, in discourse and practice, therefore continue to be dominated by men.

4.2. Covid-19 and emerging drivers

4.2.1. Pandemic poses additional challenges to sustainable and inclusive irrigation development

Covid-19 has disproportionately affected the poorest and most marginalized sections of society. While there were immediate consequences, and several measures such as repatriation and health support were undertaken, the pandemic has

[4] The Second Irrigation Master Plan 2019 (hereafter IMP 2019). The IMP was prepared by Tractebel Engineering GmbH in association with NIRAS and TMS Package 4 Project Office Department of Irrigation Lalitpur, Kathmandu Nepal for Water Resources Project Preparatory Facility, Department of Water Resources and Irrigation, Ministry of Energy, Water Resources and Irrigation, Kathmandu.

resulted in long-term socioeconomic hardships, especially for the poor who have received less attention from the government. According to a study by the National Planning Commission (NPC), Nepal's agriculture sector lost NPR 12 billion (approx. USD 102 million) because of Covid-19. The study also estimates that NPR 65 billion (approx. USD 555 million) is needed to help the sector recover from the loss (Paudel 2020). A rapid assessment by the KISAN II project (Winrock International, 2020) in the FtF ZoI, which includes 25 districts in Lumbini, Karnali and Sudurpashchim provinces, reports increasing economic strain on farmers. The assessment reports that among the targeted group, 67% have not received any support from the government, 83% have borrowed money and 71% have used their savings to cope financially. In addition, 18% of companies which have closed their businesses in the past six months were owned by women and disadvantaged groups.

4.2.2. Impact of Covid-19 on agriculture and producers

Lack of transportation and market access adversely influences prices in input and output markets: In the FtF ZoI, farmers faced transportation limitations (37%) and inputs shortages (29%) (Winrock International, 2020). Farmers lost income when they were not able to sell perishable products like vegetables and dairy because of limited transportation and market access.[5] Dairy products contribute 3.3% to GDP and represent 12.4% of the agriculture sector. The initial lockdown caused a loss of about 80%, amounting to USD 30 million, in the privately owned dairy industry (UNDP, 2020). Vegetables contribute 2.6% to GDP and represent 9.7% of the agriculture sector (ibid, p. 52). Similarly, vegetable exports plummeted in the first nine months of the financial year 2019/2020, with sales amounting to only USD 13,300 compared to USD 10.05 million in same period a year earlier. Farmers were forced either to distribute vegetables free of charge to less fortunate people, leave them decaying in the field as local agents stopped collecting crops because of limited demand in urban centers (ibid, p. 52) or sell them to dealers at prices below those fixed by the government.

Nepal suffers from a massive fertilizer shortage almost every planting season. There is a heavy reliance on fertilizer import. With the Covid-19 pandemic disrupting trade, farmers were unable to access subsidized chemical fertilizer until mid-December 2020. Some 50,000 metric tons (MT) of fertilizer is still to be imported from Bangladesh under a government-to-government) deal (New Business Age, 2020).[6] Hence, farmers were unable to gain access to fertilizers during the planting season. Most fertilizer depots are owned by private businessmen, who sell on the black market. With no other options, farmers were forced to buy fertilizers at high prices.[7] An agro-irrigation hardware proprietor indicated that other inputs have been harder to access under Covid-19 too, with a hike in diesel prices to NPR 3,000 per liter. It can be assumed that this has negatively impacted smallholders, particularly women with no negotiation skills.[8]

According to SunFarmer, a solar energy services provider, Covid-19 has negatively impacted the sale of solar pumps, mainly because of farmers' reduced incomes and the increased cost of pump accessories such as panels and silicon. According to a private sector actor, the price of silicon has hit a historic high and fluctuates every three or four days. Transportation limitations and high transport costs pose additional challenges.[9]

Unemployment hits women and the most vulnerable the hardest: According to Nepal Rastra Bank's annual report, agriculture is the largest employer at 21.5% (UNDP, 2020). Women make up the majority of the workforce in agriculture, forestry and fisheries (76.7%) compared to men (54.65%) (UN Women, 2015). Informal agriculture accounts for 20.2% of the total share. The economic impact of the pandemic has severely affected women and the most vulnerable groups, particularly those involved in the informal employment sector – the unskilled, the low-paid, those with vague or no employment contracts and those lacking health insurance and social security benefits. According to the Nepal Labour Force Survey (NLFS 2017/18), 98% of vulnerable people working in paid agriculture are daily wage earners. Over 90% of working women are engaged in informal employment – low-paying, informal and insecure jobs (CBS, 2019). Women lost jobs, faced increased responsibility at home and are also at increasing risk of being paid less than men, widening the gender pay gap (Winrock International 2020). More women (41%) than men (28%) lost their job during the lockdown (UNDP, 2020). Likewise, more women (31%) than men (14%) borrowed food. According to Winrock International (2020), while men are more likely to take loan (34.3%) than women (29%), this indicates that more women (7%) than men (2%) sell assets like livestock. In addition, 20% of women compared to 7% of men reduced the number of meals they ate per day. Similar findings reported by previous research demonstrate that in emergency situations, women sell their assets first, leading to increased incidences of poverty among women and female-headed households (Shrestha and Leder, 2020).

---

5 Chairperson of the small farmers' micro finance cooperative interviewed in October 2020; Rapid assessment UNDP 2020. Rapid assessment of socio-economic impact of Covid-19 in Nepal. UN House, Pulchowk, Lalitpur, Nepal: United Nations Development Programme..

6 New Business Age (2020). Nepali Delegation to Visit B'desh to Finalize Fertilizer Import Deal. https://www.newbusinessage.com/Articles/view/12805

7 Telephone interview with chair of the Nepal Agricultural Cooperative Central Federation, October 8, 2020.

8 Telephone interview with an entrepreneur, October 8, 2020.

9 Telephone interview, SunFarmer, October 8, 2020.

Hence, women-led households have been the hardest hit. Of these, 69% struggled to earn money, 53% faced falling prices for their produce, 57% faced increased discrimination, 62% reported having no access to information and others reported decreased collective farming. Women's lack of entitlement to productive land also negatively impacted income and food security.

Impact of Covid-19 on migrant households: The most visible and immediate impact of Covid-19 in Nepal was the return of migrants and decline in remittances (UNDP, 2020). Remittances contribute over 29% of national GDP in Nepal (World Bank, 2016), and the country is ranked as the top remittance-receiving country in South Asia (ibid). In province 5 and 7, the majority of the population relies on migration as an alternative livelihood option. Only 5% of households in province 5 and 6% of households in province 7 are able to meet their daily necessities with income from agriculture. Decreasing reliance on farming is also evident in increased fallow lands in both provinces (Bhattarai et al., 2020).

With the global economic slowdown and consequent return migration, Nepal Rastra Bank (2020) projected a 15% drop in remittance inflows.[10] Migrants have lost jobs and returning in masse without economic backup plans (ILO, 2020). An estimated 127,000 labor migrants have returned to Nepal from various destination countries because Covid-19. An additional 400,000 are expected to return as a result of health issues and non-renewal of contracts in destination countries (ILO, 2020). This figure does not include laborers in India, which shares an open border with Nepal. Hence, Nepal lacks an official record on migrants who have returned from India. Historically, Nepali migrants have migrated to India in search of seasonal and permanent employment opportunities. In March 2020, when India become a Covid-19 hotspot and the government announced a 21-day lockdown as a preventive measure, the majority of those in wage labor jobs had no option but to return to their villages in remote Nepal. Media reports estimate that 300,000-400,000 migrants have returned from India to Sudurpashchim Province alone. A recent report by the International Organization for Migration (IOM) (2020) shows that the majority who return from India are residents of Karnali and Sudurpashchim provinces. Migrants have returned almost penniless. The movement of migrant workers in Nepal has been declining since February 2020, with Covid-19 adding to the challenge of job creation. Employment opportunities in destination countries are contingent on how and when economies will rebound.

In addition to long-term migration, short-term migration is a popular livelihood strategy in Nepal. Short-term migrants are typically from poor rural households and thus at greater higher risk of negative Covid-19 impact. An assessment of 400 individuals and 700 small and micro-entrepreneurs from 27 districts (UNDP, 2020) showed that about half of the households have at least one migrant, of which 23% are domestic migrants and 32% are international migrants. Because of the lockdown, 28.3% of males and 41% of females in the sample lost their jobs. Internal migrants and day laborers in agriculture and non-agriculture were among the most vulnerable as they were only able to cope with the shock for one or two months. According to the same report, 93% of respondents had not received any external support and had devised various coping strategies. These included reducing the number of meals and borrowing food and money, either from formal or informal sources (UNDP, 2020).

Reduced income and increased food insecurity: Covid-19 lowered income by 31% among non-migrant households. Migrant households are at even greater risk and twice as likely to have zero earnings than non-migrant households during Covid-19. Income and food security among migrant families have dropped more than income and food security among non-migrant families across multiple samples. In Western Tarai, the harvest declined from 80% (wheat production in October) to less than 20% (rice production in April) in migrant households. Similarly, monthly non-farm income decreased from USD 400 to USD 180 in these households. Remittance income also declined for migrant-sending households. Households in Western Tarai received an average of NPR 4,900 in late 2019. This fell to NPR 1,700 in April- May 2020 (Mobarak, 2020).

Social stigma, exclusion and challenges to reintegration in agricultural and domestic work: Returning migrants face stigma, which makes labor market reintegration difficult. Households with recently returned migrants are four times more likely to report exclusion from social events (Mobarak, 2020). Agricultural and domestic work were noted as the main employment options for migrants returned because of Covid-19. However, migrants reported multiple challenges to entering these sectors. These included availability of and access to inputs, credit, training and marketing opportunities (IoM, 2020). Labor market skills from migration do not transfer to local occupations. Migrants also lose economic or social networks while they are away (Mobarak, 2020).

[10] Mandal, CK, 2020. 'Covid-19 results in massive decline in labor migration numbers, with no immediate hopes of recovery.' *Kathmandu Post*, July 20, 2020.

4.3. Covid-19 emerging responses

As discussed in the following sections, most of the immediate responses focus on the safety, repatriation, social protection and welfare of migrant workers in destination countries (ILO, 2020).

4.3.1. Farmers' response

The Small Farmer Development Microfinance has been lobbying with the government for land to establish selling areas to provide relief to both the farmers and customers who have been buying vegetables at a high price. In Bhaktapur, the cooperative delivered vegetables door to door. Market operation only by the private sector is not the solution.[11]

4.3.2. Provincial governments' response

The provincial governments in the FtF ZoI were active in establishing guidelines, policies and programs to build farmers' resilience in view of Covid-19 impacts. The response mechanisms are mostly agriculture-based. The Lumbini and Sudurpashchim provincial governments introduced a number of guidelines and schemes targeting young people, smallholder farmers, bonded labor, women and disadvantaged groups. For example, the Ministry of Land Management, Agriculture and Cooperatives (MoLMAC) in province 7 developed a guideline for implementing an agricultural development program in 2019. The guideline includes the provision of a subsidy covering 50-100% of the cost of agricultural inputs, depending on the category. Small irrigation infrastructures like cement, ponds, plastic tanks, sprinklers and solar irrigation are eligible for 80% subsidies (MoLMAC 2019). In province 5, MoLMAC also has a policy of up to 75% subsidies or NPR 250,000 (approx. USD 2,136) whichever is less, for installing irrigation equipment such as solar/drip/sprinkler irrigation, rainwater storage irrigation, plastic ponds and multiple-use water systems (MoLMAC 2019). In addition, MoLMAC's Covid Special Agriculture Program 2020 in province 5 targets groups vulnerable to Covid-19, including entrepreneurs, farmers, cooperatives, companies and unemployed returnee migrants. The program focuses on seven activities: i) agricultural ambulance operation; ii) off-season potato cultivation promotion; iii) Covid-19 targeted commercial vegetable farming promotion; iv) agricultural development to encourage returnee migrants and agro-entrepreneurs; v) subsidies for dairy farmers; vi) subsidies for poultry farmers; and vii) increasing the productivity of seed developers or cooperatives. History has shown that policies often remain unimplemented when they fail to recognize the local reality (Mosse, 2004) and when capacity for policy implementation is inadequate (FMIST, 2020). Whether the policies of provincial governments, which intend to increase incomes and employment among populations vulnerable to Covid-19, will deliver, needs further research.

Despite the aim to reduce the vulnerability of populations impacted by Covid-19 through agricultural interventions, the institutional mechanisms proposed by the related policies and guidelines are gender-blind. As an example, the 2020 Chaklabandi agriculture program operation work plan developed by MoLMAC in province 7 has provisions to form a program advisory committee (five members) and a subsidy management and technical committee at the provincial and central level (five members each). However, none of the committees ensure compulsory representation of women, youth, Dalit or any other marginalized groups. Similarly, there is no mention of ensuring experts on gender and social issues as part of the committee.

The government response mechanisms (e.g., subsidies and reintegration packages) also fail to absorb returnee migrants in agriculture subsidy projects. A recent report from Sudurpashchim Province shows that only 5,000 individuals were accepted out of a total of 80,000 applicants. Experts had already speculated on this challenge of possible non-absorption at the start of the Covid-19 pandemic, when the estimated number of returnee migrants in Sudurpashchim Province alone was reported to be about 300,000-400,000. Of these, over 150,000 returned from India. The other challenge that has led to a delay in the implementation of the program is farmers identification process. The process of collecting information on applicants from local government is time-consuming. Neither were women migrant workers informed about government reintegration packages. These returnees distrust that the government scheme will reach the target group (Mandal, 2020).

4.3.3. Federal government's response and youth unemployment

With tens of thousands expected to return from abroad, the need to create jobs is huge. The GoN plans to absorb returnee migrants by creating 700,000 jobs. The government has doubled its budget for the employment program to NPR 11.6 billion (USD 99 million) in the current fiscal year (2020/2021) from NPR 5.01 billion (approx. USD 43 million) in the fiscal year 2018/2019. The GoN has introduced four new programs in the agriculture sector to help build resilience to Covid-19 and future shocks (**Annex 4-1**).

Some of the initiatives presented in **section 8** represent an opportunity for CSISA to develop a flagship program on scaling climate-resilient irrigation and agricultural development in Western Tarai targeted at the individuals and households impacted by Covid-19 presented earlier. The socioeconomic and biophysical issues and opportunities identified by CSISA research can help

[11] Telephone interview with the chairperson of the Small Farmers' Microfinance Cooperative, October 2020.

to identify investment areas for agricultural water-focused interventions through new initiatives such as the GoN's **Green Recovery Plan**.[12] This plan is a coordinated effort by the GoN and DPs to tackle Covid-19 and the impacts of climate change in Nepal. This will support the GoN's Relief, Recovery and Resilience (3R) Plan to enable Nepal's green and sustainable recovery from the Covid-19 pandemic and to help Nepal get back on track to achieve middle-income status and the Sustainable Development Goals by 2030. It is expected that up to USD 6.6 billion will be made available to support green recovery in four areas: i) nature-based solutions for growth and job creation in agriculture, forestry and biodiversity and water management, and tackling the impacts of climate change in the Himalayas; ii) green and resilient infrastructure, urban development and pollution management, that together create jobs and protect human health; iii) increasing resilience to future shocks such as health, climate and earthquake risks, by strengthening health, social protection, education and disaster management systems; and iv) stimulating private sector recovery, and increasing green investment and job creation in finance, tourism, clean energy, waste management, forestry and agriculture.

[12] https://eeas.europa.eu/delegations/nepal/90497/government-nepal-%E2%80%93-international-development-partners-joint-statement-green-recovery-nepal_en

5 Policy Environment

5.1. Policy framework

Several national, including the new Constitution of Nepal 2015 and sectoral policies aim to address poverty, food insecurity, inequality and environmental degradation through sustainable WNRM (Water and Natural Resources Management) practices. In the following sub-sections, six groups of policies influencing the enabling scaling environment are discussed.

5.1.1. General national development framework

The 15th Plan 2019-2023 and Approach Paper, the Sustainable Development Goals Road Map 2015-2030, and the Multi-Sectoral Nutrition Plan 2018-2022 (Phase II) are key policies that guide national priorities for development and sectoral interventions. These policies focus on advancing economic prosperity, happiness, food and nutrition security, governance and inclusion through conservation, management and sustainable use of natural resources such as water resources, irrigation, energy, forests, land and agricultural development. The 15th Plan provides a 25-year development vision. It sets targets for graduating Nepal from least development country to middle-income country (with USD 4,100 per capita income) by achieving the SDGs in 2030, and to high-income country (with USD 12,100 per capita income) in 2044. The plan also has a target of increasing food secure households from 48.2% to 80% by 2023 and increasing economic growth from 6.8% in 2019 to 10.5% in 2044. Under the SDG target, the GoN aims to reduce poverty (USD 1.25 purchasing power parity per day) from 23.7% of the population in 2017 to 4.9% by 2030.

The Multi-Sectoral Nutrition Plan (MSNP II) aims to improve policies, plans and multi-sectoral coordination at federal, provincial and local government level to enhance the nutrition status of all population groups. It also has a goal to improve access to and equitable use of nutrition-sensitive public services. To achieve this, the plan focuses on promoting the production of fruits, vegetables, nutritious roots, cereals and pulses to increase consumption of diversified foods in households. The MSNP II also targets an increase in women's access to resources and opportunities such as start-up entrepreneurship grants and business training for women's groups. Other targets include increasing the ratio of women to men in professional and technical professions from 24% in 2015 to 40% in 2030, as well as leadership positions held by women in private and public sector institutions.

All of these policies acknowledge the importance of PPP and the role of community institutions, farmer groups, women and disadvantaged groups and non-state actors in national policy implementation, including irrigation development, technology innovation and local capacity development. Despite the greater focus on improving year-round irrigation facilities, public and private sector investment and partnership, these policies are silent on promoting farmer-led irrigation, GESI in water governance, agriculture VCs, research and capacity building.

5.1.2. Agriculture development

Policies related to agriculture and land use are pro-poor, GESI-sensitive and promise to implement water-agriculture-energy nexus programs targeted at smallholder, tenant and women farmers and youths (**Table 5-1**). The National Agricultural Policy 2004 provides food safety nets for land-poor farmers, farmers lacking production inputs like year-long irrigation facilities, and landless and marginal farmers lacking other sources of income in order to help them to cope with climatic fluctuations and other disasters. The Agricultural Mechanization Promotion Policy 2014 aims to enable private actors, farmer groups and cooperatives interested in leasing farm equipment by providing a leaser's tax and custom reduction on equipment purchased and creating suitable loan mechanisms for smallholders to be able to lease them. The GoN's recent commitment to mainstreaming youth in national economy and agriculture development is also confirmed by the National Youth Policy 2015 and the Youth Vision 2025. These policies, when implemented, will offer an opportunity for youth to engage in commercial and profitable agriculture connected to irrigation technology supply chains and markets.

New agricultural and land use policies developed since the introduction of federalism also enable a cross-sector and integrated programmatic approach to increase farmers' incomes and food security. The new National Irrigation Master Plan, 2019 (hereafter DWRI, 2019) provides a 25-year vision for economic development through agricultural water management. The plan aims to achieve the food and nutrition security goal of the Agriculture Development Strategy (ADS) through improved irrigation efficiency and system management. Realizing the importance of irrigation for commercial agriculture, the ADS envisions increasing round-the-year irrigation coverage to 80% from the current 18% (DWRI, 2019). Therefore, the plan identifies the potential areas for irrigated agriculture and the investment requirement. It shows that there are

Table 5-1: Agriculture sector policies for pro-poor, pro-youth and inclusive scaling in irrigation and agricultural value chains.

Policies	Small-scale irrigation	Groundwater conservation and use	Irrigated agricultural value chains	Public-private partnership (PPP)	Equity, inclusion and gender
Agro-forestry Policy 2019, Ministry of Agriculture and Livestock Development (MoALD)	Promote irrigation, technologies, equipment for commercial agro-forestry	Climate resilient ecosystem promotion	Agro-forestry crops to be promoted according to agroecological zones	Promote PPP for agro-forestry promotion	Not specific
National Land Policy 2018, Ministry of Land Reform, Cooperatives and Poverty Reduction (MoLRCPR)	Agricultural mechanization, industrialization and commercialization, consolidated lands and cooperative-based farming to be promoted	Not specific	Commercial agriculture and cooperative-based farming Leasing public lands to landless and disadvantage groups for commercial agriculture	PPP for land access and management for business purpose	Pro-poor focused (smallholder and tenant farmers and women's groups) for collective farming with access to irrigation and agriculture inputs
Agri Mechanization Policy 2014, MoALD	Promote equipment and technologies for agriculture, including solar energy	Not specific	Solar energy for irrigation; organic farming	PPP; cooperative-private sector partnership for production, trade, services and distribution of agri equipment	Environment- and women-friendly equipment; collateral-free or low interest rate loan for smallholder and women farmers
Youth in Agriculture Program Operation Guideline 2019 (MoALD, 2019)	Agro-enterprises technologies	Not specific	Commercial agriculture (crops, vegetables, animal husbandry, horticulture, fisheries)	Yes	50% subsidy targeted at youth (18-45 years old)

Source: GoN policies

3.561 million hectares (M ha) of agricultural land in Nepal, of which 1.59 M ha are in the Tarai and 1.57 M ha and 0.40 M ha are in the Hills and Mountains agroecological zones respectively. Over 60% of the lands are identified as irrigable (2.26 M ha), of which 1.48 (65%), 0.63 (28%) and 0.16 (7%) M ha are in the Tarai, Hills and Mountains zones respectively (TRACTEBEL ENGINEERING GMBH, 2019).

New changes in policy vision towards improved land access by women, youth and the landless for productive uses articulated in the **National Land Policy 2018** and the Youth in Agriculture Program Operation Guideline 2019 can support farmer-led irrigation scaling, if a coordinated approach is taken to investment in irrigation technologies and services. Agricultural policies have in recent decades demonstrated positive linkages between women and agriculture. Change in policy is largely postulated on two basic tenets, namely i) migration of men and the subsequent feminization of agricultural labor; and ii) a rise in the cash crop economy and women's increasing recruitment as wage laborers. The focus on reducing gender inequality in agriculture also evolved from decades of international intervention, which gained momentum in the interim Constitution 2007 (World Bank and DFID, 2013) and the 2015 Constitution, which focuses on transformational change (IDPG GESI WG, 2017). However, policy implementation on the ground remains problematic.

Agricultural policies also focus on private sector involvement in agricultural commercialization. The ADS 2015-2035 recognizes that the '(Fertilizer) policy needs revision to include the private sector in fertilizer import and distribution in order to meet demand' (MoAD, 2016). Even though, in the short run, imports may overtake any domestic chemical fertilizer production, the size of the market means there needs to be an assessment of the feasibility of in-country production. The government is interested in exploring the establishment of a fertilizer factory under a PPP model (ibid). More research may be required to ensure feasibility and modality.

However, implementation of these pro-poor and youth-centric policies remains a challenge. Critics (RSS, 2020) point out a lack of an integrated program and duplication of policies empowering youth. For example, over 18 ministries at the federal level implement youth-related programs (ibid). The evolved market-oriented agricultural development policies, because devolution of the sector giving more roles and power to local governments is

only after federalsim, while in previous system only the extension services was decentralized to local governments, could be an opportunity to scale different farming models, thereby improving incomes and food access by poor and tenant farmers. However, the agriculture sector's public institutions need a radical shift towards bottom-up agricultural development (Devkota and Thapa, 2019, Paudel, 2020). Likewise, while the National Irrigation Master Plan aims to reduce rural poverty from 27% to 10% by 2035 through agricultural commercialization, it does not provide strategic orientation for the irrigation sector reform that scholars (Udas 2014, Shrestha and Clement, 2019b) argue is needed to implement development policies.

5.1.3. Water resources management for multiple uses

The new Constitution and subsequent water policy instruments acknowledge the roles of multiple-use water resources for socioeconomic development, including ecosystem conservation. Developing a sustainable and reliable irrigation system by preventing water-induced disasters and managing river systems is one of the nine state policies related to management and sustainable use of natural resources in the Constitution (article 51-g-4). Two key policies – the National Water Policy 2020 and National Irrigation Master Plan 2019 (**Table 5-2**) – form the strategic frameworks for multiple-use water resources management (MUWRM), including irrigation development to increase socioeconomic development, while conserving water resources. In addition, two federal bills (water resources and water supply and sanitation) are under discussion in the parliament and intend to guide three levels of WRM government for irrigation, drinking, sanitation and ecosystem services, including biodiversity. One of the ambitions of the White Paper (2018) published by the Ministry of Energy, Water Resources and Irrigation (MoEWRI, 2018, p. 2) is '**Promoting Irrigated Lands, Prosperity of Federal Nepal**'. The National Water Resources Policy 2020 aims to provide frameworks for water conservation, management, multiple uses and regulation at local, provincial and federal level to achieve the national vision of prosperity, while securing water for the next generation (MoEWRI, 2020). It also focuses on water quality, water auditing and water accounting as important strategies for sustainable WRM, access, use and water benefit-sharing.

Although the policy framework is silent on specific provisions for equality, inclusion and gender aspects of water and water governance outcomes, it establishes the basis for developing policies, master plans and strategies for MUWRM by all levels of government. A provincial official interviewed was of the view that this policy can guide subnational governments to develop WRM policies and plans under their jurisdiction.[13] The policy can also be instrumental in promoting farmer-led irrigation (FLI) by developing the knowledge and capacity of local governments for policymaking, plans and programs on MUWRM, which are currently lacking (NAAN, 2020, Khadka et al., forthcoming). Scholars (Pradhan, 2000) argue that national water policies that carry the farmer-managed irrigation system (FMIS) within the broader principles of sustainability and democratic values need interventions to empower farmers. Successful WRM for improved livelihoods relies on good governance, social inclusion and gender equality. Nepal's water sector needs to improve in three areas: resource reliability, accessibility and governance for promoting water security (Biggs et al., 2013).

While the **Water Resources Bill 2020** acknowledges community-based WRM, it undermines GESI and does not mention strategies for WRM for development outcomes. Critics points out that the bill tends to focus less on protecting the rights of communities and resource-poor farmers to access water[14] and undermines the rights of highly marginalized communities and their participation in sustainable WRM:[15]

"I found the bill to be regressive compared to the previous water act, although the sector is preparing a new bill after 25 years. The new bill is unable to envision the roles of water for development and define the institutional changes required in the water sector to implement the vision of water and development under the federal system. Neither does the bill reflect the roles of three levels of government on water management, as per the Constitution".[16]

All the new water policies evolved since the introduction of federalism make only limited reference to policy implementation measures to ensure equitable, inclusive and sustainable WRM for multiple uses and improved water governance. The target interventions mostly focus on inter-basin water transfer, hydropower and large-scale water reservoirs and irrigation projects. Our interactions with stakeholders involved in the water and irrigation sector confirm biased policies that favor economic growth and large-scale production (meeting with water experts, October 14, 2020). This happens because the state lacks mechanisms to deal with unequal power relations (e.g., unequal access to state mechanisms and decision-making bodies in the water sector). This undermines smallholders' interests in the sense that hydropower groups, powerful irrigation stakeholders and large-scale farmers are able to lobby higher up and protect their interests and needs (stakeholder consultation workshop, December 7, 2020 CSISA). This insight is confirmed by other study (Loboguerrero et al., 2018) that states large landholders are usually politically influential and shape agendas.

[13] Telephone interview, provincial official, February 12, 2021.
[14] FMIST, 2020
[15] Water expert, October 14, 2020
[16] Former bureaucrat, law sector, October 14, 2020

Table 5-2. The water sector's new policies.

Policy name	Small-scale irrigation	Groundwater conservation and use	Irrigated value chain	Public-private partnerships (PPPs)	Equity, inclusion and gender
National Water Policy 2020	Focuses on ensuring multiple uses of water resources, including water access for irrigation No specific provisions on SSI and FLI	Has provision for controlling overexploitation of groundwater, including some measures for groundwater recharge	Prevent/reduce water-induced disaster through effective watershed management Technological innovation for efficient water use	Focuses on multi-stakeholder roles in multi-purpose water resources management Commits to improving policy for PPPs	The term equity is mentioned in reference to water resources use and management but not specifically to GESI Focus on state-community-private sector engagement
Water Resource Bill 2020	Local government's role to manage irrigation scheme up to the max. 50 ha command areas (art. 63). Community-based WRM (art 10). Drip sprinkler, community irrigation system and water-efficient technologies (art. 27.1)	Groundwater resources conservation, management and use (art. 22) Groundwater management plan, preparation and use (art. 22-1-cha) Local level maintains groundwater resources and use data (art. 22.2) Community's role in groundwater conservation and management (art. 10.1)	The first priority is given to drinking water/domestic use, livestock, fisheries, irrigation, hydropower, mines/industries, waterways, cultural, environmental, conservation, aesthetic and other (art. 15)	Article 18 calls for the need for corporations to get permission to use groundwater resources (except for domestic use), industries, waterways, fisheries and animal husbandry, eco-tourism etc.	Right to water provision such as no one can be discriminated from access to safe and adequate water for drinking and domestic uses (art. 4). Participatory irrigation management system (art. 10.4) Policy provisions are not specific to promote GESI
Irrigation Master Plan (IMP) 2019	Provides the development potential for irrigated agriculture: i) intensification of existing irrigated lands (approx. 1.4 M ha) through improving irrigation facilities, increasing cropping intensities and modernizing infrastructure systems and O/M; and ii) expanding irrigated lands (approx. 1.2 M ha) through surface water and groundwater development, and associated system and farm development	Year-round irrigation across the country with a particular focus on the Tarai using groundwater New laws are required to ensure proper use of groundwater for both drinking and irrigation (p. 202) Reduce rural poverty from 27% to 10% by 2035	Prioritized areas: Districts where the economic return on irrigation is likely to be relatively higher. Transferring the main irrigation system management to: local governments; private operators under management contract; water users cooperative (WUC); agency-WUA joint management	Recommends developing value chains where actors are connected along the chain Recognizes the need for PPP model for sustainable functioning of irrigation infrastructure, although irrigation sector lacks legal and PPPs policy framework. Provides options for to be implemented PPPs within an overall reform strategy in irrigation sector to improve the irrigation financing, efficiency and scale	Acknowledges four main barriers to meaningful participation of women in agriculture (section, 1.4): social norms and laws, land entitlement, male domination in agriculture extension services, women's limited access to institutional credit and other production units. Formation and strengthening of WUAs continue to be an important part of irrigation management transfer (tertiary canal and below)

Source: Water Resources Bill 2020, Water Resources Policy 2020, National Irrigation Master Plan, 2019.

5.1.4. Devolution of irrigation and resilient irrigation development

There has been a historic shift in irrigation policymaking and resilient irrigation development since the transition to federalism. The Local Government Operation Act (LGOA) 2017, which operationalizes the single power of local governments assigned by the Constitution, is an influential policy framework for sustainable and inclusive irrigation and agriculture development (Devkota and Thapa, 2019). Local governments now have the authority to manage local services and markets, environmental protection and biodiversity, local roads, rural roads, agro-roads, irrigation, agriculture and animal husbandry, agro-products, animal health and cooperatives (Tractebel Engineering GmbH, 2019). Moreover, managing and protecting local watersheds is an absolute core function of local governments under federalism. Federal and provincial governments will be able to guide local governments when it comes to watershed management practices and conservation and protection of soil and water. However, it will be the local governments that will be **on the frontline** and directly involved in managing competing use of limited water and land resources, handling conflict resolution and ensuring sustainable forest management (Tractebel Engineering GmbH, 2019, p. 101).

The GoN's interest in resilient development is apparent. Between 2006 and 2020, it has developed over 13 policy frameworks on climate-resilient development, including water resources and solarized irrigation. These policies focus on promoting renewable energy technologies, climate-smart technologies and solar-powered irrigated pumps (SIPs) for facilitating irrigation access and community-based climate change adaptation (**Annex 5-1**). The climate-resilient focused policies emerged after the introduction of the new Constitution, further enabling the promotion of resilient irrigation development under the leadership of local governments. For example, the Climate Change Policy 2019 makes it compulsory to mainstream climate change adaptation and mitigation measures in policies and programs at all levels of government. It sets the target that all 753 local governments will prepare and implement climate-resilient and gender-responsive adaptation plans by 2030. The plans are expected to address climate change and disaster risks and prioritize adaptation and risk-management measures focusing on women, people with disabilities, children, senior citizens, youth, indigenous peoples, economically marginalized communities and people residing in climate-vulnerable geographical areas.

Likewise, the MoEWRI's 2018 White Paper also supports resilient irrigation. Taking an 'each hamlet with energy access' approach, the paper sets a target to produce 100 to 500 kilowatts of solar energy by providing a 50% subsidy from the federal level to each local government. The White Paper estimates that 200 megawatts of solar energy will be produced to facilitate irrigation, water supply for drinking and community electrification (strategy # 86). The Business Rules 2019 decided by the federal parliament specified that a local government can prepare and implement solar energy projects up to 3 megawatts. In addition, the second nationally determined contribution (NDC) aims to establish **500 climate-smart farms by 2030**, and it has a GESI-specific development target of ensuring increased access to climate-smart agricultural technologies by women, indigenous peoples, smallholder farmers and marginalized groups. The NDC also complements the Climate Change Policy 2019 that aims to build the capacity of all 753 local governments to prepare and implement climate-resilient and gender-responsive adaptation plans.

Overall, the Climate Policy, the NDC and the White Paper acknowledge 'equity, inclusion, rights, gender equality, inter-governmental cooperation and relationship approaches to Nepal's development'. However, putting these approaches into practice during the design, implementation and monitoring of resilient irrigation development programs is needed, as they currently focus on 'infrastructure' and 'technocratic fixes approaches' to water resources development (FMIST, 2020, FMIST, 2005). This view was confirmed by perspectives and approaches articulated in national irrigation policies and plans that focus on major hydro projects (which include multi-purpose projects aimed at irrigation) and devote less attention to small-scale irrigation or farmer-led irrigation technologies.

In addition, the new Irrigation Master Plan (IMP) intends to achieve economic growth through mechanization of agriculture. However, it lacks pro-poor and inclusive approaches, strategic focus and action plans. It also lacks GESI-specific strategies. Women spend significant amounts of time on irrigation activities, but their work remains invisible (ADB, 2020). The IMP also conceptualizes farmers as a homogenous group and assumes everyone will be able to harness the opportunities and benefits equally. It also does not recognize power differences in governance structures (e.g., private sector, WUAs, irrigation/water cooperatives, water user groups etc.) that could exclude those lowest in hierarchy based on their gender, caste, ethnicity, age, ability, language, geography or economic identity. There is no mention of smallholder farmers, the landless and wage laborers involved in agriculture. The 114-page main IMP document contains GESI-related words the following number of times: gender (1), women (16 times), disadvantaged (3), Dalit (0), poor (0), smallholder (1), youth (1), inclusion (0), equity (2) and equality (0). The only strategy to solve GESI barriers in the IMP is to train rural women as extension workers to gain meaningful participation in agriculture VCs, which is very narrow GESI strategy considered by the IMP. Without an explicit approach to deal with power hierarchies in irrigation service access and decision-making, the IMP is unlikely to achieve inclusive agriculture development and runs the risk of aggravating socioeconomic gaps in communities.

5.1.5. Private sector investment

Engaging the private sector as a key player is a hot topic in Nepal's development discourse and policies (NAAN, 2020, Paudel et al., 2021). The Financial Act 2019 and draft Financial Bill (2020) have a number of provisions for subsidizing irrigation equipment such as solar. The private sector, following submission of recommendations by the Alternative Energy Promotion Center (AEPC), enjoys some tax relief. This includes: i) 1% customs duty and 0% value added tax (VAT); ii) 1% customs duty on 8504.40.90 solar inverters and 8507.60.00 lithium batteries; and iii) no VAT on solar panels and modules. The VAT Act 1995 (amended in 2019) has a provision of zero VAT for the use of solar equipment. There is no tax or VAT for importing agricultural produce and tools. The VAT Act also exempts many agricultural goods and irrigation equipment from VAT (**Annex 5-2 and 5-3**). The Industrial Enterprise Act 2018 ranks energy and agro-forestry-based enterprises as priority businesses. The act has a provision to provide 30% discount on registration fees when an enterprise is registered in a woman's name and 20% discount when registering industrial assets owned by women entrepreneurs. The act also provides for a 15% income tax waiver for firms that employ at least 50% women and people from other marginalized groups.

Policy landscapes are increasingly embracing PPPs as a means to promote economic growth through greater productivity, capital investment, exports

and capacity development of target groups. As an example, over seven national policies and pieces of legislation promote PPP-based trade and agro-enterprises with the aim of increasing economic opportunity, jobs and employment. The federal government's PPP Act 2018 and PPP Rule 2019 acknowledge the need to engage the private sector to promote economic prosperity through investment both by native and foreign private sector actors in infrastructure construction and services sectors.

Although it does not mention irrigation infrastructure specifically, the PPP Act 2018 defines physical infrastructure such as reservoirs, canals, hydropower, renewable energy production including solar, cold storage and related services. 'Investments' include loans, equity, re-financing or transfer of technology. The PPP approach focuses both on services and products, which could be an opportunity for private sector actors in irrigation technologies and services to collaborate with the government and DPs to scale irrigation. For this to happen, a legal/policy framework for promoting PPPs in irrigation – which is currently missing – needs to be established (IMP 2019). Under the current PPP model, however, the public sector treats private sector actors as contractors and not as partners, which is a challenge for scaling irrigation development.[17] Private sector investment in irrigation is constrained by PPP policies that give high priority to investment in large-scale physical infrastructure and roads and export-oriented goods. PPP policies also lack a perspective on decentralized development.

Moreover, PPP legislation lacks GESI-specific provisions. The policy advisory or proposal evaluation committees provisioned in the legislation are gender exclusionary. For example, the 12-member monitoring and facilitating committee envisioned by the PPP and Investment Act 2018 is all men. The provision of an expert group with the representation of sectoral ministries at the federal level presented in the PPP Rule 2020 lacks representatives from the water sector and social science, although it does include the commercial, economic, management or banking sector (article 48). A guideline for a detailed proposal to be presented by an investor screened after submission of a letter of intent does not have a governance, socioeconomic and GESI dimension (article 32), but focuses on technical, finance and environmental aspects only. GESI in trade has been conceptualized mostly at the service level but not in the system or policy and governance aspects of trade. For instance, the Commerce (Trade) Policy 2015 envisions the creation of programs that enable small and cottage industries and women- and minority-owned/run businesses to export their products.

5.1.6. Gender and social inclusion and pro-poor development

The national protocol on gender equality, social inclusion and inclusive development is broadly guided by **the Constitution of Nepal (2015)**. The Constitution ensures equal rights to all Nepali citizens and prohibits discrimination on the grounds of origin, religion, race, caste, tribe, sex, physical condition, disability, health, matrimonial status, pregnancy, economic status, language or geographical region, ideology or any other identity. The principles of gender equality, inclusion, justice, accountability, participation and non-discrimination are institutionalized through various articles such as article 18 (right to equality),[18] article 24 (right against untouchability and discrimination), article 38 (right of women), article 40 (right of Dalits) and article 42 (right to social justice). The Constitution also ensures the fundamental right of every citizen to live in a healthy and clean environment (article 30) and to access safe water and sanitation (article 35). Article 51 calls for state policies on natural resources, agriculture and employment that cater to the rights and interests of farmers, young people and communities. Regarding social justice and inclusion, article 51-j-7 mentions employment opportunities for young people. Article 51-g-1 calls for ensuring rights of people to equitable distribution of benefits generated by natural resources by giving them priority and preferential rights and prioritizing national investment in water resources based on people's participation and multiple uses of water resources. Translating these constitutional frameworks into bylaws, sectoral policies and programs requires capacity building at all levels (Suhardiman et al., 2017).

The National Gender Policy 2021 and National Poverty Reduction Policy 2019 were formulated in alignment with the new Constitution. The main aim of the **National Gender Policy 2021** is to guide federal, provincial and local governments in integrating gender in their policies, plans, acts, strategies, programs and activities. The overall goal of the National Gender Policy is to end all forms of gender discrimination, violence and inequality and to ensure equal opportunity, access and benefit for people with all genders in all sectors and development.

The **National Poverty Reduction Policy 2019** envisions a poverty free and equal society. It aims to reduce poverty, create employment for the poor, women and marginalized groups, end discrimination against women and people with disabilities, enhance the roles of cooperatives for small-scale enterprises pro women, the poor, Dalits and returning migrants. It aims to reduce the economic poverty rate to 5% by 2030 and to make Nepal poverty free by 2044. The policy emphasizes

[17] Interview with private sector leader, September 1, 2020.

[18] The right to equality (article 18) dictates special legal provisions for the protection, empowerment or advancement of women lagging behind socioeconomically, Dalits, Adibasi Janajatis, Madhesi, Tharus, Muslims, the oppressed class, backward communities, minorities, marginalized groups, peasants, laborers, youths, children, senior citizens, sexual minorities, persons with a disability, pregnant, incapacitated and helpless persons, and citizens who belong to backward regions as well as financially deprived citizens, including the Khas Arya.

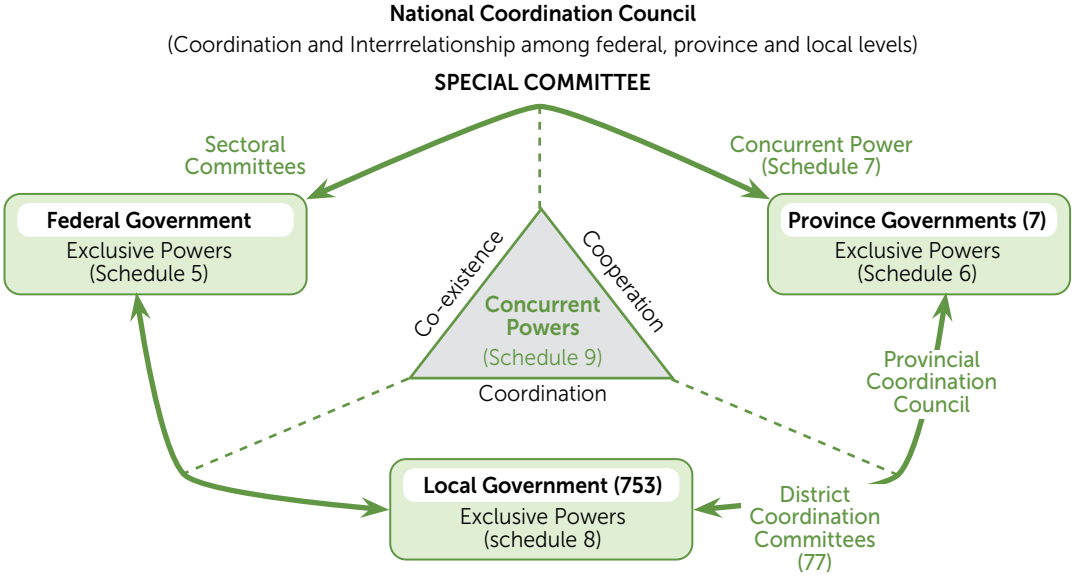
different strategies for policy implementation, some which directly support agriculture VCs, irrigation development, private sector investment, GESI and multiple use of water for health and food security outcomes. It recognizes the need to develop a mechanism at the local government level to plan and implement pro-poor enterprise programs in multi-stakeholder partnerships that facilitate the roles of the private sector and NGOs in providing knowledge, skills, finance and market services for the target groups. The policy calls for equitable access to and participation by the poor, women and marginalized groups in natural resources use, agricultural VCs and market systems. It also offers an approach to land pooling or land lease (both public and private land) for poor, tenant and landless farmers who are interested in agro-enterprises. This can enable scaling functions with access to irrigation facilities, agronomies and extension services by tenant and marginal farmers and needs case studies on how this approach is implemented in the future. However, studies from the Eastern Gangetic Plain reveal that access to lands on lease facilitates water access for agriculture production thereby contributing to incomes and food access by poor and tenant farmers (Sugden et al., 2020).

Like at the federal level, policies at the provincial level are oriented towards reinforcing inequalities and exclusion. As an example, policy advisory committees proposed in subsidy or agriculture development-related provincial policies are not inclusive. Most of the positions are reserved for the heads of institutions. There is no specific provision for compulsory representation of women members and GESI experts. The assumption that (female) farmers are homogenous and will benefit from programs equally appears intact in the policies.

5.2. Institutional arrangements for water and irrigation development

5.2.1. Three levels of government and intergovernmental relationships guiding water and irrigation development

The new Constitution has introduced a three-level structure of federal government (federal, provincial and local) (**Figure 5-1**). All levels of government have the constitutional power to enact laws, prepare budgets and mobilize their own resources (Shrestha 2019). In the federal structure, there are 761 governments at the three levels (1 federal, 7 provincial and 753 local). The previous administrative boundaries such as development regions, zones, municipalities and village development committees (VDCs) have been dismantled and restructured into 7 provinces and 753 local governments. The total number of districts has increased from 75 to 77. However, the districts remain administratively the same but with significant curbing in power and authority for development and administrative functions (Devkota and Thapa 2019). Out of 753 local governments, 6 are metropolitan cities, 11 are sub-metropolitan cities, 276 are municipalities (Nagarpalika-NP) and 460 are rural



Federal Nepal

- 3 levels of government
- 761 governments
- Local governments with single power of local irrigation and water supply
- All levels of government with single add shared powers on water resources

Figure 5-1. Federal Nepal's three levels of government and intergovernmental relationships and coordination bodies.
Source: Nepal's Constitution 2015, Draft Bill on Inter-governmental Coordination and Relationships, 2020, Government of Nepal

municipalities (Gaupalika-GP). In the 6 Tarai districts of the FtF ZoI, there are 58 local governments and 570 wards (**Annex 5-4** for elected representatives by gender and caste/ethnicity in the region).[19]

These local governments have powers and roles to manage small-scale irrigation interventions in collaboration with private sector and agriculture sector staff housed in the local government's structure (schedule 8). Federalism means transforming the country from centralized unitary governance to federal governance that focuses on three levels of transformation (Sharma, 2014,101-103). These include: i) promoting social and geographic diversity; ii) inclusive and equitable development with greater attention for GESI; and iii) devolving administrative, political and fiscal systems to local level. These transformations, if implemented in the sectoral portfolios, can contribute to the design and implementation of water resources management, irrigation and agricultural development policies and programs with inclusive development outcomes.

As shown in the **Figure 5-1**, each of the government have exclusive as well as concurrent rights and jurisdictions regarding water resources and irrigation development, as provisioned in the Constitution. The schedules 5, 6 and 8 of the Constitution define the exclusive rights of federal, provincial and local governments, while the schedules 7 and 9 specify the shared function between the provincial and the federal government, and across the three levels of government respectively. These provisions reveal that the three tiers of government established by the federal process are independent and autonomous in themselves. Each level of government can prepare laws, by-laws, policies, plans, strategies, and guidelines for managing water resources that are in their administrative boundaries (Unbundling report, 2016). However, each level of government has to cooperate with other level/s of government when the boundary of rivers or water catchments or sources fall under more than two governments (ibid). Article 232 of the Constitution, which that establishes the relationships among between the three levels of government, clearly stipulates that they are not hierarchically related, and that their relationships 'should be based on the principles of co-existence, cooperation, and coordination'. The draft bill on Inter-Governmental Cooperation and Relationships unpacks the operationalization of the 3 three constitutional principles (3C – coordination, cooperation and co-existence) and proposes five coordinating bodies at federal and provincial levels to smoothen coordination and cooperation for implementation of 'shared' or 'concurrent' power of the three levels on water and other resources. The bill proposes five different committees to facilitate coordination across the governments. These changes in the State's governance system provides an opportunity to understand water resources issues and development by fostering inter- and intra-governmental and cross-sectoral collaboration and cooperation (Suhardiman et al., 2018). The benefits of this for irrigation scaling are presented in the following sections.

5.2.2. Governance arrangement for water and irrigation development

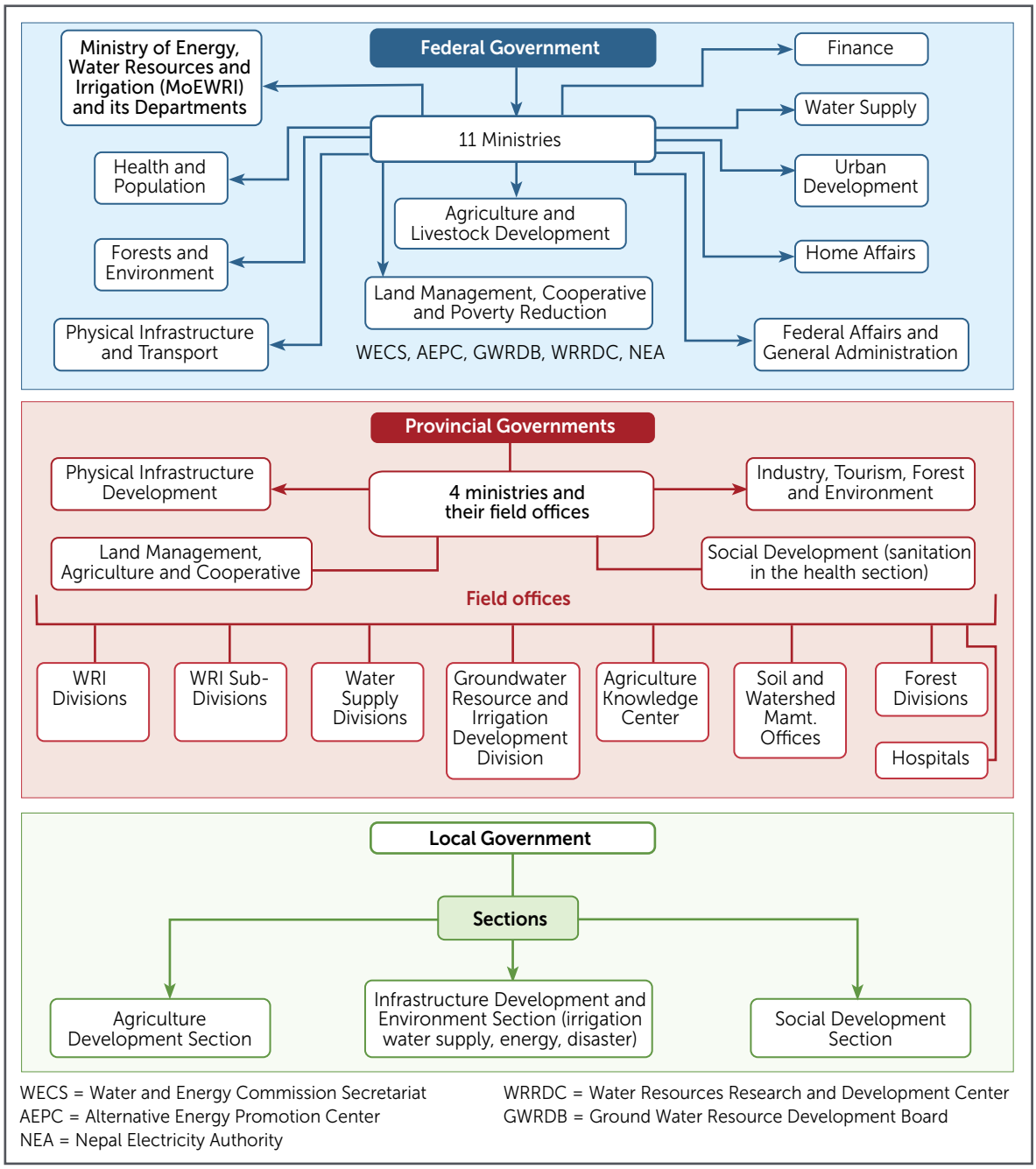
A complex governance arrangement interacts in each level of government for shaping policies and policy implementation on water resources, irrigation and water benefit-sharing. Two constitutional bodies, the National Natural Resources and Fiscal Commission and the NPC, are the influential policy actors shaping policy frameworks and benefit-sharing on WRM, irrigation and other natural resource sectors. The NNRFC is a new entity established since the introduction of federalism that defines mechanisms for natural resources revenue and benefit-sharing across the three levels of government. The NPC, which was founded in 1956, provides frameworks for national development and sectoral policies and planning.

The WRM and irrigation governance structure under the federal system is composed of three levels (**Figure 5-2**). At the federal level, the formerly fragmented water-related ministries (irrigation, energy and water resources) are integrated into a single ministry, now named the Ministry of Energy, Water Resources and Irrigation (MoEWRI). The MoEWRI mainly focuses on policy, law, standards and regulation related to multiple uses of water including irrigation, water quality, river basin management and transboundary WRM. It has two secretariats: Water Resources and Energy, each headed by a secretary. While the MoEWRI is the key line ministry in shaping water and irrigation policies, another 10 sectoral ministries (**Annex 5-5** for the main mandates) also have coordination, policy and program development roles regarding WRM, watershed management and water governance. There is more likely to be duplication of strategies and programs at the federal level unless an institutional mechanism for water cooperation and development is developed and implemented in the MoEWRI.

The MoEWRI has three departments with policy implementation roles such as the Department of Water Resources and Irrigation (DWRI), the Department of Electricity Development (DED) and the Department of Hydrology and Meteorology (DHM). The DWRI is the main department with implementation and coordination roles related to water resources and irrigation. The structure and scope of the DWRI has evolved, resulting in changes in administrative structure influenced by political changes in the country. It has been restructured six times since its foundation in 1956. The current department with a broader mandate regarding water resources and irrigation was created in 2018. Federalism downsized the scope and human resources of the DWRI, as some roles relating to irrigation scaling devolved to the provincial and local level. The DWRI has its main office in Kathmandu and 11 Irrigation Management Division field offices. It is responsible for implementing and monitoring central-level large projects on water resources, irrigation, water-induced disaster management, watershed conservation and projects that are interprovincial and transboundary in nature.

Established in 1975, the Water and Energy Commission Secretariat (WECS) also has a policy role but is limited to river basin management planning and coordination. WECS' previous policymaking and national direction-setting roles have been weakened under federalism (FMIST, 2020). Critics have raised concerns that more 'hydropower'-centric perspectives and limited technical capacity to strategize sustainable WRM are barriers to strong policymaking by WECS.

They also argue for the need to restructure water institutions in alignment with the Constitution (Suhardiman et al., 2018, FMIST, 2020). Other institutions such as the Groundwater Resource Development Board (GWRDB), Water Resources Research and Development Center (WRRDC), the Alternative Energy Promotion Center (AEPC), and the Nepal Electricity Authority (NEA) are involved in groundwater monitoring, WRM research and alternative energy (Section 8 for their implementation roles).



WECS = Water and Energy Commission Secretariat
AEPC = Alternative Energy Promotion Center
NEA = Nepal Electricity Authority
WRRDC = Water Resources Research and Development Center
GWRDB = Ground Water Resource Development Board

Figure 5-2. Governance arrangement for shaping policies and programs on water under federalism.

At the provincial level, the Ministry of Physical Infrastructure Development (MoPID) is the main provincial line agency dealing with water resources, irrigation and water supply-related public services. Its functions also intersect with the Ministry of Land Management, Agriculture and Cooperatives (MoLMAC) and the Ministry of Industry, Tourism, Forests and Environment (MoITFE) and the Ministry of Social Development (MoSD). These line ministries are involved in developing policies related to irrigation, agricultural development, sanitation and health. As discussed in section 8, divisional offices of all these ministries implement irrigation, water and agricultural programs in the field. The chief minister of Sudurpashchim remarked that the creation of provincial ministries and the integration of several portfolios into a single ministry (unlike at the federal level) is enabling the provincial government to strategize, plan and implement an integrated development approach (chief minister, province 7, NTV dialogue, February 13, 2021).

At the local level, staff housed in the Infrastructure Development and Environment Management Section, Agriculture Development Section and Social Development Section are involved in irrigation, water supply, disaster risk management, alternative energy and GESI. As local governments and their ward offices are the government entities closer to people, linking them with irrigation supply chain actors, including the private sector, farmers and their allied institutions, is an essential pathway to sustainable irrigation development that facilitates bottom-up water resources development (GC, 2020, GC et al., 2019, Clement et al., 2019, Suhardiman et al., 2018) along with access to financial and agricultural extension services, including market linkages (Minh et al 2021, IWMI 2021).

The changes in the governance system have created huge potential for state and non-state actors to interact and collaborate on addressing the current gaps in irrigation technical skills and knowledge at the local level (Pandey et al., 2020b, Pradhan and Belbase, 2018) that are limiting the reach of reliable irrigation services aimed at smallholders. Following the government's plan, announced in 2018, to establish at least one technical and vocational education and training (TVET) institute in each local government, the number of local governments with technical institutes has risen sharply from 332 to 653 (Sharma Neupane, 2020, UNDP, 2019). Western Tarai has a significant number of TVET institutes that deliver technical and vocational training programs locally. For example, a total of 172 (province 5 = 98, province 7 = 84) out of 197 local governments now have technical institutes that provide technical training to locals on agriculture, engineering, health, tourism, hospitality and other service sectors (Sharma Neupane, 2020). Sudurpashchim and Karnali provinces implement more agricultural programs, but they are underdeveloped in terms of agro-enterprises (ibid). This presents an opportunity to promote skilled irrigation technicians at the local level if the TVET programs focus on irrigation technologies, services, O/M and climate-smart irrigation, including solar irrigation pump operation and maintenance.

Nepal is advanced in terms of developing GESI guidelines in the agriculture, land and forests resources sector. The GoN has also recognized a third gender, and official documents now give people the option to identify their sex as 'other' (ADB, 2020). The federal governance system has also resulted for the first time in at least 33% representation of women and marginalized groups in federal and provincial assemblies, and 40% representation in local government councils (20% of elected women at local level are from Dalit and minority groups). This policy environment also presents an opportunity to promote policymaking processes and outcomes that are inclusive (White and Haapala, 2018, TAF, 2018) if elected women lawmakers are engaged with required knowledge and environment to play their roles in water governance (Khadka et al., forthcoming). Moreover, the federalization of the water sector has adjusted the public sector's roles and functions in three levels of government and created policy frameworks that support holistic WRM and development for national socioeconomic development. The rights and jurisdiction of the three levels of government assigned by the new Constitution, as discussed below, have shaped the governance arrangement presented in **Figure 5-2**.

5.2.3. Jurisdiction and cooperation among three government levels

The 2015 Constitution defines the roles and responsibilities of all government levels regarding water by giving them single and common rights to water resources, irrigation and water supply. As shown in **Table 5-3**, the **federal government** is mandated to develop national policies, laws and standards for water conservation and multiple uses of water, implement large projects and deal with transboundary water and international treaties and agreements. The **provincial governments** are mandated to develop and implement policies, laws, standards, plans and programs on irrigation development within their provincial boundaries. Irrigation projects that are interprovincial in nature are expected to be managed at the federal level, while a provincial government can manage inter-municipal irrigation projects. Local irrigation, water supply and conservation of watersheds are the exclusive jurisdiction of **local governments**. Unlike in the previous system, local governments in the federal structure are granted executive, legislative and judicial functions related to local development, including irrigation and agricultural development and extension services. They can make laws, polices, guidelines, standards and plans related to irrigation development using water resources in their administrative jurisdiction and within the framework of federal laws. This presents an opportunity to scale irrigation technologies with the technical, financial and capacity support of NGOs, the private sector, investors and finance institutions.

According to schedule 8 of the Constitution, watershed conservation, local irrigation, water supply, small-scale alternative energy, agricultural

Table 5-3. Jurisdiction of three levels of government for water resources, irrigation and associated sectors.

Provision of rights	Single and common rights of the government		
	Federal	Provincial	Local
International treaties and agreements and transboundary rivers	√		
Conservation and multiple uses of water resources	√		
Central-level large projects on electricity, irrigation and other projects	√		
National and global environmental management and wetlands	√		
Provincial electricity, irrigation and water supply services		√	
Land management and land documentation		√	
Provincial water resources use and environmental management		√	
Agriculture and livestock development		√	
Local-level development projects and programs			√
Basic health and sanitation			√
Local market management, environment conservation and biodiversity			√
Agricultural extension services			√
Water supply, small hydropower and alternative energy			√
Disaster risk management			√
Local roads, rural roads, agro-roads, irrigation			√
Watershed conservation			√
Provincial boundary rivers, waterways, environmental protection and biodiversity	√	√	
Disaster risk management	√	√	
Water supply and sanitation	√	v	
Inter-province water uses	√	√	
Services such as energy, water supply, irrigation	√	√	√
Service fees, charges, penalties and royalties from natural resources	√	√	√
Water use, environment, ecology and biodiversity	√	√	√
Disaster risk management	√	√	√

Source: Adapted from the Constitution of Nepal 2015, unbundling report 2016, Government of Nepal.

Note: Exclusive or single rights of federal, provincial and local governments are defined by schedule 5, 6 and 8 of the 2015 Constitution. Common rights between the provincial and federal level are included in schedule 7, and common rights among the three levels of government are included in schedule 9.

extension services and agriculture development fall under the exclusive power of local governments. This provides opportunities for decentralized scaling of irrigation development and irrigated agricultural VCs in collaboration and partnership with private sector actors, I/NGOs and farmers. However, operationalizing the constitutional power and jurisdiction of national and subnational governments over water and natural resources takes time (CAMRIS, 2019, DRCN, 2020), as does achieving fully functional federalism (Pant, 2020). Sectoral lawmaking at the federal level, based on which province and local level can make sectoral laws, is slowly taking place (Pant, 2020, Ojha, 2020). Therefore, the existing Water Resources Act (1992) and the Water Resource Rules (1993) are influential legal instruments that guide WRM and irrigation until new federal water legislation is enacted. Such legislation is urgently needed to shape WRM and development in collaboration and cooperation with the three levels of government (FMIST, 2020).

Even though the new governance system and policy create an ecosystem for scaling irrigation, they also created overlapping functions and power. For example, the constitutional provisions on the shared rights between the federal and provincial government (schedule 7) and among the three levels of government (schedule 9) on water resources use, irrigation and environmental conservation clearly show these overlaps. As shown in **Table 5-3**, while local irrigation and water supply are the exclusive jurisdiction of local government (schedule 8), these also overlap with the 'provincial irrigation and water supply' function assigned to the provincial government (schedule 6), 'multiple uses of water resources' function assigned to the federal government (schedule 5) and 'water uses' as a power shared by all levels of government (schedule 9). This overlap might be a challenge for SSI and FLI scaling and irrigated VC interventions, unless new water law specifies the roles and responsibilities of federal and subnational government on WRM and irrigation governance.

Moreover, fragmented sector institutions and a lack of clarity on roles among public water institutions and overlapping responsibilities among sector line agencies are barriers to reliable water services (Sharma and Adhikary, 2020). The inconsistency in defining water, watersheds and priority of water for irrigation, and the roles related to water quality and watershed and wetland conservation is apparent in sectoral policies (**Table 5-4**). In addition, the priority order of water uses laid out in the Water Resources Bill 2020 differs from the Water Supply and Sanitation Bill 2020, which also shows limited horizontal coordination between two water-related ministries. These situations require concerted efforts to coordinate and harmonize scaling programs for development impacts.

Table 5-4. Inconsistency in roles and responsibilities around sectoral polices at federal level.

Dimensions	Overlapping scope of activities among line ministries	Policies
Definition of water resources	Water resources refers to rivers, streams, lakes, wetlands, canals, watersheds, ponds, reservoirs, surface and groundwater resources, ice, including sources of all these water resources (article 2.6)	Draft Water Resources Bill 2020
Definition of water sources	Water sources refers to natural sources such as rivers, streams, lakes, ponds, wells, surface or groundwater resources, including artificial structures to store rainwater and supply systems	Water Supply and Sanitation (WSS) Bill 2020
Water conservation	Activities related to river, lake, wetland, ecosystem and watershed conservation are listed as the responsibility of the Forest and Environment Ministry, which overlaps with the responsibilities of the MoEWRI	Business Rules 2019
Irrigation priority	Drinking water is the first priority followed by irrigation and hydropower in the Water Supply Bill; In the Water Resources Bill, the water use priority order is drinking and domestic uses followed by water for livestock/fisheries, irrigation, hydropower, industries, waterways, cultural and social purposes, environment, tourism and other	Water Supply and Sanitation Bill 2020, Water Resources Bill 2020
Disaster risk management	Disaster risk reduction and management falls under the federal-level Ministry of Home and MoEWRI	Business Rules 2019
Watershed and wetland conservation	Activities related to watershed conservation, landslide control and river basin conservation overlap with the water and forest sector. Watersheds and hydrological cycles are defined as ecosystem services and included in the definition of environmental services in the Forest Act 2019. Conservation of watersheds and wetlands are the jurisdiction of the MoEWRI	Forest Act 2019, Water Resources Bill 2020
Water resources as forest products	Mountains with or without snow as well as lakes, ponds, wetlands, rivers and streams situated in state forest lands are considered as 'forest products'	Forest Act 2019
Irrigation development	Overlaps with the activities of the agriculture and irrigation departments at the federal level	15th Plan (and Approach Paper) 2019
Landslide control and riverbank protection	Activities related to the water sector such as landslide control, watershed conservation and protection of riverbank cutting overlaps with the forest sector	White Paper 2018, Forest Act 2019
Water quality	Water quality-related activities are the responsibility of the Ministry of Water Supply and Sanitation, the Ministry of Forests and Environment and the MoEWRI	Water Resources Bill 2020, WSS Bill 2020, Forest Act 2019

Source: Sectoral policies prepared by the Government of Nepal after the introduction of federalism.

5.2.4. Cross-sectoral collaboration and synergies to accelerate irrigation development

National and sectoral policies and the new governance arrangement analyzed in previous sections clearly show that there is a policy environment conducive to irrigation scaling through collaborative efforts in different dimensions of scaling in the FtF ZoI ZoI (**Table 5-5**). The policy ecosystem creates an opportunity for collaboration and synergies among eight public sector agencies at federal and subnational levels and non-state actors.

The areas of linkages for scaling include: i) policy and regulatory oversight on WRM and water security, water access and use; ii) institutional changes and governance for policy implementation; iii) agro-irrigation technologies; iv) capacity development; v) inputs; vi) markets, financial services, investment and PPPs; and vii) GESI and farmers' empowerment. While there is confusion due to the overlapping functions across the levels of government and sectors, the nine dimensions of cross-sectoral linkages and collaboration opportunities that the GoN's new policies have created offer a good basis for a flagship program for scaling functions in the FtF ZoI.

The potential for cross-sectoral linkages also creates an opportunity for sectoral ministries and offices for different roles in scaling. For example, at the federal level, linkages can be strengthened between key sectors – such as water, agriculture, energy, forest, industry and commerce, employment, federal affairs and general administration, and women and children – on policies, standards, regulatory oversight, impact assessment and research related to scaling irrigation development. It is essential to establish similar collaboration between key line ministries at the provincial level in order to develop policies and plans that help local governments, WUAs, the private sector and NGOs to introduce bottom-up policy innovations and development practices on WRM, land resources, irrigation and agriculture VCs, and local capacity development.

Table 5-5. Potential areas for cross-sectoral synergies and collaboration for scaling small-scale irrigation and agricultural development as a strategic intervention to build resilience to Covid-19 and climate change.

Scaling elements	Energy and water resources	Agriculture	Environment	Trade and industry	Poverty reduction, land and disaster management	Federal affairs and general administration	Employment	Women, children, senior citizens
Policy and governance	Policies for resilient and inclusive WRM and water governance aligned with the federal system, scale MUS for WASH and irrigation. Empower WUAs, inclusive WRM and irrigation development	Devolved irrigated agriculture policy. Group farming, social capital and extension services through local technicians trained at TVET institutions	Water-resilient CCAR interventions targeted at commercial farmers and WUAs; Funds for water-based CCAR programs and inclusive policy platforms, committees, and LAPA planning	PPP policy to promote private sector roles in water security, irrigated value chains, irrigation supply chains, financial inclusion and GESI in private sector governance and programs	Remove land access barriers to scale commercial farming through ELFs, collectives of tenant and marginal farmers; GESI in land access, use and governance for irrigated agricultural development	Policy guide for LGs on water security and water and land resources governance; Strengthen women lawmaker's roles in local water governance	Policy guide for LGs on SSI/FLI irrigation programs targeted at migrants and youth and promote inclusive local water governance	Assess water policy impacts through GESI lens in the water-agri-energy sectors. Evidence-based policy advocacy on the roles of water in positive development
Irrigation technology	Scale SSI/FLI technologies, i.e. solar irrigation pumps, and MUS technologies through LGs investment and institutional support	Efficient use of agricultural water and water-saving crops, inclusive subsidies for energy access to cold storage facilities	Climate-resilient technologies for access and efficient water use, incentives for FLI thru LGs	VAT/ tax reform and PPP support for production of irrigation equipment in Nepal and agro-produces	Access to irrigation and agricultural technologies by commercial farmers (ELF, women, returning migrants)	Policy guide for LGs on scaling solar irrigation pumps and sustainable use of groundwater	Develop local irrigation technicians targeted at returning migrants and women	Promote knowledge about GESI in irrigation governance and water politics
Capacity strengthening	WRM for multiple uses; promote multi-stakeholder dialogues (MSD) and policy platforms	Water-agri-energy nexus- based agricultural development	Water-smart climate change adaptation and mitigation	Support for sanitary and phytosanitary policy implementation and innovation	Water-smart poverty reduction and social mobilization in SSI/FLI irrigation management	Sustainable and equitable WRM planning and development	Develop TVET technicians' irrigation skill in targeted at returning migrants	Capacity development in water-based empowerment of women and social groups
Inputs (seeds, fertilizers, skills, information)	Technical skills on groundwater and surface irrigation management	Promote decentralized agricultural extension services and inputs	Water-agri-energy-based adaptation inputs	Credit facility for irrigation equipment	Input services to poor and smallholder farmers and women farmers	Input services to poor and smallholder farmers and women farmers	Provide returning migrants/youth with irrigation technology, skills and subsidies	Promote knowledge about GESI in agri. value chains and supply chains
Markets, financial services and PPPs	Link WUAs with MFIs; promote PPPs in irrigation interventions	Link WUAs with cooperatives and irrigation supply chain actors	Promote access to climate funds by WUAs, smallholder farmers and women	Facilitate product supply process; Investment in SSI and FLI	Credit facility for poor, women and youth	Monitor markets	Market support for high-value crops and irrigation services enterprises	Financial literacy for women producers and entrepreneurs
GESI	Enhance institutional capacity for inclusive WRM, equitable access to irrigation technologies and governance	Capitalize on smallholder and women collectives, and support women role models in value chains and institutions	Socially just local adaptation plan of action (LAPA) and water technology subsidy through WUAs	Link WUAs with agriculture cooperatives and private sector	Facilitate equitable access/use of agri. Lands, equipment, finance and markets	Integrate water and irrigation governance in the PLGSP	Develop skills on solar irrigation technology (targeted at commercial farmers, youth, women)	Promote knowledge about GESI impacts of national policy on water-food-energy and irrigation governance

LG = local government/palika; PLGSP = Provincial and Local Governance Support Program; FLI/SSI = farmer-led irrigation/small-scale irrigation; Experienced Leader Farmers = ELFs; SIP = solar-powered irrigation pump; WRM = water resources management; TVET = technical and vocational education and training; CCAR = climate change adaptation and resilience; LAPA = Local Adaptation Plan of Action; MUS = multiple-use water system; Source: Study team's analysis (2020).

6. Agricultural Value Chains

In Nepal, cropping systems in the hills are based on growing maize, rice and vegetables. Major monsoon crops include paddy in flat terraces and maize in unirrigated and non-waterlogged areas (USAID, 2011). The Tarai, with its subtropical lowlands, has the best agricultural potential. Rice is the main crop, but other crops such as wheat, pulses, barley and oilseeds are also grown (New Agriculturalist, 2009). Almost 67% of agriculture depends on rain-fed cultivation (Malla 2008 cited in Shrestha, 2014, p.6), meaning that weather conditions play an important part in determining agricultural outputs.

There is a national interest in VC development, as a way to increase food security and enhance farmer incomes which aligns well with global VC development. This is evidenced by several policy instruments in trade and agriculture (such as the ASD 2015-35 and the Nepal Trade Integration Strategy 2016) and the substantial donor assistance to develop VCs. A 2018 UNDP project lists 12 development partner-funded projects for selected agricultural commodities such as fruits, vegetable seeds, fresh vegetables, tea, coffee and livestock. The role of water, however, seems to be understudied in VC development projects. For instance, the same UNDP project chiefly mentions water only in terms of water and sanitation at collection and disposal centers, and not as an integral part of agricultural VCs (UNDP, 2018).

Out of the many possible VCs, this report looks at the vegetable VC and the cereal VC. Vegetables are recognized as a smallholder crop (IFAD 2020), successfully grown on smaller land parcels and as a high value commodity lends itself well for irrigation investments. It also has been identified by the ADS 2016 strategy as one of the major VCs to be promoted on a national scale. The cereal VC in this report comprises of rice and maize. Firstly, rice remains the staple grain grown in Western Tarai and occupies a sizeable domestic market but with many complications that could be simplified to enable better returns. Secondly, maize has been identified as one of the five important crops for VC development by the ADS 2015-2035 (MoAD, 2016).

6.1. The vegetable value chain

Vegetable farming provides subsistence to over 3.2 million families in the country, the majority of whom have less than 0.5 ha of land (**Table 6-1**). However, only 18% participate in commercial markets and only 5% derive their main income from vegetable farming (LTS International, 2017), the reasons for which are explored in later sections. The rapid urbanization of towns and cities along with changes in consumers' preference for healthy food in the FtF ZoI have created demand for high-value crop VCs, especially organic vegetables (World Bank, 2020, Tractebel Engineering GmbH, 2019).

The vegetable VC (**Figure 6-1**) involves many different actors at different capacities, from supplying inputs, engaging in production, collecting, trading, wholesaling and finally to retailing and consuming. Major actors are agro-vets, farmers, collectors, traders, wholesalers, retailers and consumers. Each actor is linked to the other either directly or through intermediaries, but at times these links are not well developed (for instance, fewer input suppliers in very remote areas) or are strained (private cartels dissuade smallholders from trying to access markets). There are several governmental and non-governmental supporting actors who try and ease access and linkages for different actors along the chain.

Input suppliers include agro-vets, government agencies, cooperatives and, sometimes, NGOs who supply fertilizers, pesticides and seeds. Irrigation inputs such as micro-irrigation equipment and machinery (such as pumps) form part of the inputs that will be explored in detail in the irrigation equipment supply chain later. Private agro-vet suppliers are predominantly men while cooperatives and NGOs tend to be more inclusive (Honsberger, 2015).

Production is carried out by **farmers** (both male and female). Men are often more easily able to access inputs and training, negotiate better prices for their produce and take advantage of their relative literacy,

Table 6-1. Major vegetables by production in six districts in the FtF ZoI (in metric tons).

Vegetables	Banke	Bardiya	Dang	Kailali	Kanchanpur	Kapilvastu
Cauliflower	11,366	11,241	5899	9,396	4,323	4,793
Cabbage	15,995	10,701	8,420	10,174	4,307	5,678
Tomato	13,877	973	16,917	7,639	6,438	5,773
Onion	3,789	8,106	6,671	10,593	587	7,102
Cucumber	8,359	3,307	8,717	10,160	5,030	3,227

Source: Statistical Information on Nepalese Agriculture 2075/76 (2018/19) (MoALD, 2020).

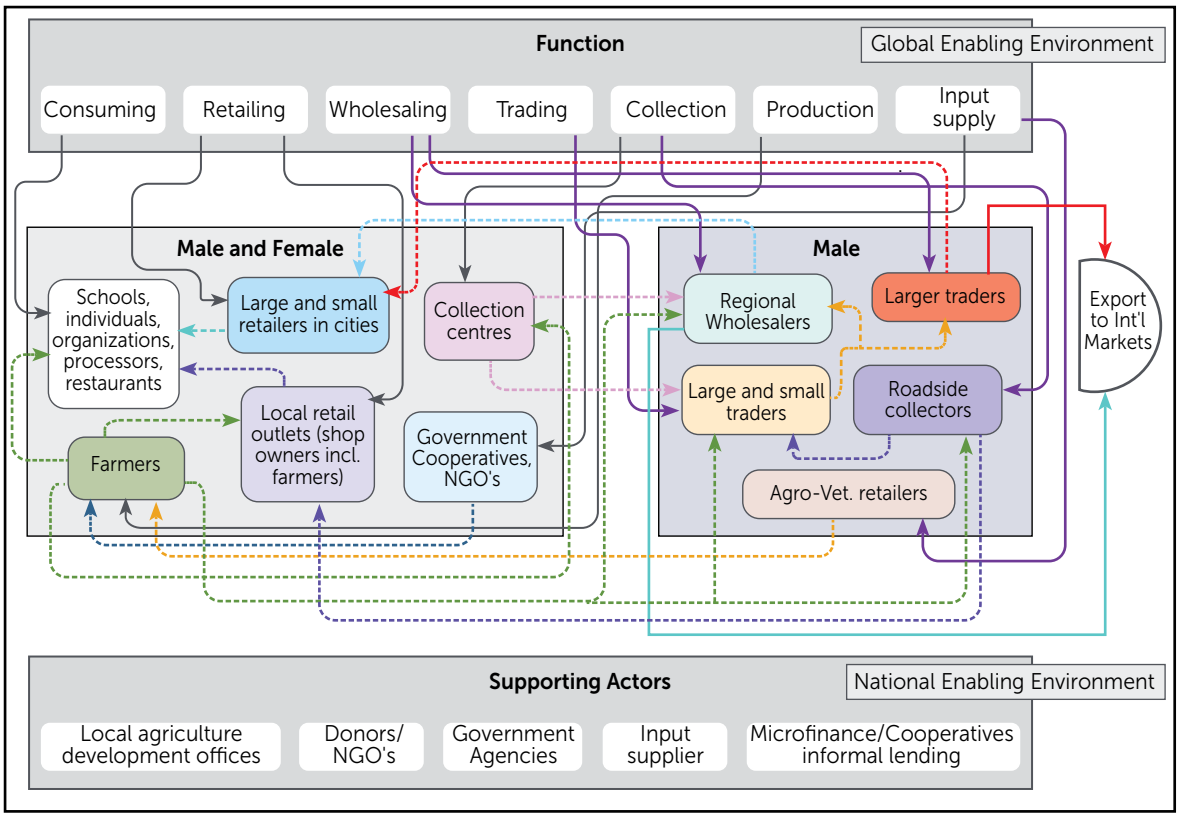


Figure 6-1. Typical vegetable value chain in Nepal with gender considerations (Honsberger, 2015).

women are often left behind with considerably lower wages (ibid). GC and Hall (2020) found that small commercial farmers making a good income from agriculture used improved seeds, non-conventional irrigation technologies (like drip, sprinklers and sprayers) or pipe irrigation and sold crops in local formal markets (collection centers, local bazaars). On the other hand, those growing traditional crops sold more to informal markets. The use of technology and access to markets are thereby considered critical to commercial production (ibid). Additionally, Brown and Kennedy (2005) found that while total returns and gross returns increase with farm size, small farms growing vegetables are actually more efficient per hectare with higher gross margins than medium or larger farms.

After harvest, the produce is collected in **collection centers or by roadside collectors**. Collection centers have been created by farmer groups and cooperatives, NGOs, individuals and sometimes the government (Honsberger, 2015). If farmers have multiple 'options' of where to sell (better direct access to markets), they could negotiate a better price, but this is often not the case. Cooperatives are often more equitable and offer better prices. An informally chosen person (often a man) from the farming community may be responsible for collecting the produce and selling to collectors (also most often men) (ibid).

As reported by the respondent interviewed, crop storage is a problem for farmers.

> *"Agriculture markets are captured by private business owners; smallholders are not allowed to sell their crops through those platforms. Instead, they are forced to sell their products at businessmen rates" (telephone interview with chairperson of the Agriculture Cooperative Association, October 2020).*

Collectors and traders are key links between farmers and markets. They are responsible for various functions such purchasing, packing, sorting, selling to middlemen, transporting and selling to wholesalers (USAID, 2011). In the off-season vegetable VC, their margins from the market come to about 10% (after deduction of all typical costs incurred) (ibid). Tomato, cauliflower, cucumber and cabbage are some of the major off-season vegetable crops (ibid). **Local and regional wholesalers** collect the produce in bulk and sell it in larger markets. The Kalimati Fruit and Vegetable Market in Kathmandu is the largest in the country and was established by the Ministry of Agriculture in 1986 (LTS International, 2017). Daily prices for goods are also reported on its website. The market is heavily reliant on imports from India – 31% of fresh vegetables are imported from India alone (ibid). **Regional wholesalers and large traders** are also connected to Indian commission agents who then sell to international wholesale markets in India (USAID, 2011). Vegetables are also frequently traded informally from small vehicles including rickshaws, motorcycles and bullock carts (ibid). Due to these limitations and overall market linkages described above, foreign market access for smallholders remains challenging.

Retailers are small shopkeepers/stallkeepers or cart sellers who are either connected to regional retailers or roadside collectors or are farmers themselves. Farmers who are directly able to sell in bigger cities and not engage with wholesalers can negotiate better prices for themselves, though market prices become quickly established (Honsberger, 2015). Retailers hold a market share of about 15-20% and are not organized formally (USAID, 2011). Here, women are often 'price-takers' and not 'price-makers' (bigger retailers and wholesalers that establish market prices) and are relegated to lesser decision-making and profiteering roles (Honsberger, 2015). Final consumers range from individual customers to bigger food industry players such as hotels.

Supporters support different actors in the vegetable VC. At the farming and production level, farmers are often supported by agricultural cooperatives and microfinance organizations that respectively support the buying of inputs, collection and sale of produce or provide loans. Government agencies such as the former District Agricultural Development Office, now the Agricultural Knowledge Center (AKC), and the Horticulture Research Division under the Nepal Agricultural Research Council (NARC) help provide inputs and technologies to farmers (USAID, 2011). Development partners such as USAID and iDE are also active in promoting inputs and technologies for enhancing agricultural productivity (e.g., closing the yield gap) and increasing farmer access to markets. However, those in accessible areas and with resources take advantage of information disseminated through limited campaigning by state and non-state actors, as is evidenced by the following interview statements:

> *"Aftersales advisory services such as on technology and agriculture are conducted through hotlines and media platforms such as Facebook. They also rely on door-to-door marketing on a cluster basis, mainly to deal with the cost of deliveries and quality services. There is a lack of big campaigning through other visual, radio and print materials. Only those who can invest can have access."*[20]

> *High irrigation cost coupled with a lack of knowledge and negotiation skills hits women farmers the hardest.*[21]

Subedi (2008), found that 78.57% of women in Argakhachi district faced constraints such as the distance to the training center, compounded by the problem of a lack of transportation, care responsibilities at home and the lack of female extension workers in trainings. Less participation by women in extension service trainings such as machinery and integrated pest management was also apparent (Gharti Magar, 2011). Similarly, only 8-17% of women/women's cooperatives had received mini tillers and training on how to operate them. The research noted that farmers more often received agricultural advice from indirect sources such as neighbors and relatives than extension workers. The same research reported that more than 50% of women farmers said they had not been visited by any extension workers and, in general, were not satisfied with the current services. The reasons provided were that extension workers were mostly men, who usually did not visit fields, and the timing and content of the services were not suitable, which hindered women farmers from benefitting from these services.

At the trading level, the District Chamber of Commerce and Industries (DCCI) and Agro Enterprise Center (AEC) under the Federation of Nepalese Chambers of Commerce and Industry (FNCCI) support market information and market linkage facilitation for businesses. USAID (2011) identified The Agriculture Information and Communication Center (now known as the Agriculture Information and Training Center), the Directorate of Agribusiness Promotion and Marketing Development and the National Plant Quarantine Program (now the Plant Quarantine and Pesticide Management Center) as national enabling actors other than at the ministerial level. The Trade and Export Promotion Center maintains trade and export-related information (USAID, 2011).

6.2. The cereal value chain

Most staples in Nepal have similar VCs and marketing, as individual vendors and suppliers handle a variety of staple grains (WFP and FAO, 2007). These include rice, wheat and maize, which are the biggest staples in provinces 5 and 7 in Sudurpashchim. No organized wholesale market exists for collecting and selling processed cereals. Instead, there are informal local cereal markets called gallamandis that are operated independently (WFP and FAO, 2007). Maize, in particular, is grown both for human consumption and as animal feed; more than 80% of the Tarai's production of maize is used for poultry feed (Gurung et al., 2011). In many areas of the food-deficit mid-Hills region, this situation is reversed: almost all maize is used for human consumption (1.3 million MT) and very little fed to animals (ibid). Most maize farmers have less than 0.5 ha of land but produce 80% of the total production (ibid).

In the cereal VC, **inputs** are supplied predominantly by retail agro-vets, machinery dealers and service providers (**Figure 6-2**). The National Agriculture Research Council (NARC) and Department of Agriculture (DoA) and some I/NGOs provide support for producing/accessing these inputs (Yadaw, 2018). Farmers often rely on small agro-cooperatives/smallholder-focused banks to access bulk amounts of inputs (ibid). The produce is then sold to **small traders/collectors** (commonly known as **kantawalas**

[20] Telephone interview, SunFarmer, October 8, 2020.

[21] Telephone interview with chairperson of the Agriculture Cooperative Association, October 2020.

in the Tarai[22]) or directly to mills (Sanogo, 2010). Some farmers are able to access small and large markets directly, but most rely on kantawalas as the major link to mills (WFP and FAO, 2007). A large number of *kantawala* collection centers can be found in rural areas and along the Tarai border, where a significant amount of Indian rice is purchased (Sanogo, 2010). There are not a lot of VC actors in the grain market in the Hills. For maize in particular, small traders collect grain surplus from farmers and supply it to bigger local traders who carry out simple drying and packaging (Gurung et. al., 2011). The Tarai has more actors at all levels of input supply, production, processing and marketing (ibid), enabled by the presence of comparatively more seed producers and processing mills and industries. Resource-poor farmers in remote hill areas where seed companies are few and far between are often supported by District Seed Self-sufficiency Program groups and Community-based Seed Production groups (ibid).

Smaller mills (or micro-mills) with a processing capacity of about 1 MT/day can be found in large villages and city interiors where processing is often for farmers' own consumption or for small traders (Sanogo, 2010). Eighty percent of the traded grain is processed by **medium/larger mills** with a processing capacity of 1-1.5 MT/hr. A dozen of these are located in the Tarai and are responsible for more than 50% of the rice in major markets such as Kathmandu (WFP and FAO, 2007). Mills then supply the processed grain to **large wholesalers** who sell it on to **smaller retailers** across the country. However, mills also market their own processed grain, and wholesalers may not engage with retailers and directly cater to customers in local markets (Sanogo, 2010). Wholesalers may also engage with formal imports from abroad, especially India. Bigger wholesale markets are often under the control of private cartels, and smallholders have almost no means to negotiate their position. Collective action through farmer groups and cooperatives could help support smallholders' position in relation not only to market access but also greater and timely access to inputs, better prices and improved market information (such as prices and quality regulations).

> *"In big cities like Kathmandu, the marketplace is captured by private players – our farmers are not allowed to go inside these markets [like Kalimati] ... they have to simply drop off their produce for whatever little price is offered; there is no room for bargaining. I have taken this problem to Baluwatar [the prime minister's residence], saying we need a [separate] farmer's market. Four times we have met and given documents [to authorities] asking for land – even on lease. If they provide land to us in Kathmandu, we can take care of everything else. But this has not happened yet."*[23]

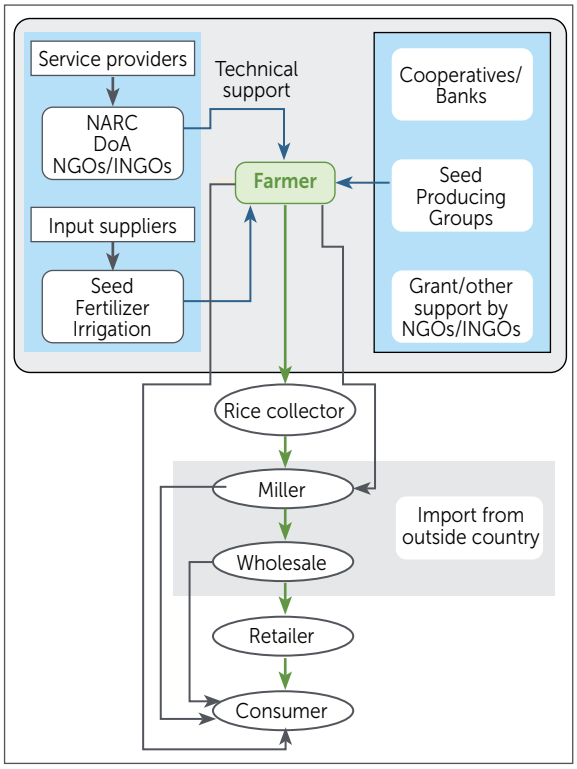


Figure 6-2. The cereal supply chain in Nepal (adapted from Yadaw, 2018).

Additionally, farmers who rely on middleperson and traders are impacted by lower prices offered to them despite government-mandated minimums:

> *"The government has stipulated prices for crops* – masino dhaan *[medium-sized variety paddy] at NPR 2,885 [approx. USD 27]* and moto dhan *(thick variety paddy) at NPR 2,735 [approx. USD 26] – but private sellers are buying it much cheaper from farmers at around NPR 1,600-1,900 (approx. USD 15-18). Now private sellers are protesting against us, saying we have ruined the market price by forcing the price minimum, which had come about after we asked the government to intervene."*[24]

Paddy production suffers greatly because of the urea shortage every year. With India having frozen its fertilizer exports due the pandemic, Nepal's struggle with fertilizer demand escalated (Dhital, 2020) for both rice and maize farmers as 2020 saw a record in paddy transplantation due to favorable rains and a surge in farm labor given the returning migrants. This is exacerbated by farmers being unaware of crop management practices, including appropriate fertilizer use (Gurung et al., 2011). Farmers rely almost exclusively on inorganic fertilizer, despite availability of organic fertilizer around homesteads. There is an opportunity to strengthen organic fertilizer production to close some of the fertilizer gaps, especially for vegetable production in smallholder farming systems of less than 0.5 ha, and to reduce potential land and soil degradation due to overdependence on inorganic fertilizers.

[22] According to the WFP and FAO (2007), kantawalas are traders in rural areas who procure unprocessed food for resale to processors, and those operating near the border are among the main sources of imported produce from India.

[23] Respondent, October 2020.

[24] Respondent, October 2020.

The GoN and DPs are making efforts to increase women's involvement in agricultural VCs (Kherallah et al., 2015, FAO, 2019, KISAN II, 2019, NAMDP, 2019). As of June 2020, Nepal had 3.5 million entrepreneurs, 59 percent of them are involved in micro-enterprises (employing up to 9 people) and 21 percent in small enterprises (employing between 10 to 49 persons) (UNDP 2020). SMEs contribute around 22% of GDP and generate around 1.7 million jobs. As of 2017/18, there were 275,433 registered SMEs (Bista, 2019). Women farmers are increasingly taking up leadership roles in agro-enterprises, helping to break gender stereotypes and change traditional perceptions of gender roles (UN Women, 2017). Around 30% of all micro-enterprises are owned and managed by women (UNDP 2020). Agricultural feminization due to male out-migration has created opportunities for women farmers to take up entrepreneurial and community leadership roles (Maharjan et al., 2012, Gartaula et al., 2010). However, embedded structural and sociocultural norms make it hard for women to realize their potential as leaders in business (Bushell, 2008). An inadequate number of women extension workers also limits access to extension services by women entrepreneurs (Joshi, 2018a). This evidence reveals that GESI-responsive investment in irrigated agricultural value chains and services could create opportunities in the FtF ZOI.

7. Irrigation Equipment Supply Chain

7.1. Structure of the irrigation equipment supply chain

Across the various districts over 247,000 agricultural landholdings are recorded to be under smallholder irrigation using shallow tube wells, deep tube wells and lifting equipment (Table 7-1).

Based on primary interviews with a range of stakeholders,[25] a typical private irrigation equipment supply chain for the Tarai and Hills regions is visualized in **Figure 7-1**.

[25] Stakeholders interviewed included solar companies, pump importers, drip irrigation kit and sprinkler manufacturers, electric/diesel pump suppliers, local agro-vets, cooperatives and farmer federations.

Table 7-1. Total agricultural landholdings under 0.5 ha reporting use of irrigation implements and other facilities in the FtF ZoI districts (CBS 2013).

Districts	Total agricultural landholdings under 0.5 ha	Shallow tube wells (No.)	Deep tube wells (No.)	Pumping set/ motor (No.)	Sprayer (No.)
Banke	32,038	5,228	6,272	5,013	2,060
Bardiya	37,477	6,756	1,697	2,750	3,632
Dang	39,144	680	441	160	1,162
Kailali	66,045	9,079	6,898	22,875	6,542
Kanchanpur	38,962	15,571	2,215	17,283	4,296
Kapilvastu	33,846	1,990	1,738	9,450	7,490

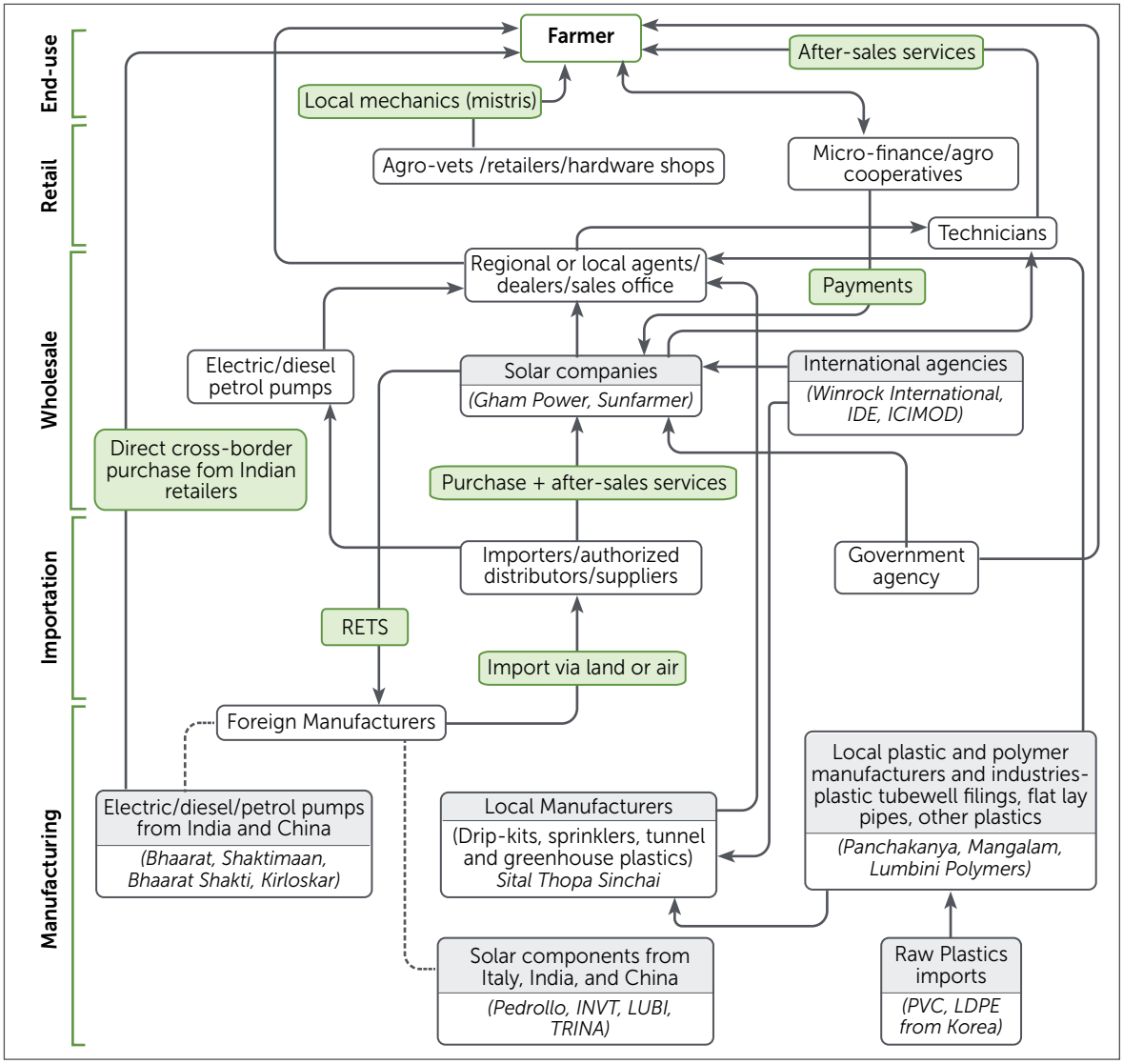


Figure 7-1. Private irrigation equipment supply chain. Source: Analysis and primary data by Uprety (2020).

Almost all electric, solar, diesel, petrol pumps are **imported** along with other pump-related components such as control panels and solar modules. Indian and Chinese imports dominate electric, diesel and petrol pumps while an Italian manufacturer (Pedrollo) is the go-to company for high-quality solar pumps. **Domestic production** in Nepal is limited to drip irrigation kits, sprinklers and various plastics. Drip irrigation kit manufacturers rely on high-quality polymers – polyvinyl chloride (PVC) and low-density polyethylene (LDPE) – that are imported by domestic polymer industries, usually from Korea. A basic drip irrigation kit can be purchased for NPR 2,500[26] (approx. USD 21) and comes with a 60-liter tank, pipes and lateral fittings that can irrigate three aanas (approx. 0.008 hectares or 80m^2) of land. Drip irrigation kits for larger commercial farms are imported from Israel, India and Korea. The plastic industry also produces plastic tube well fittings that have progressively replaced Indian imports and metal tube well fittings. Flat lay pipes are also commonly used and domestically produced (Bont, 2011).[27] Shallow tube wells are extensively subsidized by the government. Subsidies currently range from NPR 50,000 to 150,000 (approx. USD 420-1,262) depending on tube well requirements (Bhandari, 2016).[28]

Pump companies can either directly import from foreign manufacturers or rely on importers/authorized distributors for their supply. For instance, solar companies (mostly based in Kathmandu) were found to both directly import pumps and panels and also engage with importers and authorized distribution channels (**Table 7-2**). Direct importation for solar companies requires going through the Renewable Energy Test Station (RETS), which is a government-authorized body responsible for quality control of renewable energy technology. A sample of the equipment to be imported is first tested by RETS, after which clearance is issued allowing the equipment to be imported in bulk. This equipment undergoes another random check by RETS. Direct import reduces the cost of a middleman for solar companies. Working with **authorized distributors/importers** also has its advantages as they take care of import duties. Importers/authorized distributors often maintain a standard supply stock and can quickly dispatch required equipment. Additionally, they provide after-sales services to companies when there is a problem with dispatched equipment. For electric and diesel pumps, imports are handled mainly by authorized distributors and other importers.

After the equipment reaches the pump company/vendor/importer, it is then sent to districts across the country using **regional distributors/sales offices and/or regional agents**. Farmers can connect directly to these sales offices or rely on smaller ground-level retailers, which is the norm. Drip irrigation kit manufacturers have made use of a nationwide network of agro-vets, which are shops that sell a variety of agricultural inputs. There are also local mechanics, called *mistris*, who offer well-drilling services. It is common practice in the Tarai for *mistris* to be connected to hardware shops who then connect the *mistris* to customers as the drilling would require equipment purchased from the shops (Yoder and Adhikari, 2015).[29] These local mechanics also advise farmers when their electric/diesel/petrol pumps break down or have problems (ibid). Solar pump companies have local part-time and full-time technicians who can support farmers with equipment installations at the regional/district level. Male technicians are common, but one company interviewed had two local female technicians out of 12 part-time local technicians in different districts. Technical help is typically not necessary for smaller equipment like drip irrigation kits, which are often much simpler to assemble. Companies like Sital Thopa Sichai provide small leaflets with their products that visualize basic installation instructions.

Table 7-2. Some key companies in irrigation equipment importation, distribution and manufacture.

Company	Business area	Farmer-level irrigation equipment/service supplied
Sital Drip Irrigation Technology Industry (Sital Thopa Sichai)	Produces, assembles and markets low-cost drip irrigation systems	Drip irrigation kits, greenhouse plastics
Panchakanya Group	Manufactures steel, plastics and ready-mix concrete	HDPE plastics used in sprinkler and drip irrigation; plastics for tube well fittings
Mangalam Pipes	Manufactures CPVC pipes and fittings and polymer piping systems	Borewell fittings
Lumbini Polymers	Plastics and polymers manufacturer	Flat lay pipes
Laxmi Plastics	Manufactures high-density polythene (HDPE) pipes and other plastics	Raw plastics for agriculture equipment
Krishna Grill and Engineering Works	Manufactures steel structures and agricultural equipment	Treadle pumps
New Shrestha Machinery	Imports solar pump and fittings (authorized distributor of Pedrollo pumps in Nepal)	Solar pumps and fittings
Shrestha Agri Inputs	Imports various kinds of pumps and agricultural machinery (tillers, tractors, weeders etc.) and grain-processing factory	Electric pumps, diesel pumps, petrol pumps
Gham Power	Solar company	Solar irrigation pumps
SunFarmer	Solar company	Solar irrigation pumps

[26] As offered by Sital Thopa Sichai (Sital Drip Irrigation Technology Industry, Nepal) – price as of November 2020.

[27] Bont, C. (2011). What's moving them? The adoption and diffusion of small pump sets and lay-flat pipes in Rupandehi, Nepal.

[28] Bhandari, B. (2016). Tube well demand soars as irrigation project falls short. The Kathmandu Post. Accessible from: https://kathmandupost.com/money/2016/03/11/tube-well-demand-soars-as-irrigation-project-falls-short

[29] Yoder, R. and Adhikari, D. 2015. Low-cost Manual Well Drilling Village Mistris Make Groundwater Accessible for Irrigation.

Accessing electric, diesel and petrol pumps is often simpler for some **farmers** in the Tarai because of the long open border. Farmers may simply cross the border to buy these pumps directly from Indian retail shops. In doing so, they mostly do not pay any custom duties, enabled by easy border crossings and lax security checkpoints. However, cross-border purchases are not sufficient to satisfy overall farmer demand, which is why farmers rely on retail shops (e.g., hardware shops) and the previously mentioned agro-vets who are supplied through sales offices and regional agents. A common ground-level perception seems to be that branded Indian pumps are often 'better' than Chinese pumps (usually not branded), which are cheaper and do not come with a warranty, an issue that will be discussed later. Pumps of small sizes and lower horsepower are comparatively cheaper than bigger ones. For instance, a 1.5-inch electric pump costs between NPR 8,500-10,000 (approx. USD 72-84), a 2-inch electric pump costs between NPR 11,000-12,000 (approx. USD 93-101) and a 3-inch pump (which is among the most popular) costs about NPR 17,000 (approx. USD 144). Similarly, a 1.5-inch petrol pump retails for about NPR 10,000 (approx. USD 84), while a 3-inch pump would be about NPR 12,000-13,000 (approx. USD 101-110).[30]

Ownership of renewable energy technologies is usually by advantaged men, as women and excluded groups lack financial resources, information and training. Women and excluded groups are not well represented in decision-making at all levels. For women farmers, a lack of female dealers and technicians to consult with may also contribute to them not accessing these markets on their own. This could be a problem, especially in the Tarai where cultural norms often restrict interaction between women and men outside kinship circles.[31]

The last couple of decades has seen a rise in development partner and government interest in expanding renewable technology usage, especially in areas where electricity access is a problem. As said earlier, over 11 different policies mention solar-based irrigation. **DPs** have teamed up with solar companies to help pilot renewable technology projects (for instance, Winrock International supporting solar companies to help promote the rent-to-own business model for solar pumps[32]). International organizations such as International Development Enterprises (iDE) began supporting the development of low-cost drip irrigation systems in the country as early as 1995 (Mukherji and Jose, 2011),[33] and have supported the creation of **drip irrigation kit manufacturing companies** such as Sital Drip Irrigation Technology Industry in addition to widely promoting treadle pumps. Over the last decades, organizations such as iDE, Support Activities for Poor Producers of Nepal (SAPPROS), Forum of Rural Welfare and Agricultural Reform for Development (FORWARD) and Li-Bird have also substantially worked on promoting treadle pumps for farmers in the Tarai (Upadhyay 2004).[34] Drip irrigation kits have evolved to become an affordable and user-friendly technology for small farmers to increase farm productivity (Postel et al. 2001).[35]

Pumps, especially solar-powered irrigation pumps (SPIPs), on the other hand, remain far from affordable for smallholder farmers. The average cost of a SPIP was found to be NPR. 659,482 (approx. USD 5,450) (Pandey et al., 2020a). Even with a subsidy of 60% granted by the **AEPC**, the average cost was still substantial at NPR 263,793 (approx. USD 2,180). Some solar companies have thus joined forces with **microfinance institutions or cooperatives** at the ground level to help coordinate loans and collect future payments from farmers, which are later forwarded to the solar companies themselves. Loans are provided on the basis of group guarantee, which also allows resource-poor farmers to access this circle, and often, the pump itself serves as collateral. Solar companies also use these organizations to help tap into their existing member base as a marketing strategy. However, it should be noted that:

> *"Farmers don't do cost-benefit analysis between diesel and solar" (telephone interview with SunFarmer, October 8, 2020), and "the demand is mainly for diesel-led pumps; there is no demand for solar. Farmers lack knowledge of efficient technologies, lack income to pay on time and rely on the seller for maintenance".*[36]

Urfels and Foster (2020) findings also indicated huge differences (ranging from USD 5 to USD 200 per hectare per irrigation) in the prices farmers paid to access groundwater irrigation. Poor farmers and most marginalized households who lack financial capital to buy pump sets and rely on rental markets for irrigation, suffer most. Similar findings were presented by Shrestha et al., (2018) in Kailali where smallholders were found renting irrigation pumps at a higher cost than the large farmers, adding more to their production cost than larger farmers. High irrigation cost results in less or delayed irrigation by farmers. Delayed irrigation is also caused by having to queue for pump sets, tube wells and repair and maintenance. While well-off farmers schedule irrigation on time, the poor and women farmers lose yield. Farmers' lack of access to affordable irrigation increases vulnerability to monsoon variability and dry spells, leading to crop failures and chronic low agricultural productivity.[37]

---

30 Prices noted are averages as reported in interviews in October 2020.

31 FAO (2019). Country gender assessment of agriculture and the rural sector in Nepal. Kathmandu: FAO.

32 http://www.winrock.org.np/story/detail.php?i=15

33 Mukherji, S., & Jose, P. D. (2011). IDE Nepal: Developing Smallholder Ecosystem.

34 Upadhyay, B. (2004). Treadle pumps transform rural life in Nepal Terai. Appropriate Technology, 31(4), 28.

35 Postel, S., Polak, P., Gonzales, F., & Keller, J. (2001). Drip irrigation for small farmers: A new initiative to alleviate hunger and poverty. Water International, 26(1), 3-13.

36 Telephone interview with an agro-irrigation hardware proprietor, Western Nepal, October 2020.

37 According to the ADB, about 71.6% of smallholders are dependent on informal sources of credit, such as private money lenders and relatives, for loans (ADB 2012).

7.2. Emerging solar technology market for irrigation

Despite farmers' ongoing reliance on diesel pumps, the government and many DPs have experimented with different models for promoting solar irrigation in Nepal, a number of which are explained in **Table 7-3**. The piloted modalities range from 60% subsidized models to rent as you-own or pay as you go and service delivery modalities. Little evidence is available on how effective these different mechanisms have been in reaching bottom of pyramid markets and stimulate irrigation development in the Tarai. Especially, the high subsidy modalities put a large burden on the Nepali government. A better understanding on the effectiveness of the different modalities in reaching specific market segments in the Tarai in function of water availability and VC will be crucial to ensure that returns on investment for farmers, public and private sector can be achieved.

Table 7-3. Different solar irrigation models in Nepal.

Type of business/ financing model	Basic characteristics of model	Strengths	Challenges/ weaknesses	Examples
Subsidy model	Financial model where a certain percentage is a subsidy and the remainder is financed by the farmer	The subsidy model can be used to effectively market and create demand for new technology[38] as the GoN was able to do with SIPs deployed by the AEPC	Subsidy is often captured by relatively well-off farmers and is not targeted to those who actually need the subsidy (Pandey et al. 2020) Unsustainable as it requires continual massive funding from government and development agencies	The GoN SIP subsidy delivery mechanism run by the AEPC (60% subsidy) is similar to a model piloted by ICIMOD in Saptari of the Tarai (Mukherji et al., 2017). As of 2020, 1,384 of solar irrigation pumps are installed with AEPC's 60% subsidy (Pandey et al., 2021).
Subsidy-cum-loan model	This model is a combination of a certain percentage of subsidy added to a loan and a small upfront cost borne by the farmer (Shrestha and Uprety, Forthcoming)	Could help farmers who could otherwise not afford to pay the remaining capital cost up front	Loan repayment schemes need to be flexible for farmers, who may otherwise be unable to pay back the required amount	Provision of solar in Saptari at 60% subsidy, a 20% loan at a 5% interest rate and the remaining 20% upfront payment (ICIMOD model, Mukherji et al., 2017) Cost-sharing model for eight farmers under a cooperative loan modality supported by Winrock International and local municipal government (Foster et al., 2017)
Pay-as-you-go/ rent-to-own model	No subsidy. Farmers pay a fixed monthly or quarterly fee (with interest levied on the progressively declining principal balance) to rent the equipment until all debt is cleared, after which the farmer owns the pump (IRENA, 2016)	The model allows farmers to take temporary ownership of the pump and gives them the option to try out a new technology and even back out if unsatisfied (IRENA, 2016)	Transaction costs could be higher with many smaller payments over the years	SunFarmer, a prominent solar company in Nepal, has deployed this model, with farmers paying up to 20-25% of the upfront cost and the remainder under the company's rental/water-sales agreement for two-three years (Pandey et al., 2020)
Water entrepreneurship model	Water from SIPs is sold to farmers by a private individual, company or NGO (Mukherji et al., 2017)	Smallholders, in particular, could benefit from this model as they would not have to own the pump and can pay for the water	Experience in Bangladesh showed that the high cost of SIPs, long payback periods and the difficulty of running a company-led water-selling business have hindered active private player interest while NGOs seemed more forthcoming (Mukherji et al., 2017)	Water-vending markets are found in the Tarai for shallow tube well and pump rental (Urfels et al., 2020)

[38] Shrestha, S. and Uprety, L. (forthcoming). Solar Irrigation in Nepal – A Situational Analysis Report. IWMI-Nepal.

8. Public and Private Sector Interventions for Irrigation Development

8.1. Overview of irrigation development

Agriculture in Nepal is dependent on the monsoon season from June to September when 75% of the rainfall occurs (ADB n.d.).[39] Progressively erratic weather conditions, with late or pre-monsoon precipitation coupled with frequent floods and droughts in many parts of the country, have impacted crop yields (Shrestha, 2014). This is especially true for crops such as rice and maize in the Tarai, which most smallholder farmers rely on seasonal rainfall to grow. Controlled irrigation is thus critical to agricultural productivity, not just in the dry season but also during dry spells caused by the delayed monsoon (ADB n.d.). Farmers are also negatively impacted if their farms are far away from water sources (such as rivers), and thereby unable to practice supplemental irrigation, especially once the monsoon is over. There are also several delimiting factors that affect proper groundwater usage by farmers, as can be seen from **Figure 8-1**, the most common being the high cost associated with groundwater extraction coupled with no pump and load shedding (power cuts) followed by water scarcity and lack of water pump for irrigation.

The focus on and programs for irrigation development in Nepal have evolved along with the country's political and economic development (Awasthi et al., 2016). As shown in **Table 8-1**, prior to the 1920s, a customary practice of farmer-led irrigation was prevalent. This evolved to become a modern irrigation system managed by the state. The first public sector irrigation scheme was established between 1922 and 1928, with Chandra Nahar being the first irrigation system constructed in Saptari, a district in the Tarai. The Department of Irrigation was established in 1952. Irrigation development planning and investment became more systematic following the introduction of the country's first five-year development plan (1956-1961) (Bastakoti et al., 2010). The government-led irrigation system evolved from the 1960s to the present following changes in strategy (government-to-government (G2G) and the community approach – WUAs) and focus (e.g., large-scale irrigation infrastructure to small-scale along with rehabilitation or upgrading of large-scale irrigation schemes, and new large-scale irrigation schemes).

Literature shows that international organizations have driven irrigation development in Nepal since the introduction of modern irrigation systems from the mid-1950s (**Table 8-1**). The support of the Indian and US governments was critical for technical capacity development on hydrology in the 1960s. Multilateral donors entered the sector from 1970s, with a focus on large-scale irrigation development to reduce poverty and increase agricultural production. The ADB, World Bank (WB) and Saudi Fund account for over 50% of the total investment in the irrigation sector (Awasthi et al., 2016), although other developments partners such as the SDC, IFAD, JICA, Canadian International Development Agency (CIDA), UN agencies and INGOs have also supported the irrigation and agriculture sectors since the late 1980s, with the main goal of improving agricultural incomes and livelihoods of farmers. It is only since the mid-2000s that international companies have entered irrigation projects (e.g., the SDC's Small Irrigation Project in province 1), preparation of river basin management plans (WB) and the National Irrigation Master Plan (ADB) funded by bilateral and multilateral donors.

[39] ADB (n.d). Sector Assessment (Summary): Irrigation Nepal: Community Irrigation Project.

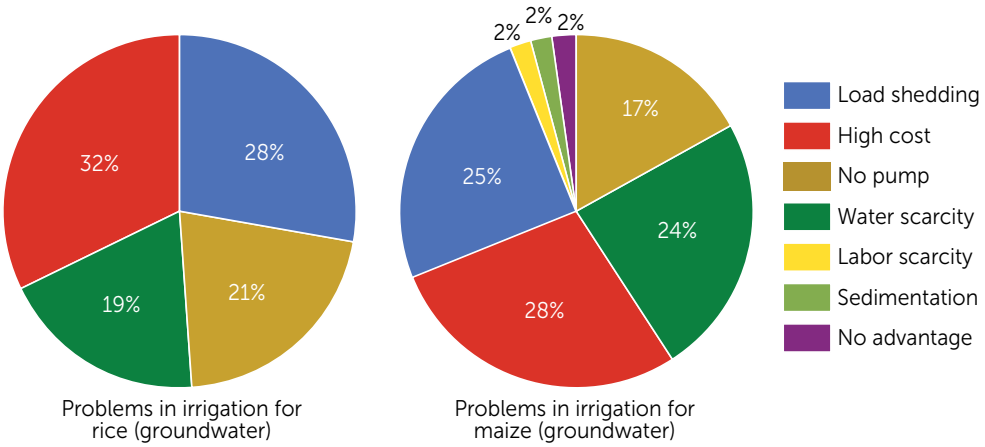


Figure 8-1. Problems in accessing groundwater in the Tarai (Chitwan district).
Source: adapted from Shrestha, 2014

Table 8-1. The evolution of irrigation development in Nepal, 1920s-2020.

Year	Until 1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Irrigation typologies	Customary system of irrigation management (FLI); modern irrigation initiated Chandra Nahar canal in 1922	Low-cost irrigation facilities: construction of small wells, irrigation tanks, reservoirs, pumps (lift) and other facilities	Large-scale irrigation infrastructure development in the Tarai through international funding & government-managed	Construction of irrigation infrastructure (canals and dams); participatory approach to irrigation, registration of national WUA	Rehabilitation of irrigation systems, SSI, support to strengthen FMIS/ WUAs	Large-scale irrigation construction and rehabilitation, SSI, FMIS and MUS	Large-scale irrigation construction and rehabilitation, SSI, FMIS and MUS Irrigated agricultural value chains, & renewable energy (solar)	Large-scale irrigation construction and rehabilitation, SSI, FMIS and MUS Irrigated agricultural value chains, & renewable energy (solar)
Implementation modality	State-only and people's practice – no presence of development partners (DPs)	G2G (state- DPs)	G2G(state-DPs)	State-DPs-WUAs	State-DPs-WUAs	State-DPs-WUAs-I/NGOs	State-DPs-WUAs-I/NGOs-private sector	State-DPs-WUAs-I/NGOs-private sector
Irrigation management system	Farmer-managed irrigation system (FMIS)	Agency-managed irrigation system (AMIS)	AMIS	AMIS-FMIS	AMIS-joint-managed irrigation system (JMIS)-FMIS	AMIS-JMIS-FMIS	AMIS-JMIS-FMIS	AMIS-JMIS-FMIS
Stakeholder participation	People only in customary irrigation management practices; state in modern irrigation	People as beneficiaries, state as implementer with technical support from DPs	People-state-DPs	People-state-DPs	People-state-DPs-I/NGOs	People-state-DPs-I/NGOs-CSOs	People-state-DPs-I/NGOs-CSOs-private sector	People-state-DPs-I/NGOs-CSOs-private sector
Development partners (DPs)	None	USAID, India	USAID, ADB, WB	WB, ADB, USAID, UNDP	WB, ADB, USAID, UNDP,	WB, ADB, USAID, UNDP, CIDA	WB, ADB, USAID, UK Aid, SDC, JICA, Saudi Fund	WB, ADB, SDC, USAID, UK Aid
Implementing agencies (INGOs and private sector)				CARE, SNV	iDE, SNV	iDE, Helvetas, GEOCE Pvt. Ltd.	iDE, Helvetas, GEOCE Consultants Winrock	iDE, GEOCE Consultants

Source: Study team's analysis (2020).

8.2. Dynamic interventions supporting irrigation development

Irrigation interventions in the FtF ZoI can be categorized into five types, according to the design and scope of the interventions, scales of beneficiaries and irrigated area (**Table 8-1**): i) large-scale irrigation projects; ii) SSI projects; iii) non-traditional irrigation included in rural development projects; iv) collective action and market development; and v) farmer-led multiple-use water management.

8.2.1. Large-scale irrigation interventions

Since the 1970s, public sector investment in large-scale irrigation systems in the Tarai has increased tremendously. Predominantly, investments are made in dams or reservoirs and canal infrastructure, including inter-basin infrastructure design and construction for irrigation and electricity. Although part of investment includes training for irrigation water groups and staff, the substantial amount of capital budget is spent on infrastructure construction and rehabilitation. Hence, investments are dominated by 'technical-managerial' approaches (Clement et. al., 2012) in which the 'construction work and engineering perspective receives higher priority over efficient use of irrigation water, public-private investment and collaboration, and socio-governance and empowerment issues of irrigation'.

These investments are mainly funded through international development loans and grants (Awasthi et al., 2016). Multilateral development partners such as the WB and ADB are the major players in large-scale irrigation interventions. An estimated USD 1.8 billion was spent in the irrigation sector between 1956-2013. Only 23% of this amount was funded by the government. The majority of the investments (around 56%) have GoNe to constructing new irrigation infrastructure. Only 18% has been spent on the rehabilitation and expansion of FMIS networks, despite a policy focus on these activities since the mid-1980s (Awasthi et al., 2016).

Large-scale irrigation infrastructure projects are managed according to the agency-managed irrigation system (AMIS), which was established in 1986 with USAID funding. Targeting both the Department of Irrigation and water users, AMIS aims to develop capacity in irrigation management. The project later supported the joint-managed irrigation system (JMIS) in 1992 (DWRI, 2019). The DWRI manages large-scale irrigation projects, although it focuses mainly on implementation

rather than providing public services related to irrigation services. As of 2019/20, the DWRI was managing 23 projects, 10 of them in Western Tarai (DWRI, 2019). The provincial governments in the FtF ZoI are also focusing on irrigation projects, mostly with infrastructure development, and budget and programs for promoting SSI are very limited (CSISA province 7 workshop, December 17, 2021).

Although large-scale irrigation interventions have contributed to crop intensification, crop diversification and an increase in commercial farming (e.g. vegetable production), the interventions tend not to be sustainable and beneficial to smallholder farmers. The key barriers, according to Awasthi et al., (2016), are: i) weak governance frameworks and enforcement in attaining effective service delivery; ii) poor understanding of farmers' priorities and needs by the public sector and intervention agencies; and iii) weak institutional arrangements that limit context-specific project planning and effective system management. Other issues that contribute to poor outcomes include: i) a lack of initiatives strengthening the roles of WUAs post-construction; ii) the absence of a legal framework that would ensure WUAs receive agricultural market support and linkages to local cooperatives; and iii) weak policies and guidelines for implementing the principles of equity, optimum use and conservation of water resources (JICA, 2013). Moreover, large-scale irrigation development is seen as the sole responsibility of the government, reinforcing 'single actor' and 'top-down' irrigation planning and decision-making (Pradhan and Belbase, 2018, Pradhan, 2000), with a sole focus on infrastructure, hindering participatory, multi-actor and inclusive irrigation management practices.

Table 8-2. Basic features of irrigation programs/projects in Nepal.

Basic features	Large-scale irrigation	Small-scale irrigation	Irrigation technologies within rural agricultural development	Collective action and market development	Farmer-led multiple-use water management
Investment and scope of irrigated land	Large-scale projects, large command area	Small-scale projects each with <25 ha command areas	Small-scale investment, based on locally available materials and resources	Small-scale investment, consolidated lease plots and small-sized land	Small-scale investment, small plots
Geographic suitability	Irrigable lands in the Tarai	Irrigated agriculture (Tarai and Hills)	Rain-fed agriculture and territory canals (Tarai, Hills, Mountains)	Rain-fed agriculture and irrigated agriculture (Tarai, Hills, Mountains)	Rain-fed agriculture (mostly in the Hills and Mountains)
Governance mechanism and lead actors	Top-down, government managed with engineering roles (AMIS, Joint Management System)	Government managed interventions but engage FMIS and WUAs	NGOs facilitate irrigated infrastructure, community driven, materials and techniques are indigenous (agricultural collectives, cooperatives)	Group farming (collectives of women, marginalized groups, tenant farmers, youth) and cooperatives	Bottom-up, materials and techniques managed through FMIS, community forest user groups, water user groups
Water uses and agriculture	Mostly irrigation for cereal production, inter-basin and canal infrastructure	Mostly irrigation for cereals and vegetables	Multiple uses, including aquaculture, sanitation, drinking, livestock, homestead off-season vegetables	Irrigation for off-season vegetables, cereals, aquaculture, livestock, sanitation	Multiple uses, including drinking, sanitation, livestock, homestead off-season vegetables,
Irrigation technologies	Large-scale surface water irrigation infrastructure (e.g., reservoirs, inter-basin)	Small-scale with surface canals and/or groundwater irrigation technologies using shallow tube wells and deep tube wells	Surface and groundwater technologies using tanks, ponds, pipes, lift irrigation (electric or diesel or solar engine), tube wells, drip and sprinkler irrigation	Surface and groundwater technologies using tanks, ponds, pipes, lift irrigation (electric or diesel or solar engine), tube wells, drip and sprinkler irrigation	Surface and groundwater technologies using tanks, ponds, pipes and lift irrigation (electric or diesel or solar engine), drip and sprinkler irrigation
Cost-effectiveness	Expensive, high dependency on multinational companies and donors	Low-cost, farmers and national private sector actors can invest in and share the cost	Low-cost, NGOs provide subsidies to smallholder farmers for irrigation equipment, and local private sector provides technical services for micro-irrigation equipment	Low-cost, NGOs and farmers are the main investors in irrigation equipment; cooperatives and microfinance institutions provide credit to water groups and farmer groups, including women	Low-cost, farmers are the main investors in irrigation equipment, and local private sector provides services (in some cases climate projects and rural natural resource management projects provide subsidies)
Suitability and accessibility by farmers	Less sustainable, effective and inequitable. Mostly male farmers, large landholding farmers in the Tarai	Becoming sustainable, effective and equitable and gender and socially inclusive (in terms of quantitative participation in WUAs and training). Mostly smallholders, including poor, women and disadvantaged farmers in all agroecological regions	Relatively sustainable, effective, locally driven rules and practices of irrigation management, friendly to women and marginalized groups. Women farmers with small plots, the poor, tenant and marginalized farmers in all agroecological regions	More sustainable, effective, locally driven rules and practices of irrigation management and market regulation, friendly to women and marginalized groups. Smallholder and tenant farmers with small plots (tenancy or private lands), women and young entrepreneurs.	More sustainable, effective, locally driven rules and practices of water management. Investment from local governments, groups or individual farmers, friendly to women and marginalized groups. Smallholder and tenant farmers, women and young entrepreneurs & SME's.

Source: Study team's analysis (2020).

8.2.2. Small-scale irrigation interventions

SSI interventions mostly focus on irrigation command areas of less than 25 ha. Since the introduction of the second three-year development plan (1962-1965), the GoN has provided low-cost-irrigation facilities to farmers (Bastakoti et al., 2010) in the form of small wells, irrigation tanks, reservoirs, pumps, shallow tube wells and others. With the interest in participatory irrigation management (PIM) in the 1980s, massive interventions supported by external funding resulted in the SSI activities. The attention in SSI remains predominantly focused on canal infrastructure and less is known about the extent to which groundwater is pumped by diesel or electric pumps in the Tarai for cereals or vegetables.

SDC, ADB and World Bank-funded projects are implemented by the DoA and Department of Local Infrastructure (DoLI). The SDC-funded Local Infrastructure for Local Livelihoods project was initiated in 2006 with the aim of improving the food security of smallholder farmers in the rural areas of Swiss cluster districts. The project targeted socioeconomically discriminated and small farmers owning farming land below 0.25 ha (eda.admin.ch). The current Small Irrigation Program (July 2020-December 2024) is fully operational through the local government, with the focal coordination by the DoLI of the Ministry of Federal Affairs and General Administration (MoFAGA) at the federal level and the MoPID at the provincial level. This is the first SSI project since the introduction of federalism that is managed by local governments, who now have exclusive power to govern agricultural development and irrigation programs at the local level (SDC, 2020). The recent World Bank-funded Rural Economy and Enterprise Development (REED) project (2020-2024) also considers local governments as the project's frontline actors (World Bank, 2020). Investments from the ADB and World Bank have been crucial in supporting SSI through FMIS, although other donors have supported SSI in the Hills and Tarai.

All of the SSI projects currently underway (Small Irrigation Program – SIP/SDC, Community Irrigation Project – CIP/ADB, Irrigation and Water Resources Management Project – AF/WB, Community-managed Irrigated Agriculture Sector Project – CMIASP/ADB, Community Groundwater Irrigation Sector Project – CGISP/ADB) aim to reduce poverty by increasing agricultural incomes and food security. Although the projects target the poor, women, Dalits, Janajatis and other marginalized groups, their GESI interventions are limited to ensuring women's representation in WUAs, technical training and agricultural extension services. The projects are implicit in terms of making project governance and steering committees inclusive and specifying measures for enabling women to access irrigation technologies or participate in agricultural VCs. Donors assume that the construction of infrastructure for small-scale farming will benefit the poor, women and disadvantaged groups, which is a challenge for irrigation scaling in Nepal (Clement et al., 2012). Despite policy reforms aimed at irrigation management transfer and participatory irrigation management, the reforms have only been implemented partially. Moreover, they contain no explicit pro-poor elements and are insufficient for improving system performance and delivering significant benefits to the poor (Hussain, 2007).

The government has in the past invested substantial financial resources in developing irrigation infrastructure, with unsatisfactory results (Paudel and Sharma, 2012, p. 17). A systematic comparative study on the performance of (government-funded) AMIS and (farmer-funded) FMIS showed that FMIS outperformed AMIS on most key parameters, including crop yield, cropping intensities and optimum use of irrigation water (Lam 1998 cited in Paudel and Sharma, 2012). Over 70% of the irrigation systems in Nepal are FMIS, while only 30% fall under the state-managed irrigation arrangement (IMP 2019). The former alone contributes to 40% of rice production in Nepal (Pradhan, 2000). Moreover, because of land fragmentation and smaller area coverage, most FMIS are developed, owned and managed by individual farmers and communities (ibid).

8.2.3. Irrigation technologies within rural agricultural development programs

This category of irrigation projects is mostly managed and implemented by NGOs. Irrigation technologies consist of non-conventional irrigation technologies (NIT), including multiple-use water systems (MUS). More common are direct micro-irrigation interventions, for instance the USAID-funded Nepal Smallholder Irrigation Market Initiative (SIMI) (2003-2009), which focused on introducing micro-irrigation technologies such as drip irrigation kits, micro-sprinklers, local water storage technologies (Thai jars), treadle pumps and low-cost diesel and electric pumps (Winrock International, 2009). SIMI was also a pioneer in terms of promoting locally appropriate and affordable SSI technologies such as MUS, linking technologies with irrigated agriculture VCs and building the capacity of all VC actors through PPPs (ibid).

The project's micro-irrigation technologies and approaches were adopted by subsequent SSI projects such as Education for Income Generation (IGE/USAID) as well as by the WB, ADB and SDC (ibid). These technologies tend to be more equitable and smallholder-centric but receive little or no attention when it comes to scaling. A review of the types of projects funded by bilateral and multilateral donors from 2004 to 2018 showed that more than 10 donors funded 35 projects in a single road corridor of central Nepal, in which some component of small-scale, MUS and NIT interventions were supported (JICA and KRI International Corp, 2014). The NIT and MUS included in rural development projects aimed to promote the use of alternative technologies other than conventional irrigation technologies and techniques (JICA, 2013, GC et al., 2019, Clement et al., 2015). NIT interventions mostly targeted the poor, women and disadvantaged groups, providing

them with low-cost irrigation technologies, skills and services to increase production and productivity of high-value crops. The projects linked farmers with agronomy and agricultural extension services and VCs. Some of the approaches that connected NIT and MUS with irrigated agricultural VCs were the commercial pocket approach and market planning committees (GC et al., 2019), which were pioneered by the SIMI project (ibid).

In MUS interventions, 40% of the total cost was covered by farmers and farmer groups (JICA and KRI International Corp, 2014). Farmer-managed or traditional irrigation systems proved to be sustainable because of the low cost of their maintenance and community rules regarding water access and use (Lam 1998 cited in Paudel and Sharma, 2012). Rising male outmigration has resulted in additional agricultural responsibility for women. NIT and MUS along with solar irrigation pump subsidies for those left behind represent gender-friendly water solutions for producing high-value crops and increasing economic empowerment.

NIT-focused projects also contributed to cross-sectoral partnerships for scaling irrigation. These projects included integrated approaches for enhanced agricultural production, water use efficiency, equity and farmers' empowerment as well as decentralized agriculture and local irrigation services from public institutions (Winrock International, 2009, JICA and KRI International Corp, 2014). NIT can support people living in rural and peri-urban areas and at the tail-end of modern irrigation canals to access water for drinking, cooking, washing, sanitation, livestock, growing food and generating incomes. However, water projects in Nepal tend to cover only a few of these uses, focusing on either domestic or productive, and they work in an uncoordinated manner (ADB, 2009, JICA and KRI International Corp, 2014). Recent IWMI studies showed that MUS technologies, although they meet farmers' domestic and productive needs in an integrated manner while making the most efficient use of water resources (Clement et al., 2019), have not been institutionalized in government policies and plans for scaling.

8.2.4. Collective action and market system development

The fourth category of irrigation interventions is small in scale and involves collective action by poor and tenant farmers to access micro-irrigation facilities along with credit and markets for irrigated agricultural produce. The GoN agriculture and natural resources management projects and action research activities on the water-food-energy-climate nexus provide technical support to establish and operate collective action (Sugden et al., 2020). In the FtF ZoI, cooperatives facilitate collectives of the poor, women and marginalized groups (e.g., Dalits) to access credit from microfinance institutions, including development banks for commercial farming (telephone interview, MP, February 12, 2020). Group farming (e.g., collectives of women, tenant and smallholder farmers) and agriculture cooperatives are the governance mechanism to access irrigation technologies and connect irrigated agricultural produce with markets. Common irrigation technologies include shallow tube wells, solar-powered irrigation pumps (SIPs) and drip and sprinkler irrigation, which are used for off-season vegetables, cereals, aquaculture, livestock and sanitation (Upadhyay et al., 2005).

A number of studies have found a positive relationship between cooperatives and their role in supporting farmers in the country. A study (Niroja et al., 2015) found that when cooperatives in Chitwan acted as mediators, they wielded more bargaining power when dealing with traders than when individual farmers acted on their own. Transportation and marketing costs were also found to have decreased dramatically when engaging with cooperatives. A comparison between farmers who are part of such cooperatives and those who are not found that member farmers used improved farming practices thanks to greater accessibility of farm inputs and subsidies (Neupane et al., 2015).

In the Tarai, tenant farmers constitute the main workforce in agricultural production (Bastakoti et al., 2017, Sugden, 2014). A lack of land tenure constrains their access to groundwater irrigation technologies and credit. However, action research carried out in the Eastern Gangetic Plain revealed that collective action by smallholder and tenant farmers helped these farmers to access groundwater irrigation technologies (ibid). IWMI-led research in the same area showed that collectives of tenant farmers enhanced their bargaining power when it came to negotiating with land owners and improved their access to irrigation equipment and extension services provided by agriculture and irrigation service centers (Sugden et al., 2020).

Collective action by farmers tends to be more effective and based on locally driven rules and practices of irrigation management and market regulation. New agricultural projects in Nepal are moving towards strengthening linkages among cooperatives, producer groups and markets. As an example, a GoN development project that aims to improve the economic capacity of groups vulnerable to Covid-19 focuses on linking producer groups with cooperatives and other VC actors (e.g.World Bank, 2020). Agricultural cooperatives could be an important institutional bridge to link farmers with microfinance institutions and private sector actors in scaling irrigation technologies that are targeted to women and small-scale farmers.

The Finnish government-supported Rural Village Water Resources Management Project (RVWRM) in Western Nepal has been a pioneer in promoting the cooperative approach to sustainability and functionality of water supply systems for irrigation, drinking, sanitation, livestock and environmental conservation (Yadav, 2018a). Connecting water user groups with local cooperatives can help mobilize financial resources for irrigated agricultural VCs. In addition, the GoN established the Youth and Small

Enterprises Self-Employment Fund in FY 2010/11 with the aim of creating employment opportunities for unemployed youth.[40] The GoN is planning to decentralize the loan process and program to all local governments. The fund can be a source for scaling irrigation technologies supporting high-value VCs, as the current business category of the fund mobilization largely focuses on off-farm and on-farm enterprises without much focus on micro-irrigation technologies and services. The fund access mechanisms also need to improve to ensure equitable access by marginalized and tenant farmers.[41]

Promoting collective action by young people in irrigation technologies and market development could also be an opportunity in the FtF ZoI. In an effort to attract young people to commercial agriculture, the Israeli government is working with the Nepali government to run the high-tech **Small Farmer Youth Agriculture Training Program**. This has provided Nepali youths with agricultural training in Israel since 2013. Similarly, Sana Kisan Bikas Laghubitta Bittiyasanstha Limited (SKBBL) in collaboration with the Embassy of Israel in Nepal runs the Small Farmer Agriculture Training Program in different training institutions/colleges in Israel. The program, which lasts 10-11 months, is aimed at young farmers aged 22-30 belonging to small farmer families affiliated with the Small Farmer Agriculture Cooperatives Ltd (SFACLs). On their return to Nepal, participants are expected to undertake an entrepreneurial activity related to the modern agricultural technologies and practices they learned about in Israel. It is hoped that their success will serve as an example to other young farmers and motivate them to follow in their footsteps.

8.2.5. Farmer-led irrigation and multiple-use water management interventions

These irrigation interventions are mostly managed by farmers with the technical support of climate change adaptation, rural water supply and rural development projects/programs in the forest/environment, water supply and agriculture sectors. The interventions aim to build the resilience of smallholder farmers, women, marginalized groups and climate-vulnerable groups whose livelihoods mostly depend on rain-fed agriculture across three agroecological zones (IWMA, 2020, IFAD, 2014, Regmi et al., 2016, iDE Nepal and Rupantaran, 2019). FMIS in combination with multiple-use water systems (MUS),[42] including local water user master planning (WUMP), water conservation and efficient use by water user groups (WUGs) and forest user groups (FUGs) are considered to be proven WRM practices. Farmers practice the construction of water recharge ponds, rainwater harvesting tanks, soil and water conservation techniques within community forests and MUS for livelihoods and water security (Thapa et al., 2016, Pradhan et al., forthcoming, GC, 2020, Nepal and Subedi, 2016, Shrestha and Clement, 2019a). These FLI practices and the municipal-level WUMP focus on conservation and water for multiple uses, including irrigation, drinking, sanitation, livestock, cultural functions and homestead off-season vegetables. Irrigation equipment includes both surface and groundwater technologies using tanks, ponds, pipes and lift irrigation (electric, diesel or solar engine), drip and sprinkler irrigation (key barriers and solutions for sustainable, efficient and effective surface water irrigation management in Nepal are found in **Annex 6**).

FMIS, including multiple-use water management, are locally driven, cost-effective, resilient, inclusive and sustainable, particularly for smallholder farmers and marginalized groups. While other types of water management systems, such as agency-managed irrigation systems (AMIS), have documented sustainability challenges, FMIS has adopted farmer-led structural and operational strategies to cope with water stress (Thapa and Scott, 2019). The structural strategies are hard path solutions that include system rehabilitation works, while the operational strategies are soft path solutions that include application of institutional rules and mechanisms to manage various types of challenges including water stress. Accordingly, as Thapa and Scott's study showed, farmers adopted three major strategies: i) expansion of water sources by bringing in additional water; ii) establishment of extra rules for equitable water distribution during stress periods; and iii) water exchange with neighboring FMIS. This has led to added volumes of water for irrigation and equitable redistribution of available water among farmers, with direct implications for agricultural productivity.

Water conservation technologies have documented success in terms of facilitating water access for agriculture and forest-based small-scale enterprises in the Hills and Mountains regions while recharging mountain springs (iDE Nepal and Rupantaran, 2019, ASHA, 2019) that are risk of vanishing as a result of climate change and other drivers (Poudel and Duex, 2017). These technologies have also contributed to improving livelihoods, income generation and time spent fetching water as well as being more sustainable compared with single-use water systems (Clement et al., 2015, GC et al., 2019). GC et al. (2019) found that around 90% of the households in their study area were engaged in two or more productive activities (e.g., vegetables, horticulture, livestock, dairy, local wine making) that contributed more than 10% of their mean annual household income (USD 4,375). In addition, MUS have shown to benefit WASH in terms of safe drinking water, better sanitation and

[40] Interview, acting executive director, March 1, 2021.

[41] Interview, acting executive director, March 1, 2021.

[42] There are around 2,800 MUS in Nepal supported by different development projects (van Koppen et al., 2019). Many MUS include traditional water supply systems that have been de facto MUS, e.g., farmer-managed irrigation systems (FMIS) that have been used for livestock water needs and washing clothes and utensils or drinking water supply systems used for irrigating vegetable plots on homestead land (Clement et al., 2015).

hygiene (reduced waterborne diseases, behavior change around bathing, use of toilets and cleaning) (GC, 2011, van Koppen et al., 2019).

MUS can also be a sustainable solution to the water poverty experienced in Western Nepal (Panthi et al., 2018). The economic returns generated by MUS could contribute to increased financial capacity to maintain the system (Rautanen and G.C., 2012). However, one study indicated that a system's sustainability could be threatened if equality and fairness are not considered (Clement et al., 2015). Therefore, it is important to consider intersectionality when designing rural water systems in order to address the structural barriers that keep out the already excluded and powerless (ibid). Other factors that could impact the sustainability of MUS include: a lack of formal linkages between the MUS/ Market Promotion Committee and government agencies; high rates of male outmigration and the inter-relationships of social capital (in particular, trust and reciprocity), characteristics of water resources (water flow) and characteristics of the infrastructure (geographical extent of the system and technological capacity to distribute water equitably) (ibid). Despite the documented positive impacts and a proven socio-technical institution, MUS needs to be institutionalized in local water planning (Clement et al., 2019).

8.3. Ecosystem for accelerating irrigation development

8.3.1. Actors and stakeholders and their roles

Several actors and stakeholders have emerged and been involved in interventions for irrigation development with different roles, interests and mandates (**Table 8-3**). The major actors and stakeholders in the FtF ZoI can be categorized into

Table 8-3. Multiple actors and their key roles in water resources and irrigation development (implementation level) in Nepal.

Category	Key institutions	Key roles
Government line agencies at federal level – water, energy, agriculture	Water sector: Department of Water Resources and Irrigation (DWRI), Department of Hydrology and Meteorology (DHM), Groundwater Resource Development Board (GWRDB), Water Resources Research and Development Center (WRRDC), Alternative Energy Promotion Center (AEPC), Department of Electricity (DoE) Department of Water Supply and Sewerage (DWSS) Agriculture and local development sector: Department of Agriculture (DoA), Nepal Agricultural Research Center (NARC), Department of Local Infrastructure (DoLI)	Water sector line agencies: Implementation of programs, master plans, river basin strategy, research and capacity development, inter-basin water transfer, inter-provincial water projects, large-scale irrigation projects, water-induced disaster risk management, early warning system, water quality, energy development, including alternative energy (e.g., solar irrigation pumps), large-scale water supply projects Agriculture sector and local development line agencies: Improved seeds and fertilizer supply, research and capacity development, programs on poverty reduction, on-farm irrigation technologies, coordination and implementation of local infrastructure development programs and projects
Government line agencies at provincial level	Water Resources and Irrigation Divisions and Subdivisions, Irrigation Management Divisions, Groundwater Resource and Irrigation Development Divisions, Water Supply Divisions Agriculture Knowledge Centers, Soil and Watershed Management Office, Forest Divisions	Develop, implement and monitor medium-sized irrigation projects, water supply projects, inter-municipality irrigation and water supply projects, groundwater and energy development, including alternative energy (e.g., solar irrigation pumps), agriculture market development and extension services, watershed conservation and management, climate change adaptation and mitigation
Local governments	Sectoral units such as infrastructure development and environment management, agriculture, social (health, education, women)	Implementation of municipal-level programs on local irrigation, alternative energy (e.g., micro-grid, solar irrigation), water supply, agriculture development, disaster risk management, watershed and environmental conservation and GESI
Private sector (irrigation equipment supply)	Gham Power, SunFarmer, Sikhar Insurance, Sun Work Nepal, technical and vocational education and training (TVET) institutions, Sital Thopa Sichai, diesel pump suppliers, agro-vets	Technical services for solar irrigation equipment, including O/M and technical training, including solar irrigation, agro-vets, extension services, enterprises, microfinance services, crop insurance, drip irrigation kits
Banks, microfinance institutions and cooperatives	Commercial banks, development banks, Sana Kisan Bikas Laghubitta Bittiya Sanstha Ltd (SKBBL), Nepal Agricultural Cooperative Central Federation (NACCF), local cooperatives	Credit services for income-generation activities, agricultural inputs, irrigation equipment, saving and credit among farmers, liaising with the subnational governments for subsidy programs and insurance
WUAs, NRM groups, CSOs	Water user groups, national federation of irrigation users and water supply, farmer groups and their federations, forest user groups and their federation	Implementation of irrigation and water conservation and management activities, safeguarding people's rights to water and natural resources, policy advocacy, capacity building, public awareness of water and natural resources management issues
INGOs, NGOs	INGOs: Renewable World, Mercy Corps, iDE, Winrock, Water Aid, Helvetas, Oxfam, SNV, CARE Nepal, Practical Action NGOs: Farmer-managed Irrigation System Trust (FMIST), Nepal Water Conservation Foundation (NWCF), Jalsort Viskas Sanstha (JVS), SAPPROS Nepal, DEPROSC, Sundar Nepal, LiBird, many local NGOs in the FtF ZoI	MUS technology, water conservation technologies, irrigated agricultural value chains, solar irrigation, local-level water use master planning (WUMP), resilience programs, research, policy and institutional capacity development, policy analysis and advocacy, markets, public awareness, rural livelihoods, SMEs, networking
Research institutions	IWMI, Kathmandu University, Tribhuvan University, Agriculture and Forestry University and affiliated institutes	Research for development, academic research and evidence-based policy and capacity development
Development partners (DPs)	SDC, ADB, WB, USAID, IFAD, JICA, UK Aid, Finnish government, UNDP, UNICEF, UNEP, UN Habitat, FAO	Small-scale irrigation, large-scale irrigation, WASH, solar irrigation, resilience, markets initiative, WUMP at municipality level, agricultural value chains, climate change, national adaptation plan of action, disaster risk reduction

Source: Study team's analysis (2020).

seven broad categories: i) government line agencies at the local, provincial and federal level; ii) private sector; iii) banks, microfinance institutions and cooperatives; iv) natural resources management groups, including water users and their associations; v) national and international NGOs; vi) research institutes; and vii) development partners.

Government agencies at the federal level: The DWRI and the DoA are the key departments that coordinate and implement water resources, irrigation and agriculture-related policies, strategies, master plans and national projects. The DoLI is the key department that implements infrastructure projects, including SSI and agricultural markets. The DHM and the AEPC are nodal agencies for hydro-metro data collection and access, and for promoting renewable energy technology (RET), including solar-powered irrigation pumps (SIPs). The Department of Water Supply and Sewerage (DWSS) implements large-scale drinking water and sanitation projects. The GWRDB, established under pre-federal system, has roles in groundwater issues (e.g., delineating groundwater potential areas in the Tarai – shallow and deep aquifers – through geophysical survey and investigation, monitoring, research and capacity building on groundwater). The WRRDC and the NARC are involved in research and capacity building on water quality, availability and use and agriculture.

At the provincial level, the WRI Divisions, WRI Subdivisions, Water Supply Divisions, Irrigation Management Divisions, and Groundwater Resources and Irrigation Development Divisions of the provincial MoPID design, implement and monitor medium-sized surface and groundwater irrigation and renewable energy infrastructure projects. There are four GWRID Division in the FtF ZoI provinces [1 in Sudurpashim and 3 in Lumbini].[43] The roles of these Divisions are expected to deal with groundwater resources issues and capacity development of farmers, local service providers and governments. The AKC, Soil and Watershed Management Offices and Forest Divisions are the main actors that coordinate and implement agriculture, soil and watershed, agro-forestry and climate adaptation and mitigation programs. The Directorate of Industry, Commerce and Consumer Protection along with domestic and small enterprises offices coordinate and provide services relating to technical capacity building, public and private sector investment and enterprise registration.

At the local level, the new federal structure and the creation of local governments (*gaunpalikas* and *nagarpalikas*) since 2017 have better enabled decentralized, bottom-up, democratic, demand-driven and integrated interventions than the previous system (Khatri et al., 2021, Pokharel et al., 2020a). Local governments are the main player with overwhelming power for local development, including irrigation and agricultural development. Their Agriculture Services Center interfaces with the provincial AKC for input services to farmers (Devkota and Thapa, 2019).

The federal-level draft Water Resources Bill 2020 and the Business Rules 2019 define the scope of water, energy, WASH and irrigation project implementation roles at all levels of government. Large-scale irrigation projects are implemented at the federal level, while medium and small projects are assigned to the provincial and local level respectively (**Table 8-4**). This delineation of project implementation function might limit the policy and regulatory oversight roles of federal and provincial governments when it comes to supporting local governments in implementing devolved and inclusive irrigation, water supply, agriculture and energy development. However, enabling local governments to design and implement local-level integrated WRM projects through PPPs could be an opportunity to scale FLI and SSI for multiple water use purposes.

State actors have direct interface with the private sector, microfinance institutions, cooperatives and farmers' collectives, WUAs and other natural resources management groups at the grassroots level. This interface also offers potential for scaling FLI and SSI, as discussed below.

The cooperative federation that supports the Small Farmer Cooperative Limited (SFCL – the umbrella organization of the Nepal Agricultural

Table 8-4. Scenario for scaling irrigation through varying sizes of irrigation command areas at three levels of government.

Level of government	GoN Business Rules 2018			Draft Water Resources Bill 2020		
	Tarai-Madhesh	Hills	Mountains	Tarai-Madhesh	Hills	Mountains
Federal	> 5,000 ha	>100 ha	>50 ha	>5,000 ha	>100 ha	Not specified
Provincial	2,000-5,000 ha	50-100 ha	25-50 ha	2,000-5,000 ha	50-100 ha	25-50 ha
Local	Command areas not specified; local water resources, rehabilitation, repair, maintenance and management of small water infrastructure are the responsibility of local government			<2,000 ha	<50 ha	<25 ha

Source: GoN Business Rules 2019 and draft Water Resources Bill 2020.

[43] Altogther 11 GWRID Divisions are established in provincial level in the federal strucutre housed in the provincial Ministry of Physical Infrastructure and Development. The Province 4 and Province 6 don't have this Division. The number of GWRDI Divisions in Province 1, 2, 3, 5 and 7 include 1, 4,2,3 and 2 respectively.

Cooperative Central Federation) has three main working areas: **policy advocacy, coordination and linkage development** (advocates wholesale markets for small farmers and works with different levels of government), **capacity building** (about 1,100 small farmer groups are affiliated with the federation in 75 out of 77 districts and are supported with production, marketing, business and accounting training) and **farmer-to-farmer replication** (network expansion). In addition, the federation's small farmer microfinance arm provides financial services such as loans and saving schemes. Women form a substantial part of these small farmer cooperatives, which have 33% inclusivity criteria.

Water user groups, NRM groups and civil society organizations: Over 91,000 grassroots WNRM institutions (**Annex 7**) operate in Nepal. They are critical for the conservation and sustainable operation of water supply systems (Pradhan et al., forthcoming). Many scholars (GC. et al., 2016, Pradhan et al., forthcoming, GC, 2020, Suhardiman et al., 2015, Clement et al., 2019) argue that community-based WNRM institutions are important stakeholders in irrigation scaling, as they play a critical role in policy advocacy, sharing information on and investing in sustainable conservation, management and use of water and natural resources. The FMIS is a community practice of irrigation governance and management (Thapa and Scott, 2019). Likewise, Nepal's community forestry has been a successful model for producing, conserving and using water and forest resources for local livelihoods while protecting natural capitals. Forest user groups generate income from the sale of vegetables in the local market thanks to irrigation access (Thapa et al., 2018, Pradhan, 2000). The WUAs, water supply and community forestry associations (e.g., NIFUWAN, FEDWASUN and FECOFUN) are key civil society organizations (CSOs) for raising people's voices on scaling challenges and solutions at the policy level, and their networks exist from local to provincial and federal levels.

I/NGOs and CBOs interactions with the governments and private sector actors at scales: Over 47,000 national non-governmental organizations (NGOs) and 200 international NGOs (INGOs) are on the frontline of development project implementation in Nepal (Joshi, 2018b). Key INGOs that implement larger projects on rural WASH and irrigation in the FtF ZoI in collaboration with the GoN and DPs include HELVETAS, Mercy Corp, Water Aid, iDE, CARE, Oxfam, SNV, and Winrock International. These actors collaborate with local NGOs such as SAPPROSC, DEPROSC, Sundar Nepal, Li-Bird, and other community based organizations for implementing bilateral and multilateral funding projects on WASH, water conservation, small-scale irrigation and agriculture projects. The Renewable World implements renewable energy technologies, including solar irrigation technologies in collaboration with local private sector and NGOs. While the private sector actors have limited engagement with the WASH (UNDP, 2010) and irrigation sectors, the need for strengthening private sector's participation in irrigation development is increasingly realized (Tractebel Engineering GmbH, 2019). I/NGOs and private sector are playing important roles in promoting non-traditional irrigation technologies in Nepal (GC and Hall, 2020). The private sector however has limited engagement with the water sector (UNDP, 2010), but its involvement in the irrigation sector is gradually taking up as discussed in the section 7. While new private sector actors in irrigation supply chains are key stakeholders that provide technical and local capacity development services at the local level, commercial and development banks, microfinance institutions and cooperatives facilitate access to credit for agro-entrepreneurs.

Bilateral and multilateral DPs: Over 13 bilateral and multi-lateral DPs are involved in irrigation, WASH and water resources development in Nepal. The World Bank and Asian Development Bank (ADB) are actively involved in large-scale infrastructure projects in the irrigation sector. While ADB is influential player in energy sector development (see ADB, 2020), the UK Government and the Norwegian Government are also involved in renewable energy programs. All development partners are involved in small-scale irrigation, WASH, along with agricultural development projects in collaboration with the government, NGOs and private sector. To minimize overlapping of interventions, they key DPs have own geographical working areas. For example, SDC is working in the Eastern Nepal (Province 1), while the USAID, IFAD and Finland Government are working in the Western Nepal (Province 5, 6 & 7). The UK Aid and DFAT supports are mostly in central Nepal (Province 2, 3 & 4). The IFAD has been working on agricultural markets and climate change adaptation programs in the Hill districts of Province 6. The working areas of the European Union (EU) tends to be throughout the country with coverage in over 59 districts of seven provinces.[44] The roles of UN agencies such as UNDP, FAO, UNICEF, UNEP and UN Habitat are mainly on implementation of the WASH, agriculture and climate change adaptation programs at scales.

Research Institutions: The main national academic institutions of water resources in Nepal include Tribhuvan University, Kathmandu University, Agriculture and Forestry Universities and affiliated institutes working in different regions of the country. Jalsrot Vikas Sanstha (JVS), Nepal Water Conservation Foundation (NWCF) and Farmer Managed Irrigation System Trust (FMIST) provide technical expertise on research, policy advocacy and capacity building related to water resources. The International Water Management Institute (IWMI) is the only international think-tank on water resources researches and evidence-based policy and capacity development in Nepal. It does interdisciplinary researches on water resources management, including irrigation, WASH, and governance, policy and GESI aspects of water management.

[44] https://eeas.europa.eu/delegations/nepal/86520/map-eu-projects-nepal_en

With huge capacity gaps in delivering and managing government services, the GoN acknowledges the roles of I/NGOs and research institutions in national development, human capital development and access to services in rural areas (NPC, 2018, Joshi, 2018b).

8.3.2. New direction for and approaches to irrigation development

The interest of international development partners in supporting the GoN in implementing federalism[45] and promoting economic growth has significantly increased since the Covid-19 pandemic. These partners have initiated large-scale rural development programs to be implemented in collaboration with local governments. This approach could support the scaling SSI/FLI of technologies and irrigated agricultural VCs by enabling the private sector and farmers. For example, the World Bank initiated the Youth Employment Transformation Initiative (YETI) (2020-2024) with the aim of promoting jobs and employment for poor and vulnerable youth by engaging them in the maintenance and upgrading of public infrastructure and public services. The project targets 100,000 unemployed youth, 60% of them are women. The Ministry of Labor Employment and Social Security (MoLESS) is the lead implementing agency at the federal level, but 90% of the total budget is allocated to the local level (World Bank, 2019). Similarly, the REED project (2020-2025), which is also funded by the World Bank and coordinated by the Ministry of Agriculture and Livestock Development (MoALD), aims to strengthen rural market linkages and entrepreneurship ecosystems and to create job opportunities as a recovery response to Covid-19. The project focuses on market linkages among rural entrepreneurs, including smallholder farmers and producers; development of rural enterprises in key economic corridors by promoting PPPs, climate-smart agricultural VCs and SSI; and policy and capacity development (World Bank, 2020).

Agricultural water management (AWM) is a multi-actor process in which making AWM sustainable, equitable and poverty reduction-centric depends on the interaction of actor interests, roles, capacity, collaboration and partnership (Merrey et al., 2007, Bharati and Uhlenbrook, 2020, Minh et al., 2021). This is further influenced by socio-institutional and governance processes, as access to irrigation is defined by the social relationship of a farmer with external actors (Clement et al., 2019). The emergence of and interaction between actors provide a good ecosystem for scaling SSI and farmer-led irrigation (FLI). The level and forms of partnership and collaboration between these actors have evolved over the last four decades. The partnership dynamic changed i) from the government-to-government relationship in the 1960s, to ii) the governments and community relationships (1970s-1980s), iii) the governments, I/NGOs and community relationships (1990s), iv) the governments, I/NGOs, the community/CSOs and private sector (2000-2015), and v) the three spheres of governments, development partners, I/NGOs, the community/CSOs and private sector (since the introduction of federalism). This multi-actor partnership trend is promising for scaling sustainable and inclusive irrigation development from multi-sectoral aspects.

[45] The Provincial and Local Government Support Program is a multi-donor-funded flagship program aimed at strengthening the capacity of new governments such as local and provincial governments. UNDP in collaboration with the Ministry of Federal Affairs and General Administration, which has direct interfaces with 753 local governments, has been implementing the program since 2020.

9. Factors Influencing Sustainable and Inclusive Farmer-Led Irrigation Development

A number of factors influence the scaling of inclusive farmer-led irrigation development in a sustainable manner. In this section, we present these factors in the form of barriers and opportunities (**Table 9-1**).

Table 9-1. Summary of barriers and opportunities for scaling sustainable and inclusive farmer-led irrigation development in Nepal (social lens)

Themes	Barriers	Opportunities
New drivers	- Micro-irrigation technologies and services as well as FLI development receive less weighting in programs responding to shocks and stressors (e.g., Covid-19, climate change)	- Covid-19 as an opportunity for scaling multiple-use water resources management practices for WASH outcomes and Covid-19 resilience - Increasing interest by development partners and the GoN in resilience building and economic opportunities for those impacted by climate change and the pandemic
Policy and governance	- Policies focus on economic growth instead of inclusive growth - Policy framework biased towards large-scale water infrastructure - Institutional mechanisms (e.g., advisory committees) envisioned in national water and natural resources policies are 'bureaucratic and exclusionary' - Lack of agriculture sector laws at federal level and natural resources laws at provincial level - Lack of policy frameworks for sustainable and inclusive groundwater management, use and monitoring - Lack of approaches for implementing national GESI and pro-poor policies in the water sector - Limited understanding of GESI in national irrigation policies - Missing GESI dimensions in PPP policies - Subsidies for irrigation technologies mostly benefit better-off farmers - Agricultural subsidies are not pro-poor and women farmer-centric	- Policy recognition of water management and irrigation development as key components of agricultural and economic development - New federal PPP legislation acknowledges the need for investment by and participation of the private sector - Most policies create an environment for inclusive WRM decision-making and policymaking - Water polices are favorable to multiple-use water management and farmer-managed irrigation systems - Agriculture, land and trade policies are favorable to women, youth, poor and marginal farmers - Devolution of irrigation and resilient irrigation development - The new governance structure creates a potential opportunity for cross-sectoral synergies and collaboration for irrigation scaling
Interventions	- Overlapping roles and responsibilities across three levels of government and sectoral line ministries - Establishing inter-and intra-sectoral collaboration and coordination for scaling FLI development takes time - Greater focus on 'infrastructure'-centric irrigation interventions - GESI provisions in agricultural policy are not reflected in national-level programs and guidelines - Inadequate technical capacity to operate an inclusive policy processes at subnational government level - Limited discourse and dialogue on water under the federal system - Limited data, skills and knowledge for water resource management planning at the all levels - Lack of technical and human capacity in sanitary and phytosanitary implementation hampers agricultural exports	- Presence of women lawmakers at the local level - Local governments are the 'frontline' and a powerful government institution for scaling small-scale irrigation, resilient agriculture development and natural resources management - Local governments support gender inclusion with entrepreneurship and leadership capacity building - New development programs focused on climate-resilient agriculture and green recovery - Continued commitment of the government and development partners to GESI-responsive development - Multi-stakeholder partnerships support the service provision on the ground
Irrigated agricultural value chains (VC)	- Fertilizer shortage - Limited water access in many agricultural areas - Limited VC linkages impact market access, bargaining power, postharvest losses and rural-urban connections - Limited financial capital of smallholder farmers constrains investment in irrigation - Limited access to finance for agriculture - Few women professionals means limited reach of gender-responsive information and services	- Effective implementation of existing value chain development commitments - Dynamic changes in gender roles and more women in value chains and technical services (e.g., women role models as service providers, entrepreneurs and technicians in agri-irrigation value chains) - Potential approaches for different actors to collaborate – market systems development
Irrigation supply chains	- High and discretionary application of taxes on raw materials and irrigation equipment imports hinders private sector investment in irrigation supply chains - Unreliable land ports and road conditions hampers the importation and supply of irrigation equipment - Political instability limits opportunities for the private sector to profit in the medium to long term - Land tenancy rights prohibit borehole investment by smallholder farmers - Electricity access and stability limits pump uptake - Farmers lack awareness of and information on efficient irrigation practices	- Emergence of new private sector actors in irrigation equipment and services in the FtF ZoI - Support for domestic manufacture of irrigation equipment - Enabling importation of high-value products for irrigation - Potential to address fertilizer solutions locally by establishing a fertilizer manufacturing industry - Active roles of agricultural cooperatives and microfinance institutions
Gender and social inclusion	- Irrigation technology and infrastructure is not gender friendly - Gaps in transformative thinking and GESI capacity for scaling irrigation development - Limited data on and analysis of GESI issues in agricultural value chains and irrigation supply chains. - GESI considerations in private sector interventions not practiced - GESI is limited to women's mandated number in WUAs	- Capacity building activities tailored to women's needs - GESI in the private sector involved in agro-irrigation value chains - Private sector as key players to connect women with finance institutions and markets - Social capital and networks of women and marginalized groups - Increasing farmer cooperatives' roles to facilitate access to credit, technologies and knowledge

9.1. Barriers to scaling sustainable and inclusive irrigation FLI development

9.1.1. Policy and governance barriers to scaling FLI development

Policies focus on economic growth instead of inclusive growth: Water and agriculture sector policies are biased towards economic growth through water infrastructure development and mechanization and commercialization of agriculture. They lack pro-poor and inclusive approaches. As an example, the IMP 2019 does not recognize structural power relations in irrigation nodes such as the private sector, WUAs, irrigation/water cooperatives and WUGs, largely setting development targets based on economic and production outcomes. Subsidies are limited to agriculture packages that are not pro-poor. Moreover, subsidy policies in the irrigation sector with a focus on poor, marginalized and women farmers are yet to be developed.

Policy framework biased towards large-scale water infrastructure: Despite policymakers seeing water and multiple uses of water as crucial for economic development and food security, the scope of the water sector is limited to large-scale water infrastructure development, including energy development. The responsibility for agricultural water management tends to visualize under the agriculture sector with insufficient linkages drawn to water infrastructure or energy development. Hence, sustainable and inclusive approaches to irrigation development are overlooked in the vision of water resources management and development. The water sector's new policies and bill drafted under federalism are increasingly influenced by the understanding of water as 'large-scale infrastructure' and 'technocratic fixes or solutions' to water resources management. The Water Resource Policy 2020 does not touch upon small-scale, pro-poor and inclusive irrigation development, despite its reference to community-based water resources management.

Institutional mechanisms envisioned in national water and natural resources policies are bureaucratic and exclusionary: While the Constitution underlines the importance of making state policies community needs driven and state bodies inclusive, this vision has not been realized in the recently developed sectoral policies and laws when it comes to the composition of advisory/policy committees. The recently developed federal and provincial laws and policies (5), including draft bills (3) for water and natural resources reveal that consideration of inclusion is missing at the policymaking and decision-making levels. The institutional mechanisms (e.g., tariff fixation committees, policy advisory committees, contract management and regulation committees) presented in the new policies, and draft bills related to water and water supply have limited provisions on GESI. None of the provisions in the water resources bill and water supply and sanitation bill have provisions for ensuring representation of rights-holders, civil society organizations, women and marginalized groups in water governance and WRM. Some sectoral policies, other than water, have provisions for ensuring women are represented in national committees but these are nominal (e.g., one or two women in a committee).

Lack of agriculture sector laws at federal level and natural resources laws at provincial level: While the role of irrigation in agricultural development is acknowledged by the government at all levels, the policy environment in the agriculture sector is weak (Devkota and Thapa, 2019). In the absence of agriculture legislation, a commercial regulatory environment for cooperative farming, contract farming, leasing, PPPs and access to agricultural finance is lacking (Shrestha, 2019). Law-making at local and provincial level is constrained by the limited technical capacity and knowledge of contextual development issues by elected officials, and a lack of sectoral federal laws based on which subnational governments can prepare their laws (International Alert, 2020, Ojha, 2020, DRCN, 2019, DRCN, 2020). The absence of natural sectoral policies and guidelines at the subnational level might limit scaling irrigation development.

Lack of policy frameworks for sustainable and inclusive groundwater management, use and monitoring: Groundwater irrigation plays a critical role in supporting food security, rural livelihoods and economic development in Nepal (Yadav, 2018b, Shrestha et al., 2018b, Urfels and Foster, 2020). Yet the policy frameworks in the water (including irrigation), renewable energy and agriculture sectors focus on the use of groundwater without consideration of its sustainable extraction and recharge (ibid). The governance, equity and inclusion dimensions of groundwater resource exploitation need attention in water policies (Pandey et al., 2020a). The Irrigation Policy 2013, the Groundwater Act 2015 and the Renewable Energy Policy 2016 intend to promote the use of renewable energy technology for groundwater abstraction (Bastakoti et al., 2019). However, there is no law on irrigation, which is essential for sustainable use of groundwater for irrigation and other development (FMIST, 2020). Moreover, a lack of good governance, together with declining groundwater levels, poor water quality, inadequate quantity and improper monitoring, are serious issues for groundwater resource management in Nepal. Addressing these issues needs policy and governance frameworks that support community and/or farmer-driven groundwater resources management, use and monitoring (Yadav 2018b). In addition, better knowledge about water resources, stronger capacity of institutions tasked with managing resources, monitoring to inform decision-making and planning, and adaptive rules to govern water uses within sustainable limits (Pavelic, 2013, Villholth, 2013, Bastakoti et al., 2019, Shah, 2014, World Bank, 2020a).

Lack of approaches for implementing a national GESI policy in the water sector: The water sector's legal frameworks largely assume that provisioning water for hydropower, irrigation, drinking water and industrial uses will lead to the socioeconomic

development of farmers. This assumption is problematic for achieving equitable development impacts, especially in the lives and livelihoods of water users such as women, smallholders, land- and resource-poor farmers and tenant farmers (Clement et al., 2012). The new Irrigation Master Plan even undermines strategies of equity, inclusion and irrigation governance that were reflected in the Irrigation Policy 2013 prepared prior to the introduction of federalism (Irrigation Policy, GoN 2013). The new Water Resources Bill largely focuses on 'permission and license' approaches to access water for multiple uses. Water professionals and experts contend that this perspective undermines people's rights to water for livelihoods and limits multi-stakeholders' participation in water governance (FMIST, 2020). Indeed, all the new water sector policy frameworks poorly conceptualize sustainable and inclusive scaling of irrigation development.

Limited understanding of GESI in national irrigation policies: GESI in national irrigation policy is limited to 33% reservation in WUAs and no provision is made for inclusive irrigation VCs. The irrigation sector works on the assumption that the WUA approach will ensure access to services for all group members and fails to recognize the possibility of self-exclusion of the extreme poor and often socially excluded groups (like women, Dalits and Muslims) due to time constraints and the inability to make the financial contributions that are generally required.

Missing GESI dimension in private sector-related policies: The major gap, which is just as widespread in other sectoral policies, is the non-acknowledgement of inclusion issues at the committee and decision-making levels in PPP legislation. As discussed in section 5.1.5, the policy advisory and proposal evaluation committees and expert groups provisioned in the PPP Act 2019 and the PPP Rule 2020 are GESI-blind and do not consider experts from the water/irrigation sector. GESI in trade has been conceptualized mostly at the service level. For instance, the Commerce (Trade) Policy 2015 envisions the creation of programs to enable small and cottage industries and women- and minority-owned/run businesses to help them export their products. The policy lacks perspectives on making trade governance inclusive.

Agricultural subsidies are not pro-poor and women-centric: The federal and provincial governments have developed and implemented several subsidy policies for agricultural development, but subsidies for irrigation development are very limited. While a few policies state that the subsidy could be invested in small-scale irrigation equipment, the subsidy amount is very low. The subsidy is mainly targeted at rain-fed agriculture and therefore prioritizes purchases of seeds and fertilizer instead of irrigation equipment. The GoN is spending NPR 18 billion (approx. USD 154 million) annually on subsidies for agriculture development. Critics note that subsidies are not supportive of the needy farmers, including smallholders and women farmers. Better off farmers, and people who have strong social connections with political leaders and bureaucrats, reap the benefit of subsidies. A lack of monitoring of the implementation of subsidy programs and inadequate review and design of subsidy policies and programs also contribute to their poor outcomes (Khatiwada, 2020).

Irrigation technology subsidies mostly benefit better-off farmers: In an effort to support smallholders and improve technology uptake, the GoN has introduced several subsidies for private irrigation. Shallow tube wells are subsidized as are solar pumps (up to 60%) under the Renewable Energy Subsidy Policy 2016. The current subsidy policy and mechanism being implemented by the AEPC provides a 60% subsidy to households selected for a solar-powered irrigation pump (SIP). Although the policy aims to reach smallholders, the criteria and processes set for subsidy delivery structurally exclude them, along with women farmers. For example, to access the 60% subsidy, a household has to submit a copy of their land ownership certificate and citizenship, a recommendation letter from their local government, and a minimum land size of 1 ha (Uprety and Pandey, 2020). This situation is preventing smallholders with less than 0.5 ha of land, tenant and women farmers from reaping the benefits of SIP technology. Furthermore, the price of a SIP (e.g., NPR 263,793/USD 2,180) is relatively high for those who cannot afford the up-front costs (Pandey et al. 2020). The GoN's energy policies and guidelines nevertheless continue to lag behind when it comes to conceptualizing equitable and socially inclusive SIP technologies (Khadka, et al., 2021).

9.1.2. Intervention barriers to scaling FLI development

Overlapping roles and responsibilities across three levels of government and sectoral line ministries: As discussed in section 5.2, there is an overlap of jurisdiction and rights for water resources and irrigation development across the layered government. Roles regarding water resources and watershed conservation also overlap among line ministries. This overlap might be a challenge to scaling SSI, FLI and irrigated VC interventions unless a new water law defines the roles and responsibilities of federal and subnational governments when it comes to water. The federal government is trying to limit the roles and power of local governments in local development, by sending circulars and directives to local governments (DRCN, 2020). This goes against the spirit of cooperation, coexistence and coordination embodied in article 232 of the Constitution. According to elected officials at the local level, this situation is a systemic barrier that is undermining local needs and contexts as well as the constitutional rights of local governments (ibid). Therefore, water dialogues and cooperation across the three levels of government tends to be a prerequisite for FLI development, while supporting the GoN in policy and institutional strengthening in the water sector.

Establishing inter- and intra-sectoral collaboration and coordination for scaling FLI development takes time: As water is the responsibility of more than 10 ministries at the federal level and 4 ministries at the provincial level, establishing coordinated policy development and implementation is a daunting task. Although the federal structure has brought together formerly dispersed subsectors such as energy, irrigation and water resources into a single ministry as MoEWRI, sub-sectoral coordination within the ministry and between water and affiliated sectors is needed to strengthen coherent development programs (stakeholder consultation, water bill, October 14, 2020). A lack of coordination among ministries and stakeholders has in the past led to the poor scaling of available technologies for impact (ADB, 2009). For example, while the Youth Employment Policy 2014, Youth Vision 2025 and Youth Policy 2017 clearly state that the policies should be adopted by sectoral agencies, this is not reflected in agriculture or irrigation policy. The water-food-energy sectors have not progressed in terms of coordinated visioning and policymaking in water planning and develoment (DWRI, 2019, Devkota and Thapa, 2019, Shrestha, R. 2019). While the absence of an integrated approach in water resources infrastructure development is a limit for the scaling and sustainability of irrigation systems, a lack of policy and institutional efforts to institutionalize multi-actor-based irrigation development and empowering WUAs is hindering irrigated agricultural VC practices.

Focus on 'infrastructure'-centric irrigation interventions: The lack of vision at all levels of government on WRM and the greater priority for 'infrastructure'-centric development is a challenge for scaling FLI development. Development planning of the water sector at the sub-national government level; is taking place without robust data and evidence about water resources use for irrigation, sanitation, drinking, industries and environmental conservation. The annual plans mostly focus on 'irrigation canal construction and rehabilitation'. For example, province 7's government has 1,172 irrigation infrastructure schemes planned for the fiscal year 2020/21 (with no emphasis on the social, institutional and governance aspects of irrigation to be included in the WRI programs) (P7.gov.np).

GESI provisions in agricultural policy are not reflected in national-level programs and guidelines: For example, the Local Level Agriculture Infrastructure Development Program Operation Guideline 2020 talks about the use of the central fund transferred through the Center for Agriculture Infrastructure Development and Mechanization Promotion to provincial and local levels in developing agricultural infrastructure such as collection centers, selling points, market and irrigation infrastructure, processing facilities, cold stores and cereal store. The guideline demarcates responsibilities at three levels but is silent on GESI provisions. It makes an initial environment evaluation (IEE) and environmental impact assessment (EIA) compulsory for project area selection. However, a GESI assessment is missing. The local level is responsible for identifying the demand and formulating the program. It is also responsible for beneficiary selection and subsidy distribution. Nevertheless, none of the sections in the guideline mention the process and provisions for dealing with unequal access to information, benefits, subsidies and decision-making.

Inadequate technical capacity to operate an inclusive system of policy processes at sub-national level: sub-national governments are new entities, but they have a shortage of technical capacity for conceptualizing and managing water resources management in holistic, techno-social and institutional ways.[46] MoPID staff deputed in provincial governments have limited technical expertise on policy processes. Since deputed engineers in local governments need to cover several technical areas (water supply, irrigation, agriculture, roads), it is unreasonable to expect in-depth irrigation-related knowledge and skill on their part (DWRI, 2019). In addition, law-making processes in local governments are not meaningful, despite each municipality preparing these instruments as a basis for decentralized governance (International Alert, 2020). Elected women representatives in local governments have much less knowledge about sectoral policies compared to their male counterparts, and they are not involved in local law-making (TAF, 2018, International Alert, 2020). They also lack information about water budgets and are not engaged in water decision-making and planning (Khadka et al., forthcoming). These information gaps among women lawmakers and their exclusion from local policymaking could also hinder the definition of policy priorities and programs related to the scaling of inclusive irrigation that represent the ideas and knowledge of women lawmakers.

Limited discourse and dialogue on water under the federal system: Functions, functionaries and fund flows have been changed, new entities have been created, responsibilities for water management have been devolved and space for public-private sector investments and engagement has been created for bottom-up and inclusive water development (e.g., Clement et al., 2019, Shrestha and Clement 2019, Devkota and Thapa 2019, World Bank 2020. Khadka et. al. 2020. However, public discourse and dialogue on 'water and federalism' is lacking, limiting public awareness of the potential opportunities in the irrigation sector for scaling sustainable and inclusive farmer-led irrigation development. Mainstreaming the concepts and goals of federalism and inclusion in all parts of state affairs is still a long way off, as the IMP 2019 points out (TRACTEBEL ENGINEERING GMBH, 2019).

Limited data, skills and knowledge for water resource management planning at the federal, provincial and local level: Although the IMP 2019 and other literature provide a substantial amount of information on hydrological aspects of the irrigation-agricultural interface, including irrigation systems/projects, there is no robust and disaggregated data and knowledge on: i) municipality-level irrigated

[46] Participants in the CSISA workshops, December 7, 2020; February 17, 2021.

land in function of VC, irrigation technology and farming system typology; ii) water availability, demand and water users at municipality-level; ii) actors involved in irrigation service provision and irrigation supply chains and marketing; iii) community water management practices and WUAs within a local government and their interface with state and non-state actors, including the private sector; iv) socioeconomic dynamics of groundwater access, use, irrigation pump owners and O/M entrepreneurs; v) the intersectionality between water-agriculture and energy policymaking and decision-making processes by subnational governments, water cooperation mechanisms across sectors and governments, and CSO participation; vi) assessment of policies and institutional gaps at subnational level on water resource management- agriculture and energy; and vii) effectiveness of gender-responsive implementation of programs by subnational governments for inclusive irrigation and agricultural development.

Lack of technical and human capacity in sanitary and phytosanitary (SPS) implementation hampers agricultural exports: India is the biggest importer of Nepalese vegetables, but SPS regulations remain a challenge. While plant quarantine offices at the border carry out sample checks to ensure exported products meet Indian standards, Nepali officials often lack the technical capacity and staff to operate successfully. Hence, many of these facilities are not functional despite having equipment (UK Aid 2020).[47] This means that exported volumes are usually small and far below their potential.

9.1.3. Barriers in agricultural value chains to scaling FLI development

Fertilizer shortage: The annual demand for fertilizer is about 800,000 MT whereas importation accounts for only 450,000 MT (Bhattarai, 2020). India's plans to construct a facility capable of producing 800,000 MT of urea in Gorakhpur, close to Nepal, could reduce the country's interest in manufacturing locally (Dhital, 2020). The fertilizer market is highly regulated, with only two companies authorized to oversee fertilizer procurement and distribution. These are the Krishi Samagri Company Limited, also known as the Agriculture Inputs Company Limited (70% of the fertilizer stock), and the Salt Trading Company Limited (30% of the stock) (Saini, 2020). The Agriculture Inputs Company Limited held a monopoly before the market was deregulated in 1997/98. Private players then made a significant contribution to fertilizer import and distribution before another policy change in 2009. The National Fertilizer Policy brought fertilizer back under the control of government-owned entities (Panta, 2018). As private players could not compete with government-subsidized fertilizers, they were forced to reduce their share in the market dramatically (ibid). A lengthy tendering process and a lack of buffer stocks also means every harvest season sees a massive fertilizer shortage.[48] This has created a pervasive problem of illegal fertilizer imports from India, which meet about 70% of demand, something that the ADS 2015-2035 recognizes (MoAD, 2016).

Limited water access in many agricultural areas: Poor agricultural productivity is a result of several factors including its complex topography and agroecological climate, limited access to farmer-friendly and low-cost irrigation technologies, heavy reliance on rainfalls, and conventional farming practices among others (GC and Hall, 2020). Water stress is one of the major forces limiting stable crop production in the EIGP (Eastern Indo-Gangetic Plains) that particularly affects the predominant rice-based production system (Urfels et al., 2020). The irrigation development sector had remained focused on large-scale canal and groundwater projects or developing expensive technology such as high-quality pressurized sprinklers and large drip irrigation kits only suitable for commercial farmers and non-staple VCs. Considering this, many farmers are engaging in supplementary irrigation enabled by shallow tube wells, but still irrigation is seen as 'too little, too late' (Urfels et al., 2020).

Limited VC linkages impact market access, bargaining power, postharvest losses and rural-urban connections: Poor access to roads and transport facilities is just one of the many problems that limit access to markets. The bigger wholesale markets such as Kalimati in Kathmandu are controlled by private cartels and vendors who have an extractive relationship with farmers. Additionally, farmers who rely on middlemen and traders receive lower prices despite government-mandated minimums. Access to these markets is thus dictated by various forms of capital, but access alone is not enough. Postharvest losses of fruits and vegetables have been reported to be as high as 25%, predominantly due to a lack of storage facilities (very few cold stores, poor handling). Even Kalimati has no such facilities, increasing postharvest deterioration (LTS International, 2017).

Limited financial capital of smallholder farmers, including women farmers, constrains investment in irrigation: Smallholders are limited in their access to groundwater because of the high costs of accessing or purchasing irrigation equipment (Urfels and Foster, 2020). Prices for accessing groundwater irrigation also differ widely, from USD 5 to USD 200 per hectare per irrigation. Poor farmers and most marginalized households who lack financial capital to buy pumps and rely on rental markets for irrigation equipment suffer most. Furthermore, small farmers are often not looking to invest in expensive irrigation equipment, which on its own does not guarantee a good yield. For women farmers, a lack of female dealers and technicians may also contribute to them not accessing these markets on their own. This could be a problem, especially in the Tarai where cultural norms often restrict interaction between women and men outside kinship circles.[49]

[47] UK Aid (2020). Vegetable Sector Strategy – Nepal CASA Nepal Country Team.

[48] https://kathmandupost.com/national/2020/09/03/nepal-s-fertiliser-conundrum-governments-ponder-over-it-every-paddy-season-and-then-forget-after-harvest

[49] FAO (2019). Country gender assessment of agriculture and the rural sector in Nepal. Kathmandu: FAO.

Limited access to finance for agriculture and irrigated supply chains: Access to agricultural finance stands at 21.2% for farmers with less than 2 ha of land, who make up the vast majority of farmers in the country (CBS, 2013). While a vast network of agricultural cooperatives exists in the country, unless they are specifically tied to an irrigation tech-promotion company or development project, they often do not have irrigation-specific loan provisions and focus more on smaller agro-input loans that allows them to tap into a much larger member base. For most smallholders, informal lending from relatives is a much easier option and the most frequently used (ibid) compared to going to formal banking institutions that often require collateral). While agricultural credit disbursement is said to have risen over the past years, case studies such as that of Kailali (Shrestha et al., 2018a) found that most disbursed credit was used for capital instruments such as threshers, and tractors whilst a much lower credit utilization was observed for micro-irrigation technologies and services (Nepal Rastra Bank 2014).[50]

Few women professionals mean limited reach of gender-responsive information and services: The number of female professionals in the water and agriculture sector is very low, both in the government and private sector. With the exception of small farmers' cooperatives, none of the private sector actors involved in the irrigation VC indicated provisions on gender when recruiting staff. Remoteness of a community, low literacy levels and social norms (restricted mobility, cellphone access, time poverty) can also exclude women, poor and disadvantaged groups from access to information. One of the GoN strategies to enhance women's participation in agriculture is to expand female-friendly extension services. Yet evidence suggests that extension services (trainings and information sessions) are dominated by men. As most frontline extension workers are men, extension messages and information, including on agricultural inputs and technologies, do not reach women living in remote areas. This leads to poor performance in crop and livestock productivity.

9.1.4. Barriers in irrigation supply chains

High and discretionary application of taxes on raw materials and irrigation equipment imports hinders private sector investment into irrigation supply chains: The reliance of domestic irrigation equipment producers (such as drip irrigation kit and agri-plastic manufacturers) on imported raw plastics significantly increases their costs. According to Customs Tariff 2020-21, both PVC and LDPE plastics (of less than 0.94 g/cm^3) are subject to 10% customs duty and 13% VAT. Plastic manufacturers have asked for taxes to be increased on finished plastic products from abroad but have demanded tax deductions on raw materials (Kathmandu Post, 2014).[51] Like raw plastics, pump imports are more expensive by tax allocations. Some concessions have been made, and pumps for agro-purposes are tax exempt. For example, equipment using renewable energy such as solar modules and panels are only charged 1% customs duty and no VAT. Battery-operated DC pumps are also charged only 1% customs duty. Despite tax specifications, a major problem is the subjective application of the tax formulation and its interpretation at the ground level. A respondent noted having to pay different tax rates for the same product in consecutive years.

Unreliable land ports and road conditions hamper the importation and supply of irrigation equipment: As a landlocked country, Nepal has a marked dependence on India for its sea freight imports, relying almost exclusively on the Kolkata port where the government owns a container freight station (CFS) with a 500-container capacity (Logistics Capacity Assessment, n.d.). The Tatopaani-Khaasa border with China was closed after the 2015 earthquake and reopened in May 2019 but experienced extremely limited trade as a result of new stringent trade protocols from the Chinese side (Giri and Khanal, 2019).[52] China closed the trading point again in October 2020 but reopened it later in the month after three Nepalis tested positive for Covid-19 (Tiwari, 2020).[53] Intermittent border disputes with India also regularly affect these trade points. In the current pandemic and with the intermittent closure of major ports, importers have begun using charter flights. Although they are trying not to pass on the extra cost to the customer, this is likely to happen eventually. Road conditions are often a problem when companies transport machinery and equipment in bulk to sales offices/regional agents or sometimes directly to project sites. Equipment being transported on large vehicles often has to be unloaded and reloaded onto smaller trucking or transportation units along the way, which increases costs. This is particularly problematic in the Hills region with its rugged terrain and narrow roads, while the Tarai fares better thanks to its flat topography and wide roads.

Political instability limits opportunities for the private sector to profit in the medium to long term: There is an almost total reliance on foreign imports for all types of pumps. In the last decade, pump imports have risen from a total of NPR 950 million to a cumulative NPR 4 billion (approx. USD 8,060,143 to USD 33,937,448) (Pokharel et al., 2020b). This indicates a fast-growing demand and huge local market potential. However, potential manufacturers are wary of investing significant capital in a country that lacks the ability to protect and promote local industries. This sentiment is understandable, as Nepal has a history of political instability. This instability limits opportunities for the private sector to profit in the medium to long term.

[50] Nepal Rastra Bank (2014). Agricultural Credit and Its Impact on Farm Productivity: A Case Study of Kailali District. Banking Development and Research Unit.

[51] https://kathmandupost.com/money/2014/11/17/manufacturers-focus-on-plastics-industry-scope

[52] https://kathmandupost.com/national/2019/06/28/only-five-trucks-have-crossed-the-tatopani-border-since-its-reopening

[53] https://kathmandupost.com/province-no-3/2020/10/29/tatopani-border-point-comes-into-operation

Land tenancy rights prohibit borehole investment by smallholder farmers: The government has focused on subsidizing borewell drilling costs (ADB 2012 in Foster et al., 2019), which vary across the Tarai depending on where aquifers are located (Sugden, 2014). Tenant farmers in the region are less likely to invest in borewells because their tenancy rights are barely protected, and they rely heavily on oral contracts with the landowners (Sugden, 2014, Sugden et al., 2020). Tenant farmers are thus understandably reluctant to invest resources in boring wells when they could be evicted and replaced quite easily in the absence of formal tenancy contracts (Sugden, 2014). Therefore, many small and tenant farmers make use of shared diesel pumps and wells. In the groundwater-sharing and equipment-rental market, well-sharing costs are marginal (at about USD 0.05 per hour) compared to sharing pump equipment including fuel costs, which are between USD 2 and USD 4 per hour (ibid).

Electricity access and stability limits pump uptake: Energy constraints limit farmers' use of groundwater. Nepal et al. (2019)[54] show that of the 100,000 shallow tube wells (most of them in the Tarai), almost 80% used diesel pumps. Most diesel is imported and is often affected by political and other disruptions with India (Havana, 2015).[55] Electricity has not reached all areas and farms, and even where it has, connections are unstable and intermittent. This has led to the paradox of Nepal having plentiful groundwater but low utilization (Nepal et al., 2019). Additionally, as a respondent noted, the development community and government's interest in promoting solar pumps also corresponds to an era marked by heavy load shedding (power cuts) in the country. If coupled with continual national electrification efforts (*The Himalayan Times,* 2020),[56] this could eventually mean greater adoption of electric pumps in the country. However, country-wide electrification schemes take substantial time and infrastructure development focusing only on solar or electric options will fail to take in near-term gains that could be seized from diesel pumps themselves (Foster et al., 2019).[57]

Farmers lack awareness of and information on efficient irrigation practices: Irrigation costs can be high for farmers if they lack awareness of and information on efficient irrigation practices (Urfels and Foster, 2020). For poor and marginalized farmers, this would mean long-term poverty and vulnerability to climate variability and change. A lack of information, knowledge and awareness also arise from existing coordination gaps in equipment and service supply (government, NGOs, private sector) and demand (farmers). Despite subsidy provisions from the government for agricultural machinery, the high costs associated with the technology and poor information and dissemination strategies at the local and national level cause problems in adoption (Baral, 2016).

9.1.5. Barriers in gender and social inclusive FLI development

Irrigation technology and infrastructure is not gender-friendly: Technology and infrastructure developers and service providers are not only dominated by men but often also designed for men (Kelkar, 2009). A Guardian article suggests that research and technology are not aimed at women even though they are the larger demographic involved.[58] A survey found that only 3% of women used mechanical equipment compared to 8% of men in Nepal (FAO n.d., cited in Kafle, 2017 p. 6). One contributing factor is that their needs in terms of physical parameters, preferences, location, accessibility, affordability are often not taken into consideration in decision-making.

Gaps in transformative thinking and GESI capacity for scaling irrigation development: The ongoing interest of water professionals and institutions in the technical aspects of irrigation development has limited the implementation of inclusive principles laid out in national policies. This clearly reveals that Nepal's water sector needs to approach water development differently. Masculine attitudes, engineering approaches and knowledge predominantly influence the plans and programs of the public water sector (Udas 2014, Shrestha and Clement, 2019b, Liebrand and Udas, 2017). The persistent dominance of 'technical' and/or engineering discipline influences in (re) producing similar skills, knowledge, perspectives and interests in the daily practices of all water resources subsectors (e.g., irrigation, hydrology/ metrology, drinking water, river basin management, energy, water-induced disaster). This significantly limits an understanding of water issues from a holistic development perspective. Agricultural systems are dependent both on hydrology and related institutions such as systems of governance that support sustainable and wise use of land and water. A technical approach to water resources and irrigation management reinforces social exclusion and gender inequality when it undermines GESI (ADB, 2020). The agriculture and natural sector in Nepal needs to make institutional efforts to implement policy commitments that lead to inclusive development outcomes (ibid).

---

54 Nepal, S., Neupane, N., Belbase, D., Pandey, V. P., & Mukherji, A. (2019). Achieving water security in Nepal through unravelling the water-energy-agriculture nexus. *International Journal of Water Resources Development,* 1-27.

55 Havana, O. 2015. Fuel crisis grips Nepal as border crossings close. Aljazeera. https://www.aljazeera.com/gallery/2015/9/29/fuel-crisis-grips-nepal-as-border-crossings-close

56 The Himalayan Times (2020). Editorial: Manage surplus power. https://thehimalayantimes.com/opinion/editorial-manage-surplus-power/

57 Foster, T., Adhkari, R., Urfels, A., Adhikari, S., & Krupnik, T. J. (2019). Costs of diesel pump irrigation systems in the Eastern Indo-Gangetic Plains: What options exist for efficiency gains?

58 https://www.theguardian.com/global-development/2012/aug/10/nepal-women-farmers-research-technology

Limited data on and analysis of GESI issues in agricultural VCs and irrigation supply chains: While VCs remain a high priority both at governmental and development partner level, it is important to note that VCs may often miss ultra-poor households (Mausch et al., 2020). Despite increasing focus on agricultural VCs in development projects, there are evidence- and knowledge-related challenges to making VCs inclusive (ADB, 2020). These include women and excluded groups having limited access to production inputs, a lack of recognition of social differences across agricultural VCs and a lack of disaggregated data and analysis on the impacts of VCs. An understanding of existing gender and social-based power relations for high-value and climate-resilient crops is also lacking (ibid).

9.2. Opportunities for scaling farmer-led irrigation development

9.2.1. New drivers

The Covid-19 pandemic as an opportunity to scale multiple-use water resources management for WASH outcomes and Covid-19 resilience: As discussed in section 4.2, Covid-19 has exposed the deeply embedded structural inequalities in Nepal, with social groups struggling to escape the vicious cycle of poverty, exclusion and marginalization being the hardest hit. Yet, the pandemic not only presents challenges but also opportunities for sustainable transformation when interventions by the public and private sectors focus on and work with groups vulnerable to Covid-19. As discussed in section 8.2.5, FLI and multiple-use water management practices could offer opportunities for WASH outcomes alongside agricultural and economic resilience by improving water access with bundling of low-cost, climate-resilient micro-irrigation technologies, extension and market services for high-value agricultural VCs.

Increasing interest from development partners and the GoN in resilience building and economic opportunities for those impacted by climate change, Covid-19 and other shocks: Commitments from international development partners to support the GoN by pledging USD 6.6 billion under the Green Recovery Plan could be an entry point for USAID to support scaling of small-scale and farmer-centric irrigation development backed by scientific research and evidence for informed policymaking and decisions on WRM, environmental conservation and inclusive water governance. In addition, the focus of development projects on economic opportunities for populations affected by Covid-19, including youth and women, is an opportunity to scale FLI development.

9.2.2. Policy and governance

Policy recognition of water management and irrigation development as key components for agricultural and economic development: As mentioned in chapter 5, the 15th Plan (Approach Paper) in its 25-year vision recognizes water management and irrigation development as key components in achieving economic growth, prosperity and agricultural development. The national SDG targets and the second nationally determined contributions (NDC) focus on improving the socio-ecological resilience of people and natural resources. These provisions will enable the scaling of FLI development, if water resources and irrigation sector policies, institutional mechanisms and policy implementation approaches consider gender and social inclusion and sustainable development perspectives.

New PPP legislation introduced by the federal government acknowledges the need for investment by and participation of the private sector: This could be an opportunity to explore the state-markets-people relationships in strengthening irrigation equipment and service supply chains while ensuring stable markets for high-value crops. The policy environment increasingly focuses on low-carbon development, including solar irrigation, which is an opportunity for dry season irrigation of staples and high value crops. Linking farmers with markets and guaranteeing the supply of inputs is essential for sustainable intensification of agriculture for commercial farming (Adhikari et al., 2021).

New Constitution and most national general policies create an environment for practicing inclusive WRM decision-making and policymaking: Changes in the national policy are largely driven by the need to reduce gender inequality and empowering women and marginalized groups. Moreover, reservation practices promoting better representation of women in government, along with women's increasing entry into the public service workforce (Khadka and Sunam, 2018, ADB, 2020) would enable inclusive WRM decision-making and policymaking.

Policies on agriculture, land, trade and private sector investment are favorable to women, youth, poor and marginal farmers: The recent Industrial Enterprise-related Policies and Acts on VAT, PPPs and business and finance (discussed in section 5.1.5), along with agricultural and land policies that give priority to smallholders, youth, tenant and marginal farmers, if implemented on the ground through coordinated efforts by the water-agriculture-energy and trade and commerce sectors, could enable the promotion of irrigated agricultural VCs, especially organic farming and high-value indigenous crops and vegetables in the urban and peri-urban areas of the FtF ZoI.

Water polices are favorable to multiple-use water management and farmer-managed irrigation systems: National water policies and plans have institutionalized the FMIS and are backed by democratic values, decentralized water management and equity. Although the new water policy framework make no specific provisions for GESI water and water governance outcomes, it establishes the basis for developing policies, master plans and strategies of subnational governments that can be developed with consideration of the inclusion, equity and sustainability aspects of water.

Devolution of irrigation and resilient irrigation development: The new Constitution along with the Local Governance Operational Act 2017 have devolved the responsibilities for local irrigation, agriculture, water supply and renewable energy development to local governments. National policies on climate change adaptation and natural resources also enable decentralized climate adaptation planning. A national policy environment increasingly focused on climate-smart agriculture and low-carbon development, including solar irrigation, could be an opportunity for dry season irrigation. This could also be an opportunity to explore the state-markets-people relationships in promoting irrigation equipment and services in the leadership of local governments while ensuring sustainable markets for high-value crops.

The new governance structure creates a potential opportunity for cross-sectoral synergies and collaboration for scaling farmer-led irrigation: The institutional governance structure allows all levels of government to enact laws, policies and plans on water resources, irrigation, agricultural development and alternative energy within their jurisdiction. Direct fund flow from the federal to local governments under the intergovernmental fiscal transfer facilitates public services access by water users/farmers. This sharing of powers among the governments would also allow sharing of roles and resources to support FLI programs. This is also an opportunity for inclusive and decentralized water resource management planning in the leadership of local governments.

9.2.3. Interventions for scaling farmer-led irrigation development

Presence of women lawmakers at the local level: Political inclusion of women and marginalized groups in the three levels of government might contribute to inclusive WRM policymaking and decision-making for multiple uses, including irrigation development, if they are enabled through scientific evidence and knowledge about water solutions for agricultural development.

Local governments are the 'frontline' and a powerful institution for scaling SSI, resilient agriculture development and natural resources management: Decentralization of development projects, including SSI and resilient agriculture, which recognizes the constitutional power and roles of local governments, is a new direction in Nepal. Multi-stakeholder-based irrigation programs in collaboration and partnership with local governments, the private sector, farmers and CSOs/NGOs can be established and operated at the local level. These can create an enabling environment for private sector actors to connect with farmers for irrigation services and equipment and develop the skills of local technicians on resilient water resources management, including irrigation practices.

Local governments support gender inclusion through entrepreneurship and leadership capacity building: Women have increasingly taken on farm roles as a result of rapid male outmigration (Pant and Resurrección, 2014, Gartaula et al., 2010). However, they are still limited to being producers with often weak market linkages and have less presence in entrepreneurship and leadership functions of agro-enterprises (ADB, 2020). Increasing government interest in promoting women in agriculture (supporting women farmers with training, increasing the number of women technicians and extension workers) could support this. There are also many small women-led groups under agriculture cooperatives at the local level that could coalesce to form larger collective action groups to support women in accessing other actors in the VC.

New development programs focused on climate-resilient agriculture and green recovery: Agriculture and NRM projects focus on micro-irrigation technologies and multiple-use water system. Some development partners have initiated new climate-resilient agriculture development programs led by local governments while non-state actors provide technical support for irrigation schemes and markets. This could be an opportunity for a new program on integrated natural resources management that focuses on the scaling themes we presented in this research.

Renewed commitment to GESI-responsive development: The GoN and development partners' renewed commitment to GESI along with new approaches (e.g., market system development, leasing lands for commercial agriculture, subsidies for attracting youth in agro-forestry enterprises, tax waivers when registering land in a woman's name and the emergence of role models) would support the scaling of inclusive irrigation if the target groups are empowered with technical knowledge and information and engaged in agricultural VCs and irrigation supply chains.

Multi-stakeholder partnerships are supporting service provision on the ground: Over 90,000 local NRM institutions and affiliated CSOs and over 40,000 NGOs are providing services on the ground in collaboration with public and private sector actors. These multi-stakeholder practices are an opportunity to scale FLI development in an equitable manner.

9.2.4. Irrigated agricultural value chains

Effective running of existing value chain development commitments and market based development: The ADS 2015-2035 already has a vision for supporting the national development of certain competitive VCs (including vegetables, and cereals) that have been identified for poverty reduction and growth potential. Each VC is to be supported by a Value Chain Program Steering Committee made up of farmers, agri-business enterprises, and extension service representatives.

There is also an emphasis on the markets system development (MSD) approach. The market system development approach aims to meet the poor's needs through the effective participation of the private sector and facilitation of actors such as the government and development partners (Mutambara et. al., 2015). It has been used extensively by development partners such as the Swiss Agency for Development and the cooperation-funded Nepal Agricultural Market Development Programme (NAMDP),[59] (phase 1 – 2016-2020, phase 2 – 2020-2024) to support market-based solutions to farming. Smallholders in province 1 have been targeted to help boost farm productivity and supplement agri-business support, in collaboration with private and public actors, especially provincial and local governments. The DFID-funded Samarth-Nepal Market Development Programme (Samarth-NMDP) found that smallholders are likely to adopt changes that have low barriers to entry, and that fragmented markets like those in Nepal impose information, input and output constraints on producers (Oxford Policy Management and Itad, 2019).[60]

Dynamic changes in gender roles and more women in VCs and technical services: Women are emerging as role models and entrepreneurs in Nepal leading 30% of firms, including agri-businesses (UNDP, 2020). Women make up 12.3% of workforce in engineering and manufacturing, while they constitute over 22% in agricultural and natural resources workforce (FAO, 2019). This change in gender roles and increasing participation of women in sectoral workforce and agricultural business is an opportunity for promoting irrigated agricultural VCs in the FtF ZOI targeted at women service providers, entrepreneurs and technicians. Women's successful participation in markets will also need men to shoulder more household and child-care (Stoian et. al, 2018). Essentially, more work is required to answer gender-centered questions in VCs on what kind of VCs are best suited to addressed gender inequalities and how gender relations could affect VC participation (Bolwig et al., 2008) in Nepal.

Potential to address fertilizer solutions locally: Since fertilizer shortage is a recurrent problem, the government needs to understand fertilizer demand first before engaging in importation. It also needs to maintain a stock of fertilizer and allow private players to re-enter the fertilizer supply industry, so that they are able to support and address the shortfall. An incentive for local organic fertilizer, which has environmental benefits and overall greater affordability, also needs to be introduced to offset some of the yearly fertilizer shortage.

Active role of agricultural cooperatives and microfinance institutions: Microfinance institutions and agro-cooperatives remain important because traditional banks have often shown a lack of interest in financing agriculture. Few branch offices in remote areas make service delivery expensive. This coupled with climate and weather risks inherent to agriculture make it a risky investment (Kloeppinger-Todd and Sharma, 2010). Banks often require a land title and/or other collateral that small farmers may not have. Even if they do, farmers may prefer collateral-free informal loans to low-interest formal loans requiring collateral as they may risk one of their most important possessions – land (Wenner, 2010). One of the largest smallholder cooperatives in the country, the SFCL, and its related microfinance institution mostly function on group guarantee. This means collateral is not always a necessity, allowing poorer farmers to access this credit facility. However, farmers require more support from the government and other actors to do more.

9.2.5. Irrigation supply chains and services

Emergence of private sector actors in irrigation equipment and services supply chains: The rapid entry of private sector actors in agriculture and irrigation technology promotion, enabled by agricultural and renewable energy development projects, is an opportunity to scale farmer-led and multiple-use water resources management. As an example, around 39 private sector actors are involved in solar-powered irrigation pump projects alone (Khadka et al., forthcoming), providing expertise on feasibility studies, installation, monitoring and technical capacity development in collaboration with the AEPC, development partners and I/NGOs. Many private sector actors also provide technical services in micro-irrigation technology and agricultural VCs, services that could be crucial in scaling. Furthermore, innovative financing modalities such as rent-as-you own or pay as you go with low upfront capital costs provide alternatives to the high subsidy schemes and its ineffectiveness to reach farmers in bottom of pyramid markets.

Support for domestic manufacturing of irrigation equipment: Reducing and/or revising taxes levied on raw materials required for the domestic production of irrigation equipment would help lower manufacturing costs. This, in turn, would support the plastic and metal industries as well as finished-product manufacturing industries such as drip irrigation kit and sprinkler manufacturers while also encouraging newer investors in the pump business.

Enabling exportation of high-value products for irrigation: China has now allowed Nepal to use a number of its land and seaports (seaports in Tianjin, Shenzhen, Lianyungang and Zhanjiang and land ports in Lanzhou, Lhasa and Shigatse) for third-country trade,[61] meaning Nepal can slowly reduce its reliance on India. This needs to be coupled with appropriate port and related infrastructure as well as

[59] Swiss Contact (2021). Sahaj – Nepal Agricultural Market Development Programme. https://www.swisscontact.org/en/projects/namdp

[60] Oxford Policy Management and Itad (2019). Samarth-NMDP Programme Final Evaluation Report. https://beamexchange.org/resources/1322/

[61] https://kathmandupost.com/money/2019/05/08/china-deal-offers-nepal-more-options-for-third-country

quality control mechanisms on the Nepali side for businesses to take advantage of the agreement and ensure high-quality products enter the market.

9.2.6. Opportunities for gender and social inclusive in FLI development

Capacity-building activities tailored to women's needs: Capacity-building activities tailored to the specific needs of women being implemented on the ground could strengthen women's resilience to the risks arising from Covid-19, climate change and gender and social norms. Simplified training and information provided in the local language at a suitable time and place would help women make informed decisions and access credits, information and insurance (Gurung et al., 2020, Subedi, 2008).

GESI in private sector-led agro-irrigation VCs: Some private sector actors consider GESI in their activities (e.g., preference given to women technicians in hiring and training). Mainstreaming GESI in the private sector by partnering with I/NGOs could offer an opportunity to achieve GESI outcomes at the project-implementation level. Opportunities include targeted advisory services, assembling services, training and affirmative subsidies for women farmers.

The role of the private sector in connecting farmers with financial institutions: Private sector actors play a vital role in connecting men and women smallholder farmers to banks, local cooperatives and MFIs with guarantee schemes. Local cooperatives could make provisions for collateral-free loans, with members becoming personal guarantor, particularly in the case of women, landless and tenant farmers.

Social capital and women's networks: Women's social networks could be key to technology adoption (Bantilan and Padmaja 2008, cited in Rola-Rubzen et al., 2020, p. 8). These networks would help women to participate in agricultural projects and programs. This could also boost women entrepreneurs in irrigated agricultural VCs. Small women-led groups under agricultural cooperatives at the local level could coalesce to form larger collective action groups that support women in accessing other actors in the VC. Group distribution of technology can have other benefits beyond securing rights. Agricultural technologies disseminated through women's groups could not only lead to an increase in women's assets relative to men's within the household but could also strengthen women's social capital, which in the short term could substitute for a lack of physical capital and in the long term help build women's assets (Quisumbing and Kumar, 2011).

The role of smallholder farmers' cooperatives in facilitating access to credit, technologies and knowledge: Nepal's new Constitution, including new cooperative legislation, focuses on agricultural cooperative approaches to create economic opportunities for women, the poor and disadvantaged groups. The Nepal Agricultural Cooperative Federation (NACF) being implemented in 72 districts acts as a 'bridge' between smallholder farmers, mainly women, indigenous peoples, the poor and disadvantaged groups and public sector institutions. The federation receives external support for trainings, nurseries, technology and relief activities on uncultivated land and expand irrigation technology through cooperatives. Farmers have benefited from access to collateral-free or low-interest loans from microfinance institutions, including development banks, which is mediated by local cooperatives. The NACF recently began collaborating with local and provincial governments to subsidize 50% of the cost of irrigation pumps.

10. Recommendations

The analysis of factors (barriers and opportunities) influencing scaling FLI development presented in previous sections provides a framework to define a medium to long-term development vision of scaling FLI development in the FtF ZoI. To achieve the vision to *improve incomes, nutrition, health, knowledge, and representation and voices of smallholder farmers, especially women, youth and disadvantaged groups through sustainable and inclusive FLI development,* the following five objectives are essential:

- Enable a supportive policy and institutional environment and governance mechanisms for the scaling of sustainable and inclusive FLI development along irrigated agricultural value chains and public and private investment
- Capitalize upon private sector investment into irrigation equipment and input supply chains
- Enhance adaptive interventions to support small-scale irrigation and farmer-led irrigation development
- Support collaborative scaling ecosystem in responding to dynamics and driving changes needed for scaling FLI development
- Transform the irrigation and agricultural development system

10.1. Enabling a supportive policy and institutional environment and governances

The focus here is on enabling a supportive policy, technical, financial, and institutional environment to facilitate the scaling of FLI development in a sustainable and equitable manner along irrigated agricultural value chains, and public and private investment. The following recommendations are suggested as action strategies for scaling:

- Provide policy support to create **an environment for private sector's partnership** and investment for SSI technologies and services. Technical support for policy development to the GoN includes PPP, SSI, sustainable groundwater resource development and management, subsidy mechanisms for irrigation equipment and services suitable to the socio-economic and biophysical context of smallholder farmers, women, tenants and marginal framers.
- Support policy interventions on tax reductions (e.g., raw materials) and explore the possibility of domestic agro-irrigation input manufacturers. Policy support to **regulate markets for cheap Indian agriculture** produce is an utmost need. In addition, facilitating agricultural exports, by strengthening the technical and human capacity in **Sanitary and Phyto-Sanitary** (SPS) implementation is critical.
- Support a detailed review of existing policies and standards, a **revision of the fertilizer policy**. There is a need to include the roles of the private sector in importing and distributing fertilizer and developing a sustainable business model for in-country production and supply of organic and inorganic fertilizer through a PPP approach.
- Assess **the effectiveness of existing subsidy policies and governance mechanisms** in the agriculture sector. This intervention is important to ensure access to climate resilient irrigation equipment and services, including information, financial and markets services by smallholders, women, tenants and marginalized groups. This will aid in better designing innovative financing mechanisms in bottom of pyramid markets by including smallholder farmer cooperatives and WUAs in scaling farmer-led irrigation (e.g., cooperative acting as a collateral for low interest rate loan from Banks).
- Support developing, implementing and monitoring of **GESI tools and approaches to transform** public and private sector partnership, irrigated agricultural value chains, irrigation supply chains and irrigation governance. Tools are needed to overcome the systemic barriers that hinder women, youth and those most vulnerable from meaningfully engaging in climate resilient agriculture planning, technological innovations and WRM decision-making. The tools such as engaging men, boys, entrepreneurs and social leaders, in participatory gender training can be important in challenging gender stereotypes that conceptualize engineering/technical and policymaking roles as 'men's domain. This also includes the development and **mobilization of female technicians, extension workers, and irrigation social mobilsers local women leader** who would act as 'frontline' technical resource persons to provide policy, technical, institutional, financial and markets information to commercial farmers, farmer's collectives on irrigation, irrigated agricultural value chains, local service providers, and government policies. This is an extremely needed GESI transformative strategy to promote women and returnee migrants locally for providing technical services to farmers on irrigation and agronomy services, while they are connected in supply chains.

10.2. Capitalizing private sector investment into irrigation equipment and input supply chains

The role of the private sector as service providers is critical for scaling FLI development. This is because the private sector brings skills, innovation, knowledge and support for the advancement of technologies as well as the emergence of new private sector actors in irrigation equipment and

services. Capitalizing upon the private sector investment into entering the irrigation and agriculture should consider:

- **Develop innovative financing modalities** that help de-risk private sector investment into novice irrigation markets, especially micro-irrigation technologies and bottom of pyramid markets. More collaborations between DPs, government, locally operated TVET institutions and private sector is needed to assess situation of essential infrastructure such as cold stores and collection centres to enable smallholder produce to effectively reach bigger markets and reduce food loss.
- Foster **scaling partnerships** between private entrepreneurs, farmer groups, cooperatives, private and public sector actors to establish direct demand and supply linkages and ensure farmer benefit from markets created for irrigated agricultural value chains and irrigation technologies.
- Support **domestic manufacturers and create** an enabling environment for more domestic agro and irrigation input businesses to grow (e.g. revising raw material taxes those required for irrigation equipment, engaging with private sector to establish input factories).

10.3. Enhancing adaptive interventions to support small-scale irrigation and farmer-led irrigation development

It is essential to emphasize that scaling FLI development requires bundles of irrigation technologies, agronomic practices, extension services, financial and market services as well as corresponding actions to reach scale of the locally driven, bottom-up, effective and efficient climate smart agriculture, sustainable water resources use and gender and social inclusion. Therefore, adaptive interventions are needed to enable FLI development scaling that benefits smallholder, tenants, and women and youths from historically excluded groups (e.g., bonded labor, haliya, migrant households, Dalits, Janajatis, Muslim, people with disability, sexual and gender minorities)—the identified target groups of scaling in the FtF ZoI. The following recommendations are suggested:

- Design and implement interventions based on the **best-fit of** bundled irrigation technologies, agronomic practices and extension, financial, and market services, cold-storage, entrepreneurial activities that enable the target groups to scale up high-value irrigated agricultural VCs such as indigenous crops, vegetables, and cereals. Partnering with research institutes to design and implement potential innovative interventions is suggested. The research institution can support to better understand complex socio-cultural and political economy settings that influence water access, use, extension services, fund flow, pro-poor investment, actors' roles, social capitals interacted in irrigated agriculture value chain, and foster evidence-based policy advice to the GoN and DPs in Nepal for equitable and sustainable development impacts.
- Support scaling of **solar-powered irrigation pumps (SIPs)** technologies for water access for multiple use, including WASH in areas with unreliable electricity access. The intervention should consider the lead role of private sector financing, local governments awareness and demonstration as well as addressing aspects of enabling policies, strengthening markets and ensuring GESI and environmental regulations and monitoring.
- Address access of poor women and smallholder farmers to irrigation equipment and finance, four approaches are recommended. First, facilitate the effective implementation of **farm equipment leasing** policy as already envisioned in projects such as the Prime Minister Agriculture Modernization Project. This is important as most smallholders may not be able to buy small pumps and other farm related equipment. Second, support to provide **irrigation technologies to poor women farmers using 'group distribution' model**. Third, there is a need for **integrating irrigation investment with agriculture-related input**s for women and excluded groups to benefit fully from such investments, recognizing that irrigation is a factor of production, not a product itself. Fourth, action research can identify **unheard women role models and invisible social groups** and connect them to women lawmakers and influential social actors in local and subnational governments. These are critical intervention strategies to develop new discourses and knowledge about inclusive irrigation, water and value chains politics and capitalize the potential impacts of political inclusion at all levels institutions and policy spaces.
- Support **local governments to pilot and implement frameworks** for decentralized water and land management as a sustainable solution to water security, environmental conservation and equitable development outcomes. Support productive use of underutilized private and public lands on lease for commercial and conservation agriculture by collectives of women and tenant farmers could support reach function of scaling. Ensuring their access to agriculture inputs (finance, skills, irrigation equipment, information, seeds, fertilizer, and energy) and participation in agricultural value chain are potential intervention activities. DPs and the GoN should focus on need-based capacity building activities targeted at women farmers and marginalized groups considering time, place, language, participatory learning methodology, facilitator, and specific information on the crops they are cultivating. Simplify documentation processes to access government services such as subsidy, insurance etc. Here, media can play an important role.
- Develop and mobilize local WRM technicians to address the current challenge of lack of **local service provision for O/M** of irrigation technologies and multiple use water systems. For this, a partnership between private sector, local governments, TVET and research organization (as a knowledge broker) can be one of the strategies. This training can support the implementation of federal government's agriculture, youth and land use policies that aim to empower youth.

10.4. Supporting collaborative scaling ecosystem in responding to dynamics and driving changes needed for scaling FLI development

Scaling FLI development simultaneously proceeds in an ecosystem and through multi-actor engagement and collective actions. Support to create a collaborative scaling ecosystem can be carried out with:

- Establish **inclusive and sustainable financing ecosystem for public and private sector investment.** This can be achieved by evaluating the subsidy schemes, importation/export taxes, blended financing mechanisms as well digital services for fintech and innovative financing solutions in a holistic manner. Different technologies, VCs and socio-economic contexts will require a variety of financing mechanisms. The financing ecosystem will need to be adaptive to the market system and the technological constraints faced by smallholders, women, youth and those most vulnerable. For example in areas with high market system development and low tech based platforms investments data driven credit and default assessment tools (e.g. pay as you go) will likely fail whereas default credit mechanisms (e.g. outgrower model) will likely be more viable.
- Promote a **'multi-stakeholder partnerships approach for scaling'** to strengthen resource leverage, harmonized irrigation investment, market system development, evidence-based policymaking and knowledge development, and local capacity building. Strengthen partnerships with research organizations as a knowledge broker to address information and innovation gaps to support the niche, reach and accelerate functions of scaling is essential.
- Invest into an **integrated program for scaling** SSI/FLI combined with irrigated agriculture VCs, policy, governance and GESI components. The implementation modality will need to be multi-stakeholder driven. It will involve the federal level line ministries (e.g. water, agricultural, poverty reduction, and federal affairs and general administration) and provincial line ministries as key actors. It will require a technical and policy guide to enable local governments to act as implementers of the program with the support from private sector, NGOs, WUAs, and research institutions.
- **Develop capacity of sectoral staff, WUAs** leadership, local leaders, and private sector on inclusive irrigation (barriers, change stories, roles models). The role of WUAs and farmers' collectives should be recognized, engaged and strengthened to promote climate smart agricultural development by linking them with cooperatives, private sector and the government agencies, as part of the scaling FLI development.
- **Enhance action research for development to develop and institutionalize a multi-stakeholder-based water cooperation** and development framework that could guide local governments and investors to plan, implement and monitor sustainable use of groundwater for scaling FLI development in Western Tarai is suggested. This action **research is important to gain practical knowledge** on opportunities and challenges related to water security, groundwater irrigation scaling, water cooperation and GESI responsive irrigation services, technologies, finance and skills. In the absence of multi-stakeholder platforms and interdisciplinary learning and policy practices in the water sector, this action research would improve coordination and collaboration between key line agencies of scaling FLI development.

10.5. Transform the irrigation and agricultural development system

To achieve this objective, systemic barriers that hinder transformative changes in the irrigation, private sector and agricultural value chain sectors should be addressed. Transformative change also aids in challenging gender stereotypes and enhances knowledge from learnings on the implementation of a holistic and adaptive scaling framework. Some suggested recommendations are:

- **Facilitate policy processes in local, provincial and federal levels** on **inclusive sustainable** FLI/SSI scaling approaches, investments and capacity development. This supports evidence-based policy and capacity development of the government, CSOs and private sector o**n multi-use water resources management** and **farmer-led irrigation practices** and its impacts on food and nutrition security, gender relations and resilience building. It also needs promoting of gender and socially inclusive innovations in irrigation technologies and services supportive of sustainable water use in agricultural value chains.
- **Create and operate multi-stakeholder dialogue (MSD)** platforms, dialogues, and knowledge forum (national and subnational level) which connects private sector actors, government, cooperatives and association of water user groups to discuss barriers and opportunities for scaling small-scale/farmer-led irrigation. The MSD in the initial stage will allow multi-actors to assess the demand and supply linkages for irrigation supply chains and irrigated value chains (e.g., collection centers, cold storage, pack houses, and on-farm storage mechanisms, energy access, finance, value addition, markets) that could then be addressed by combining efforts and resource leverage among the actors. The MSD will take up as an institutional mechanism to promote sustainable market system development for irrigated value chains that is lacking in the current irrigation intervention. This MSD platform will also support

the development of a knowledge system on what (does not) work taking the local reality into account. It will also foster cross-sectoral cooperation and collaboration, especially among the water, agriculture and energy sectors at each level of government for implementing scaling FLI development.

- Support the **policy and institutional capacity development** of local governments, staff of the irrigation department and divisions, WUAs, CSOs, farmers' associations and cooperatives, and women and men farmers on multi-use WRM, irrigation technologies and water governance. An evidence-based policy dialogue and deliberation on scaling FLI development in the FtF ZoI is a critical element of capacity development.
- An investment into Research for Development (R4D) programs to design, implement and learn from '**sustainable and transformative irrigation development** in the FtF ZoI is essential to develop local capacity on inclusive business, and policy implementation support. Further **inter-disciplinary research is needed** to understand the dynamic relationships between new drivers and resilience capacity of the Covid-19 and climate vulnerable affected populations taking into account current agro-ecologies, water availability and use, gaps in inclusive WRM and public and private sector investment in the water-agriculture-energy nexus. The commitments of DPs to support the GoN pledging USD 6.6 billion under the Green Recovery Plan could be an entry point for USAID to achieve the long-term vision/goal of scaling FLI development.

11. References

ADB 2009. Agriculture and Natural Resources Sector in Nepal. Reference Number: SAP: NEP 2008-62 Sector Assistance Program Evaluation June 2009. Retrieved 31 Dec 2020 https://www.adb.org/sites/default/files/evaluation-document/35389/files/sap-nep-2008-62-0.pdf.

ADB 2020. Gender equality and social inclusion diagnostic of selected sectors in Nepal Kathmandu: ADB.

ADB, DFID & WB 2012. Gender and social exclusion assessment 2011: Sectoral series: Monograph 5. Sectoral Perspectives on Gender and Social Inclusion - Irrigation. P. 35-36. Kathmandu: Asian Development Bank, Department for International Development, UK, and The World Bank.

ADHIKARI, J., TIMSINA, J., KHADKA, S. R., GHALE, Y. & OJHA, H. 2021. COVID-19 impacts on agriculture and food systems in Nepal: Implications for SDGs. Agricultural Systems 186 (2021) 102990.

ANSARI, N. & PRADHAN, P. Overview of the seminar paper. In: N. ANSARI & PRADHAN, P., eds. Assistance to Farmer-Managed Irrigation System: Experiences from Nepal. Papers presented in the seminar on "Improving Farmer Managed Irrigation Systems: Experiences of Different Agencies and Organizations" held on 27 June, 1990, 1991 Kathmandu. Ministry of Water Resources. Department of Irrigation, Planning and Research Division, 1-8.

ASHA, 2019. Adaptation for Smallholders in Hilly Areas (ASHA). Annual Repor 2018/2019. Kathmandu: Ministry of Forests and Environment of Nepal, Government of Nepal.

AWASTHI, B., DUPUY, C. & ZAMAN, A. 2016. Nepal: Water Resources Project Preparatory Facility Pre-Feasibility Study Report of a Solar PV Power based Groundwater Irrigation Development Project in Terai (Package 6). Final Report, June 2016. Report Prepared for the Ministry of Irrigation, Department of Irrigation, Nepal. Kathmandu: ADB and DOI.

BARAL, S. 2016. An Analytical Desk Review Report on Work Load Distribution between Men and Women in the Agriculture Sector of Nepal, 28 October 2016 (unpublished).

BASTAKOTI, R. C., SHIVAKOTI, G. P. & LEBEL, L. 2010. Local Irrigation Management Institutions Mediate Changes Driven by External Policy and Market Pressures in Nepal and Thailand. *Environmental Management,* 2010, 411-423.

BASTAKOTI, R. C., SUGDEN, F., RAUT, M. & SHRESTHA, S. 2017. Key Constraints and Collective Action Challenges for Groundwater Governance in the Eastern Gangetic Plains. *In*: SUHARDIMAN, D., NICOL, A. & MAPEDZA, E. (eds.) Water Governance and Collective Action: Multi-scale challenges. Oxon, UK: Earthscan.

BASTAKOTI, R., RAUT, M. & B.R., T. 2019. Groundwater Governance and Adoption of Solar-Powered Irrigation Pumps Experiences from the Eastern Gangetic Plains. Washington D.C.: World Bank Group.

BENNETT, L., DAHAL, D. R. & GOVINDASAMY, P. 2008. Caste, Ethnic and Regional Identity in Nepal: Further Analysis of the 2006 Nepal Demographic and Health Survey. Calverton, Maryland, USA: Macro International Inc.

BHARATI, L. & UHLENBROOK, S. 2020. Moving from water problems to water solutions in a climate-challenged world. *Rural 21 The International Journal for Rural Development* 54, 4-7.

BHARATI, L., GURUNG, P., JAYAKODY, P., SMAKHTIN, V. & BHATTARAI, U. 2014. The Projected Impact of Climate Change on Water Availability and Development in the Koshi Basin, Nepal. *Mountain Research and Development, 34(2):118-130*.

BHATTARAI, A. 2020. Fertiliser shortage: Heading towards hunger, Nepali farmers shouldn't pay for govt's incompetence. Online Khabar. https://english.onlinekhabar.com/fertiliser-shortage-heading-towards-hunger-nepali-farmers-shouldnt-pay-for-govts-incompetence.html.

BHATTARAI, K., YOUSEF, M., GREIFE, A. & NARAHARISETTI, S. C. S. 2020. Influence of Topography on Sustainable Land Management: An Analysis of Socioeconomic and Ecodemographic Conditions of Nepal. Agriculture 2020, 10, 224. https://doi.org/10.3390/agriculture10060224.

BIGGS, E. M., DUNCAN, J. M. A., ATKINSON, P. M. & DASH, J. 2013. Plenty of water, not enough strategy How inadequate accessibility, poor governance and a volatile government can tip the balance against ensuring water security: The case of Nepal. *Envrionmental Science and Policy,* Volume 33, November 2013, Pages 388-394.

BISTA, I. 2019. SMEs Financing in Nepal: Five key findings of the report. https://nepaleconomicforum.org/neftake/smes-financing-in-nepal-five-key-findings-of-the-report/.

Bolwig, S., Ponte, S., Du Toit, A., Riisgaard, L., & Halberg, N. (2008). Integrating poverty, gender and environmental concerns into value chain analysis: A conceptual framework and lessons for action research (No. 2008: 16). DIIS working paper.

BROWN, S. & KENNEDY, G. 2005. A case study of cash cropping in Nepal: Poverty alleviation or inequity? *Agric Hum Values 22, 105–116 (2005).* https://doi.org/10.1007/s10460-004-7234-z.

BUSHELL, B. 2008. Women Entrepreneurs in Nepal: What Prevents Them from Leading the Sector? *Gender and Development. Vol. 16, No. 3, Gender, Development, and Leadership (Nov., 2008), pp. 549-564*.

CAMRIS 2019. Federalism in Nepal: Current status and challenges, background for federalism learning summit – 2019, June 2019 *In:* KATHMANDU (ed.) *USAID's Monitoring, Evaluation and Learning Activity* CAMRIS International.

CBS 2011. National Population and Housing Census 2011 (National Report). Kathmandu, Nepal: Central Bureau of Statistics (CBS), Government of Nepal.

CBS 2013. National Sample Census of Agriculture, Nepal, 2011/2012. Kathmandu: Central Bureau of Statistics (CBS), Government of Nepal, National Planning Commission Secretariat, Nepal.

CBS 2014. National Population and Housing Census 2011 Social Characteristics Table (Caste/Ethnicity, Mother Tongue and Second Language) Volume 05, Part II, NPHC2011. Kathmandu, Nepal: Central Bureau of Statistics (CBS), Government of Nepal.

CBS 2019. Nepal Labour Force Survey 2017/18. Kathmandu: Central Bureau of Statistics (CBS). Retrieved from https://cbs.gov.np/wp-content/upLoads/2019/04/NLFS-III_Final-Report.pd.

CLEMENT, F., BASNET, G. & BHARATI, L. 2012. Rethinking Development Models and Irrigation Projects in Nepal. *HYDRO NEPAL SPECIAL ISSUE APRIL 2012,* 112-120.

CLEMENT, F., POKHREL, P. & SHERPA, T. Y. C. 2015. Sustainability and replicability of multiple-use water systems (MUS). Study for the Market Access and Water Technology for Women project. This publication was produced at the request of the United States Agency for International Development.: International Water Management Institute (IWMI).

CLEMENT, F., PRADHAN, P. & van KOPPEN, B. 2019. Understanding the non-institutionalization of a socio-technical innovation: the case of multipleuse water services (MUS) in Nepal. *Water International.*

DE STEFANO, L. & GARRICK, D. 2018. Governing water in federal river basins. *Regional Environmental Change* 1573-1578 .

DEVKOTA, K. & THAPA, D. 2019. Agriculture Extension Service Delivery in Federal Nepal: Emerging Challenges and Way Forward. No. 2, June, 2019. http://www.nepalpolicynet.com/new/wp-content/uploads/2014/01/policy-brief-2-1.pdf.

DHITAL, K. 2020. Corruption and Nepal's chronic fertiliser crisis. Nepali Times. https://www.nepalitimes.com/here-now/corruption-and-nepals-chronic-fertiliser-crisis/

DRCN 2019. Functioning of local and provincial governments in Nepal. Periodic report, 3, January, 2019. Kathmandu: Democracy Resource Center Nepal (DRCN).

DRCN 2020. The interrelationship between three levels of governments in Nepal's federal structure. A study report. Kathmandu: Democracy Resource Center Nepal (DRCN).

DWRI 2019. Irrigation Master Plan 2019. November 2019. Kathmandu, Nepal: Department of Water Resources and Irrigation, Ministry of Energy, Water Resources, and Irrigation, Government of Nepal.

FAO 2010. Agricultural value chain development: Threat or opportunity for women's employment? http://www.fao.org/3/i2008e/i2008e04.pdf

FAO 2019. Country gender assessment of agriculture and the rural sector in Nepal. Kathmandu: FAO.

FMIST 2020. Feedbacks of stakeholders on the draft water resources bill submitted to the Department of Water Resources and Irrigation on 24 December 2020. A report based on the webinar organized for stakeholders consultation on the draft WR bill on 14 October 2020. . Kathmandu: Farmer Managed Irrigation System Promotion Trust (FMIST).

FMIST. Farmer Managed Irrigation Systems and Governance Alternatives. The Proceeding of the Third International Seminar held on 9-10 September, 2004. *In*: PRACHANDA, P. & GAUTAM, U., eds., 2005 Kathmandu, Nepal. FMIST.

FOSTER, R., PANDEY, B., UPRETY, B., SHRESTA, B. & PIYA, R. Solar Water Pumping for Productive Uses in Nepal. Conference Proceedings Solar World Congress 2017 Abu Dhabi, United Arab Emirates, 29 October- 2 November, 2017. *In*: INTERNATIONAL SOLAR ENERGY SOCIETY (ISES), ed., 2017.

FOSTER, T., ADHKARI, R., URFELS, A., ADHIKARI, S. & KRUPNIK, T. J. 2019. Costs of diesel pump irrigation systems in the Eastern Indo-Gangetic Plains: What options exist for efficiency gains. CSISA Research Note 1. *November 2019.* Kathmandu, Nepal: The Cereal Systems Initiative for South Asia (CSISA).

GARTAULA, H., NIEHOF, A. & VISSER, L. 2010. Feminisation of Agriculture as an Effect of Male Out-migration: Unexpected Outcomes from Jhapa District, Eastern Nepal. *The International Jounral of Interdisciplinary social sciences* http://www.SocialSciences-Journal.com, 5, 555-577.

GC, R. K. & HALL, R. P. 2020. The Commercialization of Smallholder Farming—A Case Study from the Rural Western Middle Hills of Nepal. Agriculture, 10(5), 143.

GC, R. K. 2011. Experiences from Multiple Use Water System in Nepal -A case study of Phulbari village of Syangja District, 6th Rural Water Supply Network Forum 2011 Uganda, Rural Water Supply in the 21st Century: Myths of the Past, Visions for the Future.

GC, R. K. 2020. *Exploring the Potential of Multiple Use Water Services for Smallholder Farmers in the Western Middle Hills of Nepal. Dissertation submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Planning, Governance, and Globalization.*

GC, R. K., RANGANATHAN, S. & HALL, R. P. 2019. Does Rural Water System Design Matter? A Study of Productive Use of Water in Rural Nepal. *Water 2019,* 11.

GC., D. B., CHENG, S., XU, Z., BHANDARI, J., WANG, L. & LIU, X. 2016. Community forestry and livelihoods in Nepal: A review. Journal of Animal & Plant Sciences, 26(1), pp 1-12.

GENTLE, P. & MARASENI, T. N. 2012. Climate change, poverty and livelihoods: adaptation practices by rural mountain communities in Nepal. *Environmental Science & Policy* 21, 24-34.

GHARTI MAGAR, S. B. 2011. An Assessment of Men and Women Farmers' Accessibility to Government Agriculture Extension Program A Case of Arghakhanchi District, Nepal. Master Degree in Management of Development Specialization: Rural Development and Gender Wageningen, the Netherlands, 2011. https://edepot.wur.nl/192651.

GIRI, B. R. 2010. The Bonded Labor System in Nepal: Exploring Halia and Kamaiya Children's Lifeworlds. *HIMALAYA 29(1). Available at:* https:/ https://digitalcommons.macalester/digitalcommons.macalester.edu/himala .edu/himalaya/vol29/iss1/3 ol29/iss1/3

GREY, D. & SADOFF, C. W. 2007. Sink or Swim? Water security for growth and development. *Water Policy 9 (2007) 545–571.*

GURUNG, D. B., BAHADUR, K. C. D., ORTIZ FERRARA, G., GADAL, N., POKHREL, S., BHANDARI, D. R. & TRIPATHI, B. 2011. Maize value chains in Nepal. Addressing Climate Change Effects and Meeting Maize Demand for Asia. Asian Maize Conference, 11, Book of Extended Summaries; Nanning, Guangxi (China); 7-11 Nov. 2011.

GURUNG, Y. B., PRADHAN, M. & SHAKYA, D. 2020. State of social inclusion in Nepal: Caste, ethnicity and gender. Evidence from Nepal social inclusion survey 2018, Kirtipur : Central Department of Anthropology. Tribhuvan University, 2020.

HAROU JJ, M. J., SMITH DM ET AL., 2020. Water at COP25: Resilience enables climate change adaptation through better planning, governance and finance. *Proceedings of the Institution of Civil Engineers – Water Management* 173(2): 55 –58.

HONSBERGER, A. L. 2015. *Professionals in their field: Women vegetable farmers in Nepal.* Doctoral dissertation, The University of Guelph. https://eeas.europa.eu/delegations/nepal/90497/government-nepal-%E2%80%93-international-development-partners-joint-statement-green-recovery-nepal_en.

HUSSAIN, I. 2007. Pro-poor intervention strategies in irrigated agriculture in Asia: Issues, lessons, options and guidelines. Irrigation and drainage 56, 119-126.

HUYNH, P. T. A. & RESURRECCION, B. P. 2014. Women's differentiated vulnerability and adaptations to climate-related agricultural water scarcity in rural Central Vietnam. *Climate and Development,* 6, 226-237.

ICIMOD 2017. The Water-Livelihoods-Gender Nexus to Advance Koshi Basin Management, 24–25 March 2016, Kathmandu, Nepal. Workshop Report 17. Kathmandu: International Centre for Integrated Mountain Development (ICIMOD).

IDE NEPAL & RUPANTARAN 2019. Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED). Catalogue of Climate Change Adaptation Approaches and Technologies. Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED)/Anukulan-X Project. UK Aid. Kathmandu: iDE Nepal and Rupantaran.

IDPG GESI WG 2017. Common Gender Equality and Social Inclusion Framework. Kathmandu: GESI Working Group, International Development Partner Group, Nepal.

IFAD 2014. Nepal: Adaptation for Smallholders in Hilly Areas. Final Project Design Report. Main report and appendices.

ILO 2020. Impact of COVID-19 on Nepali Migrant Workers: Protecting Nepali Migrant Workers during the Health and Economic Crisis. Challenges and the Way Forward, June 2020. Nepal: ILO, Country Office. https://eeas.europa.eu/delegations/nepal/90497/government-nepal-%E2%80%93-international-development-partners-joint-statement-green-recovery-nepal_en.

INTERNATIONAL ALERT 2020. Status and process of law-making in local governments: Reflections from two provinces. FEDERALISM IN NEPAL - VOLUME 4.

IOM 2020. Status of Nepali Migrant Workers in Relation to COVID-19. Kathmandu, Nepal: International Organization of Migration (IOM).

IRENA 2016. Solar pumping for irrigation: Improving livelihoods and sustainability. Abu Dhabi: The International Renewable Energy Agency.

IWMA 2020. Integrated Watershed Management Activity-Nepal. Final Report, Februray 2018-February 2020. Kathmandu: Winrock International.

IWMI 2020. Annual Report 2018: Connecting the role of water management. Colombo, Sri Lanka: International Water Management Institute (IWMI).

IWMI 2021. Adaptive scaling to achieve system transformation in One CGIAR. Colombo, Sri Lanka: International Water Management Institute (IWMI). 8p. https://hdl.handle.net/10568/113924.

JICA & KRI INTERNATIONAL CORP 2014. The project for the master plan study on high value agriculture extension and promotion in Sindhuli Road Cooridor in Nepal. Final Report, Volume I Main Report, March 2014. Ministry of Agriculture Development in Nepal. Japan International Cooperation Agency (JICA) and KRI International Corp. .

JICA 2013. Preparatory survey on JICA's cooperation program for agriculture and rural development in Nepal- Food production and agriculture in Nepal. Main report. Japan International Cooperation Agency (JICA), Nippon Koei, Ltd., Vision and Spirit for Overseas Cooperation (VSCO), Co., Ltd., and C.D.C. International Corportation.

JOSHI, A. 2018a. Women in agriculture. https://kathmandupost.com/opinion/2018/08/02/women-in-agriculture.

JOSHI, D. & NICOL, A. 2020. COVID-19 is a deadly reminder that inclusive water supply and sanitation matters for all of us.

JOSHI, K. 2018b. I/NGOs in federal Nepal: Their roles and challenges. https://thehimalayantimes.com/opinion/i-ngos-in-federal-nepal-their-roles-and-challenges.

KAFLE, N. 2017. Understanding the barriers to access and use of mechanical equipment in a feminized agriculture climate. Ministry of Agricultural Development, Daayitwa Summer Fellow. Kathmandu. Nepal.

KELKAR, G. 2009. Gender and productive assets: Implications of national rural employment guarantee for women's agency and productivity'. In IHD-UNIFEM Workshop on Women's Employment through Guaranteed Employment (Vol. 31).

KHADKA, M. & SUNAM, R. 2018. Workforce diversity and reservation policy in Nepal: A strategic approach to strengthening women's visibility in formal employment sector. A research paper for the regional conference on Women and the Future of Work in Asia and the Pacific Conference, Jan 31- 1 Feb 2018 Bangkok, ILO and DFAT.

KHADKA, M. 2009. *Why Does Exclusion Continue? Aid, Knowledge and Power in Nepal's Community Forestry Policy Process,* Maastricht, the Netherlands, Shaker Publishing.

KHADKA, M. 2010. Actors' Interaction at the Policy Level and Implication for Exclusion: Nepal's Community Forestry in Gómez, et al. (eds) Participation for What: Social Change or Social Control? Hivos, Oxfam-Novib and ISS Publications, Pp 139-160, The Hague: International Institute of Social Studies.

KHADKA, M., UPRETY, L. & SHRESTHA, G. forthcoming. Inclusive WASH (Water, Sanitation and Hygiene) under federalism in Nepal: the need for moving beyond 'engineering fixes'.

KHADKA, M., UPRETY, L., SHRESTHA, G., MUKHERJI, A. & MITRA, A. forthcoming. Do water-food-energy and solar irrigation policies consider gender, equality, and inclusion? Evidence from Bangladesh and Nepal? Draft 5 July 20201. IWMI-Nepal.

KHATIWADA, D. 2020. Why agricultural subsidies have failed to benefit needy farmers. *The Himalayan Times, 20 February 2020.* https://kathmandupost.com/money/2020/02/20/why-agricultural-subsidies-have-failed-to-benefit-needy-farmers.

KHATRI, D., POKHAREL, B., CHHETRI, R., CHHETRI, B., POUDEL, D., KHADKA, M. & B.K., N. 2021. Local community based institutions and collective action. Theme 2 : Institution. *In:* PAUDEL, N., OJHA, H., BANJADE, M., KARKI, R. & TAMANG, S. (eds.) *Reframing Nepal's community forestry in the changing socioeconomic context: A collaborative review of policy and practice. Dfrat for Comment, January 2021, Kathmandu.*

KHERALLAH, M., CAMAGNI, M. & BAUMGARTNER, P. 2015. Sustainable inclusion of smallholders in agricultural value chains. Scaling up note. https://www.ifad.org/documents/38714170/40264252/Scaling+up+note+-+Sustainable+inclusion+of+smallholders+in+agricultural+value+chains.pdf. IFAD.

KISAN II 2019. Project Fact Sheet: Knowledge-Based Integrated Sustainable Agriculture in Nepal (KISAN) II Project, https://winrock.org/wp-content/uploads/2019/03/AVP-Project-fact-sheet-KISAN-II.pdf. Kathmandu: Winrock International

KJELDSBERG, C., SHRESTHA, N., PATEL, M., DAVIS, D., MUNDY, G. & CUNNINGHAM, K. 2017. Nutrition-sensitive agricultural interventions and gender dynamics: A qualitative study in Nepal. Wiley, Maternal and Child Nutrition, 1-9.

KLOEPPINGER-TODD, R. & SHARMA, M. 2010. Innovations in Rural and Agriculture Finance: Overview. In: KLOEPPINGER-TODD, R. & SHARMA, M. (eds.) ions in Rural and Agriculture Finance: Overview, Focus 18, Brief 1, July 2010. *file:///C:/Users/user/Downloads/Innovations_in_rural_and_agriculture_finance.pdf*. Washington D.C.: IFPRI and World Bank.

LEDER, S., CLEMENT, F. & KARKI, E. 2019. Reframing women's empowerment in water security programmes in Western Nepal. *In:* SWEETMAN, C. & MEDLAND, L. (eds.) *Gender and Water, Sanitation and Hygiene.* Practical Action Publishing.

LIEBRAND, J. & UDAS, P. B. 2017. Becoming an Engineer or a Lady Engineer: Exploring Professional Performance and Masculinity in Nepal's Department of Irrigation. *Engineering Studies*.

LOBOGUERRERO, A. M., BIRCH, J., THORNTON, P., MEZA, L., SUNGA, I., BONG, B. B., RABBINGE, R., REDDY, M., DINESH, D., KORNER, J., MARTINEZ-BARON, D., MILLAN, A., HANSEN, J., HUYER, S. & CAMPBELL, B. 2018. Feeding the World in a Changing Climate: An Adaptation Roadmap for Agriculture. The Global Commission on Adaptation. Rotterdam and Washington, DC. 20 p. Available online at www.gca.org

LOON, J., WOLTERING, L., KRUPNIK, T. J., BAUDRON, F., BOA, M. & GOVAERTS, B. 2020. Scaling agricultural mechanization services in smallholder farming systems: Case studies from sub-Saharan Africa, South Asia, and Latin America. *Agricultural Systems 180 (2020) 102792*.

LTS INTERNATIONAL 2017. Sector Analysis Studies for the Commercial Agriculture for Smallholders and Agribusiness Programme. Nepal: Country Value Chain and Market Analysis Report Final.

MAHARJAN, A., BAUER, S. & KNERR, B. 2012. Do Rural Women Who Stay Behind Benefit from Male Out-migration? A Case Study in the Hills of Nepal. *Gender, Technology and Development, 16(1) 95–123*.

MANDAL, C. K. 2020. Returnee women migrant labourers stare at bleak future, survey finds. Kathmandu Post, October, 18, 2020. https://kathmandupost.com/national/2020/10/18/returnee-women-migrant-labourers-stare-at-bleak-future-survey-finds.

MAUSCH, K., HALL, A. & HAMBLOCH, C. 2020. Colliding paradigms and trade-offs: Agri-food systems and value chain interventions. Global Food Security, 26, 100439.

MERREY, D. J. 2018. Will 21st Century Water User Associations do Better than in the 20th Century? New Approaches Needed to Support Farmer-Led Collective Management of Irrigation. ICID conference, 2020, Kathmandu. *In:* PRADHAN, P. (ed.) *Symposium on Nexus Challenges in Irrigation Institutions. Irrigation in support of evergreen revolution. The 8th Asian Regional Conference, May 2-4, 2018, Kathmandu.* Kathmandu: FMISPT.

MERREY, D. J., MEINZEN-DICK , R., MOLLINGA, P. & KARAR, E. 2007. Policy and institutional reform: the art of the possible. Chapter 5. *In:* MOLDEN, D. (ed.) *A Comprehensive Assessment of Water Management in Agriculture.* Colombo, SriLanka: International Water Management Institute (IWMI).

MINH, T. T. 2020. More Than Money: Stakeholders Look Beyond Financing to Expand Farmer-Led Irrigation. https://www.agrilinks.org/post/more-money-stakeholders-look-beyond-financing-expand-farmer-led-irrigation.

MINH, T. T., COFIE, O., LEFORE, N. & SCHMITTER, P. 2020. Multi-stakeholder dialogue space on farmer-led irrigation development: An instrument for driving systemic change with private sector initiatives *Knowledge Management for Development JournalOnline first. 21pp*.

MINH, T. T., ZWART, S., APPOH, R. & SCHMITTER, P. 2021. Analyzing the enabling environment to enhance the scaling of irrigation and water management technologies: a tool for implementers. Colombo, Sri Lanka: International Water Management Institute (IWMI). 18p. (IWMI Working Paper 197). [doi: https://doi.org/10.5337/2021.201].

MOAD 2016. Agriculture Development Strategy, 2015-2035. Part I. Kathmandu: Ministry of Agricultural Development (MoAD).

MOAD 2016. Agriculture Development Strategy, 2015-2035. Part I. Kathmandu: Ministry of Agricultural Development (MoAD).

MOBARAK, A. M. 2020. Mobility and Migration during COVID-19, Yale University. CESLAM Migration Conference. Key Note Lecture, presented on 15.9.2020.

MOEWRI 2018. White paper on the status and future roadmap of energy, water resources and irrigation sector, 2018 (2075). Kathmandu, Nepal: Ministry of Energy, Water Resources and Irrigation (MoEWRI).

MOEWRI 2018. White paper on the status and future roadmap of energy, water resources and irrigation sector, 2018 (2075). Kathmandu, Nepal: Ministry of Energy, Water Resources and Irrigation (MoEWRI).

MOLMAC 2019. Subsidy guidelines for cooperatives, 2076. Sudurpaschim Province: Ministry of Land Management, Agriculture and Cooperative (MoLMAC).

MOLMAC 2020. Covid Special Agriculture Program, 2077. Ministry of Land Management, Agriculture and Cooperative. Lumbini Province.

MOLESS 2020. Nepal Labour Migration Report 2020. Ministry of Labour, Employment and Social Security.

MOSSE, D. 2004. Is Good policy unimplementable? Reflection on the ethnography of Aid Policy and Practice. *Development and Change.* Oxford UK: Blackwell Publishing.

MUKHERJI, A., CHOWDHURY, D., FISHMAN, R., LAMICHHANE, N., KHADGI, V. & S., B. 2017. Sustainable Financial Solutions for the Adoption of Solar Powered Irrigation Pumps in Nepal's Terai Kathmandu: ICIMOD.

MUTAMBARA, S., DARKOH, M. B. K. & ATLHOPHENG, J. R. 2015. Making markets work for the poor (M4P) approach and smallholder irrigation farming.

NAAN. International Knowledge Forum, Journey to Federalism in Nepal, Netherlands Alumni Association of Nepal (NAAN), Kathmandu Nepal. . *In:* KOIRALA, P., DAHAL, K., BASNET, G., PANT, D., KHADKA, M., PAUDEL, R., DHAKAL, S., RAGHUBANSHI, M., SHRESTHA, S., RAI, J., GADAL, N. & KOIRALA, P., eds. International Knowledge Forum, Journey to Federalism in Nepal: For resilient society during/after Covid-19, 2020 Kathmandu. Netherlands Alumni Association of Nepal (NAAN), 263.

NAMDP 2019. The Nepal Agricultural Market Development Programme (NAMDP) supported by Swiss Agency for Development and Cooperation. https://www.swisscontact.org/en/projects/namdp. Kathmandu: swisscontact.

NEPAL, P. & SUBEDI, S. 2016. Water Use Master Plan: A Gateway to Integrated Water Resource Management in Small-scale Watershed Area (An Experience from the Rural Village Water Resources Management Project - RVWRMP1). *Society of Engineers for Rural Development, Nepal (SERDEN).* https://8b4410ba-234b-41d7-a94c-241149a3ad93.filesusr.com/ugd/b72297_0dddc80002234d318a81c4747e2c9831.pdf.

NEPAL, S., NEUPANE, N., BELBASE, D., PANDEY, V. P. & MUKHERJI, A. 2021. Achieving water security in Nepal through unravelling the water-energy-agriculture nexus. *International Journal of Water Resources Development,* 37, 67-93.

NEUPANE, H., ADHIKARI, M. & RAUNIYAR, P. B. 2015. Farmers' perception on role of cooperatives in agriculture practices of major cereal crops in Western Terai of Nepal. Journal of the Institute of Agriculture and Animal Science, 177-186.

NEW AGRICULTURALIST 2009. Country Profile- NEPAL. http://www.new-ag.info/en/country/profile.php?a=935

NIROJA, P., MAMORU, I. & MUTO, Y. 2015. Marketing System of Agricultural Cooperatives in Nepal: A Case Studies of Janagarathi Vegetable and Fruit Producer Agriculture, Cooperative. *Review of Integrative Business and Economics Research, 4(4), 337-348*.

NPC 2017. Multi-Sector Nutrition Plan -II (2018-2022). Unofficial translation. Approved by the Cabinet Meeting of the Government of Nepal on 19 November 2017. Kathmandu, Nepal: National Planning Commission (NPC), Government of Nepal.

NPC 2018. Needs Assessment, Costing and Financing Strategy for Sutainable Development Goals. Kathmandu: National Planning Commission (NPC), Government of Nepal.

NPC 2019. 15th Plan, 2019-2023 and Approach Paper. Kathmandu: National Planning Commission (NPC).

OJHA, R. 2020. Constraining local governments to function due to contested laws (English Translation of Nepali) https://www.onlinekhabar.com/2020/11/912248.

PAHL-WOSTL, C. 2020. Adaptive and sustainable water management: from improved conceptual foundations to transformative change. *International Journal of Water Resources Development,* 36, 397-415.

PANDEY, V. P., SHARMA, A., DHAUBANJAR, S., BHARATI, L. & I.R., J. 2019. Climate Shocks and Responses in Karnali-Mahakali Basins, Western Nepal. Climate (7), 92; https://doi.org/10.3390/cli7070092.

PANDEY, V., KAFLE, K., UPRETY, L., MUKHERJEE, A., SHRESTHA, G. & KHADKA, M. 2020a. A Rapid Assessment of AEPC's Subsidy Delivery Mechanism for Solar Irrigation Pumps (SIPs) in Nepal. Submitted to AEPC in May 2020. Kathmandu: IWMI-Nepal.

PANDEY, V., KAFLE, K., UPRETY, L., MUKHERJI, A., SHRESTHA, G. & KHADKA, M. 2020b. A Rapid Assessment of AEPC's Subsidy Delivery Mechanism for Solar Irrigation Pumps (SIPs) in Nepal. Kathmandu: IWMI-Nepal.

PANT, D. 2020. Practicality of federalism: How long before it is fully functional? https://thehimalayantimes.com/opinion/practicality-of-federalism-how-long-before-it-is-fully-functional/. *The Himalayan, November 9, 2020*.

PANT, D., GAUTAM, K. R., SHAKYA, S. D. & ADHIKARI, D. L. 2006. Multiple Use Schemes: Benefit to Smallholders. IWMI Working Paper 114. Colombo, Sri Lanka: International Water Management Institute (IWMI).

PANT, S. K. & RESURRECCIÓN, B. R. 2014. Gender and Caste Relations Amidst a Changing Political Situation in Nepal: Insights from a Farmer-Managed Irrigation System. *Gender, Technology and Development,* 18(2) 219-247.

PANTA, H. K. 2018. Supply Chain of Subsidized Chemical Fertilizers in Nepal. *Journal of the Institute of Agriculture and Animal Science*, 35(1), 9-20.

PANTA, S. & THAPA, B. 2017. Entrepreneurship and women's empowerment in gateway communities of Bardia National Park, Nepal. *Journal of Ecotourism, DOI: 10.1080/14724049.2017.1299743*.

PANTHI, J., KHATIWADA, K., SHRESTHA, M. L. & DAHAL, P. 2018. Water poverty in the context of climate change: a case study from Karnali river basin in Nepal Himalaya. *International Journal of River Basin Management, DOI: 10.1080/15715124.2018.1531421*.

PAUDEL, K. 2020. *RE: Agriculture, farmer and employement after the Covid-19 pandemic. Presented at the policy dialouge organized by Martin Chautari on 22 September 2020, Kathmandu.*

PAUDEL, K. P. & SHARMA, S. 2012. *Small Irrigation Systems in Nepal. An Analytical Perview from Irrigated Development Perspective of Batch I Irrigation Sub Projects under Community Managed Irrigated Agriculture Sector Project,* Kathmandu, Community Managed Irrigated Agriculture Sector Project (CMIASP), Ministry of Agriculture Development. Directorate of Agriculture Development. .

PAUDEL, N., OJHA, H., BANJADE, M., KARKI, R. & TAMANG, S. 2021. Reframing Nepal's community forestry in the changing socioeconomic context: A collaborative review of policy and practice. Dfrat for Comment, January 2021, Kathmandu.

PAVELIC, P. 2013. Practical Efforts to Improve Groundwater Governance in the Challenging Context of Lao PDR. Confererence papers h046403. International Water Management Institute (IWMI).

POKHAREL, K., KARKI, R., OJHA, H. R., GENTLE, P., ACHARYA, D., BANJADE, M. & PAUDEL, D. 2020a. State-community relations and deliberative politics within federal forest governance in Nepal *International Forestry Review,* 22, 370-381.

POKHAREL, N., GHIMIRE, A., THAPA, B. S. & THAPA, B. 2020b. Opportunity for research and manufacturing of pump in Nepal *Journal of Physics: Conference Series. Vol. 1608. No. 1. IOP Publishing, 2020.*

POUDEL, D. D. & DUEX, T. W. 2017. Vanishing Springs in Nepalese Mountains: Assessment of Water Sources, Farmers' Perceptions, and Climate Change Adaptation. *International Mountain Society,* 37(1) : 35-46.

PRADHAN, P. & BELBASE, M. 2018. Institutional Reforms in Irrigation Sector for Sustainable Agriculture Water Management including Water Users Associations in Nepal. *HYDRO NEPAL | ISSUE NO. 23 | JULY 2018* 58-70.

PRADHAN, P. 2000. Farmer managed irrigation systems in Nepal at the crosssroad. This paper was prepared to present in the 8th Biennial Conference of the International Association for the Study of Common Property (IASCP) to be held in Bloomington, Indiana May 30 to 4 July, 2000

PRADHAN, P. 2016. Challenges and Opportunities for Farmer Managed Irrigation Systems (FMIS) in Koshi Basin, Nepal. https://prachandashare.files.wordpress.com/2018/05/challenges-and-opportunities-for-farmer-managed-irrigation-systems-fmis-in-koshi-basin-of-nepal-dr-prachanda-pradhan-fmist-1.pdf. Kathmandu: FMIS Promotion Trust.

PRADHAN, P., SUBEDI, D. R., KHATIWADA, D., JOSHI, K. K., KAFLE, S., CHHETRI, R. P. & AL., E. 2021. COVID-19 pandemic not only puts challenges but also opens opportunities for sustainable transformation. *Earth's Future, e2021EF001996,* July 2021.

PRADHAN, P., van KOPPEN, B., KHADKA, M., GC, R. K., RAJOURIA, A. & PANDEY, V. forthcoming. Community institutions in water governance for sustainable livelihoods. A manuscript submitted to the International Journal of the Commons.

QUISUMBING, A. R. & KUMAR, N. 2011. Does social capital build women's assets? The long-term impacts of group-based and individual dissemination of agricultural technology in Bangladesh. *Journal of Development Effectiveness,* 3, 220-242.

RAUT, M. & RAJOURIA, A. 2020. COVID-19, Hand Washing, and Access to Water. *The Himalayan Times*.

RAUTANEN, S. L. & G.C., R. 2012. Multiple-use water services (MUS) – Nepal country paper.

REGMI, B., STAR, C. & FILHO, W. 2016. Effectiveness of the Local Adaptation Plan of Action to support climate change adaptation in Nepal. *Mitig Adapt Strateg Glob Change, DOI 10.1007/s11027-014-9610-3.*

RIJAL, S. P. 2017. Female Ownership of Fixed Assets in Nepal: A Regional Perspective. *The Third Pole: Journal of Geography Education, 17, 73-82.* https://doi.org/10.3126/ttp.v17i0.19984.

ROLA-RUBZEN, M. F., PARIS, T., HAWKINS, J. & SAPKOTA, B. 2020. Improving Gender Participation in Agricultural Technology Adoption in Asia: From Rhetoric to Practical Action. *Applied Economic Perspectives and Policy (2020) volume 00, number 00, pp. 1–13. doi:10.1002/aepp.13011.*

RSS. 2020. International Youth Day. Challenges in iImplementation of youth policy. Published in dailys newspaper, 12 August 2020, The Rising Nepal. https://risingnepaldaily.com/nation/international-youth-day-challenges-in-implementation-of-youth-policy.

SANOGO, I. 2010. How to conduct a food commodity value chain analysis. Technical Guidance Sheet (TGS) Prepared under ENCAP-Enhance Capacities in Food Security and Response Analysis. World Food Program.

SDC 2020. Program Document of Small Irrigation Program (SIP) II, 01 July 2020-31 Decemebr 2024. Government of Switzerland and the Ministry of Fiance, Government of Nepal. Kathmandu, Nepal: Swiss Agency for Development and Cooperation (SDC).

SHAH, T. 2014. Groundwater Governance and Irrigated Agriculture. Background papers No. 19. Global Water Partnership Technical Committee (TEC) Global Water Partnership (GWP).

SHARMA NEUPANE, M. 2020. TVET Programs in Nepal: Issue of Access and Relevancy. *Journal of Training and Development, 5, 16-28.* https://doi.org/10.3126/jtd.v5i0.33888.

SHARMA, A., KARKI, E., ERIYAGAMA, N., SHRESTHA, G., JEULAND, M. & BHARATI, L. 2020. Whose river is it? An assessment of livelihood and cultural water flow requirements for the Karnali basin. *Ecology and Society 25(3): 22*.

SHARMA, P. 2014. State restructuring in Nepal: Context, rational and possibilities. *In:* KARKI, B. & EDRISINHA, R. (eds.) *The federalism debate in Nepal: Post Peace Agreement Constitution Making in Nepal Volume II.* Kathmandu: United Nations Development Programme (UNDP) and Support to Participatory Constitution Building in Nepal (SPCBN)

SHARMA, P. 2020. Federalism in Nepal: Opportunities and Challenges. Key note speech at the virtual International Knowledge Forum, The Netherlands Alumni Association of Nepal (NAAN), 11-12 October, 2020. Website: ikf.naan.org.np.

SHARMA, S. P. & ADHIKARY, S. 2020. Securing Safe Water and Sanitation Services in Nepal Search for a Breakthrough. Policy Brief, December 2020. Kathmandu: Nepal Water Conservation Foundation (NWCF).

SHRESTHA, G. & CLEMENT, F. 2019a. Gender, social capital and collective action: A gender perspective on collective

sustainability of water resource governance in west Nepal. The Digo Jal Bikas workshop, 13, March 2019, Kathmandu.

SHRESTHA, G. & CLEMENT, F. 2019b. Unravelling gendered practices in the public water sector in Nepal. *Water Policy,* 21, 1017-1033.

SHRESTHA, G. & LEDER, S. 2020. To counter COVID-19 in Nepal, we must support small-scale women farmers. June, 2020. Thive, CGIAR ,https://wle.cgiar.org/thrive/2020/06/24/counter-covid-19-nepal-we-must-support-small-scale-women-farmers.

SHRESTHA, G., CELEMENT, F. & DROWN, P. 2018a. Unacknowledged Irrigators. The Kathmandu Post, Feburary 8, 2018.

SHRESTHA, N. 2014. *Improving Cereal Production In The Tarai Region of Nepal. Assessment of field management strategies through a model based approach.* KU Leuven, Science, Engineering & Technology.

SHRESTHA, R. 2019. Governance and institutional risks and challenges in Nepal. Manila, Philippines: Asian Development Bank (ADB).

Shrestha, R., Tripathi, G., & Laudari, D. (2018). Groundwater Resources of Nepal: An Overview. In A. Mukherjee (Ed.), Groundwater of South Asia (pp. 169-193). Singapore: Springer.

STOIAN, D., DONOVAN,J., ELIAS, M. & BLARE, T. 2018. Fit for purpose? A review of guides for gender-equitable value chain development. *Development in Practice*, 28 (1), 494-509.

SUBEDI, R. 2008. Women Farmers' Participation in Agriculture Training: in Kavre District of Nepal. Retrieved from http://edepot.wur.nl/1198.

SUGDEN, F., AGARWAL, B., LEDER, S., SAIKIA, P., RAUT, M., KUMAR, A. & RAY, D. 2020. Experiments in farmers' collectives in Eastern India and Nepal: Process, benefits, and challenges. *Journal of Agrarian Change,* 2020, 1-32.

SUGDEN, F. 2014. Landlordism, tenants and the groundwater sector: lessons from Tarai-Madhesh, Nepal. Colombo, Sri Lanka: International Water Management Institute (IWMI). 33p. (IWMI Research Report 162). doi: 10.5337/2015.204.

SUHARDIMAN, D., BASKATORI, R., KARKI, E. & BHARATI, L. 2018. The politics of river basin planning and state transformation processes in Nepal. *Geoforum,* 96, 70-76.

SUHARDIMAN, D., CLEMENT, F. & BHARATI, L. 2015. Integrated water resources management in Nepal: key stakeholders' perceptions and lessons learned. *International Journal of Water Resources Development,* 31, 284-300.

SUHARDIMAN, D., LEBEL, L., NICOL, A. & WONG, T. 2017. Power and politics in water governance. Revisiting the role of collective action in the commons. In: D. SUHARDIMAN, A. NICOL & MAPEDZA, E. (eds.) Water governance and collective action: Multi-scale challenges. London and New York: Routledge.

TAF 2018. Nepal's Locally Elected Women Representatives: Exploratory Study of Needs and Capacity Kathmandu, Nepal: The Asia Foundation.

THAPA, B. & SCOTT, C. 2019. Institutional Strategies for Adaptation to Water Stress in Farmer-Managed Irrigation Systems of Nepal. *International Journal of the Commons, 13(2), pp. 892–908. DOI:* https://doi.org/10.5334/ijc.901.

THAPA, B., SCOTT, C., WESTER, P. & VARAD, R. 2016. Towards characterizing the adaptive capacity of farmer-managed irrigation systems: learnings from Nepal. *Environmental Sustainability 2016, 21:37–44*

THAPA, K., GNYAWALI, T. P., CHAUDHARY, L., CHAUDHARY, B. D., CHAUDHARY, M., THAPA, G. J., KHANAL, C., KARKI THAPA, M., DHAKAL, T., RAI, D. P., BHATTA, S. R., UPADHYA, D., BHANDARI, A. R. & JOSHI, D. 2018. Linkages among forest, water, and wildlife: a case study from Kalapani community forest in the Lamahi bottleneck area of Terai Arc Landscape. *International Journal of the Commons,* 12, 1-20.

TIWARI, N. 2010. Economic and technological constraints facing farm women. *International Journal of Rural Studies,* 17, 1-5.

TRACTEBEL ENGINEERING GMBH 2019. Irrigation Master Plan. Main Report. Prepared by Tractebel Engineering GmbH in association with NIRAS and TMS Package 4 Project Office Department of Irrigation Lalitpur, Kathmandu Nepal for Water Resources Project Preparatory Facility (WRPPF), Department of Water Resources and Irrigation. Ministry of Energy, Water Resources and Irrigation. Kathmandu: Tractebel Engineering GmbH.

UDAS, P. B. 2014. *Gendered Participation in Water Management in Nepal: Discourses, Policies and Practices in the Irrigation and Drinking Water Sectors.* PhD, Wageningen University.

UDAS, P. B., TAMANG, D. D., UNNI, A., HAMAL, M., SHRESTHA, K. & PANDIT, A. 2019. Basin level gendered vulnerabilities and adaptation: A case of Gandaki River Basin. *Environmental Development,* 31, 43-54.

UN WOMEN 2015. Progress of women in Nepal (1995-2015), Substantial equality: Non-negotiable Kathmandu: UN Women.

UN WOMEN 2017. Women farmers of Nepal take charge of their lives and livelihoods. https://www.unwomen.org/en/news/stories/2017/2/feature-women-farmers-of-nepal-take-charge-of-their-lives.

UN WOMEN 2020. From insights to action: Gender equality in the wake of Covid-19. The United States: UN Women.

UNBUNDLING REPORT 2016. Unbundling of exclusive and concurrent power of federal, provincial and local government under the schedule 5,6,7,8 &9, Constitution of Nepal. Federalism Implementation and Adminsitrateive Restructuring Coordination Committee (FIARCC), Government of Nepal 2015

UNDP 2010. Country Sector Assessments: Volume 2 UNDP GoAL WaSH Programme, Nepal. file:///C:/Users/user/Downloads/UNDP_UNDP001330_GoALWaSHVol2_MECH_Revised_081810_Nepal_hi.pdf. Kathmandu: UNDP.

UNDP 2018. Value Chain Development of Fruit and Vegetables in Nepal (2018-2022).

UNDP 2019. Status of TVET institutions in Nepal. Retrieved in 17 November 2020 https://www.np.undp.org/content/nepal/en/home/library/sustainable-development-goals-national-report---nepal/status-of-TVET-institutions-in-Nepal.html.

UNDP 2020. Rapid assessment of socio-economic impact of Covid-19 in Nepal. UN House, Pulchowk, Lalitpur, Nepal: United Nations Development Programme.

UPADHYAY, B., SAMAD, M. & GIORDANO, M. 2005. Livelihoods and gender roles in drip-irrigation technology: A case of Nepal. Colombo, Sri Lanka: IWMI. v, 13p. [IWMI working paper 87].

UPRETY, L. & PANDEY, V. 2020. Why we need smarter, targeted subsidies to promote solar irrigation? Spotlight, 10 September, 2020. https://www.spotlightnepal.com/2020/09/10/why-we-need-smarter-targeted-subsidies-promote-solar-irrigation/.

URFELS, A. & FOSTER, T. 2020. Reducing Poverty in South Asia Through Accelerating Irrigation Intensification. https://www.agrilinks.org/post/reducing-poverty-south-asia-through-accelerating-irrigation-intensification.

USAID 2011. Value Chain/ Market Analysis of the Off-Season Vegetable Sub-Sector in Nepal. Kathmandu, Nepal: USAID.

van KOPPEN, B. V., RAJOURIA, A., KHADKA, M. & RAUT, M. 2019. Fact Sheets on Multiple Use Water Services (MUS). Draft Kathmandu: IWMI.

van KOPPEN, B. 2002. A gender performance indicator for irrigation: Concepts, tools, and applications. Research Report 59. Colombo: International Water Management Institute.

van KOPPEN, B. V., RAJOURIA, A., KHADKA, M. & RAUT, M. 2019. Fact Sheets on Multiple Use Water Services (MUS). Draft Kathmandu: IWMI.

VILLHOLTH, K. G. 2013. Challenges of Groundwater Management in Sri Lanka. Conference papers, h046402 https://publications.iwmi.org/pdf/H046402.pdf. International Water Management Institute (IWMI).

WENNER, M. D. 2010. Innovations in Rural and Agriculture Finance Credit Risk Management in Financing Agriculture, *Focus 18, Brief 10, July 2010.* http://cdm15738.contentdm.oclc.org/utils/getfile/collection/p15738coll2/id/7506/filename/7507.pdf.

WFP & FAO 2007. Food and Agricultural Markets in Nepal. Kathmandu: World Food Programme (WFP) and FAO.

WHITE, P. & HAAPALA, J. 2018. Water security and social inclusion: Local governance within the newly established rural municipalities in Nepal *NEW ANGLE: Nepal Journal of Social Science and Public Policy,* December 2018, Vol. 5, 1-29.

WINROCK INTERNATIONAL 2009. Nepal Smallholder Irrigation Market Initiative (SIMI). Project Completion Report, June 2003- September 2009, Submitted to USAID by Winrock International on December 29, 2009.

WINROCK INTERNATIONAL 2020. Feed the Future Nepal Knowledge-Based Integrated Sustainable Agriculture in Nepal (KISSAN) II Project Rapid Assessment of COVID-19 Impacts Among KISAN II Supported Women and Disadvantaged Groups August 2020.

WINTHER, T., K., K. U. & ANJALI SAINI, A. 2018. Solar powered electricity access: Implications for women's empowerment in rural Kenya *Energy research and social science,* 44, 61-74.

WOLTERING, L., FEHLENBERG, K., GERARD, B., UBELS, J. & COOLEY, L. 2019. Scaling – from "reaching many" to sustainable systems change at scale: A critical shift in mindset. *Agricultural Systems 176 (2019) 102652*.

WORLD BANK 2016. Migration and remittances: Recent development and outlook. Migration and Development Brief 26. April 2016. https://openknowledge.worldbank.org/bitstream/handle/10986/24012/9781464809132.pdf?sequence=2&i. Washington D.C.: World Bank.

WORLD BANK 2019. International Development Association Project Appraisal Document on a proposed credit in the amount of SDR 86.4 Million (US$120 MILLION EQUIVALENT) to Nepal for a Youth Employment Trantrafornation Initiative (YETI), August 16, 2019. Agriculture And Food Global Practice South Asia Region.

WORLD BANK 2020a. Managing Groundwater for Drought Resilience in South Asia. Delivered under the South Asia Water Initiative (SAWI) Regional Cross-Cutting Knowledge, Dialogue, and Cooperation Focus Area. file:///C:/Users/user/Downloads/WBK%202020%20South%20Asia%20GW%20Resilience%20Synthesis%20Report%20Final%20W19027.pdf. World Bank Group.

WORLD BANK 2020b. Rural enterprise and economic development project (REED). October 6, 2020. International Development Association Project Appraisal Document on a proposed credit in the amount of SDR 56.7 Million (US$80 MILLION EQUIVALENT). Agriculture And Food Global Practice South Asia Region.

YADAV, D. B. 2018a. Cooperative became a mileage of UCs in sustainable operation of water services. *A Journal on Rural Infrastrcuture Development- Vol IX (2075)*.

YADAV, S. K. 2018b. Groundwater Challenges, Governance, and Management in Nepal. *In:* MUKHERJEE, A. (ed.) *Groundwater in South Asia.* Singapore: Springer Hydrogeology.

YADAW, R. 2018. Rice Technological Innovation and Value Chain Development in Nepal: Current Status and Future Directions. *In:* PANDEY, P. & BHANDARI, H. (eds.) *Rice Technological Innovation and Value Chain Development in South Asia: Current Status and Future Directions.* Dhaka, Bangladesh: SAARC Agriculture Centre.

Annexes

Annex 1-1. Population dynamic (No.) by caste/ethnicity in the FtF ZoI districts

District	Brahmin	Chhetri	Janajati	Dalit	Madhesi other caste	Muslim	Badi	Other	Total
Banke	36,550	157,893	120,059	61,458	4,665	93,298	740	2,848	477,511
Bardiya	37,916	80,598	247,927	41,814	1,373	11,072	932	398	422,030
Dang	56,724	155,330	255,688	64,015	514	4,777	1,718	181	538,947
Kailali	97,178	201,594	362,349	98,851	1,853	4,928	2,822	807	770382
Kanchanpur	72,229	59,420	140,292	69,542	321	461	1,258	402	443,925
Kapilbastu	55,952	12,907	97,897	73,769	7,273	103,856	693	3,594	55,941
TOTAL No.	356,549	967,742	1,224,212	409,449	15,999	218,392	8,163	8,230	3,208,736
% of the total	**11.11**	**30.16**	**38.15**	**12.76**	**0.50**	**6.81**	**0.25**	**0.26**	**100.00**

Source: Census, 2011, GoN, Kathmandu

Annex 3-1. Lists of policy documents reviewed

Sector	Policies frameworks prepared reviewed
Constitution	Constitution of Nepal 2015
Operationalization of Constitution	GoN. (2017). *Local Government Operation Act.* Ministry of Federal Affairs and General Administration (MoFAGA). https://publichealthupdate.com/local-government-operation-act-2074/
	GoN (2020), Inter-Governmental Coordination and Relationship, Bill
National Development Plan	GoN. (2018a). *15th Plan (2019-2023) and Approach Paper*. National Planning Commission. https://www.npc.gov.np/images/category/15th_plan_concept_paper.pdf
Poverty Reduction	GoN. (2019c). *Poverty Reduction Policy, 2019*. Ministry of Land Management, Cooperatives and Poverty Alleviation. https://molcpa.gov.np/department/page/233
Agricultural Development	GoN (2017) *Multi-Sector Nutrition Plan- II (2018–2022)*. (2017, November). National Planning commission. http://nnfsp.gov.np/PublicationFiles/b8aae359-15ea-40c4-aa13-b1076efb251b.pdf
	GoN. (2019). National Agroforestry Policy 2019. Ministry of Agriculture and Livestock Development. https://www.worldagroforestry.org/sites/agroforestry/files/National_Agrofores_Policy_Nepal_2019.pdf
	GoN.(2019). *National Land Policy, 2018*. Ministry of Land Management, Cooperatives and Poverty Alleviation. https://molcpa.gov.np/department/page/242
	GoN. (2014). Agricultural Mechanization Promotion Policy 2014. Ministry of Agriculture and Livestock Development. https://www.moald.gov.np/publication/Policy
	GoN. (2016). *Agriculture Development Strategy ADS (2014)*. Ministry of Agriculture Development (MoAD) http://nnfsp.gov.np/PublicationFiles/bf53f040-32cb-4407-a611-d891935d2e97.pdf
	GoN (2012). *National Land Use Policy, 2012*. Ministry of Land Management, Cooperatives and Poverty Alleviation. https://molcpa.gov.np/department/page/253
	GoN, 2020. Prime Minister Employment Program. MoLESS, Kathamndu. Nepal. https://pmep.gov.np Information gathered from PMEP website
	GoN, 2077. PMEP Operation guidelines (2077). MoLESS. Kathmandu, Nepal, Information gathered from PMEP website. http://pmep.gov.np/uploads/notice/1596179712-jpg2pdf.pdf
	GoN, 2019. Cash for work community project operation and managment gudielines. MOLESS. PMEP, Kathmandu. Nepal.
	GoN. 2076. Youth Employment Transformation Project Guidelines, 2076. MoLESS. PMEP. Kathmandu. Nepal.
	Environmental and Social Management Framework (ESMF), 2019. Youth Employment Transformation Initiative Ministry of Labour, Employment and Social Security, Government of Nepal 2019. Retrieved from http://documents1.worldbank.org/curated/en/650961559623877743/pdf/Vulnerable-Community-Development-Plan.pdf
	GoN, 2018. The Framework for Agricultural Business Promotional Grant. Agriculture for Youth project. MoALD. Kathmandu. Nepal.
	GoN. 2019. Youth in Agriculture program operational guidelines. MoALD. Kathmandu. Nepal.
	The World Bank, 2020. Project Information Document (PID). Rural Economic and Enterprise Development Project (P170215). Kathmandu. Nepal.
	GoN. 2077 [2019]. Guideline for province and local level project related technical work operation process, reporting and statistics management, Agriculture and Livestock Development Ministry. Nepal.
	GoN. 2006. Gender Mainstreaming Strategy. Ministry of Agriculture. Kathmandu, Nepal.

Annex 3-1. Lists of policy documents reviewed, cont'd...

Sector	Policies frameworks prepared reviewed
Water resources, and energy	GoN. (2020). *National Water Policy 2020*. Ministry of Energy, Water Resources and Irrigation. https://moewri.gov.np/storage/listies/December2020/rastriya-jalshrot-niti-2077.pdf
	GoN, Draft Water Resource Bill, 2020, Ministry of Energy, Water Resources and Irrigation, Kathmandu
	GoN, Draft Electricity Bill, 2020, Ministry of Energy, Water Resources and Irrigation, Kathmandu
	GoN. (2018). White paper on the status and future roadmap of energy, water resources and irrigation sector, 2018 (2075). Ministry of Energy, Water Resources and Irrigation.
	GoN. (2016). Renewable Energy Subsidy Policy, 2073 BS. Ministry of Population and Environment https://policy.asiapacificenergy.org/sites/default/files/Renewable%20Energy%20Subsidy%20Policy%2C%202073%20BS%20%282016%29%20%28EN%29.pdf
	Government of Nepal. (1992). *Water Resources Act, 1992.* Government of Nepal. http://admin.theiguides.org/Media/Documents/WaterResourcesAct1992.pdf
	Government of Nepal. (1993). *Water Resources Rules, 2050 (1993)*. https://www.moewri.gov.np/storage/listies/May2020/water-resources-rules-2050-1993.pdf
	GoN. (2005). *National Water Plan (2002-2027).* Water and Energy Commission. https://www.slideshare.net/BhimUpadhyaya/national-water-plan-nepal-2005-by-wecs
Irrigation development	GoN. (2013). *Irrigation Policy, 2013.* Department of Water Resource and Irrigation. https://dwri.gov.np/documents/documents/1603185770.pdf
	Tractebel Engineering GmbH, Irrigation Master Plan 2019. Main Report. Ministry of Energy, Water Resources and Irrigation. Kathmandu. Nepal
WASH	GoN, Draft Water Supply and Sanitation Bill, 2020, Ministry of Watery Supply, Kathmandu
	GoN, 2015, WASH Sector Development Plan, 2015-2030
Environment, and climate change	GoN (2020), The Second Nationally Determined Contribution, (NDC), Ministry of Forests and Environment, Kathmandu
	GoN. (2019). *National Climate Change Policy, 2076 (2019)*. Ministry of Forests and Environment. https://mofe.gov.np/downloadfile/climatechange_policy_english_1580984322.pdf
	GoN. (2019). *The Environment Protection Act, 2019 (2076).* Ministry of Forest and Environment. http://blogs2.law.columbia.edu/climate-change-litigation/wp-content/uploads/sites/16/non-us-case-documents/2019/20191018_074-WO-0283_na.pdf
	GoN. (2019). *Environment Protection Rules, 2077.* Ministry of Forests and Environment. https://www.mofe.gov.np/downloadfile/Env_Regulation_rajpatra_1592360474.pdf
	GoN. (2018). *National Policy for Disaster Risk Reduction 2018.* Ministry of Home Affairs. http://drrportal.gov.np/uploads/document/1476.pdf
	GoN. (2019c). *National Forest Policy 2019.* Ministry of Forests and Environment. https://www.mofe.gov.np/downloadsdetail/8/2018/36366627/
	GoN. (2019). *Forest Act, 2019.* Ministry of Forests and Environment. https://www.mofe.gov.np/downloadfile/%E0%A4%B5%E0%A4%A8-%E0%A4%90%E0%A4%A8-%E0%A5%A8%E0%A5%A6%E0%A5%AD%E0%A5%AC_1573016200.pdf
Trade	GoN. (2015). *Commerce Policy 2072.* Ministry of Industry, Commerce and Supplies. https://moics.gov.np/public/uploads/shares/policy/trade_policy_20721_1467958214_1470736457.pdf
	GoN. (2016). *Nepal Trade Integration Strategy 2016.* Ministry of Commerce, Industry and Supplies. https://moics.gov.np/public/uploads/shares/publication/NTIS_2016_1546150729.pdf
	GoN. (2015). *Public Private Partnership Policy, 2072.* Ministry of Finance. https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/PPP%20Policy%202015%20unofficial%20translation.pdf
	GoN. (2019). *Public Private Partnership and Investment Act, 2019*. Investment Board Nepal https://ibn.gov.np/wp-content/uploads/2020/04/PPPIA2075-English.pdf
	GoN. (2020). *Public private Partnership and Investment Regulations, 2020.* Nepal Investment Board. https://ibn.gov.np/wp-content/uploads/IBN%20Documents/Legal%20Documents/PPP%20and%20Investment%20Regulations%202077.pdf?_t=1590504306
Youth	GoN, 2015.Youth Vision – 2025 And Ten-Year Strategic Plan, Nepal Government Ministry of Youth and Sports Singh Durbar, Kathmandu
	National Youth Policy 2072(2015) Approved by Nepal Government (Council of Ministers) On 2072/6/19 (October 6, 2015). Nepal Government Ministry of Youth and Sports Singh Durbar, Kathmandu.
	GoN, 2015. Youth Council Act, (2015), Nepal Government Ministry of Youth and Sports Singh Durbar, Kathmandu. Nepal.
	National Employment Policy. 2014. Government of Nepal, Ministry of Labour and Employment Singha Durbar, Kathmandu
GESI	GoN. 2077. National Gender Equality Policy. MoWCSW
	GoN, 2005. Gender Mainstreaming strategy. Improved Governance Program. Ministry of Agriculture and Cooperatives.

Annex 4-1. New initiatives on Covid-19 responses, Government of Nepal.

Programs	Main interventions
Green Recovery[62], International Development Partners Group's commitment to the GoN with envelop of US$ 6.6 billion	The Green Recovery Plan is expected to support resilience building of people and the environment through 4 sets of interventions: - nature-based solutions for growth and job creation in agriculture, forestry and biodiversity and water management, and tackling the impacts of climate change in the Himalayas; - green and resilient infrastructure, urban development and pollution management, that together create jobs and protect human health; - increasing resilience to future shocks such as health, climate and earthquake risks, by strengthening health, social protection, education and disaster management systems; and - stimulating private sector recovery, and increasing green investment and job creation in finance, tourism, clean energy, waste management, forestry and agriculture.
The Youth Employment Transformation Initiative (YETI) Project, World Bank 2020	- Ministry of Labour, Employment and Social Security (MoLESS) implements the project under the Prime Minister Employment Program [PMEP).[63] - The total funding for the project is USD $120 million to be implemented over four years, 2020-2024, with a focus on improving employment services and labor market outcomes. - Ninety percent of the total budget is allocated to the local level to create jobs in the maintenance and upgrading of public infrastructure and public services for 100, 000 unemployed youth, 60% of whom will be women as per the project's priority to inclusion. - The strategy of the project is to i) develop a digital labor information bank by consolidating labor market information such as profile of the unemployed persons including knowledge, skills, experience and the potential sector for employment along with the demand and supply aspect of the labor market; ii) support 753 employment service centers (i.e. each local government) at the local levels to strengthen the workforce and to provide services in registration, profiling, referral, temporary work placement and on job training. - Immediate strategy in response to Covid19 in 2020 proposes to create 75,000 jobs for the most vulnerable unemployed youths by supporting them with 100 days of wages through the creation of temporary employment opportunities in the maintenance and upgrading of public infrastructure.
Rural Economic and Enterprise Development, 2020-2024, World Bank	- Strengthening market linkages among rural entrepreneurs, including smallholder farmers and producers; - The enabling environment for the development of rural enterprises in key economic corridors by financing productive partnerships and small-scale infrastructure such as feeder roads, bridges, ropeways and small irrigation to support the partnerships and the communities, - Aid the federal and subnational governments to fill the identified gaps in policies, services and capacity to support the development and upgrading of the rural based value chains. - Expected to implement five economic corridors, covering six provinces (Provinces 1, 2, Bagmati, Gandaki, Province 5, and Sudurpashchim). - Environmental and Social Management Framework [ESMF] for managing the environmental and social risks and impacts of project activities. - In addition, the project has also published a comprehensive Stakeholder Engagement Plan (SEP, 2020)[64] in July 2020 with an aim to establish a functioning platform for effective interaction and meaningful consultations with potentially affected parties and persons, who have interests in the implementation, and outcomes of the REED project. - The document acknowledges possible adverse impacts of the project on vulnerable groups, Dalits, women headed households and landless agriculture workers (exclusion of such groups from the benefits of the project further contributing to their impoverishment and marginalization). - Special treatment and additional assistance to those who would lose land - Special efforts to address constraints of women in accessing project benefits and opportunities [e.g. access to market information, access to finance, access to technology, access to business skills training and business development services).

62 https://eeas.europa.eu/delegations/nepal/90497/government-nepal-%E2%80%93-international-development-partners-joint-statement-green-recovery-nepal_en

63 http://pmep.gov.np/uploads/notice/1596179712-jpg2pdf.pdf

64 MOALD 2020. Nepal Rural Economic and Enterprise Development Project, Stakeholder Engagement Plan (SEP), July 2020. Kathmandu, Nepal: Ministry of Agriculture and Livestock Development (MoALD).

Annex 5-1. Policies for resilient water resources management and irrigation development in Nepal.

Policies	Key provisions on solar based irrigation
National Water Resources Policy, 2020, Ministry of Energy, Water Resources and Irrigation, GoN, Kathmandu	- Focuses on water technologies such as rainwater harvesting technologies, solar lifting, and drip and sprinklers, although no specific mention of solar irrigation. - Strengthen the capacity and scaling of existing technologies and equipment of water resources use and development
The Second Nationally Determined Condition, 2020, Ministry of Forests and Environment, Kathmandu	- Overly emphasized on clean energy, climate smart technologies, and fair and equitable benefit sharing of benefit of energy, forest and watershed management, and biodiversity conservation - It sets the target for i) preparing an action plan to integrate GESI in NDC, ii) establishing 200 climate-smart villages and 500 climate-smart farms, iii) ensuring increased access of climate-smart agricultural technologies to women, Indigenous People, smallholder farmers and marginalized groups, iv) protect, promote and support climate-resilient indigenous seeds/crop varieties through community seed banks and national gene banks.
Irrigation Master Plan, 2019, MoEWRI, Kathmandu	- One of the strategies for increasing investment includes develop non-conventional irrigation through electric and solar pumping. It encourages private sector to invest in irrigation systems through PPP arrangements.
White Paper on the Status and Future Roadmap of Energy, Water Resources and Irrigation sector, 2018, MoEWRI, GoN Kathmandu	- It has target of 200-500 KW energy production by each local government (753), in which 100 to 200 KW solar energy will be produced through providing 50% investment from the Challenge Fund of the federal government. The energy will be used for irrigation, drinking water and surplus energy will be paid through connecting it to the national grid. - Use of solar energy for lifting water from river to uphill agricultural lands for benefiting marginal farmers (the hill region). Scaling up shallow and deep tube well in the Tarai-Madhesh region for using groundwater. Connection of electricity and solar energy to the tube wells and connecting solar energy to the grid using net metering approach - Under Integrated Energy and Irrigation Especial program of the federal government, the white paper sets the target for irrigation such as 10000 hectares in the foothills of the Hills region through solar lift, and 22000 hectares in Tarai through groundwater use from the use of solar irrigation pumps. This program is expected to be implemented by the MoEWRI in coordination with the agriculture sector (strategy 98). - Intends to initiate an Innovative and Climate Resilient Irrigated Agriculture Development
Electricity Bill, 2020 (2077), Ministry of Energy, Water Resources and Irrigation (MoEWRI), GoN, Kathmandu	- Source of energy defined include solar, hydropower, etc. It has a provision for developing electricity for ensuring access to clean and quality, regular, reliable energy by all.
Environment Protection Rule, 2019, Ministry of Forests and Environment, GoN, Kathmandu	- Promoting clean energy and energy efficient technologies, and implementation of activities that would reduce emission from energy, agriculture, forest, industry, land-use, and waste materials.
Poverty Reduction Policy, 2019, Ministry of Land Reform, Cooperative and Poverty Reduction, GoN, Kathmandu	- Promoting biogas and solar energy and for provisioning grant and low interest rate credit facility for poor people to get involved in these energy promotion, and involving private sector and NGOs in pro-poor program implementation.
Public private Partnership and Investment Act, 2018 (2075), GoN	- Although not much specific to irrigation infrastructure. The act defines 'physical infrastructure such as reservoir, canal, hydropower, renewable energy production including solar, cold storage and related services.
Renewable Energy Subsidy Delivery Mechanism, 2016, Ministry of Science, Technology and Environment, Alternative Energy Promotion Center (AEPC), GoN	- Provide guidelines for subsidy delivery and monitoring of installation of different types of alternative energy technologies including solar water system
Renewable Energy Subsidy Policy, 2016, The Ministry of Population and Environment (MoPE), GoN	- Provide subsidies for a number of RETs installation, including solar technology for electrification, drinking water, and irrigation.
Agri Mechanization Policy 2016, GoN	- Equipment using clean energy, equipment used for organic agriculture are promoted
National Energy Strategy, 2013, Water and Energy Commission Secretariat (WECS)	- Promote different forms of clean energy (hydropower, solar, wind, biomass etc.)
Rural Energy Policy, 2006, Ministry of Environment (MoE), GoN	- Arrange operation of solar energy technology at community and institutional level by integrating it with irrigation, health, education and drinking water (4.4.2)

Annex 5-2. VAT-exempted products and equipment in the agriculture sector.

Sub-sector	VAT-exempted agricultural goods and irrigation equipment
Agricultural crops	- Paddy, rice, wheat, maize, barley, millet, buckwheat, pulses, flour, rye flour, grains, peas, chickpeas, kidney peas, beans and similar basic unprocessed food materials and their extracts, - Green and fresh vegetable, fresh fruits, fresh eggs, tuberous roots, and fruits, vegetables and as use in vegetable and tuberous roots, fresh and unprocessed agro-products. (Except those to be supplied hotels, restaurants, bars, guest houses, cafeteria and other similar organizations) - Unprocessed cash crops/cereals (such as sugarcane, cotton, cardamom, ginger and saffron, flax, unprocessed tobacco, tea leaf sold by farmers, proved orthodox tea producing using biological fertilizer, coffee, soybean, groundnuts, rapeseed, mustard seed, sarsyuko geda, sunflower, sesamum seed) and oilcake. - Herbs (including their extracts)
Tools used in agriculture	- Hand tools, mattocks, picks, forks and rakes, axes, bill hooks and similar hewing tools, secateurs of any kind, scythes, sickles, hay knives, other than hand saws, hedge shears, timber wedges, ploughshare and other tools of a kind used in agriculture.
Machines used in agriculture activities	- Tractors, cultivators, tantalum, levelers, harvesting or threshing machine, threshers, fishing nets, up to 8 hours power pumps, and up to 30 meters hose pipe.
Energy equipment	- Biogas, solar power and wind power operated machine and equipment recommended by AEPC.

Source: different VAT Act 1995 (amended in 2019), Government of Nepal.

Annex 5-3. Trade policies of the GoN enabling solarized irrigation scaling.

Policy Document	Purpose of the policy	Basic features for scaling water solution, including small-scale irrigation and natural resources management and GESI promotion
Commerce (Trade) Policy, 2015	- To achieve economic prosperity by enhancing trade sector's contribution to the national economy through export promotion. - The strategies focus on strengthening supply-side capacity, increasing exports of value-added competitive products and services in the world market, increasing access of goods, services, and intellectual property to regional and world markets, among others	- Engage with private sector as facilitator for increasing trade competitiveness, make social accountability an institutional aspect of business and industry, - Focus on e-commerce, export-oriented industries to be eligible for tax-refunds on raw materials, free trade agreements to be pursued with nations/regional blocks - Programs to be created to enable small and cottage industries, women and minority owned/run businesses to help them export their products (10.6.12) - There will be a provision to be able to lease lands to do commercial farming (10.1.11) - Ensure consistency between monetary policy, policies of foreign investment, industrial, tourism, agriculture, forestry, physical infrastructure, and trade policy (10.6.9) - Improve forward and backward linkages in product and service development to help economic growth (10.1.18) - Collect and process agricultural products and send them to processing centers (create these) to increase exports (10.2.15)
Nepal Trade Integration Strategy (NTIS), 2016	-Aims to address the challenges and constraints of Nepal's export promotion and trade competitiveness. - It has four objectives: i) strengthen trade and export enabling environment, ii) focus on product development and strengthen supply capacity of priority products, iii) strengthen institutional capacity, trade negotiation and inter-agency coordination, and iv) build and enhance trade related infrastructures	- It recognizes the potentials for product and value chain development in the following priority export sectors: (i) Agro and forest products (Cardamom, ginger, tea and medicinal & aromatic plants. (ii) Crafts and manufacturing (iii) services. - It indicates opportunities for expanding cultivation of a number of potential agro- commodities such as tea, ginger and medicinal plants to new geographical areas. - There is also a thematic committee present in the Enhanced Integrated Framework Steering Committee (with presence of Min of Agri as member) - (Agricultural products development, and SPS measures- MoALD Joint Secretary, Agri- Business Promotion and Statistics Division, MoALD - Criteria and weightage of gender impact for selecting priority export potential goods and services is about 4%

Annex 5-3. Trade policies of, cont'd....

Policy Document	Purpose of the policy	Basic features for scaling water solution, including small-scale irrigation and natural resources management and GESI promotion
Public-Private Partnership Policy, 2072 (2015)	- To enhance the public-private sector investment through PPP model for a comprehensive socio-economic development. - Create an environment attracts private investment to meet requirement of capital, means and resources for development - Reconstruction and operation of public infrastructure and services, from private sector by utilizing private sector expertise.	- Even if the policy seems to focus mostly on the large scale interventions, it recognizes the importance of development of irrigation infrastructure in its background portion. - Small scale infrastructure is not specified as the importance of growth. - Priority areas still remain large physical infrastructures and roads.
Public private Partnership and Investment Act, 2018 (2075)	- The arrangement of project implementation for construction, operation or rehabilitation of infrastructure structure or for the delivery of public services in collaboration with government body and private having allocated or bearing the cost of, resources, return or risks (Chapter 1) - To contribute to economic prosperity through the investment; native or foreign in infrastructure construction and service sectors - To manage the projects that are conducted in public private partnership - To consolidate and amend to the legal provisions related to investment.	- Although the act isn't specific to irrigation infrastructure it does define physical infrastructures like reservoir, canals, hydropower, renewable energy production including solar, cold storage and related services. - Investment includes of loan, equity or refinance or transfer of technology. - Of the provisioned institutional mechanism none of their functions include making investment pro-poor, inclusive and responsive to socio-economic and livelihood improvement of the locals. - The structure is GESI exclusionary as High Level Investment Board: Policy and decisions making functions related to PPP and investment consists of 13 members where it has a provision of only one women. - Monitoring and facilitating committee: 12 members envisioned are all men.
Public private Partnership and Investment Rule, 2020 (2077)	- Its main objective is to implement the PPT Act 2018	It includes energy section along with other section but irrigation section is not a priority. - In Schedule 9- Article 31- 6: It lacks socio economic and beneficial features along with co-ordination and collaboration with local government. - In schedule 9- Article 35-1: Investments project also lacks such indicators - Article 24: The template for project development does not have any focus on social aspect (art 24) after the government, calls for a tender - Article 17- (5) only EOI stage an investor has to include technical, social, financial and environmental facility criteria - Article 30: Project proposal committee consists of 5 members;; there is no specific mention of inclusion criteria. - Provision of an expert group with the representation of sectorial ministries in federal level, which does not have water sector and composition of the expert group exclude social scientist, albeit it includes commerce, economist or management or banking sector (Art 48) - Letter of Intent does not have governance, socio-economic and GESI dimension (article 32) as it focuses on technical, finance and environmental aspects only.

Annex 5-4. No. of local governments, gender dynamics of leadership in the government's executive and ward offices in the FtF districts.

Province Name/ No.	Districts Name	Palika (No.)	Ward (No.)		Total Ward (No.)	Mayor/ Chairperson (No.)		Deputy Mayor/Vice-chairperson (No.)		Ward Chairperson (No.)		Ward Members (No.)	
			NP*	GP*		Men	Women	Men	Women	Men	Women	Men	Women
Lumbini, 5	Kapilvastu	10	67	29	96	10	0	0	10	95	1	192	192
Lumbini, 5	Dang	10	47	53	100	10	0	0	10	95	5	200	200
Lumbini, 5	Banke	8	38	43	81	8	0	0	8	77	4	162	162
Lumbini, 5	Bardiya	8	60	15	75	8	0	0	8	71	4	150	150
Sudurpashchim, 7	Kailali	13	82	44	126	13	0	0	13	124	2	252	252
Sudurpashchim, 7	Kanchanpur	9	81	11	92	9	0	0	9	91	1	184	184
	GRAND TOTAL	**58**	**375**	**195**	**570**	**58**	**0**	**0**	**58**	**553**	**17**	**1140**	**1140**

NP= Nagarpalika or Municipality, GP= Gaupalika/Rural Municipality;
Source: adapted from the election data, Election Commission of Nepal, 2017.

Annex 5-5. List of ministries at federal level that have roles related to water resources use and management.

Ministries	Key policy and development roles
Ministry of Energy, Water Resources and Irrigation (MoEWRI)	• National policy, laws, master plans, programs related to energy, water resources, including irrigation • Monitoring of environmental pollution related to water resources, irrigation and energy (Environmental Rule, 2019, p. 159)
Ministry of Agriculture and Livestock Development (MoALD)	• National policy, laws, master plans, programs related to agricultural and livestock development • Monitoring of agricultural pollution related to agriculture production and marketing (Environmental Rule, 2019, p.159)
Ministry of Water Supply (MoWS)	• National policy, laws, plans, programs related to water supply and sanitation
Ministry of Industry, Commerce and Supply (MoICS)	• National policy, laws, plans, programs related to industry, supply, and trades related to irrigation technologies
Ministry of Forests and Environment (MoFE)	• National policy, laws, plans, programs related to environmental sanitation, water pollution, and climate change
Ministry of Urban Development (MoUD)	• National policy, laws, plans, programs related to urban water infrastructure, including urban river sanitation and urban environment
Ministry of Home Affairs (MoHA)	• National policy, laws, plans, programs related to water induced disaster risk reduction and management
Ministry of Federal Affairs and General Administration (MoFAGA)	• National policy, laws, plans, programs related to strengthening institutional capacity of local governments
Ministry of Finance (MoF)	• Coordinating climate investment and is the National Designated Authority to the Global Climate Fund (GCF)
Ministry of Health and Population (MoHP)	• National policy, laws, plans, programs related to water quality, agricultural water pollution
Ministry of Land Management, Cooperative and Poverty Reduction	• National policy, laws, plans, programs related to land conservation and use for agricultural production and enterprises

Source: Study team's analysis, 2020

Annex 6. Barriers and solutions for sustainable, efficient and effective surface water irrigation management in Nepal.

In Nepal, around 48 percent of cultivated land is reported to have irrigation facilities, of which 59 percent are reported to be irrigated from surface water, 22 percent from groundwater, and 19 from conjunctive use (Tractebel Engineering GmbH, 2019, p. 3). The true number are likely more skewed toward groundwater irrigation as private and public investments in groundwater infrastructure has increased and performance and extension of surface schemes has been haphazard. In addition, monitoring and records of groundwater wells has been challenging; and as such, the numbers of groundwater based irrigation command areas are likely to be higher than official records indicate (Urfels et al., 2020). Surface water irrigation systems are predominantly managed in three forms of institutional arrangements, including (1) Agency Managed Irrigation Systems (AMIS), (2) Farmer Managed Irrigation Systems (FMIS), and (3) Joint Managed Irrigation Systems (i.e. schemes are developed and operated by the Department of Water Resources and Irrigation (DWRI) and/ or other government agency and some roles are handed over to the beneficiary community). The total number of schemes with different institutional arrangements documented by the National Irrigation Master Plan is presented in Table A6-1. Over 50 percent of schemes are developed and managed by the FMIS with and without the government support, while the 49 percent schemes are managed by the government (especially the DWRI) (See **Table A6-1**).

Geographically, 81% of the surface water irrigated area of 591,000 ha are on the Terai. The irrigated area covered in the hills and mountain regions include 15% and 4% respectively. JMISs irrigate about 357,000 ha most of which is on the Terai in 24 systems. FMISs account for 51% of the total surface water irrigation systems. On the Terai FMIS are 33% (240,213 ha) of the area and 97% (809) by number. The FMIS make up 18% of the irrigated area (131,181 ha) in the mountains and hills regions (Tractebel Engineering GmbH, 2019, p 123, DWRI, 2019).

In the FMIS systems, irrigation users are usually responsible for making decisions regarding the operation and management of the system. Farmers therefore managed 70 percent of the country's irrigated areas (Pradhan, 2016). Many of these irrigation systems are nonetheless not functioning well (JICA, 2013, GC et al., 2020). Although there seem to be limited systemic analysis of the factors contributing to this, a review of available literature from Nepal shows that socio-economic changes including the monetization of the rural economy, urbanization, gender and social equity, out-migration of men, inadequate legal frameworks, weak institutional capacity of water user associations (WUAs), limited roles for WUAs over water governance and irrigation management, change in livelihoods practices including the diversification of farmers' income out of agriculture and policy challenges in accessing the government's support system causes these schemes to have limited functionality (**Table A6-2**). Several analysis point out the need for a cultural change in irrigation bureaucracies and systems of governance to develop an ethos of service orientation toward farmers and water users as a fundamental requirement for successful technical and management of surface water irrigation schemes (Renault et al., 2007, Pradhan and Belbase, 2018, Dahal et al., 2020, Lam and Ostrom, 2010). Indeed, such farmer-led approaches to irrigation are gaining traction not only in South Asia, but globally (Minh et al 2021, IWMI 2021).

In Nepal, rice remains one of the most important cereals contribution to human sustenance on a daily basis. As highlighted in more detail in **Table A6-2**, the major timing of water stress to the rice crop and social conflict for water access occurs during transplanting at the start of the rainy season, as well as during the dry season. At both times water levels in the rivers are low and often insufficient to service entire command areas. Before the rainy season, canals also require dredging and additional work is required for repairing headwork that may be damaged by floods during the start of the monsoon.

Table A6-1. Types and no. of surface water irrigation management system in Nepal.

Province	No. of irrigation systems			Total No.	% of total schemes
	Agency Assisted FMIS	Non Assisted FMIS	AMIS		
1	72,873	7,183	82,877	162,933	22.37
2	65,032	10,984	154,720	230,736	31.68
3	33,803	8,750	9,516	52,069	7.15
4	24,452	4,778	162	29,392	4.03
5	77,741	11,607	84,274	173,622	23.83
6	19,434	892	76	20,402	2.80
7	31,223	2,642	25,428	59,293	8.14
Total no.	**324,558**	**46,836**	**357,053**	**728,447**	**100**
%	**44.55**	**6.43**	**49.02**		

Source: Tractebel Engineering GmbH, 2019, p. 32. AMIS = Agency Managed Irrigation Systems; Farmer Managed Irrigation Systems = FMIS.

This, however, is increasingly difficult due to limited labor availability.

In addition, water user groups (WUGs) are not always adequately equipped to devise plans for determination of water use charges and their collection to cover operations and maintenance (O&M) cost, and devising and rules for just and equitable water distribution, and systems O&M and sustainable water uses. In many cases, they also lack access to state resources and support to address these issues. Irrigation bureaucracies, on the other hand, are also not be equipped or mandated to remain fully attentive to the heterogeneous demands and practical concerns and production goals of users (DWRI 2019). This can lead to conflict and inequity that intersects with existing inequalities and socio-economic changes. Moreover, insufficient coordination between canal water users (at both heads and tail ends of canals), the private sector (including agricultural input and output market actors), groundwater development initiatives, other water users and agricultural development programs can result in insufficiently successful efforts to meet economic and agricultural productivity goals. Lastly, there is a lack of information on the performance of different irrigation schemes that hampers targeted interventions to support the specific and heterogeneous needs of different WUGs/Water User Associations (WUAs). Addressing these challenges requires a concerted effort among WUAs and different levels of government and agricultural and irrigation development and management programming that can streamline existing resources and support programs to cater to water user needs, requirements and management more specifically and effectively.

The national goal is to increase system efficiencies to 50% or more by the year 2027. However, water use efficiency of surface water irrigation systems is a challenge in Nepal. It is estimated 170,000 ha of irrigation schemes, which is 12.5% of the total irrigated land (1,357,067 ha) are working at less than 40% efficiency in terms of water use in Nepal (MoAD, 2016). The National Irrigation Plan, 2019 also point outs that efficiency of an irrigation system falls in the range of 30 to 40%, which are well below the potential efficiency of 50-60% (Tractebel Engineering GmbH, 2019, p. 131). This has contributed to reduce the overall productivity of water for cereal crops (paddy, wheat and maize) well below (less than 50%) the potential productivity (ibid).

Many studies from Nepal and South Asia, along with Nepal's Agriculture Development Strategy 2015-35 and the National Irrigation Master Plan 2019 are cognizant that current surface water schemes could be made more efficient, inclusive, and sustainable, and proposes a number of strategies to achieve this. These propositions have been combined with other such recommendations and presented altogether with challenges and barriers in **Table A6-2**.

Table A6-2. Challenges, barriers and possibilities for effective and efficient use of surface water irrigation, including Operation and Maintenance (O M).

Dimensions of challenges	Reasons for limited effectivity and efficiency of schemes and its Operation and Maintenance (O&M) challenges	Possibilities for increasing surface water scheme efficiency, effectiveness, and equity
Labor availability, irrigation service fees (ISF) and irrigation systems management	• Reduced labor due to out-migration (particularly of youth) can cause shortages for irrigation and O/M maintenance. • Lack of strategies and interventions in the irrigation sector to promote women in WUAs governance and develop their skills as water services providers (e.g. O&M mechanics) by addressing social norms and patriarchal attitudes and behaviors visible in irrigation institutions in Nepal (e.g. Udas 2014, Shrestha and Clement 2019). • While WUAs have rules on the collection and use of irrigation service fee (e.g. NPR 15 per Katha/0.0339 hectare in case of Terai), the tariff collected is used for minor O/M and the cost of water watcher. Women and smallholders with limited power lack information about the processes for deciding and using ISF (Interviews 9 June 2021). • Equity is understood as 'equality' and none of the WUAs interviewed have practiced 'equity' approach for water access and O&M functions. Some users are unwillingness to pay tariff because they don't know where and how the fee is spent [lack of transparency about resources mobilization by WUAs] • Irrigation systems (which are large to medium scale infrastructure) managed through AMIS and JMIS are not sustainable and effective as the systems lack strategies for water management and system's functionality (ADS 2016 cited by Tractebel Engineering GmbH, 2019, p 132) • The large-scale schemes are costly in O&M and rehabilitation, which is beyond the capacity of the government institutions and WUAs.	• Innovative niche for mobilizing returnee migrant youths in water enterprises and agro-irrigation value chains. • Train more women and socially marginal farmers on the operation, maintenance and repairing of irrigation schemes (MoAD, 2016). They can be developed and mobilized in collaboration with local governments as local service providers as "irrigation technicians" and link them to WUAs for service delivery [as developing and mobilizing local service providers for irrigation services management, including O & M services is new to Nepal, while it has been widely practiced in Turkey, Bangladesh, and Ethiopia [IWMI's regional forum, February 2021; IMP 2019 recommended to test it in Nepal] • Tailor irrigation technologies to women's needs and as per local scenarios for greater adaptation and continued use. • Include irrigation equipment subsidy or lease scheme under the Center for Agriculture Infrastructure Development and Mechanization Promotion (CAIDMP) program for increased use of modern/efficient irrigation equipment which requires lesser labor.

Table A6-2. Challenges, barriers and possibilities, cont'd.....).

Dimensions of challenges	Reasons for limited effectivity and efficiency of schemes and its Operation and Maintenance (O&M) challenges	Possibilities for increasing surface water scheme efficiency, effectiveness, and equity
Availability of water	• A study done by Dhakal et al. (2018) states that only around 70% of the FMIS surveyed (n=228) had at least a nine-month water supply with the remaining 30 percent having 4-8 months or less of water supply. Over 65% of FMIS surveyed had no other alternative source of water supply.	• Promote small-scale and affordable irrigation technologies that enable farmers efficient use of water (Khadka et al., 2021) • Focus on watershed conservation and efficient water uses mechanisms backed up by inclusive water governance and promotion of farmer-led collective actions (Merrey et al., 2007, Merrey, 2018, Pradhan and Belbase, 2018) • Combining surface water use with groundwater use could help farmers exert greater control over water requirements where both ground and surface water resources are sufficient. • Institutionalizing Multiple Use System (MUS) in National Water Use Plan for efficient use of available water (Clement et al., 2019)
Access to materials and resources	• Dhakal et al., (2018) states that many of the small and medium-sized FMIS have temporary headwork which are usually built with local raw materials such as boulders and wood. Such interventions are clearly not designed for long-term use, although such interventions also represent pro-active initiative by farming communities to assert agency over water resources management. • Deforestation and restrictions in access to river and forest resources however denies their access to materials (e.g. stones, bamboo, logs, woods etc.) that can be used for temporary constructions that are of importance to smallholder farmers. • Sectoral silos and the limited coordinated approaches for irrigation and agriculture development planning is a challenge to enable effective irrigation policies and practices (Khadka et al., 2021) • Inadequate legislation, lack of data on water resources, and lack of resources and capacity of groundwater authorities to enforce even the most limited laws and compliance regimes (World Bank, 2020, Shah, 2014)	• Create inventory of existing systems that require repair and maintenance based on rigorous survey (MoAD, 2016) that could be supported by relevant government level and technical support provided by relevant ministry/ departments and development partners. • Support the GoN to develop a public and private financing modality for required rehabilitation. For this, association of Irrigation WUAs, private sector of irrigation technologies, local governments and the provincial ministry (e.g. Ministry of Physical Infrastructure and Development) and the DWRI can jointly define the modality and submit it to development partners (e.g. USAID) for matching grants. • Explore a mechanism for coordination and collaboration between forest user groups and WUAs through institutional collaboration between water and forest sector line ministries for sustainable conservation, management and uses of natural resources. • To make continual outside infrastructural investment more effective for operation, maintenance and expansion, it should be complemented by certain degree of collective action among farmers or by strict implementation of fines. Without continual assistance, collective action of farmers becomes an important factor affecting irrigation performance (Lam & Ostrom, 2010). • Study on the institutional and policy options for implementing decentralized, sustainable and multi-stakeholders centric irrigation systems under the federal structure of governance and climate crisis.
Competing interests for water access and uses, and water disputes	• Dhakal et al. (2018) suggested that during periods of water deficit, theft of water by breaching diversion structures is an important potential source of conflict between two different irrigation systems. • Disputes in irrigation systems in Nepal generally arise due to water use activities, resource mobilization and exercise of power by advantaged groups over economically and socially disadvantaged groups (Tractebel Engineering GmbH, 2019, p. 114). • Conflicts in irrigation systems are mostly caused by social and institutional reasons. These include (i) allowing water leakages from a diversion weir of an upstream system leaving little or none for those downstream, (ii) water users not interested in paying irrigation service fee and participation in maintenance and repair activities, (iii) dominance of social elites on decision-making of water allocation and tariffs, (iv) weak institutional capacity of WUAs in managing conflicts, and (vi) lack of technical knowledge of farmers on water uses (Interviews, 9-10 June 2021). Water stealing during right is a common due to weak governance and institutional capacity of WUG.	• Rules devised based on particular biophysical conditions – in particular the seasonal availability of water– with emphasis on the local community and context normally results in better enforcement of agreed rules, thus resulting in improved collective action and better performance of the irrigation systems (Bastakoti and Shivakoti, 2012). • Strengthening WUAs on socio-technological and institutional aspects of irrigation management (FMIST, 2018). • Strengthen technical and social knowledge of water and agricultural professionals, WUAs and farmers on water uses efficiency, and water governance, including GESI for enabling women and marginalized groups to participate in WUAs (Tractebel Engineering GmbH, 2019, World Bank 2020, Shah 2014).

Table A6-2. Challenges, barriers and possibilities, cont'd.....).

Dimensions of challenges	Reasons for limited effectivity and efficiency of schemes and its Operation and Maintenance (O&M) challenges	Possibilities for increasing surface water scheme efficiency, effectiveness, and equity
Gender issues	• Men influence planning and decision-making in WUAs, although women are included in the water user committees • Women are included to fulfil the quotas and they attend WUAs meeting passively. Meeting implementation processes (e.g. formal, technical agenda, only a few women) don't empower women to raise ideas and concern (Interview with woman members of WUA in Kailali, 10 June 2021). • Women lack information about executive committee and its roles and operation. • Patriarchal attitudes and behaviors, mutated resistance and non-acceptance of women's leadership and their participation in water/irrigation sector resulting in fewer women in leading roles (Shrestha and Clement, 2019). • Systematic barriers in terms of caste, class, education, language, place of meetings, trainings, time, child care facilities etc. • Limited access of extension services such as irrigation information and technical training by women. • Persistence gender stereotypes (e.g. women are responsible for household activities, bad mouth on women when traveling for training; lack of trust on women's experience and knowledge, and perception that women don't have knowledge to lead WUAs) discourage women to participate meaningfully in WUAs and irrigation governance. • Dominant knowledge system that equate GESI to women and their tokenistic representation in WUA committee to fulfil the quota is undermining women's roles in water governance, O&M systems, and irrigation management (reflection of interviews with WUAs committees, 9 and 10 June 2021).	• Identify resistance and develop strategies to address it. One of the strategies would be formulate long-term program to capacitate local level women and men leaders in gender and water issues, link them with women farmers and local governments. Continuous mentorship and support, through developing social capital/network, is important to encourage women farmers to meaningfully participate in water governance. • Immediate response could be in terms of enhancing women's access to information, trainings, networks, subsidies, mechanization schemes, extension services. In doing so, conduct gender analysis (on context specific barriers/challenges) and pay closer attention to the gendered process (formal/informal) of access and entitlement that may hinder women from participating effectively in water governance (Tractebel Engineering GmbH, 2019, Khadka et al., 2021). • Public awareness on gender roles change in water institutions [respondents during our interviews mentioned that technologies such as mobile phone, and training on women's empowerment, agronomy and commercial farming, and road access facilitated them to take part in community activities (e.g. WUAs committee) • Engaging women journalists, organizations/ CBOs of indigenous people, women, youths, Dalits, People with Disability etc.), and CSOs of water, agriculture and forests in public awareness on water and development.
Revenue sharing mechanism	• Lack of revenue sharing mechanisms between water uses for hydropower and irrigation results in only one agency (for e.g. Department of Irrigation) bearing the cost of O & M without any revenue resulting in inefficient O & M. (Pradhan & Belbase 2018)	• Development of proper revenue sharing mechanism between water users (for e.g. irrigation, hydropower). The mobilization of revenue from hydropower can assist in maintenance and operation of irrigation systems. • Promote commercialization and crop-diversification in WUAs (Acharya, 2018). • Advocate for integration of WUAs' roles and rights on Payment for Ecosystem Services being practiced as pilots by some local governments and sectoral line agencies in Nepal.
Limited coordinated planning for irrigation development among sectors	• Lack of harmonized water development planning across the sectors, particularly weak coordination between irrigation and agriculture ministries and departments, and within sectoral ministries and new departments and centers under the new political arrangement results in function overlaps, and inefficient resource use and allocation (Dahal et al., 2020). • Division of water services roles across line ministries (e.g. hydropower developer registration take place under the non-water sector, while irrigation systems through which energy is produced are constructed by the Department of Water Resources and Irrigation. There is no mechanism to share water revenue between sectors, which undermines efficiency and coordination in irrigation and energy generation efforts. • Weak linkages and poor coordination between multiple actors with each other – including line ministries, departments, different government levels, NGOs, credit agencies and farmers – resulting in project inefficiencies and limited impact (Devkota et al., 2016)	• Promote and capacitate the role of local governments for planning and overseeing context specific FMIS and/or small-scale irrigation management programs in partnership with local service providers, WUAs and CBOs and NGOs (e.g. Terai, hills, mountains, urban, peri-urban and rural specific) • All levels of government (federal, provincial and local) are autonomous and independent under the federal system. A coordinated planning and implementation for inclusive irrigation development and rehabilitation of existing systems can be possible through establishing a water coordination body in provincial and local level. • Focus on or invest in integrated irrigation development projects in which at least agriculture and irrigation sectors have some functional roles during project implementation (FMIST, 2018).

Table A6-2. Challenges, barriers and possibilities, cont'd.....).

Dimensions of challenges	Reasons for limited effectivity and efficiency of schemes and its Operation and Maintenance (O&M) challenges	Possibilities for increasing surface water scheme efficiency, effectiveness, and equity
Conflict among the users	• Bastakoti and Shivakoti (2012) stated that 92% of 50 Irrigation schemes experienced had some form of social conflict, with conflict among farmers (62%) over resource allocation being the most significant. • A water conflict among upstream and downstream users takes place when rules, roles and responsibilities on water resources access, use and management are not defined and socially powerful groups influence decision-making and benefit sharing (Upreti, 2004) • The existence of economic heterogeneity among water users in FMIS is another important factor affecting the collective management of irrigation resources (Dhakal et al., 2018). Due to their stronger position, wealthier farmers usually claim larger share of the collective benefits while bearing a similar or lesser share of costs compared to poorer families. This results in discouragement of poorer families from participating actively in maintenance activities (Dhakal et al., 2018). • The asymmetry between the labor, cost and effort needed to operate and maintain at head and tail end also results in the conflict among the water users. This specifically increases when the labor contribution from tail enders is not needed for the overall maintenance of the irrigation structures (Lam, 1996, Ostrom et al., 1994, Lam & Ostrom, 2010, Dhakal et al., 2018)	• A municipal level multi-stakeholder based water dialogue [PAANI CHAUTARI] could be a tool for water cooperation (Devkota et al., 2021) and can be piloted in the FtF ZOI for irrigation governance and scale up after learning from the pilot. • Programs and trainings will be needed for irrigation WUAs to improve agriculture water management practices and water productivity. These programs will have to be based on farmer demand and what problems exist at the ground-level that farmers needs support on. • Support to strengthen policy and institutional mechanisms of local governments keeping in mind that the governments are not necessarily implementers of irrigation projects, but key governments to engage NGOs and other services providers in facilitating irrigation management and services, inclusive water, including capacity development of farmers and WUAs (Tractebel Engineering GmbH, 2019; Khadka et al., 2021).
Lack of multi-stakeholders based irrigation development to empower Water User Associations (WUAs)	• The absence of an integrated approach in water resources infrastructure development is a limit for sustainability of irrigation systems (Clement et al., 2012). • Lack of policy and institutional efforts to institutionalizing multi-actors based irrigation development and empowering WUAs (Pradhan & Belbase 2018, Khadka et al., 2021). • Lam & Ostrom (2010) found that irrigation rules of conduct unravel rapidly in the absence of strong leadership, frequent changes of leadership, and in the case of less effectiveness of WUAs. • The dominance of technocratic approaches to irrigation systems planning and implementation with focus on 'construction of infrastructure without considering water management, sustainability, socio-institutional and gender elements is a limit to generate ownership and responsibilities for system's functionality and O/M (Interview with an irrigation policymaker, 9 June 2021).	• The momentum for the farmers' self-organization can be set through farmer to farmer training, getting farmers involved in project implementation, identifying local leaders, and helping farmers to work out rules (Lam & Ostrom, 2010). • A targeted program in the irrigation sector to incentivize and engage youths, especially women leader farmers and returnee migrant youths for WUAs functioning need to explore, given the increased feminization of agricultural activities and irrigation technologies (ADB, 2020, FAO, 2019, ADB, 2012) and recent trend of commercial or group farming by returnee migrants (Interviews 8-9 June 2021) • A municipal level multi-stakeholder based water dialogue [PAANI CHAUTARI] could be a tool for water cooperation (Devkota et al., 2021). • The municipal level multi-stakeholder dialogues needs to be promoted for implementing federalism in the irrigation sector with an aim to promote devolved and demand driven irrigation development (Khadka et al., 2021). • Encourage engagement of media to collect and disseminate irrigation challenges and good practices of FMIS (e.g. collective action, irrigations service fee collection and mobilization, youths and women roles models service providers or WUAs leaders, gender issues, conjunctive use, etc.) and roles of state/ GoN on WUAs strengthening, etc.

Table A6-2. Challenges, barriers and possibilities, cont'd.....).

Dimensions of challenges	Reasons for limited effectivity and efficiency of schemes and its Operation and Maintenance (O&M) challenges	Possibilities for increasing surface water scheme efficiency, effectiveness, and equity
Infrastructural issues	• Gajmer (2014) finds old/dated infrastructure is linked to the poor performance of existing systems and the inability to tap into major rivers which have substantial water discharge even in dry season result in limited irrigation. • Lack of appropriate and timely advisory services when required resulting in decreased agricultural productivity (Gajmer, 2014). • Lack of local irrigation/water technicians who could support WUAs in O&M and repairs. • Top-down engagement of WUAs over O&M, asset management, financing and dispute management, and WUAs not sufficiently empowered (Tractebel Engineering GmbH, 2019)	• Lining/upgrading canals to reduce transmission losses; land-levelling and construction of field channels (as distribution network) and piped water conveyance where needed to be supported by relevant government level where farmers could contribute labor (MoAD, 2016). • Increased irrigation extension services for farmers for creating cropping plans and improving water distribution. • Development and mobilization of local irrigation technicians, including women leader farmers could provide farmers timely information and technical services on infrastructure operation and maintenance • Empower WUAs through enabling policy/legal supports [e.g. current laws or policy of water resources and irrigation does not grant local community a power for irrigation management; IMT focuses on transferring responsibility for O&M to WUAs without sufficient decision-making power over irrigation resources management and mobilization]. • Federalism creates the devolved, participatory and inclusive irrigation management on the ground. Promote small-scale and farmer led multi-use water resource management practices in collaboration with private sector and local governments (Khadka et al. 2021). • A study to explore the roles of and policy barriers for WUAs to participate in irrigated agriculture value chains, and act as irrigation services providers.
Rainwater dependence and limited interest in conjunctive ground and surface water use	• Most current systems depend on small and medium rivers that rely on rain water for recharge (Gajmer, 2014); this dependence is then cultivated again in agriculture and current climate and weather change patterns have resulted in erratic rainfall patterns that affects food production. • Farmers also mostly grow major cereal crops on the basis of flood irrigation that is heavily dependent on timely monsoon. • Planning for both ground- and surface-water conjunctive use schemes is relatively rare, which increases dependency on seasonal flow of water in rivers.	• Policies that address supply chain barriers for farmers (that would aim to reduce the high cost of accessing GW technologies) - for instance by promoting farm-equipment leasing options by agriculture cooperatives and private players envisioned by the Agricultural Development Strategy, 2015-2035 (MoAD, 2016). • Capacitate farmers and WUAs on efficient water use technologies, and crop and water management knowledge
Weak technical, financial and institutional capacity of WUAs	• One of the weakest parts in the O&M of FMIS and AMIS in Nepal is the lack of effective irrigation asset management planning, resulting in a cycle of neglect of proper O&M and consequently, replacement at a high cost (Tractebel Engineering GmbH, 2019, p. 135). • **O&M funding and fee collection:** The level of funding is a function of the system type (gravity or pumped), size (command area), and organisation, and also the level of collection of fees from stakeholders. For surface water systems (gravity) in Nepal O&M fees are estimated to be of the order of 1,000 to 1,500 NPR per hectare per annum, and for pumped systems of the order of 2,500 to 3,000 NPR. The current rates of fee collection are generally low (Tractebel Engineering GmbH, 2019, p. 135).	• **A pilot on transforming WUAs to water user cooperatives:**[65] This may help farmers to explore various ways for improving agricultural practices through crop diversification, cropping intensity, better seeds and fertilizers, better harvesting, storage techniques and easy access to markets. All these constitute a number of areas /themes worth researching and disseminating the generated knowledge for various reform purposes (Tractebel Engineering GmbH, 2019, p. 17). • Revisit the existing irrigation service fee practices, uses, and governance issues of fund management, and identify strategies for strengthening institutional capacity of WUAs along with their linkages with local governments, private service providers and agricultural cooperatives. • Enhance capacity of WUAs through trainings. Assist operation of robust, user-governed and well-functioning WUAs and monitoring using digital innovation and citizen science approaches. • Support WUAs for enhancing coordination between agriculture, irrigation and other value enhancement sectors at local levels ((Tractebel Engineering GmbH, 2019, p. 148).

[65] Water users cooperative (WUC) is one of the documented organizational entity to whom irrigation management can be transferred. FAO (1999) notes that transfer of irrigation management to WUC is most suitable for small-scale irrigation systems or sub-systems, where management requirements are relatively simple and non-intensive ((Tractebel Engineering GmbH, 2019, p. 145-146).

Table A6-2. Challenges, barriers and possibilities, cont'd.....).

Dimensions of challenges	Reasons for limited effectivity and efficiency of schemes and its Operation and Maintenance (O&M) challenges	Possibilities for increasing surface water scheme efficiency, effectiveness, and equity
Model of IMT (Irrigation Management Transfer) and empowering WUAs or Water User Groups	• Under the IMT, authority of WUAs over irrigation governance, O & M asset management, and water management is limited in Nepal (Tractebel Engineering GmbH, 2019, p. 135). • WUAs are not empowered by enabling policy and legal frameworks such as recognizing farmers rights and responsibility for water conservation, management and sustainable uses. • WUAs have not been effective because they did not reflect the multiple needs of the farmers, rather they work as an extension of the irrigation department in many places" (Pradhan and Bandaragoda 1997 cited in Pradhan and Belbase 2018, p. 67)	• In Nepal, as conventional mode of DWRI-WUA joint management has not been that successful compared to the designed expectation, therefore irrigation management transfer to WUC can be piloted (Tractebel Engineering GmbH, 2019, p. 145-146). • Support to establish policy, legal and institutional frameworks in the federal context of water governance, including local irrigation management, water rights and irrigation asset ownership by water users (Tractebel Engineering GmbH, 2019, Khadka et al., 2021). • The fundamental of the success of IMT project rests on the establishment of practical arrangements for financing operation and maintenance of transferred irrigation system. Local governments are in better position to meet this need (Tractebel Engineering GmbH, 2019). • Piloting a private sector institution (be it an engineers' firm or local NGOs or CBOs) based IMT model in Nepal for a medium scale irrigation systems (Tractebel Engineering GmbH, 2019) • Farmer-led irrigation/small-scale irrigation model through strengthening WUAs towards 'self-management' and improving their social capital seems more sustainable approaches (Pradhan and Belbase 2018, Khadka et al., 2021). • The new Irrigation Master Plan (Tractebel Engineering GmbH, 2019, p. 148) suggests empowering WUA (WUG) legally by adopting the following strategy o WUG should be the focal institution for exercising legal authority. For this, WUGs may be registered with the local government for governance support. Accordingly, local government should empower WUGs with required authority. One such approach is to make WUG recommendation mandatory for any business transaction of agricultural land (for taking loan against land, purchase / sell of lands, payment of land tax etc.).

Source: Authors' analysis.

Reference list for the Annex 6

ACHARYA, S. Nexus challenges in irrigation institutions from Nepal perspective. *In:* PRACHANDA, P., ed. Irrigation in support of evergreen revoluation. Symposium on Nexus Challenges in Irrigation Instutitons. 8th Asian Regional Conference, May 2-4, 2018, Kathmandu, 2018 Kathmandu, Nepal. FMIST, 37-40.

ADB 2012. Shallow Tubewell Irrigation in Nepal: Impacts of the Community Groundwater Irrigation Sector Project. Impact Evaluation Study, December 2012, Reference Number: IES: NEP 2012-25. Independent Evaluation: IE-75, ADB. https://www.adb.org/sites/default/files/evaluation-document/35900/files/ies-nep-final.pdf.

ADB 2020. Gender equality and social inclusion diagnostic of selected sectors in Nepal Kathmandu: Asian Development Bank.

BASTAKOTI, R. & SHIVAKOTI, G. 2012. Rules and collective action: an institutional analysis of the performance of irrigation systems in Nepal. *Journal of Institutional Economics / Volume 8 / Issue 02 / June 2012, pp 225 246, DOI: 10.1017/S1744137411000452, Published online: 19 October 2011.*

CLEMENT, F., BASNET, G. & BHARATI, L. 2012. Rethinking Development Models and Irrigation Projects in Nepal. *HYDRO NEPAL SPECIAL ISSUE APRIL 2012,* 112-120.

CLEMENT, F., PRADHAN, P. & van KOPPEN, B. 2019. Understanding the non-institutionalization of a socio-technical innovation: the case of multipleuse water services (MUS) in Nepal. *Water International.*

DAHAL, H., KARKI, M., JACKSON, T. & PANDAY, D. 2020. New State Structure and Agriculture Governance: A Case of Service Delivery to Local Farmers in the Eastern Gangetic Plains of Nepal. *Agronomy 2020, 10, 1874; doi:10.3390/agronomy10121874.*

DEVKOTA, K., MASKEY, G. & KHATRI, D. 2021. Pani Chautari as a tool for evidence-informed policy and practice: Experiences from Dhulikhel. *In:* KHATRI, D., NEUPANE, K. & DEVKOTA, K. (eds.) *Dhulikhel's Journey towards Water Security: Insights for policy and practice.* Kathmandu: Southasia Institute of Advanced Studies (SIAS).

DEVKOTA, K., THAPA, D. & DHUNGANA, H. 2016. Weak institutional interaction: Reason for poor agricultural extension services delivery in Nepal. Nepal Journal of Social Science and Public Policy, 4(1), 88-103.

DHAKAL, T., DAVIDSON, B. & FARQUHARSON, B. 2018. Factors Affecting Collective Actions in Farmer-Managed Irrigation Systems of Nepal. Agriculture 8, 77. https://doi.org/10.3390/agriculture8060077.

DWRI 2019. Irrigation Master Plan 2019. November 2019. Kathmandu, Nepal: Department of Water Resources and Irrigation, Ministry of Energy, Water Resources, and Irrigation, Government of Nepal.

FAO 2019. Country gender assessment of agriculture and the rural sector in Nepal. Kathmandu: Food and Agriculture Organization.

FMIST. Irrigation in support of evergreen revolution. The 8th Asian Regional Conference, May 2-4, 2018, Kathmandu. *In:* PRADHAN, P., ed. Symposium on nexus challenges in irrigation institutions, 2018 Kathmandu, Nepal. FMIST

GAJMER, B. 2014. Nepal: Irrigation and Water Resource Management. The World Bank. https://www.worldbank.org/en/results/2014/04/11/nepal-irrigation-and-water-resource-management.

GC, R. K., RANGANATHAN, S. & HALL, R. P. 2019. Does Rural Water System Design Matter? A Study of Productive Use of Water in Rural Nepal. *Water 2019,* 11.

IWMI 2021. Adaptive scaling to achieve system transformation in One CGIAR. Colombo, Sri Lanka: International Water Management Institute (IWMI). 8p. https://hdl.handle.net/10568/113924.

JICA 2013. Preparatory survey on JICA's cooperation program for agriculture and rural development in Nepal- Food production and agriculture in Nepal . Main report.

KAFLEY, G. P. & POKHAREL, K. 2017. Pro-poor Leasehold Forestry: A Community-based Tenure Regime in Nepal. Journal of Forest and Livelihood 15(1) September, 2017, p. 43-56.

KHADKA, M., UPRETY, L., SHRESTHA, G., MINH, T. T., NEPAL, S., RAUT, M., DHUNGANA, S., SHAHRIN, S., KRUPNIK, T. J. & SCHMITTER, P. 2021. Understanding barriers and opportunities for scaling sustainable and inclusive farmer-led irrigation development in Nepal. Kathmandu, Nepal: The Cereal Systems Initiative for South Asia (CSISA).

LAM, W. F. 1996. Improving the performance of small-scale irrigation systems: The effects of technological investments and governance structure on irrigation performance in Nepal. World Development 24, 1301–1315. https://doi.org/10.1016/0305-750X(96)00043-5.

LAM, W. F. & OSTROM, E. 2010. Analyzing the dynamic complexity of development interventions: lessons from an irrigation experiment in Nepal. Policy Sci 43, 1–25. https://doi.org/10.1007/s11077-009-9082-6.

MERREY, D. J. 2018. Will 21st Century Water User Associations do Better than in the 20th Century? New Approaches Needed to Support Farmer-Led Collective Management of Irrigation. ICID conference, 2020, Kathmandu. *In:* PRADHAN, P. (ed.) *Symposium on Nexus Challenges in Irrigation Institutions. Irrigation in support of evergreen revolution. The 8th Asian Regional Conference, May 2-4, 2018, Kathmandu.* Kathmandu: FMISPT.

MERREY, D. J., MEINZEN-DICK , R., MOLLINGA, P. & KARAR, E. 2007. Policy and institutional reform: the art of the possible. Chapter 5. *In:* MOLDEN, D. (ed.) *A Comprehensive Assessment of Water Management in Agriculture.* Colombo, SriLanka: International Water Management Institute (IWMI).

MINH, T. T. 2020. More Than Money: Stakeholders Look Beyond Financing to Expand Farmer-Led Irrigation. https://www.agrilinks.org/post/more-money-stakeholders-look-beyond-financing-expand-farmer-led-irrigation.

MOAD 2016. Agriculture Development Strategy, 2015-2035. Part I. Ministry of Agricultural Development (MoAD). Kathmandu: MoAD.

OSTROM, E., LAM, W. F. & LEE, M. 1994. The Performance of Self-Governing Irrigation Systems in Nepal. Human Systems Management 13, 197–207. https://doi.org/10.3233/HSM-1994-13305.

PRADHAN, P. 2016. Challenges and Opportunities for Farmer Managed Irrigation Systems (FMIS) in Koshi Basin, Nepal. https://prachandashare.files.wordpress.com/2018/05/challenges-and-opportunities-for-farmer-managed-irrigation-systems-fmis-in-koshi-basin-of-nepal-dr-prachanda-pradhan-fmist-1.pdf. Kathmandu: FMIS Promotion Trust.

PRADHAN, P. & BELBASE, M. 2018. Institutional Reforms in Irrigation Sector for Sustainable Agriculture Water Management including Water Users Associations in Nepal. *HYDRO NEPAL | ISSUE NO. 23 | JULY 2018* 58-70.

RENAULT, D., FACON, T. & WAHAJ, R. 2007. Modernizing irrigation management – the MASSCOTE approach Mapping System and Services for Canal Operation Techniques. FAO IRRIGATION AND DRAINAGE PAPER 63. Rome: Food and Agriculture Organisation of the United Nations.

SHAH, T. 2014. Groundwater Governance and Irrigated Agriculture. Background papers No. 19. Global Water Partnership Technical Committee (TEC) Global Water Partnership (GWP.

SHRESTHA, G. & CLEMENT, F. 2019. Unravelling gendered practices in the public water sector in Nepal. *Water Policy,* 21, 1017-1033.

TRACTEBEL ENGINEERING GMBH 2019. Irrigation Master Plan. Main Report. Prepared by Tractebel Engineering GmbH in association with NIRAS and TMS Package 4 Project Office Department of Irrigation Lalitpur, Kathmandu Nepal for Water Resources Project Preparatory Facility (WRPPF), Department of Water Resources and Irrigation. Ministry of Energy, Water Resources and Irrigation. Kathmandu: Tractebel Engineering GmbH.

UDAS, P. 2014. *Gendered Participation in Water Management in Nepal Discourses, Policies and Practices in the Irrigation and Drinking Water Sectors. PhD Thesis* Wageningen University.

UPRETI, B. R. 2004. Resource Conflicts and Conflict Resolution in Nepal. *Mountain Research and Development,* 24, 60066.

URFELS, A., MCDONALD, A. J., KRUPNIK, T. J. & VAN OEL, P. R. 2020. Drivers of groundwater utilization in water-limited rice production systems in Nepal. *Water international,* 45, 39-59.

WORLD BANK 2020. Managing Groundwater for Drought Resilience in South Asia. Delivered under the South Asia Water Initiative (SAWI) Regional Cross-Cutting Knowledge, Dialogue, and Cooperation Focus Area. file:///C:/Users/user/Downloads/WBK%202020%20South%20Asia%20GW%20Resilience%20Synthesis%20Report%20Final%20W19027.pdf. World Bank Group.

Annex 7. Local water and NRM groups, and their associations in the natural resources sector.

NRM collectives and their associations	Total No. in Country	Remarks
Water User Associations (WUA)	15,000	
National Irrigation Federation of Water User Association in Nepal (NIFWUAN)	1	NIFWUAN has 77 district chapters
Water Supply and Sanitation Groups	41,205	Piped water supply
Federation of Drinking Water and Sanitation Users in Nepal (FEDWASUN)	1	FEDWASUN has 77 district chapters
Community Forest Users Groups (CFUGs)	22,415	Over 17000 CFUGs are the members of FECOFUN
Leasehold Forest User Group (LHFUG)	7622	Pro-poor forestry program that handed over degraded forests to the smallholder farmers with less than 0.5 ha private land
Buffer Zone Community Forests User Group (BZCFUG)	546	In country's 13 protected areas
Nepal Federation of Indigenous Nationalities (NEFIN)'s district chapters	56	NEFIN is an umbrella association of Janajatis in Nepal. I has 56 district chapters
Farmers Groups associated with National Farmers Group Federation (NFGF)	3777	Federation has 77 district chapters
Nepal Agricultural Cooperative Central Federation Ltd (NACCF	1	NACCF has 71 district chapters and 860 small-farmer agro-cooperative limited (SFACL) are the members of the NACCF
Dalits Alliance for Natural Resources (DANAR) (No. of district chapters)	77	DANAR is an umbrella network of Dalits rights in natural resources
Women only – CFUGs	1035	
HIMAWANTI Nepal (The Himalayan Grassroots Women's Natural Resource Management Association)	1	HIMAWANTI is the grassroots women groups working on NRM issues and women's rights to natural resources. It has 55 district chapters
Association of Family Forest Owner's, Nepal (AFFON)	1	AFFON has 60 district chapters and 3753 individuals are the members of AFFON and have registered private forests

Source: Kafley and Pokharel 2017, and web search, 2020.

CGIAR

International Maize and Wheat Improvement Center (CIMMYT)
CIMMYT-Nepal, Agriculture Botany Division – 1st floor, NARC
Research Station, Khumaltar, Lalitpur, Nepal

Funded by

USAID FROM THE AMERICAN PEOPLE

BILL & MELINDA GATES foundation

CSISA

Partners

CIMMYT International Maize and Wheat Improvement Center

IFPRI

IRRI

IWMI