National Smallholder Irrigation and Drainage Strategy

July 2016 G.C. / 2009 E.C.

Statement from the State Minister of Natural Resources, MoANR

[TO BE ADDED AFTER WORKSHOP]

Statement from the Director of Irrigation and Drainage, MoWIE

[TO BE ADDED AFTER WORKSHOP]

Acknowledgements

This development of this national smallholder irrigation and drainage strategy document has been realized with the invaluable contribution and extensive support of many partners and stakeholders in the agriculture, water and other sectors.This includes federal government ministries, agencies, enterprises and research institutes, regional government bureaus, authorities, enterprises and research institutes, universities, development partners, NGOs, financial institutions and other private sector firms including consultants, contractors, manufacturers, and suppliers, who engaged in the development of the strategy through joining interviews, meetings and workshops, facilitating field visits, providing data, and participating in the project steering and technical committees. A full listing of organizations who supported the development of this strategy is provided in Appendix 1.

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Acronyms

AAU	Addis Ababa University
ACSI	Amhara Credit and Savings Institution
AGP	Agricultural Growth Program
ATA	Agricultural Transformation Agency
B	Billions
BDB	Basin Development Bureau
BOAN	Bureau of Agriculture and Natural Resource
BOFE	Bureau of Finance and Economic Development
CIF	Cost Insurance And Freight
DA	Development Agents
DECSI	Dedebit Credit and Saving Institution
EABC	Ethiopian Agricultural Business Corporation
ECAE	Ethiopian Conformity Assessment Enterprise
EIAR	Ethiopian Institute of Agricultural Research
ESA	Ethiopian Standards Agency
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization
FCA	Federal Cooperative Agency
FOREX	Foreign Exchange
GIS	Geographical Information System
GOE	Government of Ethiopia
GSE	Geological Survey of Ethiopia
GTP I	First Growth and Transformation Plan
GTP II	Second Growth and Transformation Plan
HA	Hectare
HHI	Household Irrigation
HPC	High Production Crop
HVC	High Value Crop
ICT	Information Communication Technology
IFAD	International Fund for Agricultural Development
IRBM	Integrated River Basin Management
ISO	International Organization for Standardization
ISP	Irrigation Service Providers
IWMI	International Water Management Institute
JBIC	Japan Bank for International Cooperation
K	Thousands
M	Millions
M&E	Monitoring and Evaluation
METE	Metals And Engineering Corporation
MFI	Micro-Finance Institute
MOANR	Ministry of Agriculture and Natural Resources
MOE	Ministry of Education
MOFA	Ministry of Federal Affairs
MOFE	Ministry of Finance And Economic Development
MOLF	Ministry of Livestock And Fisheries

MOST	Ministry of Science and Technology
MOT	Ministry of Trade
MOWIE	Ministry of Water Irrigation And Electricity
MUS	Multiple Use System
NGO	Non-Governmental Organization
NMA	National Meteorological Agency
NRM	Natural Resource Management
O&M	Operation and Maintenance
OCSSCO	Oromia Credit and Saving Share Company
OIDA	Oromia Irrigation Development Agency
OMFI	OMO Microfinance Institution
PASIDP	Participatory Small Scale Irrigation Development Project
RARI	Regional Agricultural Research Institutes
RBOWR	Regional Bureau of Water Resource
ROI	Return on Investment
SACC	Saving and Credit Cooperative
SME	Subject Matter Specialist
SMIS	Small Scale and Micro-Irrigation Support
SMS	Short Message Service
SNNP	Southern Nations Nationalities and Peoples region
SSI	Small Scale Irrigation
SSIDCH	Small Scale Irrigation Development, Construction and Handling
TVET	Technical and Vocational Education and Training
USAID	United States Agency for International Development
VERC	Virtual Extension And Research Communication Network
WOANR	Woreda Office of Agriculture And Natural Resource
WUA	Water Users Association
WWCE	Water Works Construction Enterprise
WWDS	Water Works Design and Supervision Enterprise
ZOANR	Zonal Office of Agriculture and Natural Resource

1. EXECUTIVE SUMMARY

1.1. Introduction

Ethiopia's policies, strategies and national plans[1] have emphasized both commercial and smallholder irrigation and drainage as major drivers of agricultural growth and transformation. Significant progress was made during PASDEP and GTP I in particular to enhance institutional structures, introduce or strengthen appropriate proclamations and regulations, and expand land coverage of commercial and smallholder focused schemes and use of micro/household irrigation technologies. The total amount of land under small-scale irrigation, for example, is estimated to have grown by almost 1.5 million hectares during GTP I to 2.0 million hectares total. GTP II targets rapidly further extending land irrigated by small-scale schemes by an additional 1.75 million hectares, and ensuring that 80% of farmers have at least one source of water for irrigation and 50% will be supported to use the full package for modern irrigation[2]. Substantial funding isallocated in national and regional government budgets and programs such as AGP II and PASIDP II to support achievement of these goals.

While the use of irrigation technologies and irrigated agronomic practices by smallholders are therefore showing increased uptake in various parts of the country, in many areas high value crop value chains remain underdeveloped, making it economically impossible for farmers to afford and fully benefit from irrigation and commercialization. Few smallholder farmers are also using supplementary irrigation, water saving technologies and water efficient practices. In addition, the rapid expansion of smallholder focused irrigation schemes over the last five years has surfaced a number of critical challenges in the sub-sector that can heavily constrain performance of existing schemes, effective development of new schemes, and sustainable uptake and use of irrigation technologies by farmers.

The Ministry of Agriculture and Natural Resources, the Ministry of Water, Irrigation and Electricity, the Ethiopian Agricultural Transformation Agency, and other partners, initiated development of this National Smallholder Irrigation & Draining Strategy to guide efforts and investments in smallholder focused irrigation and drainage during GTP II. The strategy builds on previous efforts, but aims to specifically identify the most important priority areas of intervention for rapidly and effectively scaling up smallholder irrigated agriculture across the country in a sustainable manner, increase the level of stakeholder engagement and focus and align stakeholders around priority interventions, and accelerate attainment of key goals in the next five years. A separate national strategy focused on commercial irrigation and drainage should also be developed to guide that segment of the sub-sector and ensure strong alignment and coordination between smallholder and commercial irrigation and drainage development.

The vision for the smallholder irrigation and drainage sub-sector is:

Vision: ***Smallholder famers have widespread access to, take up and sustainably use irrigation and drainage services and technologies, enhancing agricultural production and productivity, food security, commercialization, and resilience to climate variability and change***

Realization of this vision will be driven by achievement of the following strategic objectives of this strategy:

[1]Ethiopian Water Resources Management Policy (2001), Ethiopian Water Sector Strategy (2001), Agriculture and Rural Development Policy and Strategies (2003), Plan for Accelerated and Sustained Development to End Poverty (2005), Agriculture Sector Policy and Investment Framework (2009), First Growth and Transformation Plan (2010), Small scale irrigation capacity building strategy for Ethiopia (2011), Climate Green Resilient Economy Strategy (2013), Second Growth and Transformation Plan (2015)

[2]Second Growth and Transformation Plan, page 124

Strategic objectives:

- ***Strengthen government policies and institutions to effectively transform the irrigation and drainage sub-sector for smallholder farmers***
- ***Expand demand-driven research on irrigation and drainage technologies and irrigated agriculture as the amount of cultivated land under irrigation also grows***
- ***Improve delivery, performance and sustainability of smallholder farmer focused irrigation schemes***
- ***Increase awareness, availability, affordability and marketing of irrigation technologies and services such as pump, drip kits, sprinklers, well drilling and pump maintenance services to smallholder farmers***
- ***Promote effective and sustainable use and maintenance of irrigation and drainage technologies, and water resources, by smallholder farmers***
- ***Ensure specific needs of lower income and female farmers are well-addressed***

1.2. Potential of irrigation and drainage for agricultural growth and transformation

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Estimating the potential for irrigation and drainage within Ethiopia and assessing the possible impact of investments in this area on the agriculture sector and the broader economy are critical to inform policy decisions as well as planning for the sub-sector. While several previous studies have attempted to estimate the irrigation potential of the country, new data has become available in recent years which support more accurate GIS-based mapping and analysis of water resources. In addition, these previous studies do not look at the actual economics of irrigation and drainage development at a national level in terms of what share of the land that can be irrigated given the existing water resources can also provide positive return on investment based on the cost of irrigation and drainage development and the increased revenue stream from production and sale of crops that can be cultivated with irrigation.[3]

As part of the development of this strategy, mapping and analysis of water resources in the country based on all available data was therefore undertaken to develop a more granular and accurate estimate of the irrigation potential including on an economic basis, the impact of developing the sub-sector, and the feasibility of supplementary irrigation. While irrigation becomes more economically feasible and attractive when production focuses on high value crops such as fruits and vegetables which provide a higher ratio of revenues to costs than staple and other crops, the share of land cultivated with high value crops and the share of total production are both relatively low today in Ethiopia. Realizing widespread access to and uptake of irrigation will necessarily require an increase in these shares. Therefore the irrigation potential analysis is undertaken under three scenarios for the projected ratio of production between high value crops (HVC) and high production crops (HPC) in five years' time, applied at woreda level and them aggregated at regional and national levels:Baseline(5% HVC and 95% HPC), Optimistic (25% HVC and 75% HPC), and Aggressive (50% HVC and 50% HPC).

Figure 1presents summary results for the Absolute Irrigation Potential (Farmed Land) for the 5% HVC and 95% HPC scenario, compared to the most comprehensive recent study by the International Water Management Institute (IWMI) in 2010. Absolute Irrigation Potential (Farmed Land)represents the projected cultivated land in 2020 that can be irrigated based on available water resources, without

[3]XX (IWMI, XX) does look at the economic return from a farmer perspective of investing in household irrigation pumps; XX (MoA, XX) looks at NPV and ROI of various types of schemes and technology combinations.

considering the economic feasibility of irrigation. The estimates made here provide a similar result to the IWMIstudy for surface water despite utilizing a very different methodology, and show a significant increase in irrigation potential from the earlier study in particular for groundwater (~4 times larger) and rainwater (~9 times larger). The total potential is ~2 times largerat 11.1 million hectares as compared to 5.4 million hectares.[4]

Estimate Source	Surface Water	Ground Water	Rain Water	*Total*
IWMI 2010	3.7	1.2	0.5	***5.4***
NSID Strategy (this document)	4.3	4.7	4.4	***11.1***

Figure 1: National irrigation potential estimate as compared to previous studies

The Economic Potential metric represents the estimated amount of land that can be irrigated assuming economically attractive returns based on achievement of GTP II target yields per crop, current farm-gate prices and when the full cost of irrigation from scheme planning through operation and maintenance is accounted for. As can be seen in Figure 2, this estimate varies between 6.8 and 7.0mn hectares. There is an increase in Economic Potential as the share of HVC increases from 5% to 25%, reflecting the increase in economically attractive irrigation opportunities as more farmers take up high value crop production. Under the 50% HVC / 50% HPC scenario, there is a decrease in the estimated amount of land that can be irrigated driven by the higher average crop water requirement for HVCs as well as the higher cost of surface water based irrigation that becomes more relevant in this scenario as less expensive groundwater and rainwater resources are fully utilized.

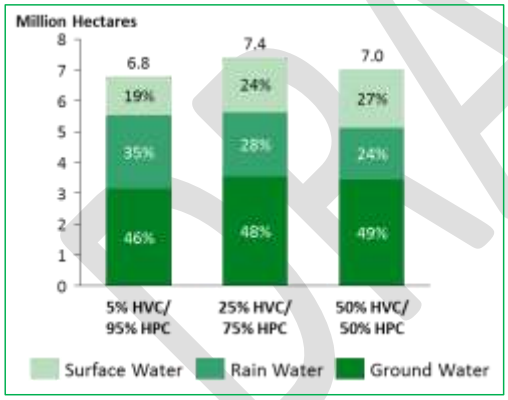

Figure 2: National Economic Potential for irrigation estimate split by water source for each scenario

The contribution by water source in Figure 2 is relatively consistent across the three scenarios at46%-49% from ground water, and 24%-35% from rainwater, and 19%-27% from surface water. As shallow and deep groundwater mapping continue to be undertaken around the country, greater groundwater resources may continue to be found and groundwater extraction technologies may reduce in price, further increasing the ground water share of potential. At the same time, the results already support a

[4]The figures for the current analysis are not additive, because there may be more water potential than cultivated land available to irrigate in a woreda. Therefore the sum of potential across surface water, ground water and rain water is capped by the projected cultivated land.

much stronger focus on rainwater harvesting based irrigation technologies than has been the case until now in most parts of the country.

Using the estimate of ~2.7 million hectares of smallholder land irrigated today, the results presented in Figure 2 imply that an additional 2.7 to 3.4 million hectares of cultivated land could be irrigated with positive economic returns. As shown in the next table, realization of this economic irrigation potential under the three HVC / HPC scenarios can translate to an annual production increment of 337%-699% over GTP II Year 5 target yields under rain-fed agriculture, at a national level[5]. This increase is significantly larger than the national production increment of GTP II Year 5 target yields over current yields of 43%-57%. The increase in production with increase in HVC's share of land cultivated shown in the table is driven by the higher yield per hectare and higher number of harvests per year of HVCs. As a regional level, the production increases are highest for Oromia due to the higher irrigation potential of the region.

Region	Production for 5% HVC / 95% HPC (M Qt)			Production for 25% HVC / 75% HPC (M Qt)			Production for 50% HVC / 50% HPC (M Qt)		
	Current yields	*GTP II target yields*	*GTP II target yields with irrigation*	*Current yields*	*GTP II target yields*	*GTP II target yields with irrigation*	*Current yields*	*GTP II target yields*	*GTP II target yields with irrigation*
Afar	0.3	1	8	1	1	17	1	1	20
Amhara	12	19	202	28	40	291	43	59	311
Benshangul	0.3	1	6	1	1	12	1	1	16
Gambella	0.1	0.2	1	0.2	0.3	3	0.3	0.5	5
Harrari	0.1	0.1	1	0.2	0.4	1	0.4	0.6	1
Oromia	24	37	244	51	73	379	78	108	416
SNNP	11	16	112	23	32	205	35	48	244
Somali	2	3	31	7	13	62	16	26	77
Tigray	2	3	27	6	10	50	11	18	59
National	*50*	*79*	*632*	*117*	*170*	*1,022*	*184*	*263*	*1,150*
% increase	-	*57%*	*699%*	-	*46%*	*500%*	-	*43%*	*337%*

Figure 3:Potential increases in production by region under Current, GTP II Year 5 Target, and Irrigated yields

Commented [s3]: Some further refinement to this analysis is being undertaken based on recent feedback from a technical committee member

Corresponding to these increases in production under irrigation, 2.2 to 2.7 times the net revenue based on farm-gate prices can be achieved annually at national level from full cultivation and irrigation of total land estimated under the Economic Potential results for each scenario. This is presented on the left side of Figure 4.The greatest area of land can be irrigated based on Economic Potential under the 25% HVC / 75% HPC scenario, translating to about 4.8 million farmers assuming an average farm size of 1.2 hectares per farmer. The right side of Figure 4 presents the same results and multiples on a per farmer basis across the three scenarios which reinforce the need for promotion and support for high value crop value chains to significantly increase economic attractiveness and uptake of irrigation and benefits to farmer from irrigation.[6]

[5] This increase in production under all three HVC / HPC scenarios is based on full cultivation of the total land estimated under the Economic Potential results for each scenario. The current yield and GTP II Year 5 Target scenarios assume only one harvest, i.e. no contribution from Belg Season.

[6]Even with widespread introduction of water fees, which is highly unlikely in Ethiopia in the next five or even ten years, the detailed results of this analysis show that a focus on high value crops can drive significantly higher uptake of irrigation despite the relatively higher crop water requirements for some high value crops.

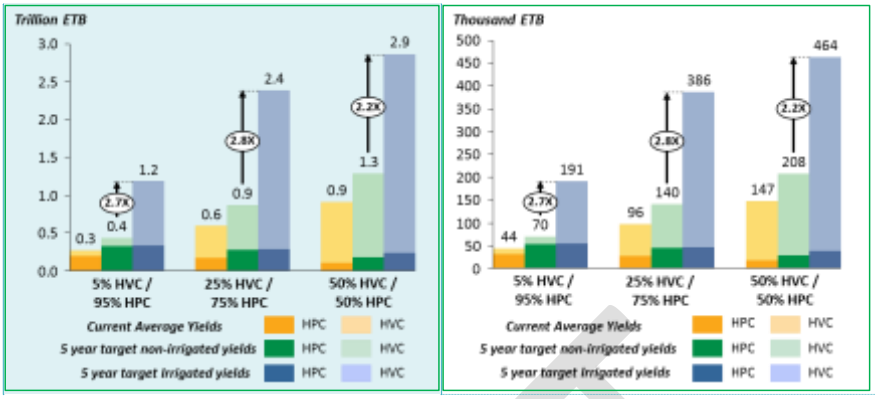

Figure4: National(left) and per farmer (right) farm-gate net revenue generatedunder HVC / HPC scenarios

Finally, analysis was also undertaken at a crop level for both high value and high production crops, to understand which crops are generally economically beneficial enough for farmers to justify uptake of irrigation for crop production, as well as to understand the feasibility of supplementary irrigation for high production crops in particular. The key findings of these analyses include:

- Uptake of irrigation for HPCs will likely continue to require initial investment to be subsidized, i.e. without major cost recovery for infrastructure and equipment in the next five years
- The risk-return profile of supplementary irrigation may not be economically attractive for an individual farmer with 1 hectare of landgrowing HVCs unless there are frequent years with low (i.e. <60% of average) rainfall during the critical growth period for crops cultivated, and for a farmer growing HPCs unless there are frequent years with very low (i.e. <5% of average)
- Use of improved inputs and adoption of better agronomic practices can significantly boost yields above those applied here (i.e. GTP II Year 5 targets) and therefore return on investment, making supplementary irrigation more attractive for farmers to invest in, however investment in supplementary irrigation as a life-saving measure will likely need to be heavily promoted and financially supported by government and development partners in the next five years until such yields and returns can be achieved by farmers across the country.

1.3. Priority strategic interventions in the sub-sector

The approach adopted to develop this strategy focuses on identification and prioritization of systemic bottlenecks and strategic interventions. A systemic bottleneck can be defined as a major structural gap, weaknessor market failureconstraining growth and development of the sub-sector, while strategic intervention refers to scalable and sustainable actions that will significantly accelerate transformation in the sub-sector if effectively executed and supported by relevant stakeholders. The irrigation and drainage sub-sector can be analytically segmented into four main thematic areas for identification and prioritization of systemic bottlenecks and strategic interventions.

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Area	Description
Policy & Institutional Framework	Relevant policies, strategies, directives, standards, and institutional roles, responsibilities, resources and arrangements, including effective implementation of this legal and institutional framework
Research & Extension	Public and private research and extension activities to support development, multiplication, awareness creation, promotion, and usage of irrigation and drainage technologies, irrigated agronomy, and other relevant topics
Scheme Planning, Design, Construction & Management	Prioritization and planning, contract management, design, construction and management of smallholder focused irrigation and drainage schemes, including public and private sector involvement and support, and community engagement
Technology Supply Chains	Multiplication (import, assembly and manufacturing), marketing and financing of irrigation and drainage technologies, and provision of drilling, installation and maintenance services, including both supply and demand issues

Figure5: Main thematic areas of the irrigation and drainage sub-sector

32 major system bottlenecks were identified in these four thematic areas, with 15 high priority and 6 medium priority. A number of bottlenecks primary within the Technology Supply Chain area relate specifically to water lifting and on-farm application technologies, namely pumps, drip kits, sprinklers and pipes. In addition, a significant number of the bottlenecks in the sub-sector have a strong bearing on or are heavily focused on enhancing environmental sustainability in irrigation and drainage development, as well as resilience to rainfall and climate variability, and climate change and adaption, while a number of bottlenecks also likely have a stronger impact on women, whether in female headed households or in male headed households. These cross-cutting issues are discussed in depth later in this document. 53interventions were defined to address the priority bottlenecks, with 32high priority interventions that are critical to implement to accelerate transformation of the sub-sector and 21 medium priority interventions that should also be implemented resource and time permitting. These high and medium priority interventions are summarized by thematic area in the next two figures.

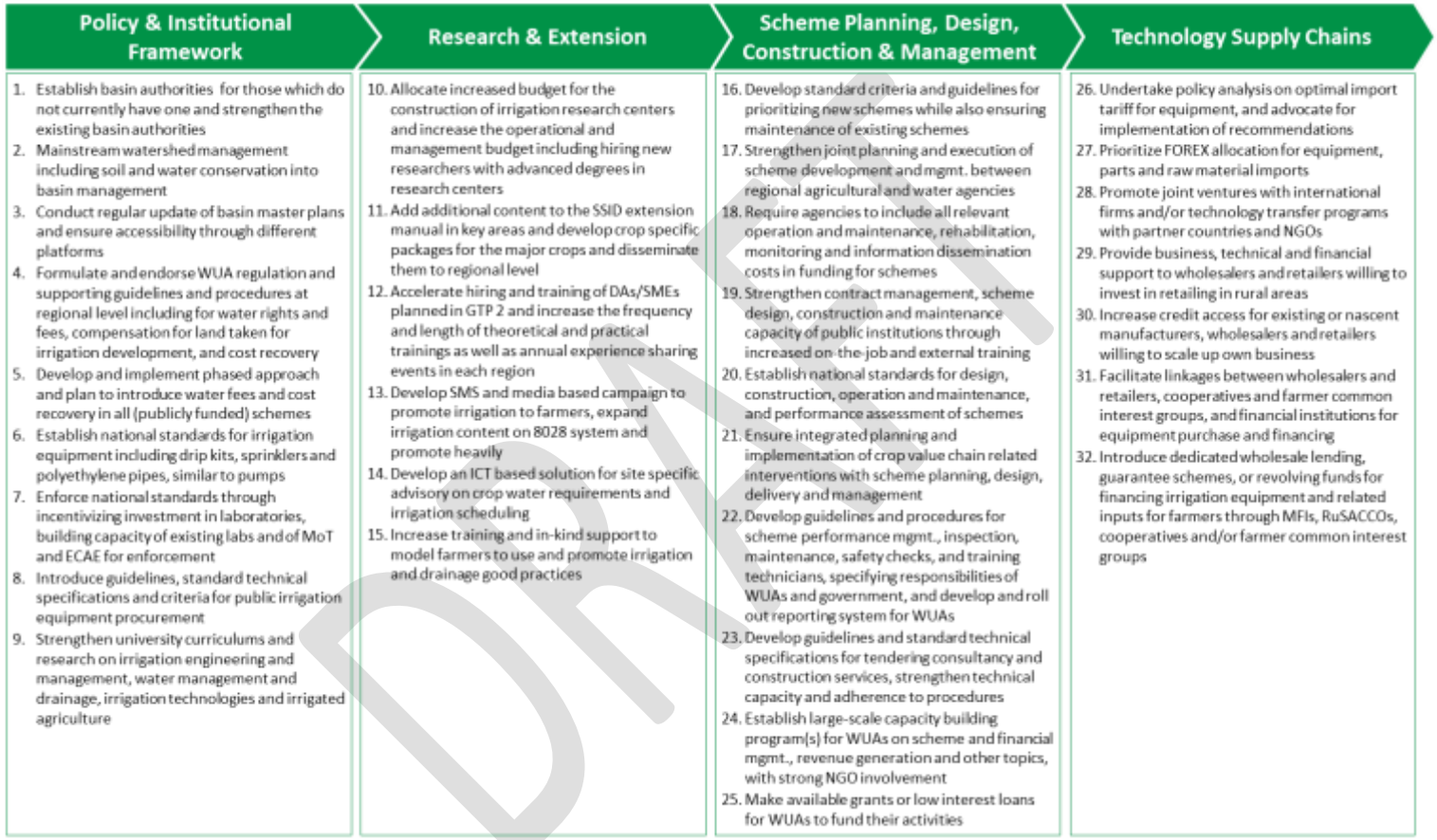

Figure 6: High priority interventions for the irrigation and drainage sub-sector by thematic area

Figure 7: Medium priority interventions for the irrigation and drainage sub-sector by thematic area

For each high and medium priority strategic intervention, implementation planning was also undertaken including definition of major activities, implementation owners and closely involved parties, major cost items and overall indicative cost estimates, aggressive and conservative implementation timelines, and mainstreaming of environmental and gender issues. An implementation roadmap was also developed for high and medium priority interventions in each of four implementation focus areas to support stakeholder alignment and coordination for effective execution of the corresponding interventions. Figure 8 below summarizes the four implementation areas in terms of overall objectives, high and medium priority interventions, and estimated costs in ETB and on a percentage basis.

Implementation focus area	Objectives	# of Interventions		Estimated Cost (ETB/%)	
		High Priority	Med Priority	High Priority	Med Priority
Enhancing Policy & Institutions	Enhance legal and institutional frameworks and capacity of government and other institutions to implement and enforce these	9	6	50 – 90 M / 18%	25 – 45 M / 9%
Strengthening Research & Extension	Strengthen research critical for development of the sub-sector, the linkage to extension, and extension activities and services	6	7	45 – 85 M / 17%	60 – 100 M / 21%
Improving Scheme Planning, Design, Construction & Mgmt.	Improve all aspects of scheme delivery, management, and performance, and strengthen capacity of organizations involved	10	3	50 – 90 M / 19%	10 – 25 M / 5%
Promoting Technology Supply Chains	Promote increased availability, accessibility and affordability of equipment, services and finance	7	5	15 – 30 M / 6%	15 – 30 M / 6%
	TOTAL	***32***	***21***	**195 – 255 M / 60%**	**125 – 185 M / 40%**

Figure 8: Interventions and financial resources required by implementation focus area

The total estimated cost across all interventions is 320 to 440 million ETB, with a mid-point estimate of 380 million ETB that is relatively evenly split between the 32 high priority interventions (~225 million ETB) that are critical to implement to accelerate transformation of the sub-sector and the 21 medium priority interventions (~155 million ETB) that should also be implemented resource and time permitting.

1.4. Implementation governance and management

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This strategy involves a wide range of interventions and owners across the four implementation focus areas as presented in the previous section. Moreover, many of the interventions are cross-sectoral in nature, requiring close involvement and coordination of stakeholders from the water and agricultural sectors as well as other sectors. Effective implementation will therefore require clear governance and management arrangements at national and regional levels. Figure 9 depicts the governance and management structure agreed for this strategy including a Steering Committee, Secretariat and Technical Committee at national level, and a Steering Committee and Technical Committee at regional level. The purpose, members and meeting frequency for each of these is detailed later in the document along with the working relationship between them. Formal Terms of Reference for each will be developed and agreed by the respective members once they are formally established.

Figure 9: Structure for governance and management of implementation

To ensure progress against the overall vision and strategic objectives of this strategy through the proposed interventions, a robust monitoring, learning and evaluation (MLE) framework should be put in place and well-integrated with ongoing strategic planning, governance and management decision-making across the wide range of intervention owners and implementers involved. At an impact level, implementation of this strategy is expected to contribute to agriculture sector-wide targets related to agricultural production and productivity, farmer incomes and commercialization, food security, and resilience to climate variability and change. Specific outcome and output indicators with required disaggregation and corresponding interventions are presented later in this document. An important first step towards implementation will be for the Secretariat to coordinate establishment of baselines and targets with specific intervention owners and have these agreed at regional and national levels.

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2. INTRODUCTION

2.1. Background and scope of the strategy

Traditional, small-scale irrigation and drainage schemes have a long history in Ethiopia while larger-scale, commercially oriented schemes have been developed from the 1960's onward. In 2001 the Ethiopian Water Resources Management Policy and the Ethiopian Water Sector Strategy clearly laid out the importance of the irrigation and drainage sub-sector in the country's development agenda going forward. Subsequent strategies and national plans[7] have emphasized both commercial and smallholder irrigation and drainage as major drivers of agricultural growth and transformation, and significant progress was made during PASDEP and GTP I to enhance institutional structures, introduce or strengthen appropriate proclamations and regulations, and expand land coverage of commercial and smallholder focused schemes and use of micro/household irrigation technologies. The total amount of land under small-scale irrigation, for example, is estimated to have grown by almost 1.5 million hectares during GTP I to 2.0 million hectares total. GTP II targets rapidly further extending land irrigated by small-scale schemes by an additional 1.75 million hectares, and ensuring that 80% of farmers have at least one source of water for irrigation and 50% will be supported to use the full package for modern irrigation[8]. Substantial funding isallocated in national and regional government budgets and programs such as AGP II and PASIDP II to support achievement of these goals.

While the use of irrigation and drainage technologies and irrigated agronomic practices by smallholders are therefore showing increased uptake in various parts of the country, in many areas high value crop value chains remain underdeveloped, making it economically impossible for farmers to afford and fully benefit from irrigation and commercialization. Few smallholder farmers are also using supplementary irrigation, water saving technologies and water efficient practices. In addition, the rapid expansion of smallholder focused irrigation schemes over the last five years has surfaced a number of critical challenges in the sub-sector that can heavily constrain performance of existing schemes, effective development of new schemes, and sustainable uptake and use of irrigation and drainage technologies by farmers. Further work is thus required to identify the most important priority areas of intervention for rapidly and effectively scaling up smallholder irrigated agriculture across the country in a sustainable manner, and to align stakeholders around these priorities.

Towards this end, The Ministry of Agriculture and Natural Resources, the Ministry of Water, Irrigation and Electricity, the Ethiopian Agricultural Transformation Agency, and other partners, initiated development of this National Smallholder Irrigation & Draining Strategy to guide efforts and investments in smallholder focused irrigation and drainage during GTP II. Smallholder focused irrigation and drainage as defined here comprises community, publically and jointly (i.e. community and publically) managed surface, ground or rainwater based schemes of any command area that serve smallholder farmers, promotion of micro/household irrigation and drainage technologies, and both full and supplementary irrigation for all crops including perennials and fodder. The strategy builds on previous efforts, but aims to increase the level of stakeholder engagement, focus and alignment around priority intervention areas, and to accelerate attainment of key goals in the next five years.

Given the primary focus on supporting sustainable smallholder irrigation and drainage development, this strategy does specifically consider cross-cutting issues related to the environment and gender. It does not however consider in-depth broader agricultural water management topics such as soil and

[7] Agriculture and Rural Development Policy and Strategies (2003), Plan for Accelerated and Sustained Development to End Poverty (2005), Agriculture Sector Policy and Investment Framework (2009), First Growth and Transformation Plan (2010), Small scale irrigation capacity building strategy for Ethiopia (2011), Climate Green Resilient Economy Strategy (2013), Second Growth and Transformation Plan (2015)

[8] Second Growth and Transformation Plan, page 124

water conservation practices, soil fertility management, reuse of excess water from wetlands, and conservation agriculture, nor issues related to rural water supply. Finally, while this document takes an exclusive focus on smallholder irrigation and drainage, water resources around the country are jointly utilized by smallholder and commercial focused schemes. A separate national strategy focused on commercial irrigation and drainage should therefore also be developed to guide that segment of the sub-sector and ensure strong alignment and coordination between smallholder and commercial irrigation and drainage development.

2.2. Vision and strategic objectives

The vision for the smallholder irrigation and drainage sub-sector is:

Vision: ***Smallholder famers have widespread access to, take up and sustainably use irrigation and drainage services and technologies, enhancing agricultural production and productivity, food security, commercialization, and resilience to climate variability and change***

Realization of this vision will be driven by achievement of the following strategic objectives of this strategy:

Strategic objectives:

- ***Strengthen government policies and institutions to effectively transform the irrigation and drainage sub-sector for smallholder farmers***
- ***Expand demand-driven research on irrigation and drainage technologies and irrigated agriculture as the amount of cultivated land under irrigation also grows***
- ***Improve delivery, performance and sustainability of smallholder farmer focused irrigation schemes***
- ***Increase awareness, availability, affordability and marketing of irrigation technologies and services such as pump, drip kits, sprinklers, well drilling and pump maintenance services to smallholder farmers***
- ***Promote effective and sustainable use and maintenance of irrigation and drainage technologies, and water resources, by smallholder farmers***
- ***Ensure specific needs of lower income and female farmers are well-addressed***

2.3. Approach and stakeholder engagement

The National Smallholder Irrigation & Drainage Strategy was developed through a five step process with extensive stakeholder engagement throughout.

Figure10: Strategy development approach

The situation analysis (step 1) was undertaken through review of relevant literature[9] and more than 75 key informant interviews with public, private and development sector stakeholders interviewed in Addis Ababa or during field trips to Amhara, Tigray, Oromia, Somali, and BenishangulGumuz regions. The full

[9]See References section for details on major documents reviewed

list of key informant interviews completed is provided in Appendix A1. The field visits also included the following irrigation schemes, to supplement various existing analysis of specific schemes in the country[10]:

- Oromia: Fentale-Tibla irrigation scheme, Wedecha-Belbela irrigation scheme
- Tigray: Raya Valley groundwater irrigation network , Agula'e irrigation scheme, Gum-Selasa irrigation scheme
- Amhara: Koga irrigation scheme
- BenishangulGumuz: Golda irrigation scheme, Hoha irrigation scheme

Details on steps 2, 3 and 4 are provided in section 4.1, while step 5 is described in section 3. In addition, the project was overseen by a Steering Committee and Technical Committee with members from 15 federal and regional government offices and three development partners. Broader stakeholders were engaged through a National Launch Workshop early in the project to validate the project scope, approach, and initial findings, and through a National Validation Project at the end of the project to validate the main content on this document. The mandate and members of the Steering and Technical Committees, as well as the agenda, invitees and attendees for the two workshops are also provided in Appendix 1.

2.4. Structure of the document

The remainder of this document in structured in four main sections. ***Section 2: Potential of irrigation and drainage for agricultural growth and transformation***presents a quantitative analysis of irrigation potential at a national level and an assessment of thepossible impact of realizing that potential on the country in terms of additional production and revenue generated from irrigation agriculture. This section also provides an economic analysis of supplementary irrigation for different types of crops.

In ***Section3: Summary of systemic bottlenecks and strategic interventions in the sub-sector***the process of identifying and prioritizing systemicbottlenecks and strategic interventions is explained, along with summaries of the prioritized bottlenecks and interventions, and consideration for mainstreaming environment and gender related issues.

Section4: Implementation planning, governance and managementpresents a summary of intervention owners and costs, as well as an implementation roadmap by thematic area. This section also outlines proposedgovernance, management and monitoring, learning & evaluation frameworks to support successful implementation and sustainability of interventions.

Theprioritized bottlenecks as well as the related high and medium priority interventions for each are further detailed in ***Section5: Discussion of prioritized bottlenecks and interventions*****.** In addition to the description of each intervention, the owner and involved parties, major cost items and indicative total costs, proposed timelines, and mainstreaming of gender and environment issues are also given.The ***Appendices*** included at the end of the document provide additional details on stakeholder engagement in the strategy development process, and various analyses undertaken.These are followed by a list of documents referred to in developing the strategy in ***References***.

3. POTENTIAL OF IRRIGATION AND DRAINAGE FOR AGRICULTURAL GROWTH AND TRANSFORMATION

Commented [s6]: This section updated throughout based on updated analysis results after incorporating TC feedback

3.1. Objectives of the analysis

[10]See XX [3 main document references to be added]

Estimating the potential for irrigation and drainage within Ethiopia and assessing the possible impact of investments in this area on the agriculture sector and the broader economy are critical to inform policy decisions as well as planning for the sub-sector. Several previous studies have attempted to estimate the irrigation potential of the country, focusing on surface, ground or rain water, or some combination of these. The more recent and comprehensive is the IWMI's *Irrigation Potential in Ethiopia* study (2010), which provides a useful starting point. However, new data has become available since 2010 which support more accurate GIS-based mapping and analysis of water resources, in particular for ground water, and other refinements to the approach followed in the IWMI and earlier studies.

In addition, these previous studies do not look at the actual economics of irrigation and drainage development at a national level in terms of what share of the land that can be irrigated given the existing water resources can also provide positive return on investment based on the cost of irrigation and drainage development and the increased revenue stream from production and sale of crops that can be cultivated with irrigation.[11] Similarly, while supplementary irrigation is often seen as a potentially life and livelihood saving intervention, there has been limited analysis of the economic feasibility of supplementary irrigation from a farmer's perspective to inform how this practice can be effectively promoted and supported.

As part of the development of this strategy, mapping and analysis of water resources in the country based on all available data was therefore undertaken to develop a more granular and accurate estimate of the irrigation potential including on an economic basis, the impact of developing the sub-sector, and the feasibility of supplementary irrigation. The results and main implications, methodology, assumptions and limitations, and future refinements proposed are presented in the following sections. These results are based on more granular data and should provide more accurate figures at a national level than previous studies, and therefore may better inform decisions by policy-makers and stakeholders in the sub-sector than these previous studies.

Due mainly to significant delays in acquiring data and challenges around validating and fully processing this data, the main analyses were however undertaken at a higher-level than initially planned. The results of the analyses are hence less accurate at a regional and especially zonal, woreda and kebele levels due to simplifying assumptions that had to be made to complete the analysis in a timely manner. In addition, an attempt was made during the project to develop a comprehensive inventory of existing irrigation schemes and overall use of irrigation across the country, to support comparison of potential against the current level of development. Four regions were able to provide an inventory or database of schemes, however with varying data completeness and quality. As a result, only high level aggregate estimates on irrigated land sourced from regional bureaus were utilized in the current analysis. Disaggregated results presented should therefore be seen only as indicative.

3.2. Irrigation potential estimates

Irrigation potential at a national level – the area of land that can potentially be irrigated by the available surface, ground and rain water resources given other relevant constraints – is estimated in three ways here at the woreda level and then aggregated to regional and national levels:

- **Absolute Potential (Total Land):** maximum amount of land in each woreda that can be irrigated given the water resources available locally, other factors such as soil type or slope that can

[11] XX (IWMI, XX) does look at the economic return from a farmer perspective of investing in household irrigation pumps; XX (MoA, XX) looks at NPV and ROI of various types of schemes and technology combinations.

constrain what types of irrigation technologies that can be applied, and the minimum water requirement across all crops and suitable irrigation technology packages;

- **Absolute Potential (Farmed Land):** Absolute Potential (Total Land), limited to land projected to be cultivated in each woreda in five years, estimated at 20% of total land on average;
- **Economic Potential (Farmed Land):** Absolute Potential (Farmed Land), further limited to the land that can be irrigated by '*water source-crop-irrigation technology package'*combinations for which the water requirements, soil requirements, and other criteria are met, and that show economically attractive returns based on current farm-gate prices and when the full cost of irrigation from scheme planning through operation and maintenance is accounted for. In other words, this estimate of potential focuses on economic feasibility and attractiveness defined through a discounted return on investment (ROI) metric, rather than minimum water requirement / maximum land that can be irrigated by available water.

Irrigation becomes more economically feasible and attractive when production focuses on high value crops such as fruits and vegetables which provide a higher ratio of revenues to costs than staple and other crops. The share of land cultivated with high value crops and the share of total production are both relatively low today in Ethiopia. Realizing widespread access to and uptake of irrigation will necessarily require an increase in these shares. Therefore the irrigation potential analysis is undertaken under three scenarios for the projected ratio of production between high value crops (HVC) and high production crops (HPC) in five years' time, applied at woreda level:

- Baseline: 5% HVC and 95% HPC
- Optimistic: 25% HVC and 75% HPC
- Aggressive: 50% HVC and 50% HPC.

The next figure presents the overall results of the analysis.

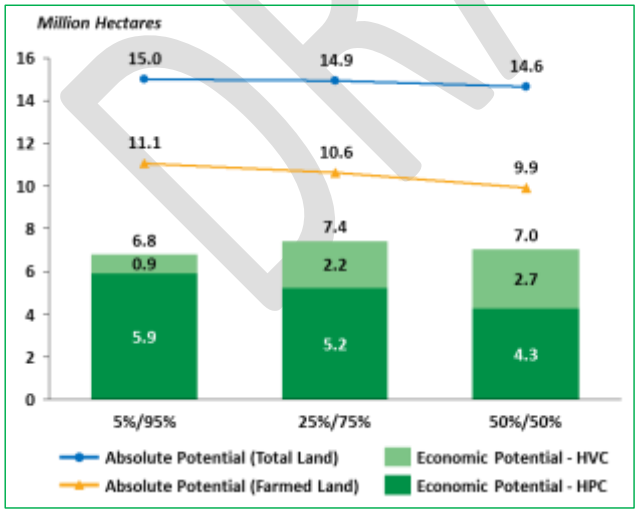


Figure11: National Irrigation Potential for three scenarios of % of High Value Crops and High Production Crops

Absolute Potential (Total Land) varies between 15.0 million hectares and 14.6mn hectares across the three scenarios, while Absolute Potential (Farmed Land) varies between 11.1mn hectares and 9.9mn hectares. The decreasing trend on both these metrics evident in the graph as the share of HVC increases is driven by the relatively higher minimum water requirement of the HVC crops as compared to HPC crops utilized in the analysis. On the other hand, the significant decrease between Absolute Potential (Total Land) and Absolute Potential (Farmed Land) is driven by the lower amount of cultivated land available for irrigation in each woreda as compared to the total land.

The Economic Potential metric represents the estimated amount of land that can be irrigated assuming economically attractive returns based on achievement of GTP II target yields per crop, current farm-gate prices and when the full cost of irrigation from scheme planning through operation and maintenance is accounted for. As can be seen in Figure 11, this estimate varies between 6.8 and 7.0 mn hectares. There is an increase in Economic Potential as the share of HVC increases from 5% to 25%, reflecting the increase in economically attractive irrigation opportunities as more farmers take up high value crop production. Under the 50% HVC / 50% HPC scenario, there is a decrease in the estimated amount of land that can be irrigated driven by the higher average crop water requirement for HVCs as well as the higher cost of surface water based irrigation that becomes more relevant in this scenario as less expensive groundwater and rainwater resources are fully utilized.

The tables below provide the same results disaggregated by region, on an absolute and percentage basis.Under all scenarios modelled,Oromia, Amhara and SNNP regions account for close to 90% of the Absolute and Economic potential for irrigation given the available water resources, total land and cultivated land, farm-gate prices and other key factors considered in the analysis. Other regions account for between 0.1% (Harrari Region) and 5% (Tigray Region, Somali Region).

Region	5% HVC / 95% HPC			25% HVC / 75% HPC			50% HVC / 50% HPC		
	Abs. Potential (Total land)	*Abs. Potential (Farmed land)*	*Economic potential*	*Abs. Potential (Total land)*	*Abs. Potential (Farmed land)*	*Economic potential*	*Abs. Potential (Total land)*	*Abs. Potential (Farmed land)*	*Economic potential*
Afar	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.1
Amhara	3.5	2.9	2.1	3.5	2.8	2.2	3.5	2.6	2.0
Benshangul	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1
Gambella	0.2	0.1	0.03	0.1	0.05	0.03	0.1	0.04	0.03
Harrari	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Oromia	7.5	5.2	2.8	7.4	5.0	3.1	7.2	4.6	2.9
SNNP	2.3	1.6	1.2	2.3	1.5	1.3	2.2	1.4	1.2
Somali	0.5	0.5	0.2	0.5	0.5	0.3	0.5	0.5	0.3
Tigray	0.7	0.6	0.3	0.7	0.5	0.4	0.7	0.5	0.4
National	**15.0**	**11.1**	**6.8**	**14.9**	**10.6**	**7.4**	**14.6**	**9.9**	**7.0**

Figure12: Indicative regional irrigation potential (mn hectares) results onan absolute basis

Region	5% HVC / 95% HPC			25% HVC / 75% HPC			50% HVC / 50% HPC		
	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential
Afar	1%	1%	1%	1%	2%	2%	1%	2%	2%
Amhara	23%	26%	31%	23%	26%	29%	24%	26%	28%
Benshangul	1%	1%	1%	1%	1%	1%	1%	1%	1%
Gambella	1%	0.5%	0.4%	1%	0.4%	0.4%	1%	0.4%	0.4%
Harrari	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.2%
Oromia	50%	47%	41%	50%	47%	41%	49%	46%	41%
SNNP	15%	15%	17%	15%	15%	17%	15%	14%	17%
Somali	3%	4%	3%	3%	4%	4%	3%	5%	5%
Tigray	4%	5%	4%	4%	5%	5%	5%	5%	5%
National	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Figure13: Indicative regional irrigation potential (mn hectares) results on a percentage basis

The next two tables further disaggregate these results by water source (i.e. surface water, ground water, rain water), under the 5% HVC / 95% HPC scenario. These results show greater variation in the relative potential across regions and across water types. Similar results for the other HVC / HPC scenarios are provided in Annex 2.

Region	Surface Water Potential			Ground Water Potential			Rain Water Potential			Total Irrigation Potential		
	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential
Afar	0.1	0.03	0.02	0.1	0.1	0.05	0.04	0.04	0.02	0.2	0.2	0.1
Amhara	1.2	1.0	0.4	1.1	1.1	1.0	1.1	1.1	0.8	3.5	2.9	2.1
Benshangul	0.1	0.04	0.02	0.1	0.1	0.02	0.1	0.1	0.02	0.2	0.1	0.1
Gambella	0.1	0.03	0.02	0.1	0.03	0.01	0.03	0.03	0.003	0.2	0.1	0.03
Harrari	0.001	0.001	0.00	0.01	0.01	0.01	0.003	0.003	0.003	0.01	0.01	0.01
Oromia	2.8	2.1	0.6	2.3	2.1	1.2	2.4	2.3	1.0	7.5	5.2	2.8
SNNP	0.7	0.6	0.2	1.0	0.9	0.6	0.6	0.6	0.4	2.3	1.6	1.2
Somali	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.03	0.5	0.5	0.2
Tigray	0.4	0.3	0.03	0.2	0.2	0.17	0.1	0.1	0.08	0.7	0.6	0.3
National	**5.6**	**4.3**	**1.3**	**5.2**	**4.7**	**3.1**	**4.5**	**4.4**	**2.4**	**15.0**	**11.1**	**6.8**

Figure14: Indicative regional irrigation potential (mn hectares) results by water source on an absolute basis

Region	Surface Water Potential			Ground Water Potential			Rain Water Potential			Total Irrigation Potential		
	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential
Afar	1%	1%	1%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Amhara	22%	24%	28%	22%	23%	30%	26%	26%	33%	23%	26%	31%
Benshangul	2%	1%	1%	1%	1%	1%	2%	2%	1%	1%	1%	1%
Gambella	2%	1%	1%	1%	1%	0.2%	1%	1%	0.1%	1%	0.5%	0.4%
Harrari	0.01%	0.01%	0%	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Oromia	51%	49%	46%	45%	45%	39%	53%	53%	43%	50%	47%	41%
SNNP	13%	13%	13%	20%	19%	19%	14%	14%	17%	15%	15%	17%
Somali	4%	4%	6%	4%	5%	4%	2%	2%	1%	3%	4%	3%
Tigray	6%	7%	2%	4%	4%	5%	2%	2%	3%	4%	5%	4%
National	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Figure15: Indicative regional irrigation potential (mn hectares) results by water source on a percentage basis

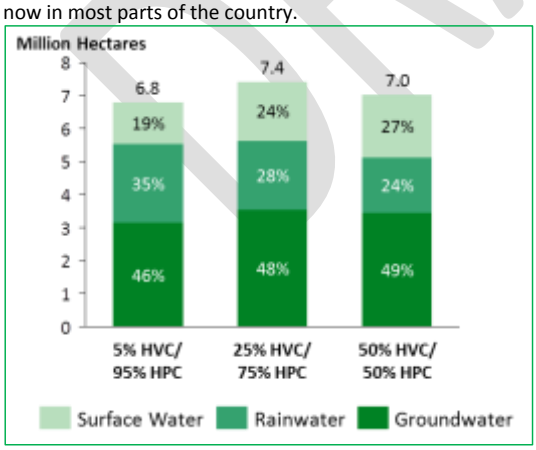
Of the various estimates presented above, the most comparable to previous studies such as IWMI 2010 are the Absolute Potential (Farmed land) figures. The estimates made here provide a similar result to the IWMI study for surface water despite utilizing a very different methodology, and show a significant increase in irrigation potential from the earlier study in particular for groundwater (~4 times larger) and rainwater (~9 times larger). The total potential is ~2 times larger at 11.1 million hectares as compared to 5.4 million hectares.[12]

Estimate Source	Surface Water	Ground Water	Rain Water	*Total*
IWMI 2010	3.7	1.2	0.5	***5.4***
NSID Strategy (this document)	4.3	4.7	4.4	***11.1***

Figure16: National irrigation potential estimate as compared to previous studies

The major driver of this difference is likely the use of the lowest water requirement in the analysis here (for Absolute Potential estimates),while other studies typically assume an average crop water requirement to try to get a more economically appropriate number but without explicitly assessing economic feasibility. Other drivers of the difference likely include the projected increase of cultivated land to 20% in the next five years, discovery of significantly larger ground water resources in the last five years than previously known, and use of a more granular and accurate approach for rainwater which assumes harvesting of up to 10% of all rain that falls on projected cultivated land.

Focusing on the Economic Potential results under the various HVC / HPC scenarios summarized in the next figure, the contribution by water source is relatively consistent across the three scenarios at 46%-49% from ground water, and 24%-35% from rainwater, and 19%-27% from surface water. As shallow and deep groundwater mapping continue to be undertaken around the country, greater groundwater resources may continue to be found and groundwater extraction technologies may reduce in price, further increasing the ground water share of potential. At the same time, the results already support a much stronger focus on rainwater harvesting based irrigation technologies than has been the case until now in most parts of the country.



[12]The figures for the current analysis are not additive, because there may be more water potential than cultivated land available to irrigate in a woreda. Therefore the sum of potential across surface water, ground water and rain water is capped by the projected cultivated land.

Figure17: National Economically Feasible Irrigation Potential estimate split by water source for each scenario

Using the estimate of ~2.7 million hectares of smallholder land irrigated today, the results presented in Figure 17 imply that an additional 2.7 to 3.4 million hectares of cultivated land could be irrigated with positive economic returns. Figure 18below presents the same results with regional disaggregation and compared to the total land irrigated for smallholder farmers as reported by each region. Fourregions show potential to increase irrigated land by 100% or more under all HVC / HPC scenarios, while Harrari region shows potential to increase irrigated land by 100% or more under the 25% HVC / 75% HVC and 50% HVC / 50% HPC scenarios. The total national increase in irrigated land is between 156% and 188% across the three scenarios. It is important to note that the analysis could be underestimating this potential due to a number of reasons:

- Data quality issues, in particular related to water resource data in some regions where less ground water has been mapped, or related to current irrigation coverage
- Conservative assumptions made in the analysis, including use of maximum ROI in estimating Economic Potential for irrigation rather than ROI above zero or some other minimum threshold
- Exclusion of spate and recession irrigation from the model (common in Gambella and other regions) given the difficulty of modelling this from available water resources.

Region	Land Irrigated (million ha's)	*Increase in Irrigated land (Million ha's)*			*Increase in Irrigated land (Percentages)*		
		5/95 Split	25/75 Split	50/50 Split	5/95 Split	25/75 Split	50/50 Split
Afar	0.06	0.03	0.05	0.05	43%	81%	83%
Amhara	0.82	1.3	1.4	1.2	157%	166%	143%
Benshangul	0.02	0.04	0.05	0.05	165%	209%	224%
Gambella*	-	-	-	-	-	-	-
Harrari	0.01	0.005	0.006	0.006	92%	126%	120%
Oromia	0.97	1.8	2.1	1.9	191%	217%	199%
SNNP	0.54	0.6	0.8	0.7	118%	140%	127%
Somali*	-	-	-	-	-	-	-
Tigray	0.23	0.05	0.1	0.1	21%	54%	55%
National	*2.65*	*4.1*	*4.8*	*4.4*	*156%*	*180%*	*166%*

*Figure18: Regional disaggregation of additional irrigated land based on economic potential (*data unavailable)*

3.3. Results of impact assessment

The national impact of irrigation can be assessed by considering the production and revenue gains from fully realizing the Economic Potential irrigation scenarios described above as compared to production and revenues based on current yields per hectare under rain-fed agriculture as well as to potential production and revenues based on GTP II Year 5 Target yields under rain-fed agriculture. Under all three sets of assumptions, production of crops with highest annual revenue per hectare should be maximized to conservatively model the potential economic impact of irrigation.

The single harvest yields for the sixteen focus crops used in the analysis here are presented below (see Section 3.5 for details on crop selection). An average increase of 49% can be achieved in the next five years based on the GTP II Target Year 5 Target Yield, and irrigation is modelled to further increase yields by an additional 30% (i.e. 79% - 49%) on average on a single season / harvest basis, compared to current yields. Considering an average annual number of harvests of 2 to 3 for irrigation and 1 harvest for the non-irrigated yields, an annual increase in yield of ~160% (i.e. 79% X 2) to ~240% (i.e. 79% X 3) can be achieved on average through raising yields to GTP II Year 5 Targets and then irrigating, compared to current yields.

Crop Group	#	Crop	Current Yield	GTP II Year 5 Target Yield	Irrigated Yield (single harvest)	% Increase – Current to GTP II Target	% Increase – Current to Irrigated
High Value Crops	1	Carrot	127	186	223	47%	76%
	2	Garlic	100	147	176	47%	76%
	3	Green Pepper	15	20	24	34%	61%
	4	Lentil	14	20	24	47%	76%
	5	Onion	105	169	203	61%	93%
	6	Potato	101	162	195	61%	93%
	7	Sweet potato	180	264	317	47%	76%
	8	Tomato	87	134	161	54%	85%
High Production Crops	9	Barley	19	28	34	47%	76%
	10	Bread Wheat	26	39	47	48%	77%
	11	Coffee	7	11	13	58%	89%
	12	Haricot bean	16	23	28	47%	76%
	13	Maize	34	50	60	47%	76%
	14	Sesame	7	10	12	47%	76%
	15	Sorghum	24	35	42	47%	76%
	16	Tef	16	23	28	47%	76%
		Average	*55*	*83*	*99*	*49%*	*79%*

Figure 19: Current, GTP II Year 5 Target, and Irrigated yields for 16 crops under single harvest assumption

Applying these yield parameters, realization of the economic irrigation potential under the three HVC / HPC scenarios can translate to an annual production increment of 337%-699% over GTP II Year 5 target yields under rain-fed agriculture, at a national level, as shown in the next table[13]. This increase is significantly larger than the national production increment of GTP II Year 5 target yields over current yields of 43%-57% as also shown. The increase in production with increase in HVC's share of land cultivated shown in the table is driven by the higher yield per hectare and higher number of harvests per year of HVCs. As a regional level, the production increases are highest for Oromia due to the higher irrigation potential of the region.

Region	Production for 5% HVC / 95% HPC (M Qt)			Production for 25% HVC / 75% HPC (M Qt)			Production for 50% HVC / 50% HPC (M Qt)		
	Current yields	*GTP II target yields*	*GTP II target yields with irrigation*	*Current yields*	*GTP II target yields*	*GTP II target yields with irrigation*	*Current yields*	*GTP II target yields*	*GTP II target yields with irrigation*
Afar	0.3	1	8	1	1	17	1	1	20
Amhara	12	19	202	28	40	291	43	59	311
Benshangul	0.3	1	6	1	1	12	1	1	16
Gambella	0.1	0.2	1	0.2	0.3	3	0.3	0.5	5
Harrari	0.1	0.1	1	0.2	0.4	1	0.4	0.6	1
Oromia	24	37	244	51	73	379	78	108	416
SNNP	11	16	112	23	32	205	35	48	244
Somali	2	3	31	7	13	62	16	26	77
Tigray	2	3	27	6	10	50	11	18	59
National	*50*	*79*	*632*	*117*	*170*	*1,022*	*184*	*263*	*1,150*
% increase	-	*57%*	*699%*	-	*46%*	*500%*	-	*43%*	*337%*

Figure20: Potential increases in production by region under Current, GTP II Year 5 Target, and Irrigated yields

Commented [s7]: Some further refinement to this analysis is being undertaken based on recent feedback from a technical committee member

[13] This increase in production under all three HVC / HPC scenarios is based on full cultivation of the total land estimated under the Economic Potential results for each scenario. The current yield and GTP II Year 5 Target scenarios assume only one harvest, i.e. no contribution from Belg Season.

Corresponding to these increases in production under irrigation, 2.2 to 2.7 times the net revenue based on farm-gate prices can be achieved annually at national level from full cultivation and irrigation of total land estimated under the Economic Potential results for each scenario. This is presented on the left side of Figure 21. The greatest area of land can be irrigated based on Economic Potential under the 25% HVC / 75% HPC scenario, translating to about 4.8 million farmers assuming an average farm size of 1.2 hectares per farmer. The right side of Figure 21 presents the same results and multiples on a per farmer basis across the three scenarios which reinforce the need for promotion and support for high value crop value chains to significantly increase economic attractiveness and uptake of irrigation and benefits to farmer from irrigation.[14]

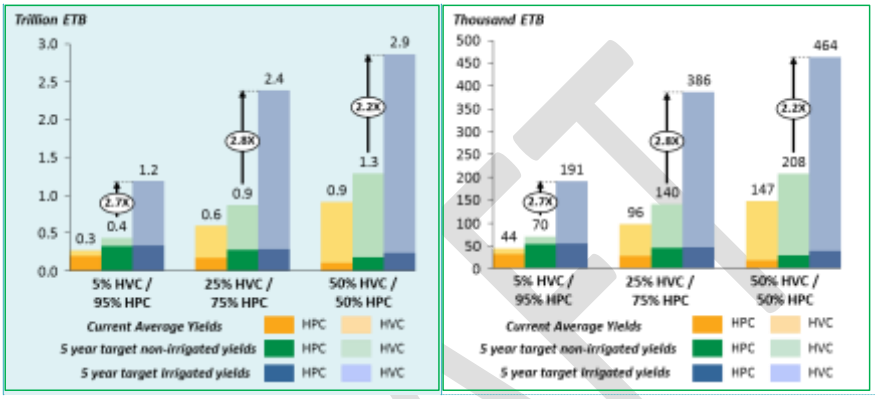


Figure 21: National (left) and per farmer (right) farm-gate net revenue generatedunder HVC / HPC scenarios

Finally, to summarize which crops are generally economically beneficial enough for farmers to justify uptake of irrigation for crop production, the table below shows the annual net revenue per hectare using national average prices and assuming the lowest cost package irrigation package is typically used. The majority of HVC as well as Sesame and Tef show sizable positive returns. Six HPC crops show negative revenues based on national prices in the fourth column which assumes that the full cost of irrigation infrastructure and equipment is borne by the farmer through cost recovery, though these crops may show positive returns based on regional or lower level data used in the main modelling given prices vary locally. The last column presents the same net revenue results, assuming the initial cost of irrigation infrastructure and equipment is subsidized as is commonly the case today. Under this assumption all crops show positive economic return. The implication of this finding is that uptake of irrigation for HPCs will likely continue to require initial investment to be subsidized, i.e. without major cost recovery for infrastructure and equipment in the next five years.

Commented [s8]: Some further refinement to this analysis is being undertaken based on recent feedback from a technical committee member

[14]Even with widespread introduction of water fees, which is highly unlikely in Ethiopia in the next five or even ten years, the detailed results of this analysis show that a focus on high value crops can drive significantly higher uptake of irrigation despite the relatively higher crop water requirements for some high value crops.

Crop Class	#	Crops	Annual Net Revenue considering initial investment borne by farmer (ETB/ha)	Annual Net Revenue with initial investment subsidized for farmer (ETB/ha)
High Value Crops	1	Green Pepper	947,145	991,321
	2	Onion	224,786	268,962
	3	Garlic	191,982	236,158
	4	Tomato	106,371	150,547
	5	Carrot	64,039	108,214
	6	Potato	50,810	94,986
	7	Sweet potato	40,160	84,336
	8	Lentil	23,624	67,800
High Production Crops	9	Sesame	16,739	60,914
	10	Tef	4,402	48,578
	11	Coffee	(8,937)	35,239
	12	Bread Wheat	(13,006)	31,170
	13	Sorghum	(15,122)	29,054
	14	Haricot bean	(15,997)	28,178
	15	Maize	(19,071)	25,105
	16	Barley	(26,941)	17,235

Figure22: Annual average net revenue for irrigation by crop, without and without subsidization

3.4. Supplementary irrigation results

The feasibility analysis of supplementary irrigation for the list of 16 crops considered produces several key insights. As shown in Figure 23, the risk-return profile of supplementary irrigation may not be economically attractive for an individual farmer with 1 hectare of land growing HVCs unless there are frequent years with low (i.e. <60% of average) rainfall during the crops' critical growth periods.

Crop	Available rainfall as a percentage of water requirement during critical growing period				
	25%	50%	75%	100%	100% without supp. irrigation
Green Pepper	199,891	125,038	50,184	(24,670)	0
Garlic	165,632	101,889	38,146	(25,598)	0
Onion	40,261	18,618	(3,026)	(24,670)	0
Sweet potato	34,448	15,245	(3,959)	(23,163)	0
Potato	22,528	5,465	(11,598)	(28,661)	0
Carrot	17,114	3,171	(10,772)	(24,715)	0
Tomato	9,548	(1,837)	(13,222)	(24,607)	0
Lentil	1,749	(6,356)	(14,462)	(22,567)	0

Figure 23: Potential HVC farmer revenue gain(ETB/ha) with supplementary irrigation under rainfall scenarios

Results of the same analysis for a farmer growing HPCs shown in the next figure highlights that supplementary irrigation may similarly not be attractive unless there are frequent years with very low (i.e. <5% of average) rainfall during the critical growth period for crops cultivated. Rainfall scenarios of 5% or lower may however not occur with sufficiently frequency to justify the investment in irrigation for most farmers. Use of improved inputs and adoption of better agronomic practices can significantly boost yields above those applied here (i.e. GTP II Year 5 targets) and therefore return on investment, making supplementary irrigation more attractive for farmers to invest in. Investment in supplementary irrigation as a life-saving measure will likely need to be heavily promoted and financially supported by government and development partners in the next five years until such yields and returns can be achieved by farmers across the country.

Crop	Available rainfall as a percentage of water requirement during critical growing period				
	25%	50%	75%	100%	100% without supp. irrigation
Coffee	12,361	763	(10,835)	(22,433)	0
Bread Wheat	(3,657)	(10,106)	(16,556)	(23,006)	0
Tef	(4,766)	(10,396)	(16,026)	(21,656)	0
Maize	(8,777)	(14,253)	(19,729)	(25,205)	0
Barley	(12,044)	(16,501)	(20,958)	(25,415)	0
Sorghum	(13,046)	(17,253)	(21,460)	(25,666)	0
Sesame	(14,620)	(19,661)	(24,702)	(29,742)	0
Haricot bean	(16,297)	(20,053)	(23,808)	(27,563)	0

Figure24: Potential HPC farmer revenue gain(ETB/ha) with supplementary irrigation under rainfall scenarios

3.5. Methodology, assumptions and limitations

This section provides a brief overview of the methodology followed to produce the results presented later in the section, as well as critical assumptions and limitations of the approach. A more detailed description of each step of the analysis is provided in Appendix 2.

Irrigation potential

The starting point for analysis of irrigation potential as defined earlier in this section is the collection and processing of a wide range of data primary data from various sources including:

- Geographic data by woreda including primary soil type, average slope, average farm size
- Ground water data in the form of a 1:250,000 scale hydrogeological map of the country, including PH, SAR, TDS, EC and discharge potential data
- Surface water data from 179 basic gauging stations in the major basin areas, including PH, SAR TDS, EC and discharge data
- Rainwater data by woreda
- Crop specific data including number of smallholder growing the crop, crop water requirement, current average and model yields (single season yields under irrigation), seed price, average number of harvests with and without irrigation, farm-gate prices, labor and mechanization costs, fertilizer prices, agrochemical prices, and land rental/property tax
- Irrigation technology data, including cost, service life, and technical requirements (e.g. water application efficiency) for usage
- Estimates of currently irrigated land cultivated by smallholders in each region

A number of intermediate analysis are undertaken using this data:

- Estimation of the quantity and quality of surface, ground and rain water available for irrigation in each woreda
- Identification of 33 irrigation technologies across the major water delivery stages from water collection through toproper disposal of the excess water post usage, feasible for use within Ethiopia within the next five years based on cost and availability considerations (see Figure 25 below)

- Identification of ~4,000 possible technology packages combining these 33 technologies across water delivery stages (headworks, storage, seepage protection, distribution, application and drainage) based on technical compatibility of different technologies
- Selection of 8 high value crops (HVC) with >120,000 ETB revenue per hectare given current average national yields, and 8 high production crops (HPC) with >1mn smallholder farmers currently growing these, to focus the analysis on so as to reduce analytical complexity and computational load of the model (see Figure 26 below);[15] Fodder crops have not been included in the analysis as price data could not be sourced for the majority of these, and crop specific details such as yield, crop water requirement and length of growing period were also not frequently available, given the limited value chain and market development for these crops and the limited use of irrigation for fodder crops in Ethiopia today.

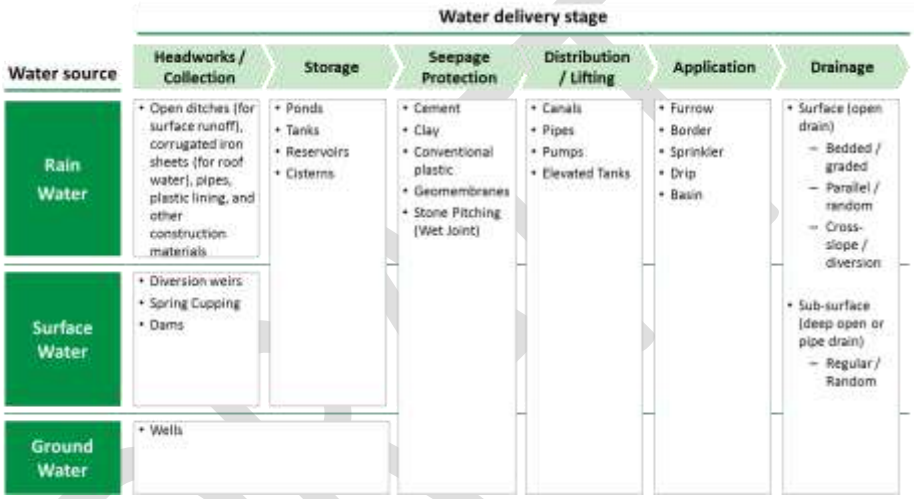


Figure25: Irrigation technologies considered by water delivery stage

#	High Value Crops (HVC)	Annual Revenue per hectare (ETB)	High Production Crops (HPC)	Annual Revenue per hectare (ETB)
1	Garlic	739,072	Sesame	87,124
2	Onion	403,058	Tef	79,517
3	Green Pepper	333,308	Bread Wheat	65,091
4	Carrot	238,755	Coffee	62,304
5	Tomato	230,507	Haricot bean	54,628
6	Potato	168,995	Maize	45,339
7	Sweet potato	140,126	Sorghum	40,500

[15]Tef can be categorized as both a high value crop and a high production crop based on these criteria. However as seen in the later results, the model yield for Tef is a smaller increment above current average yield as compared to other high value crops listed and therefore the cost-benefit of irrigation is much closer to HPCs rather than HVCs. In addition, sesame has a significantly lower number of farmers than the other HPCs (See Appendix 2), but is considered in the analysis due to its strategic importance.

8	Lentil	124,620	Barley	39,901

Figure26: List of 16 crops selected for analysis and corresponding annual revenue

The intermediate outputs of these analyses are then used to identify technically feasible 'crop-irrigation technology package' combinations for surface, ground and rainwater resources in each woreda, for both HVC and HPC crop groups. To determine Absolute Potential for irrigation, the combination requiring the lowest water requirement for each water source (i.e. surface, ground and rainwater) is selected to determine the total amount of land that can be irrigated with that combination and water source, and these are summed across the three water sources. Taking the lower of this sum and the total land in the woreda gives the **Absolute Potential (Total Land)** for both HVC and HPC, while taking the lower of this sum and the projected cultivated land in the woreda in five years' time gives the **Absolute Potential (Farmed Land)** for HVC and HPC. Three different scenarios for the ratio of production at woreda level made up by HVC and HPC (5%/95%, 25%/75%, and 50%/50%) are then applied to these values to generate final estimates of **Absolute Potential (Total Land)** and **Absolute Potential (Farmed Land)** for each woreda under each scenario, which are then aggregated at regional and national levels.

Finally, to determine the **Economic Potential** for irrigation, a similar logic to the above is followed, however the most economically attractive crop-irrigation technology package combination is selected for each of the three water sources (i.e. surface, ground and rainwater) rather than the combinations with the lowest water requirements. Economic attractiveness is defined in terms of the discounted return on investment (ROI) based on the cash inflows from sales of the crop being produced and outflows to put in place and maintain the irrigation as well as to purchase inputs for high-productivity crop production. NPV and annualized NPV metrics were also estimated, however the ROI was selected as the primary metric. In addition, average crop and input prices at regional level are used in the analysis. Finally, the most economically attractive combination (i.e. combinations with greatest positive ROI) is selected rather than the minimum economically feasible combination (i.e. combinations with smallest ROI >0%) to reflect realistic farmer preferences, and as a conservative assumption as current crop farm-gate prices are used in the analysis which may reduce if production increases due to irrigation and therefore result in lower ROI in reality.

HVC crops such as Green Pepper, Garlic, Onion, and Sweet Potato and HPC crops such as Tef, Sesame, Barley, Coffee and Bread Wheat show better returns on investment with irrigation. The irrigation technology packages that come out as both most technically and economically feasible are largely furrow based systems (~50%), followed by drip and sprinkler based irrigation systems. As mentioned earlier, the use of the ROI metric as the selection criterion is the driver for the larger share of furrow based irrigation system as the price per hectare for furrow based systems is low. If water usage / fees were to be considered, the latter two – drip and sprinkler systems – would account for a much larger share due to the much higher water efficiency of these systems as opposed to furrow based systems.

Impact assessment

Assessment of impact of increasing irrigation uptake in the country in line with Economic Potential is undertaken by estimating the additional production, net revenue (i.e. profit on farm-gate price) at aggregate (i.e. national) and individual farmers levels that could be generated assuming the economically attractive 'water-source-crop-irrigation technology package' combinations identified for each woreda are fully applied. The additional production and revenue due to irrigation is generated

primarily from the increase in the number of harvests, as the analysis assumes full use of improved inputs and good agronomic practices and the same yield per harvest without and without irrigation. Consistent with the earlier analyses on which the impact assessment builds, average crop and input prices at regional level are used for estimating revenues.

To estimate the number of famers that will benefit under the three HVC / HPC scenarios through increased net revenues, the total Economic Potential for irrigation in terms of hectares of land is divided by the average farm size nationally. The net revenues aggregated at national level are then divided by the total number of farmers to give the average additional net revenue or income per farmer. In all three scenarios the total number of farmers used in this calculation is based on the 50% HVC / 50% HPC scenario, because this scenario supports the highest amount of land and therefore farmers taking up irrigation. Under the other scenarios the net revenue per farmer will be similar, however a much smaller number of farmers can realize this net revenue. Therefore the total number of farmers under the 50% HVC / 50% HPC scenario ensures the comparability of the results in terms of aggregate impact or benefit to the country, which is most relevant from a national or regional policymaking and planning perspective.

Supplementary irrigation

Feasibility analysis of supplementary irrigation is undertaken for each of the 16 HVC and HPC crops based on consideration of the available amount of water (essentially rainfall) at the critical growth period. Varying percentage of rainfall availability is considered assuming a linear relation of crop yield to the amount of rainfall during this period, ie. 0% rainfall will result inno yield and 100% rainfall will result in 100% of the yield. Supplementary irrigation is modelled to have a negative return on investment when rainfall is 100%, since the cost of irrigation is incurred however it provides no benefit. Where rainfall is below 100%, supplementary irrigation compensates fully for the deficit in water and in yield, and therefore provides economic benefits equivalent to the potential revenues generated by the additional production less the cost of irrigation, measured as a discounted ROI. This analysis assumes full use of improved inputs and good agronomic practices as explained earlier; without full use of improved inputs and good agronomic practices the economic feasibility of irrigation will in most cases be lower as the fixed cost of irrigation remains the same but the incremental gain due to irrigation will decrease.

Critical assumptions and limitations

When computing the irrigation potential assessment, corresponding impact assessment and supplementary irrigation feasibility, some major assumptions have been considered. These assumptions are listed below along with the limitations that each causes to the robustness of the study. Further details on all assumptions made for all steps of the analysis are provided in Appendix 2.

- 20% of total land area in each woredais estimated to be cultivated (and therefore potential for irrigation) within the next five years, based on
    - Current cultivated land coverage of ~16%
    - Total growth rate of 2% over the past five years, and previous five year periods
    - Additional 2% increase modeled to allow for faster growth in cultivated land with expansion of irrigation in the next five years

  Limitation:

- If the growth rate of land cultivated does not continue as seen in the last five years, or promotion of irrigation and other areas does not increase the growth rate as modeled, the irrigation potential estimates provided here will be overstated. In addition, commercially cultivated land was not explicitly excluded despite the rest of the analysis only focusing on smallholder agriculture (e.g. industrial crops were not considered in the economic analysis).

- 20% increase in crop yields is assumed from use of irrigation due to better application of water to crop root zone during critical growth period and other periods
  Limitation:
  - This is likely a conservative estimate, as different studies show different increases in single harvest yields for various crops including very large yield gains. However, sufficient data for certain crops as well as in the Ethiopian context was not available to use crop-specific estimates or a more accurate average figure.
- Regional average farm gate and input prices used for all woredas that line within each region and are assumed to stay constant/static over the next five years
  Limitations:
  - The farm gate prices do not show the possible increase of farm gate prices along with the possibility of exporting the large produce
  - Farm gate prices vary across woredas within a region
  - Farm-gate prices will fluctuate over the next five years; possibly going down with increase in production, while still taking in the effects of inflation
  - Input prices may also decrease or increase in the future
- Discounted ROI over irrigation package service life used to select best *irrigation package–crop–water source* combination to scale up in each woreda. A water source – crop – irrigation technology package combination with the highest positive ROI selected and scaled up
  Limitation:
  - Combinations with lower positive ROI's might have lower crop water requirements, and hence allow the available water to irrigate a large amount of land
- Surface water potential mapped nationally based on buffer concept applied on 179 station data. Woredas outside the 50KM radius of all stations assigned the national average
  Limitation:
  - Applying national average may over/under estimate discharge potentials of woredas that have missing data, most likely overestimating as stations are likely not placed in these areas due to lack of surface water resources
- Large-scale transfers of water across basins are not considered
  Limitation:
  - Potential land that can be irrigated may be underestimated, as water could potentially be transferred from areas with excess water for irrigation to areas with deficits
- 10% of total rainfall amount that falls on cultivable land per woreda considered to be harvested, and hence considered as the rain water available for irrigation purposes
  - Volume of harvested rainfall = Depth of rainfall * Cultivable land area * 10%

  Limitation:
  - May underestimate potential for rainwater based irrigation, i.e. if >10% of total rainfall amount that falls on cultivable land per woreda considered to be harvested
- All water resources are assumed to be available for irrigation, without consideration water needs for water supply and other sectors
  Limitation:
  - Water available for irrigation is overestimated

3.6. Future refinements proposed

The analysis and results presented in this section can inform important policy and programming decisions, especially with further refinements to provide more accurate and useful results at lower levels of geographic granularity. Enhancement of the of the methodology, assumptions and modelling approach applied here as well as development of a comprehensive scheme inventory at national level is therefore recommended as a priority intervention later in this strategy. These efforts can build on the data already collected and analysis completed for this document, with the following key refinements proposed:

- Map surface water potential at a woreda level through the use of a bottom-up, micro-basin approach rather than usinghigh-level buffer zone assumption followed in this study
- Gather additional deep ground water data being collected by certain regions and incorporate with the ground water data (primarily shallow ground water) available at national level
- Increase data validation and cleansing of surface, ground and rain water data, e.g. to remove less reliable stations
- Incorporate spate / flood irrigation
- Include all relevant crops rather than only the 16 include here
- Compute trend analysis of the crop, input and irrigation technology prices to determine more robust national and farmer level revenue and cost streams for economic analyses
- Incorporate additional yield gains resulting from use of irrigation
- Model the HVC / HPC scenarios at an individual crop level (i.e. assuming various shares of production by crop) rather than at the overall HVC and HPC crop group levels
- Calculate a range of results for Economic Potential based on considering both ROI and water requirements / water use efficiency, rather than ROI alone, for example by estimating and incorporating water fees
- Integrate end-market prices for processed products as well as for export markets, rather than only focusing on farm-gate prices, to also assess other economic benefits of focusing on certain crops and suitable irrigation technology packages from a national perspective.

4. SUMMARY OF SYSTEMIC BOTTLENECKS AND STRATEGIC INTERVENTIONS IN THE SUB-SECTOR

4.1. Identification and prioritization of system bottlenecks and strategic interventions

The approach adopted to develop this strategy focuses on identification and prioritization of systemic bottlenecks and strategic interventions. A systemic bottleneck can be defined as a major structural gap, weaknessor market failureconstraining growth and development of the sub-sector, while strategic intervention refers to scalable and sustainable actions that will significantly accelerate transformation in the sub-sector if effectively executed and supported by relevant stakeholders. The irrigation and drainage sub-sector can be analytically segmented into four main thematic areas for identification and prioritization of systemic bottlenecks and strategic interventions.

Area	Description
Policy & Institutional Framework	Relevant policies, strategies, directives, standards, and institutional roles, responsibilities, resources and arrangements, including effective implementation of this legal and institutional framework
Research & Extension	Public and private research and extension activities to support development, multiplication, awareness creation, promotion, and usage of irrigation and drainage technologies, irrigated agronomy, and other relevant topics
Scheme Planning, Design, Construction & Management	Prioritization and planning, contract management, design, construction and management of smallholder focused irrigation and drainage schemes, including public and private sector involvement and support, and community engagement
Technology Supply Chains	Multiplication (import, assembly and manufacturing), marketing and financing of irrigation and drainage technologies, and provision of drilling, installation and maintenance services, including both supply and demand issues

Figure 27: Main thematic areas of the irrigation and drainage sub-sector

Within this framework, systemic bottlenecks were identified through reviewing previous studies, considering performance of existing programs, stakeholder interviews, and regional field visits. Identified bottlenecks were then prioritized based on considering the impact and severity / frequency of each bottleneck. Medium and high priority bottlenecks were then further assessed in-depth through extensive data collection and analysis. The identification and prioritization of bottlenecks as well as the in-depth analysis was validated through the project Technical Committee and at a national workshop.

Possible strategic interventions to address each medium and high priority bottleneck were also identified from a number of sources. Existing policy and strategy documents as well as studies propose a large number of interventions; over 200 possible interventions were identified from eight documents in particular, consolidated where similar and then mapped to the bottlenecks. These documents include: *Ethiopian Water Resources Management Policy* (2001), *Ethiopian Water Sector Strategy – Irrigation Section*(2001), *PASDEP* (2005),*GTP I* (2010),*Irrigation Potential in Ethiopia* (2010),*Small Scale Irrigation Capacity Building Strategy for Ethiopia* (2011),*Realizing the Potential of Household Irrigation in Ethiopia* (2012), and *GTP II* (2015). Additional interventions were also identified from five sources:

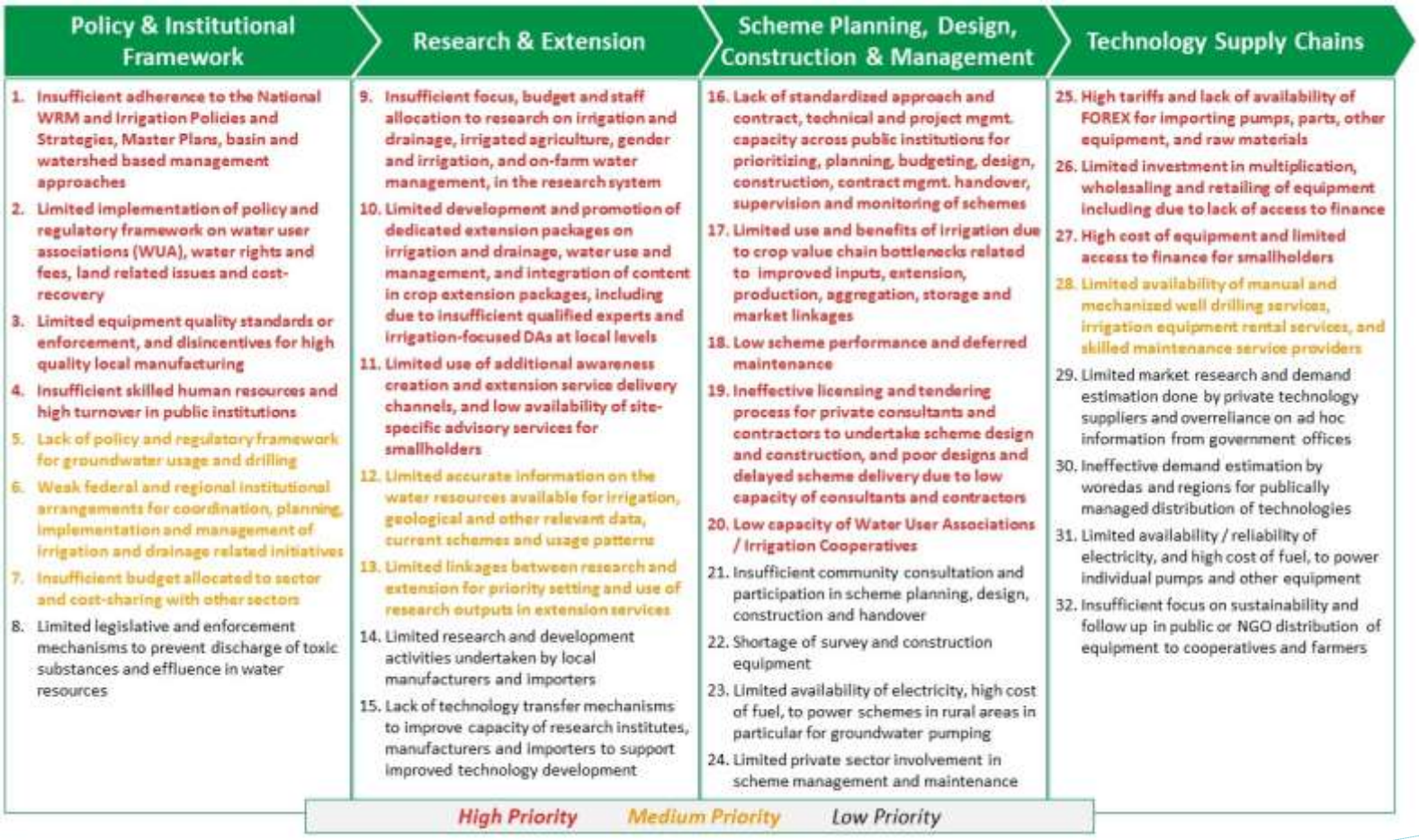
- Other studies made in the sub-sector by MoANR, IWMI, Mekelle University, and others[16]
- Stakeholder interviews and discussions, including with local and global experts
- Review of existing programs and initiatives in the country, including in particular: MoANR AGP I: Smallscale Irrigation Development Component, MoANR PASIDP, MoANR SMIS: Smallscale Irrigation Capacity Building Component, ATA HHI Value Chain Project, IWMI: Africa Rising, ELSI, and LIVES (with ILRI) projects[17]
- International case studies and best practice guidelines, relevant in particular for topics such as policy enhancement, water user associations, extension services, technology and services supply chains, and access to finance initiatives
- Quantitative and qualitative analyses undertaken by the study team.

The resulting 'long list' of interventions for each priority bottleneck was prioritized by considering the potential impact and feasibility of each intervention and lower priority interventions were eliminated. The remaining interventions were identified to be high priority, i.e. critical to address a high priority bottlenecks, or medium priority, i.e. less critical or secondary for addressing a high priority bottleneck, or critical for addressing a medium priority bottleneck. This process resulted in the final list of about 60 high and medium priority interventions which were discussed with stakeholders and further analysed and detailed to inform the specific activities, implementation owners and closely involved parties, major cost items and overall costing, timelines, and output targets proposed under each in this document.

4.2. Summary of systemic bottlenecks

The following figure provides a summary of bottlenecks identified, with prioritized bottlenecks coloured in red text (high priority) and orange text (medium priority). A total of 32 are listed with 15 high, 6 medium and 11 low priority bottlenecks. A number of these relate specifically to the supply chain for water lifting and on-farm application technologies, namely pumps, drip kits, sprinklers and pipes, as indicated by the asterisk (*) after the bottleneck name.

[16]See References section at the end of this document
[17]More detailed information on each program is provided in Annex 5.



Commented [s9]: Updated – bottleneck #20 made higher priority, ordering changed to align with interventions

Figure28: Major bottlenecks in the irrigation and drainage sub-sector with prioritization

The distirbution of bottlenecks thematic area is presened in the next table, with eight bottlenecks in the Policy & Institutions and Technology Supply Chains areas each, nine bottlenecks in the Scheme Planning, Design, Constructin & Management area, and seven in Research & Extension.

Bottleneck Priority	Policy & Institutions	Research & Extension	Scheme Planning, Design, Construction &Mgmt.	Technology Supply Chains
High priority	4	3	5	3
Medium priority	3	2	0	1
Low priority	1	2	4	4
Total	***8***	***7***	***9***	***8***

Figure29: Distribution of bottlenecks by priority and thematic area

Promotion of irrigation and drainage overall is identified as an important climate change adaptation and mitigation option in the CRGE[18]. However irrigation and drainage technologies can also be applied in an environmentally unsustainable or damaging way. Challenges such as insufficient consideration of basin and watershed management in scheme prioritization, planning and design, lack of robust environmental analysis in scheme design, low water use efficiency, frequent salinity and water quality issues, soil and water resource degradation and other damage to the ecosystem have been clearly documented around the country. A significant number of the bottlenecks in the sub-sector identified here therefore have a strong bearing on or are heavily focused on enhancing environmental sustainability in irrigation and drainage development, as well as resilience to rainfall and climate variability, and climate change and adaption. These bottlenecks are highlighted below, with details of how each relates to environmental sustainability and climate variability and change issues provided in Annex 3.

Area	Relevant bottlenecks
Policy & Institutions	1,2,3,4,5,6,7,8
Research & Extension	9, 10, 11, 12, 13, 15
Scheme Planning, Design, Construction & Management	16, 17, 18, 19, 20,21, 23
Technology Supply Chains	25, 26, 27, 28, 31

Figure30: Bottlenecks with heavy bearing / focus on environment sustainability and climate change issues

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A number of the identified and prioritized bottlenecks also likely have a stronger impact on women, whether in female headed households or in male headed households. Policy and institutional frameworks as well as research and extension services often may not address women's participation or the specific needs of women including through development of female friendly technologies. Scheme prioritization, planning and design also often may not ensure the participation of women as well as consideration of their interests and needs within the broad local community, including in scheme management and operation through water user associations. Finally, women often have lower incomes, savings and access to finance to procure both irrigation related equipment as well as crop production inputs. Enhancing women's participation in these areas is therefore critical to ensure maximum positive impact on their and their households livelihoods through irrigation and drainage development. Specific bottlenecks that likely impact females and female farmers in particular more strongly are presented in the next table, with further details provided in Annex 3.

[18]CRGE, page XX

Area	Relevant bottlenecks
Policy & Institutions	2
Research & Extension	9, 10, 11, 13
Scheme Planning, Design, Construction & Management	16, 17, 20, 21
Technology Supply Chains	25, 27, 28, 31

Figure31: Bottlenecks that likely impact females more strongly

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4.3. Summary of strategic interventions

53 strategic interventions have been developed to address the priority systemic bottlenecks, with 32 high priority interventions that are critical to implement to accelerate transformation of the sub-sector and 21 medium priority interventions that should also be implemented resource and time permitting. The next figure presents the distirbution by priority and thematic area, with 15interventions in the Policy & Institutions are, 13 interventions in the Research & Extension and Technology Supply Chains areas each, and 12 in the Scheme Planning, Design, Construction & Management area.

Bottleneck Priority	Policy & Institutions	Research & Extension	Scheme Planning, Design, Construction & Mgmt.	Technology Supply Chains
High priority	9	6	10	7
Medium priority	6	7	3	5
Total	***15***	***13***	***13***	***12***

Figure32: Distribution of interventions by priority and thematic area

The following figures present high and medium priority interventions by thematic area. The primary bottleneck which each intervention addresses is further detailed in Section 6, along with the major activities, owners and closely involved parties, costing and timelines for each intervention. These implementation details are also summarized in the roadmaps presented in Section 5.

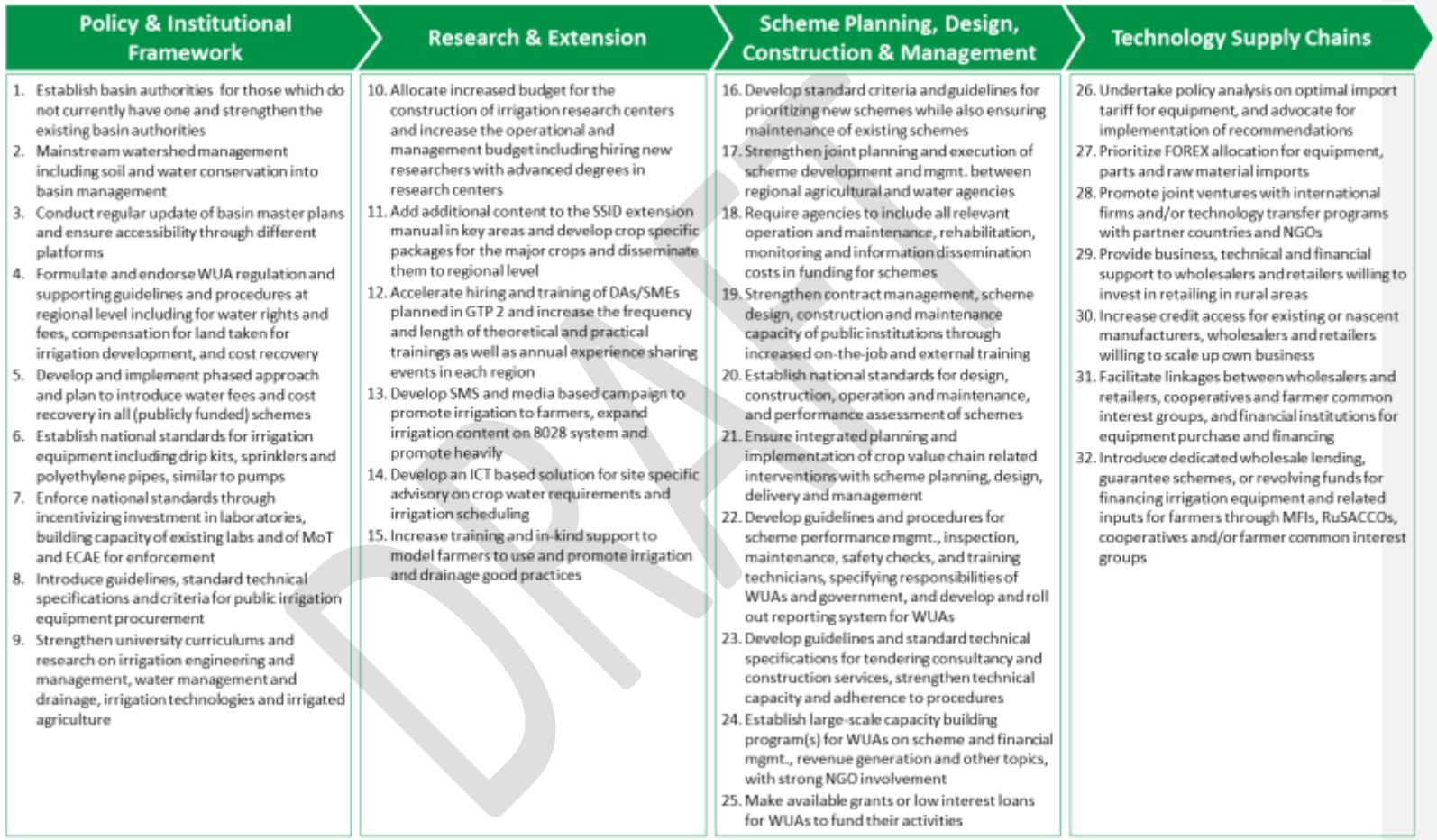

Figure33: High priority interventions for the irrigation and drainage sub-sector by thematic area

Figure34: Medium priority interventions for the irrigation and drainage sub-sector by thematic area

4.4. Mainstreaming environment and gender in strategic interventions

Achieving inclusive and sustainable development in the irrigation and drainage sub-sector requires effective mainstreaming of environmental and gender considerations in prioritized interventions.This can be done through two main modalities. Additional interventions specifically aimed at addressing environmental or gender issues can be designed, or specific activities, requirements or targets focusing onenvironmental or gender issues along with corresponding financial and human resources can be integrated within broader interventions to ensure a greater focus on these areas. In the current strategy, the first approach is used mainly for environment related issues, while the second approach is used for both environment and gender related issues. The following table summarizes the high (H#) and medium (M#) interventions which reflect mainstreaming of environment and gender issues, with additional details provided in Section 5 with each intervention.

Strategic intervention area	Interventions with mainstreaming of	
	Environmental issues	*Gender issues*
Policy & Institutions	• H1, H2, H3, H4, H5, H9 • M1, M2	• H4, H8, H9 • M9
Research & Extension	• H10, H11, H12, H13, H14, H15 • M8, M9, M10, M12, M13	• H10, H11, H12, H13, H15 • M8, M10, M12, M13
Scheme Planning, Design, Construction & Mgmt.	• H16, H17, H19, H20, H22, H24, H25	• H18, H19, H24
Technology Supply Chains	• H26, H27, H29, H30, H31, H32	• H26, H27, H29, H30, H31, H32

Figure35: Interventions reflecting mainstreaming of environmental and gender issues

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5. IMPLEMENTATIONPLANNING, GOVERNANCE AND MANAGEMENT

5.1. Implementation planning

Implementation planning was undertaken for each of the 53high and medium priority strategic interventions presented in Section 4, grouped into four implementation focus areas based on common or closely related objectives, implementation interdependencies, and to support stakeholder alignment and coordination for effective execution of the corresponding interventions. Figure 36 below summarizes the four implementation areas in terms of overall objectives, high and medium priority interventions, and estimated costs in ETB and on a percentage basis. The total estimated cost across all interventions is 320 to 440 million ETB, with a mid-point estimate of 380 million ETB that is relatively evenly split between the 32 high priority interventions (~225 million ETB) that are critical to implement to accelerate transformation of the sub-sector and the 21 medium priority interventions (~155 million ETB) that should also be implemented resource and time permitting.

Implementation focus area	Objectives	# of Interventions		Estimated Cost (ETB/%)	
		High Priority	Med Priority	High Priority	Med Priority
Enhancing Policy & Institutions	Enhance legal and institutional frameworks and capacity of government and other institutions to implement and enforce these	9	6	50 – 90 M / 18%	25 – 45 M / 9%
Strengthening Research & Extension	Strengthen research critical for development of the sub-sector, the linkage to extension, and extension activities and services	6	7	45 – 85 M / 17%	60 – 100 M / 21%
Improving Scheme Planning, Design, Construction & Mgmt.	Improve all aspects of scheme delivery, management, and performance, and strengthen capacity of organizations involved	10	3	50 – 90 M / 19%	10 – 25 M / 5%
Promoting Technology Supply Chains	Promote increased availability, accessibility and affordability of equipment, services and finance	7	5	15 – 30 M / 6%	15 – 30 M / 6%
	TOTAL	*32*	*21*	**195 – 255 M / 60%**	**125 – 185 M / 40%**

Figure36: Summary of implementation focus areas, interventions and costs

5.2. Roadmaps by implementation focus area

The implementation owners, overall cost estimate, and aggressive and conservative implementation timelines for the high and medium priority strategic interventions are presented here in separate roadmaps for each implementation focus area. Cost estimates are presented in indicative buckets (i.e. 0-1 M ETB, 1-2.5M ETB, 2.5-5 M ETB, 5-10, 10-20 M ETB, 20-50 M ETB, 50-100 M ETB, and 100-200 M ETB) based on consideration of the major cost items for each intervention. Timelines for each intervention are estimated based on previous experience in the subsector and other parts of the agriculture sector, and consultation of with stakeholders.

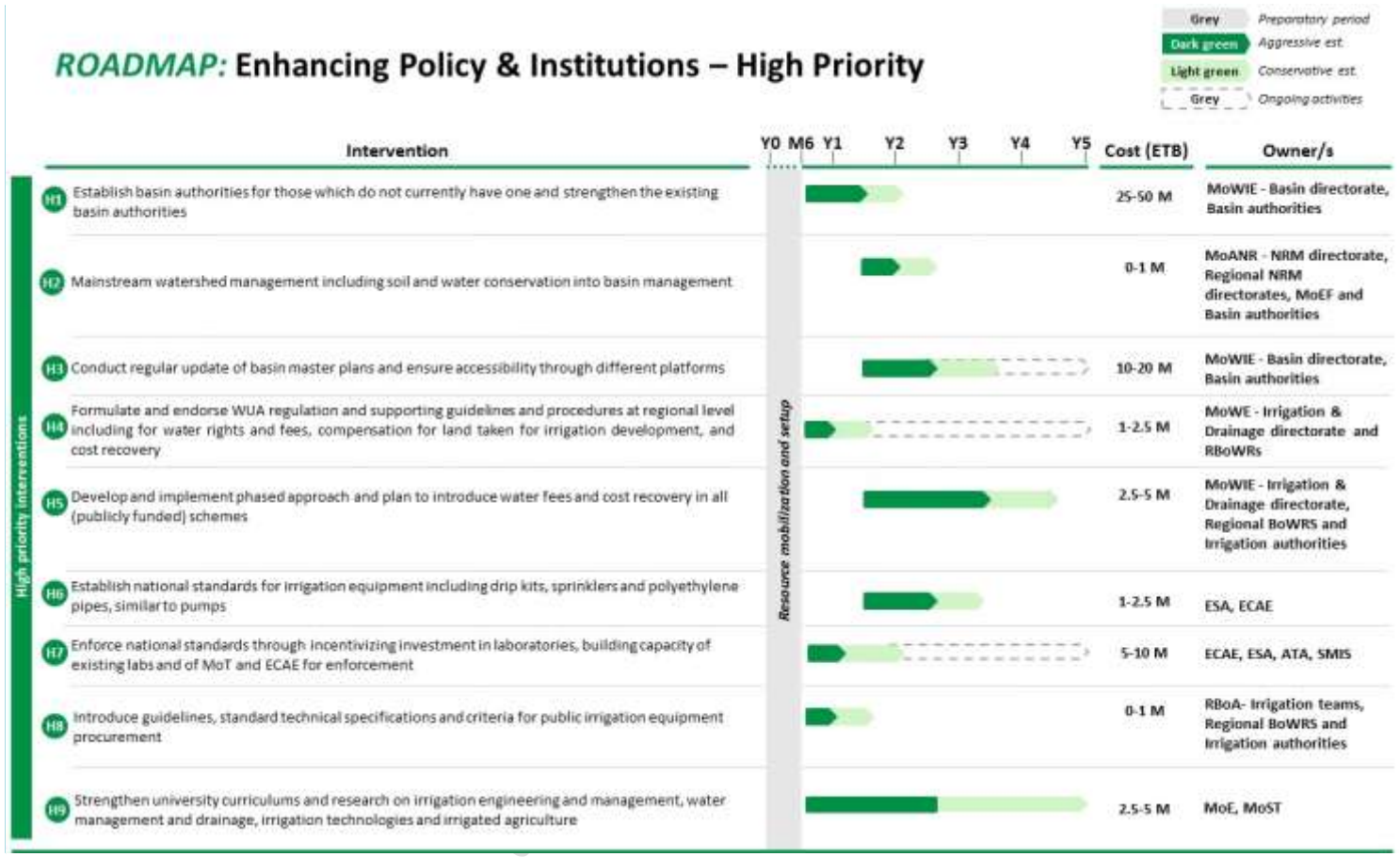

Figure37: Roadmap –High Priority Interventions I

Commented [s13]: Costings, timelines and owners updated in these graphics

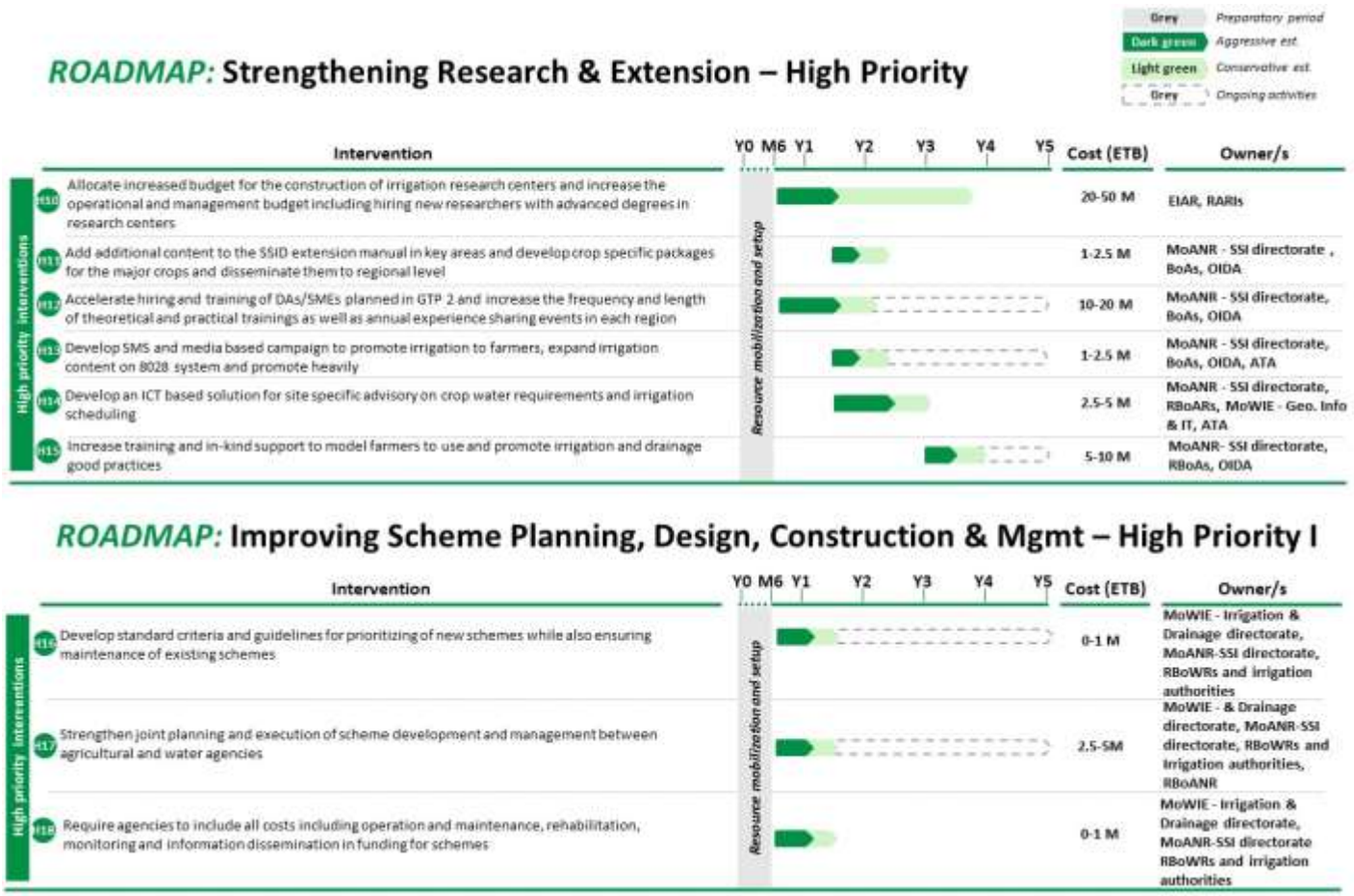

Figure 38: Roadmap – High Priority Interventions II

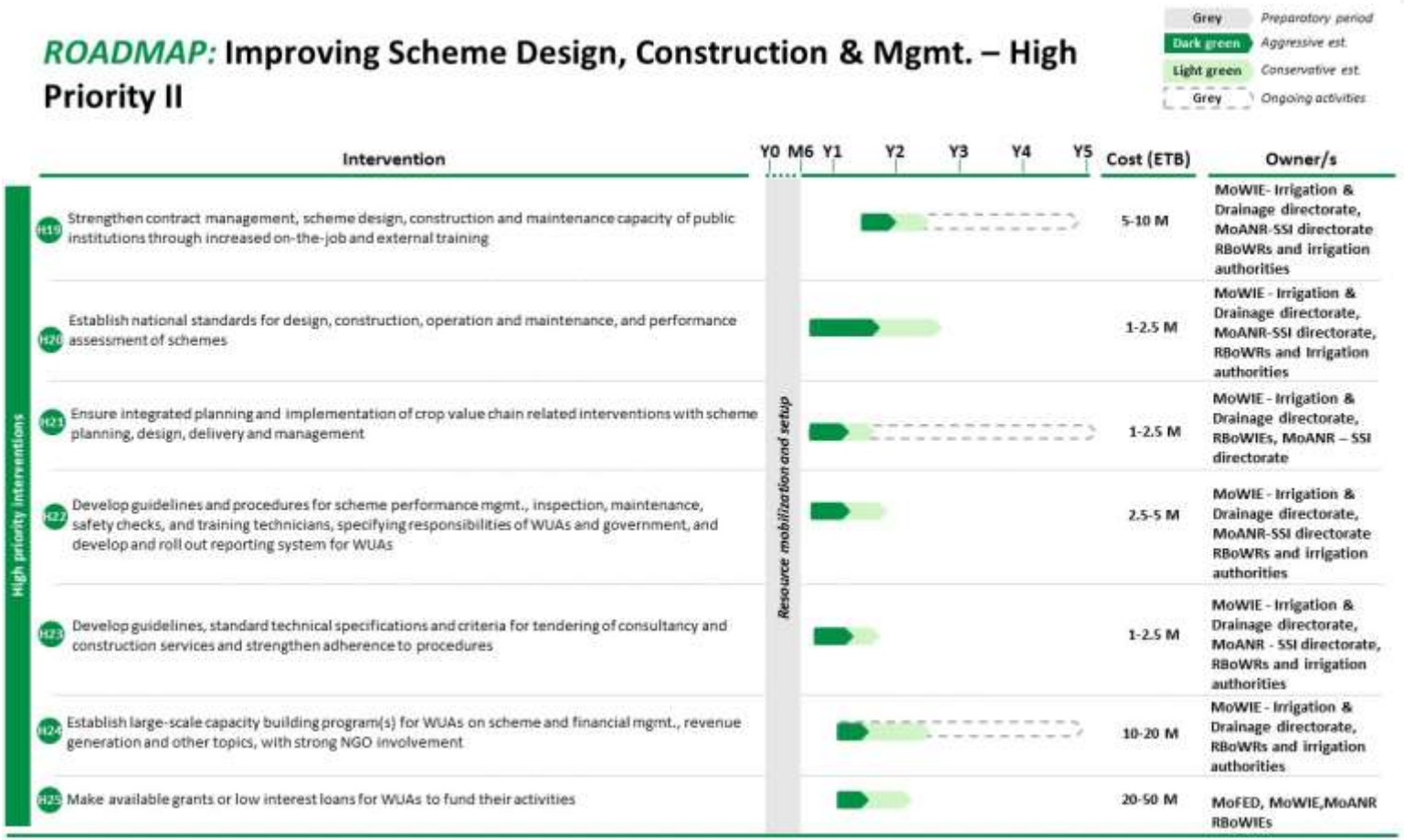

Figure39: Roadmap – High Priority Interventions III

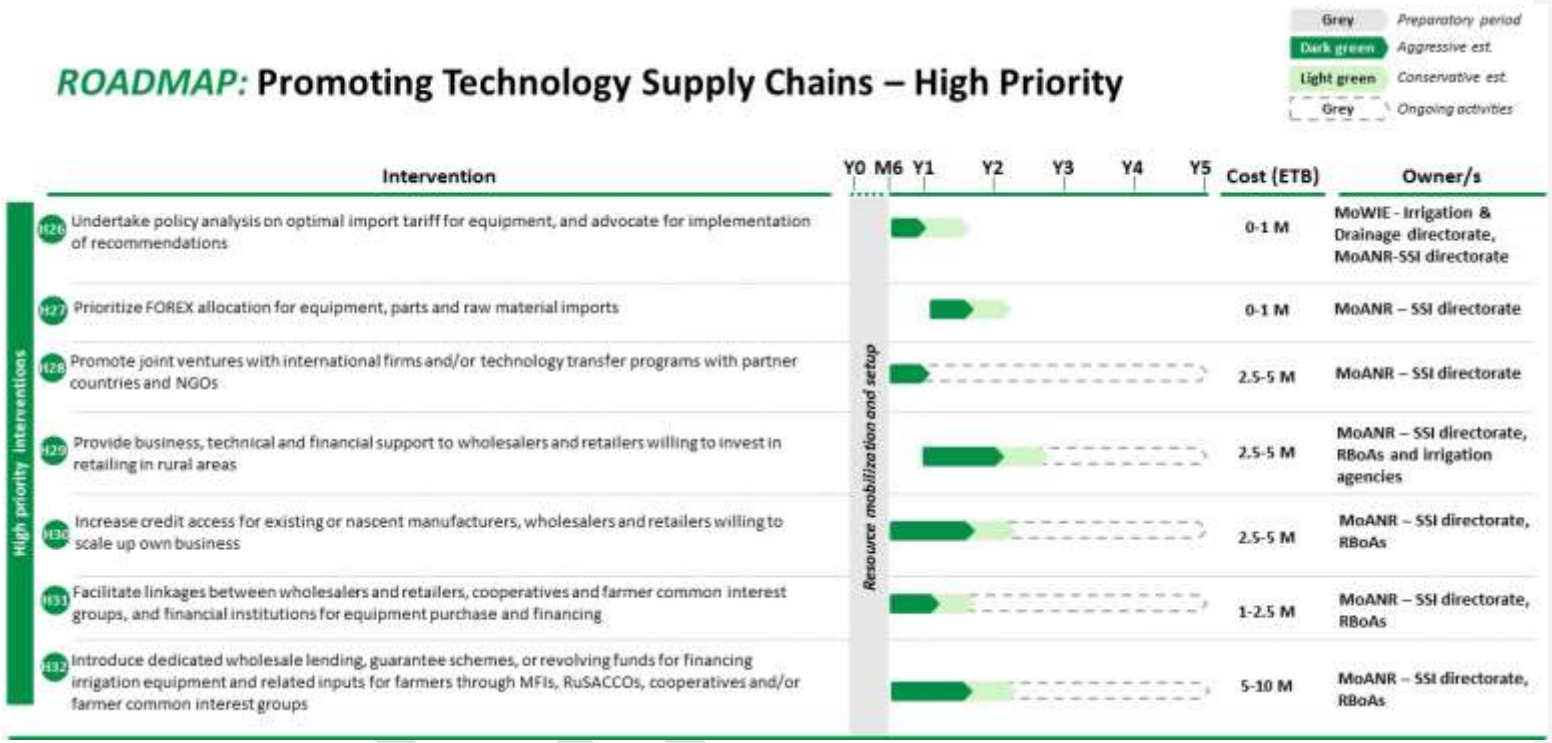

Figure40: Roadmap – High Priority Interventions IV

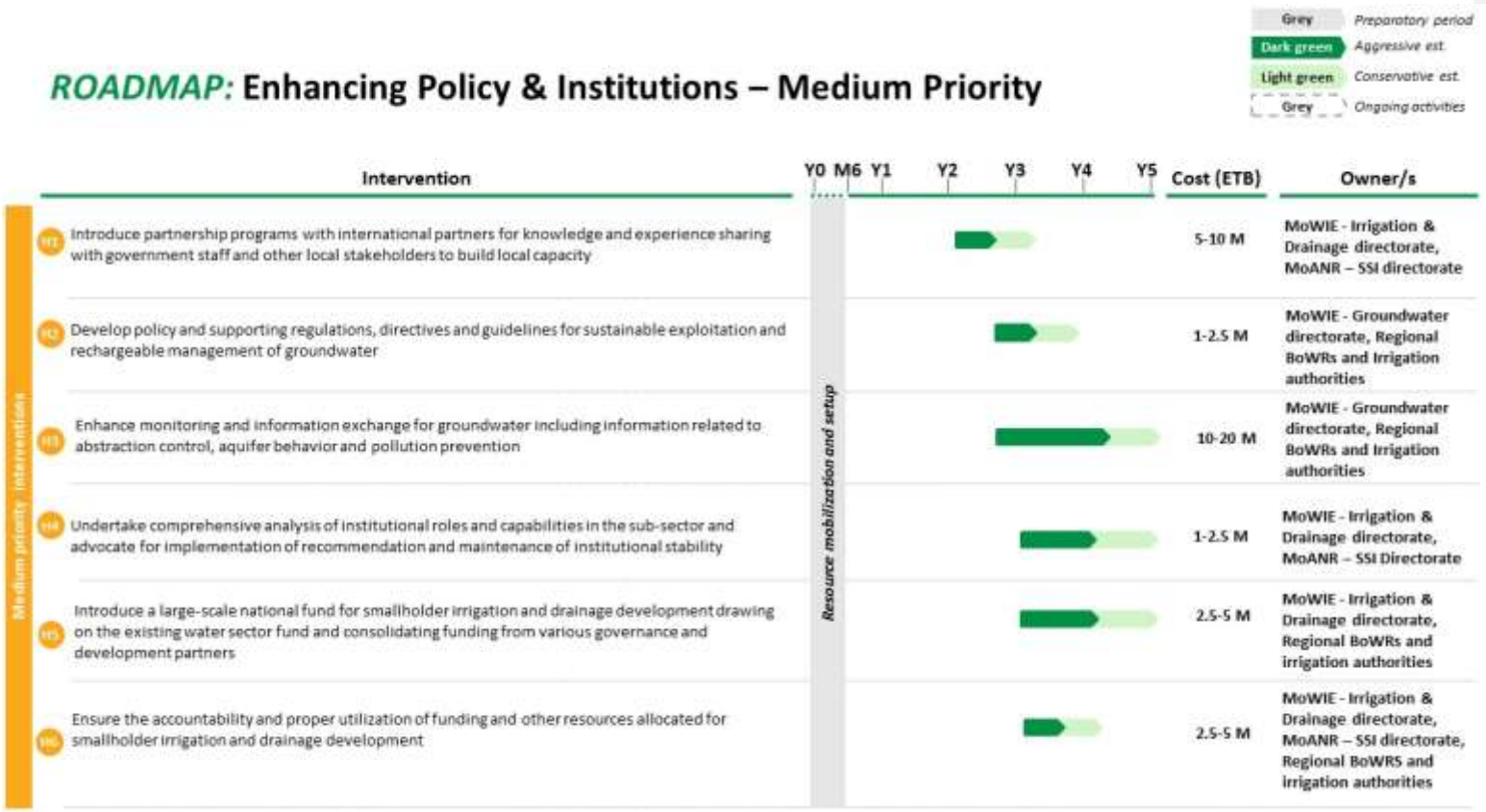

Figure41: Roadmap – Medium Priority Interventions I

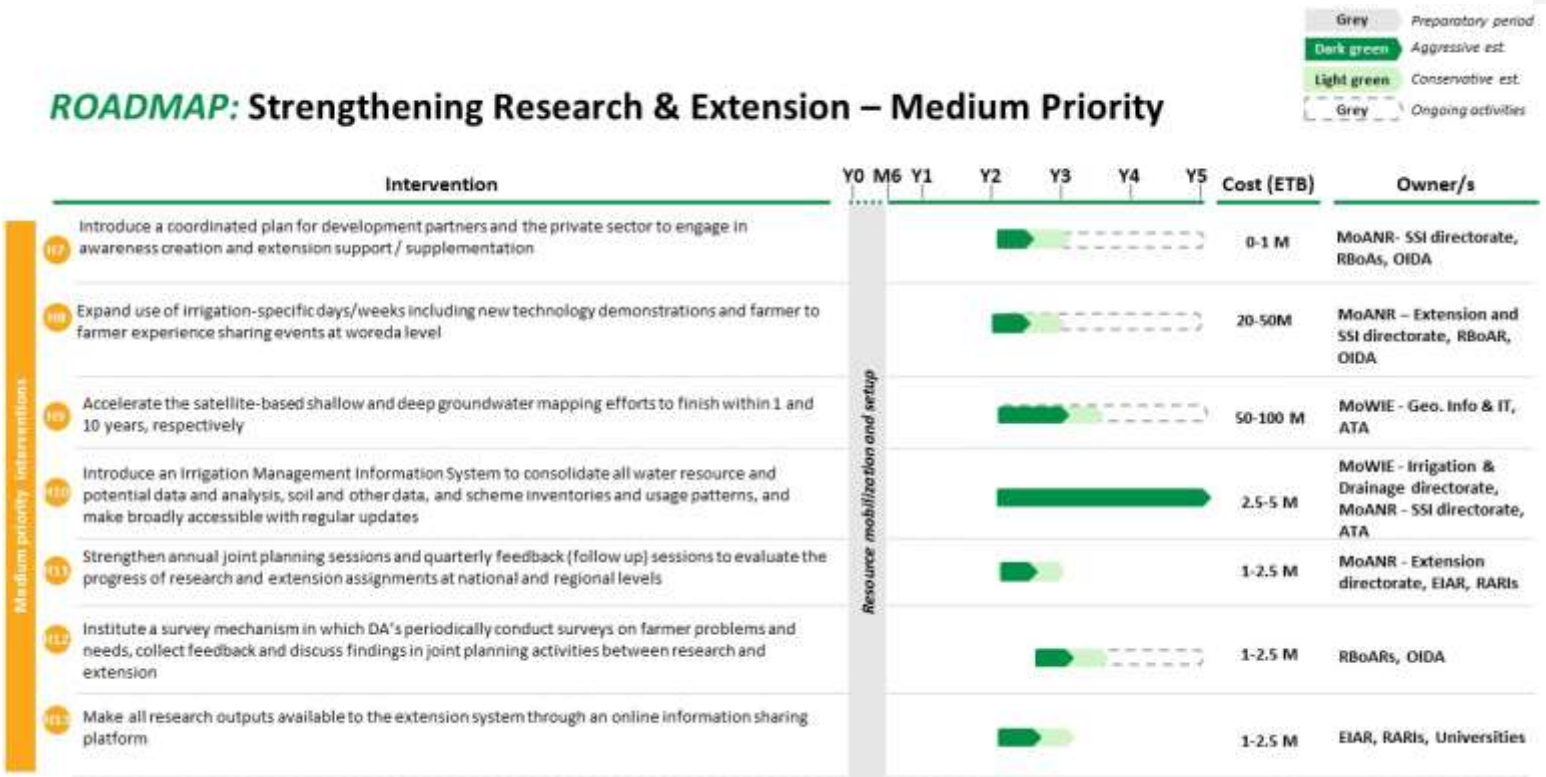

Figure42: Roadmap – Medium Priority Interventions II

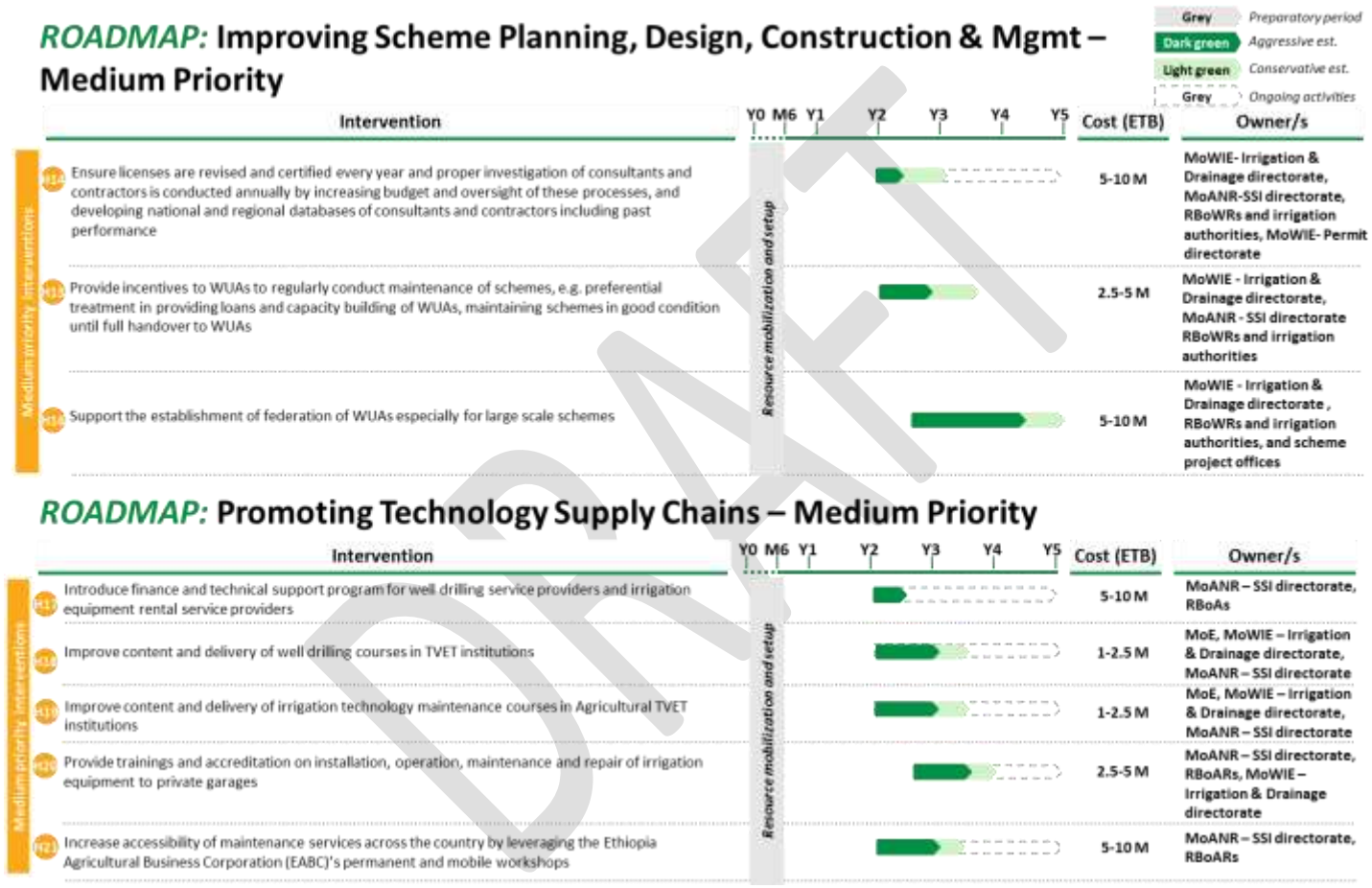

Figure 43: Roadmap – Medium Priority Interventions III

5.3. Implementation governance and management

Commented [s14]: This section updated to reflect AtoSolmon's comments

This strategy involves a wide range of interventions and owners across the four implementation focus areas as presented in the previous section. Moreover, many of the interventions are cross-sectoral in nature, requiring close involvement and coordination of stakeholders from the water and agricultural sectors as well as other sectors. Effective implementation will therefore require clear governance and management arrangements at national and regional levels. Figure 44 depicts the governance and management structure agreed for this strategy including a Steering Committee, Secretariat and Technical Committee at national level, and the same structure at regional level. The purpose, members and meeting frequency for each of these is described below along with the working relationship between them. Formal Terms of Reference for each will be developed and agreed by the respective members once they are formally established.

Figure 44: Structure for governance and management of implementation

The ***National Steering Committee*** will ensure strong coordination and alignment across key federal and regional government stakeholders, development partners and the private sector, oversee implementation of strategy, review progress against interventions and address blocking issues that need to be addressed at a national level. The Committee will be co-chaired by the State Minister of Natural Resources Management from the Ministry of Agriculture and Natural Resources (MoANR) and the State Minister of Irrigation and Drainage from the Ministry of Water, Irrigation and Electricity (MoWIE). Members include representatives from the Small scale Irrigation, Natural Resources Management and Extension directorates at MoANR, representatives from the Irrigation and Drainage, Basin and Groundwater Management directorates at MoWIE, Regional Bureaus of Agriculture, Regional Bureaus of Water Resources, Irrigation Authorities, a representative of the development partner community, and a representative of the private sector. Meetings will be held quarterly or more frequently as needed.

The National Steering Committee will be supported by a **National Secretariat** which will act as day-to-day program management office to support implementation of strategy, provide administrative support to the National Steering Committee, support implementers to plan and budget interventions, rigorously track and report on implementation, and raise issues to the National Steering Committee for resolution. The Secretariat will be housed in the Small scale Irrigation Directorate at MoANR, working very closely with the other directorates at MoANR and MoWIE through regular coordination and troubleshooting meetings. The Secretariat will also be supported on technical issues as needed by a **National Technical**

Committee with technical experts coming from federal government bodies, development partners and private sector organizations.

A **Regional Steering Committee** will also be established in each region to ensure strong coordination and alignment across key stakeholders at regional level, guide and oversee implementation of interventions in the region, review progress against interventions and report on this to the regional leadership as well as to the National Steering Committee through the Secretariat, and address blocking issues or escalate these to the national level where required. The Regional Steering Committee will be co-chaired by appropriate representatives from the Bureau of Agriculture and Bureau of Water Resources or Irrigation Authority, and include other relevant representatives from these bureaus as well as major development partners, as relevant for each region. It will meet quarterly or more frequently as required, and be supported in each region by a **Regional Secretariat** providing day-to-day implementation management and administrative support as at the national level. The placement and staffing of each **Regional Secretariat** among regional bodies in the agriculture and water sectors will be determined by each regional government. The Secretariat will work closely with other regional bodies involved through regular coordination and troubleshooting meetings. A **Regional Technical Committee** with relevant technical experts from these organizations will also be identified to support the Regional Secretariat on technical issues when required.

5.4. Monitoring, learning and evaluation

To ensure progress against the overall vision and strategic objectives of this strategy through the proposed interventions, a robust monitoring, learning and evaluation (MLE) framework should be put in place and well-integrated with ongoing strategic planning, governance and management decision-making across the wide range of intervention owners and implementers involved. At an impact level, implementation of this strategy is expected to contribute to agriculture sector-wide targets related to agricultural production and productivity, farmer incomes and commercialization, food security, and resilience to climate variability and change. Specific outcome and output indicators with required disaggregation and corresponding interventions are presented below. An important first step towards implementation will be for the Secretariat to coordinate establishment of baselines and targets with specific intervention owners and have these agreed at regional and national levels.

Outcomes

	Indicator	Disaggregation
1	Number of Policies, Strategies, Regulations, Guidelines, Studies and Standards developed/amended, ratified and implemented	• By type of policy document • By policy development stage
2	Number of new institutions established (including basin authorities and water user associations) to facilitate effective implementation of the above Policies, Strategies, Regulations, Guidelines and Standards	• By type of institution • By administrative level
3	Number of Government institutions, water user associations (WUAs), Community based organizations, private enterprises and civil societies receiving training, technical assistance and other capacity building support (mainly focusing on irrigation mainstreaming, identification of roles and responsibilities and coordination or joint planning)	• By type of institution • By area/focus of capacity • By location, etc.
4	Number of smallholder farmers applying new irrigation and/or drainage technologies and farm water management practices (including other climate smart technologies)	• By type of technology • By region, crop, etc. • By sex

5	Percentage increase in yield per hectare of land for selected and targeted high value crops	• By region, crop, etc. • By sex
6	Value of agricultural loans disbursed to irrigation equipment producers or distributers (including spare-parts), small holder farmers, WUAs, cooperatives and unions for specific purpose of financing irrigation inputs	• By type of loan received • By region, crop, etc. • By sex

Outputs

Commented [s15]: Table updated to align with updating numbering in previous graphics

Indicator		Disaggregation	Related interventions
1	Number of new irrigation technologies (including other climate smart technologies and female-friendly technologies) designed, tested and disseminated to smallholder farmers	• By type of technology, including climate smart or female-friendly	• H6, H7, H10,H15, H28 • M7, M8, M13
2	Number of individuals receiving short term trainings or participating in demonstration field days or experience sharing visits	• By training, field days, or experience sharing visit • By type of technology or training, region, etc. • By sex	• H12, H15, H16, H18, H19, H20, H29 • M1, M7, M8, M17, M20
3	Number of ICT based support services established and operationalized	• By type of ICT based support service	• H3, H13, H14, • M3, M9, M10, M13
4	Percentage increase in number of irrigation equipment maintenance service providers	• By type of service provider	• H30 • M17, M18, M19, M20
5	Number of multi-stakeholder/ information sharing platforms and joint planning forums established and operationalized	• By type of platform / forum • By administrative level, etc.	• H2, H17, H28, H31 • M3, M11
6	Percentage increase in amount of national and regional funds allocated for irrigation development (including support services like irrigation research centers)	• By administrative level • By scheme size / command area • By area funded	• H27, H32 • M5, M6
7	Proportion of well-functioning schemes (including schemes with good performance, timely maintenance and appropriate cost recovery system implemented)	• By level of performance, • By level of maintenance • By level of cost recovery • By administrative level	• H5, H22 • M15
8	Number of joint venture and/or technology transfer programs established and operationalized with partner countries, private firms and NGOs	• By type of partner • By type of program, etc.	• H24, H28 • M7

6. DETAILED DISCUSSIONOF PRIORITIZED BOTTLENECKS AND INTERVENTIONS

Commented [s16]: Recent TC feedback to be integrated into this section before distributing to workshop participants.

Environment and gender mainstreaming content to be populated before distributing to workshop participants.

6.1. Policy and institutions

6.1.1 Bottlenecks with high priority interventions

***BOTTLENECK 1*:Insufficient adherence to the national WRM and irrigation policies and strategies, master plans, basin and watershed based management approaches**

Priority: High

Description: The national water sector policy (2001) mandates adherence to Integrated River Basin Management (IRBM) approach by all levels of government. This approach entails coordinating development, management and conservation of water resources and other related resources within a given river basin or hydrological boundary of the basin in order to maximize the economic and social benefits from water resources in an equitable manner[19]. The implementation of IRBM requires effective cross-sectoral stakeholder coordination and strong commitment from the government. In this respect, the GoE has set-up different institutions including river basin authorities and the basin directorate under the MoWIE that are responsible for coordinating and supporting the activities of basin authorities. Developing integrated basin master plans is also a major initiative to be implemented under IRBM, in addition to setting up institutions.

Though policy framework and institutional set-up exist to implement basin management, the level of adherence by various government authorities has been weak. Successful adherence of basin management has nine main requirements related to effective development of basins, equitable and sustainable water use and related natural resources, and effective monitoring, supervision and data collection. Relevant regional government authorities were asked to list down their achievements in terms of adhering to the main requirements. The following table presents a summarized view of the responses by the regions:

Requirements	Effectiveness
River basin based scheme development	Low
Joint planning and execution by regions	Low
Effective water use for different purposes	Low
Address potential downstream up-stream user issues	Medium
Sustainable recharge of water	Low
Maintenance of water quality	Low
Sustainable impact on ecosystem	Low
Early identification and resolution of issues	Low
Ongoing data collection on river basin	Low

Figure45: Summary of regions response on the adherence of basin management approach

On most of the requirements, the regions responded that there is low level of adherence to basin management approach. This is due to the following reasons:

[19]WWF (world wildlife fund)

1. Regional development plans are not aligned with the national master plan. The misalignment is due to the following four main reasons:
    - Master plans for most basins are outdated. For basins which have updated their master plan, revised information is not shared with respective regions.
    - Master plan assumptions (e.g. gravity based irrigation only) are out of date or contradict information mentioned in local studies.
    - Existing feasibility assessment and design process do not ensure alignment with master plan requirements.
    - Existing capacity of basin authorities is limited.
2. Basin / sub-basin approach is not followed mainly due to unclear processes and approach, and lack of application tools.

To address the above issues, the following interventions are recommended.

INTERVENTION H1:**Establish basin authorities for those which do not currently have one and strengthen the existing basin authorities**

Priority: High

Objectives/Description: Basin authorities are set-up to coordinate the plans and activities of stakeholders in an integrated way. As of now, just three out of twelve basin authorities have been set-up, indicating the need for more basin authorities to be set-up. Since there is already an on-going effort by the basin directorate to set-up new four basin authorities, the above intervention focuses on accelerating this effort and equipping the new basin authorities with technical capacity and human resource. Furthermore, existing basin authorities have significant capacity gaps and require considerable strengthening in this respect.

The key activities under this intervention are conducting familiarization workshop for the member regions and stakeholders where the new basin authorities are to be established, developing organizational structure of new basin authorities, identifying capacity gaps of basin authorities and providing capacity building programs accordingly, reinforcing involvement of regions in governance of basin authorities, strengthening intra-region basin management (e.g. command post approach in Tigray) and enhancing the involvement of national basin council through regular meetings.

Environment and gender mainstreaming: To be updated

Owners and involved parties: MoWIE-basin directorate/ Basin council, relevant regional government stakeholders

Costs: 10-50 M(major cost items:Building infrastructure, conducting familiarization workshops, capacity building of staff, and payment of salaries)

Timeline: 12-18 months

INTERVENTION H2:**Mainstream watershed management including soil and water conservation into basin management**

Priority: High

Objectives/Description: Watershed management is not given due focus despite its enormous impact on the sustainability and continuity of the river basin. Even if some stakeholders are implementing

watershed management, it is not happening in an integrated way to ensure its effectiveness. Hence, an overall integrated approach to mainstream watershed management by the basin authorities is required.

The main activities under this intervention are involving MoANR-NRM department in the planning and overall operation as members of the basin authority, mainstreaming soil and water conservation targets into basin development planning and expanding watershed management units up to woreda/kebele level through strengthening engagement of NRM staff in the Woreda Office of Agriculture and NRM Development Agents at kebele level.

Environment and gender mainstreaming: To be updated

Owners and involved parties: MoWIE-NRM directorate, regional NRM directorate/ Ministry of Environment and Forestry, Basin authorities and MoWIE-Basin directorate

Costs: <1 M (The major cost item: training of basin authority staff)

Timeline: 6-12 months

INTERVENTION H3:**Conduct regular update of basin master plans and ensure accessibility through different platforms**

Priority: High

Objectives/Description: Master plans are guiding tools of achieving integrated and sustainable development within the hydrological boundaries of a river basin. Since they serve as the main guiding document for development plans, master plans need to be updated continually to reflect on the changing context within the basin area. Due to lack of capacity of basin authorities and directorate to undertake this complex task, existing plans have stayed outdated. In addition, the current plans are not easily accessible even by relevant government institutions. To resolve the above issues, the basin directorate needs to ensure regular update of master plans and make these plans more accessible through different platforms.

The main activities under this intervention are assigning budget to update basin master plan and agree on cost-sharing with regions for this purpose, and disseminating updated plans (i.e. hardcopies to relevant bureau and upload completed master plans into MoWIE and basin authority websites).

Environment and gender mainstreaming: To be updated

Owner and involved parties: MoWIE-basin directorate, Basin authorities/ Regional BoWRs and irrigation authorities

Costs: 10-50 M (The major cost items: periodic assessmentsto update in the master plan, printing and publishing costs)

Timeline: 12-24 months and ongoing

BOTTLENECK 2:**Limited implementation of policy and regulatory framework on water user associations (WUA), water rights and fees, land related issues and cost-recovery**

Priority: High

Description: In 2001, Ethiopia formulated its main policy document on the water sector called the Ethiopian Water Sector Policy. This policy aims to enhance and promote all national effort towards the efficient, equitable and optimum utilization of the available water resources of Ethiopia for significant

socioeconomic development on sustainable basis[20]. A supporting strategy document called Ethiopian Water Sector Strategy has a similar goal.

The irrigation sub-sector is one of main components in these policies and they include recommendations for sustainable exploitation of agricultural production potential of the country without degrading the fertility and productivity of country's land and water resources base[21]. To implement the aforementioned objective, significant emphasis is given on development and implementation of policy and regulatory framework. At present, there are gaps related to development of robust policies and regulatory frameworks and implementation of the same.
The following table describes the main elements and sub-elements of a robust water use policy and regulatory framework.

Initial Cost Recovery	• Equitable cost recovery payments considering benefits and costs • Transfer of irrigation schemes to WUAs • Operation and maintenance practice
Water User Associations	• Formation of WUAs • Mandate, roles and responsibilities • Compulsory membership of water users • Required capabilities
Water Rights	• Land demarcation • Water use scheduling • Upstream-downstream user issues and rights
Water Fees	• Fee types and amounts (Area based or volumetric) • Equitable approach to water fee collection • Water use measurement approach
Land issues	• Land resettlement issues • Consolidation and redistribution of land in command area • Right of way issues

Figure46: Main elements and sub-elements of policy framework

Regional water sector polices including WUA proclamations were compared against the main elements mentioned above. The following table summarizes the overall leverage of coverage of the policy element in federal and regional policies; the percentage reported in the regional represents the share of regions that cover the respective policy element at all within the regional policy framework.

Policy element	Federal Policy	Regional Policies
Cost Recovery	✓	✓50%
WUA	✓	✓90%
Water Rights	✓	✓90%
Water Fees	✓	✓90%
Land issue	✓	✓90%

[20]Ethiopian Water Resource Management Policy
[21]Ethiopia Water Sector Strategy

Figure47: Main policy elements and coverage in federal and regional policies

Most of the regions have covered the main policy elements except the initial cost recovery in their policy framework. They have also endorsed or are in the process of endorsing or drafting WUA proclamations covering all the main elements. However, these proclamations are recently introduced and, hence, there is limited enforcement. In addition, for some of the elements (e.g. land issues) that are covered by previous policies, there is limited implementation. Overall, the following factors are the main impediments for successful enforcement of the policies:

- Despite inclusion of cost recovery in federal and regional proclamations, it is not being practiced in existing schemes, limiting the financial capacity to develop new schemes
- No standard approach to determine water fees, and irregular payment of water fees
- Frequent resettlement and land redistribution issues
- Frequent conflicts between upstream and downstream users, hindering the performance of schemes and benefits to farmers

To solve the above issues, interventions should focus on strengthening the policy framework and enhancing the implementation capacity of stakeholders. Keeping this in mind, the following interventions are recommended.

INTERVENTION H4: **Formulate and endorse WUA regulation and supporting guidelines and procedures at regional level including for water rights and fees, compensation for land taken for irrigation development, and cost recovery**

Commented [s17]: Wording to be updated to align with TADs

Priority: High

Objectives/Description: After the federal WUA proclamation came into force, some regions have followed suit in endorsing their own WUA proclamation. However, the implementation of WUA proclamation requires the endorsement of the regulation at regional level. In addition to endorsement of WUA regulation, robust institutional capacity needs to be developed to effectively implement the regulation.

The main activities under this intervention are formulating WUA regulation covering water use efficiency and quality regulation, creating awareness among WUAs, developing and promoting standard WUA by-law, promoting WUA in existing schemes (e.g. converting irrigation cooperatives into WUAs) and ensuring organization of WUAs in new schemes.

Environment and gender mainstreaming: To be updated

Owners and involved parties: Regional BoWRs and irrigation authorities/ MoWIE-Irrigation and drainage directorate, WUA

Costs: 5-10 M (major cost items:Formalising WUAs, training of members)

Timeline: 6-12 months and ongoing

INTERVENTION H5: **Develop and implement phased approach and plan to introduce water fees and cost recovery in all (publicly funded) schemes**

Priority: Medium

Objectives/Description: Irrigation infrastructure requires very large financial investment, which necessitates a mechanism of ensuring sustainable pool of fund in this sector. Moreover, since the major share of investment is from public sector, there has to be a cost recovery mechanism for the public sector to regain the initial investment made. Currently, most of the regions are not implementing cost recovery in their respective schemes though this may change in few years since the recent WUA proclamations state the need to implement cost recovery, especially during irrigation transfer.

The key activitiesto implement successful cost recovery are developing guidelines to implement appropriate cost recovery, creating awareness on cost recovery among WUAs and phasing in cost recovery across all schemes as per the guideline.

Environment and gender mainstreaming: To be updated

Owners and involved parties: MoWIE-Irrigation and Drainage Directorate, Regional BoWRs and irrigation authorities/ WUAs

Costs: 5-10 M (major cost items: Organising awareness creation programs for WUAs)

Timeline: 24-36 months

***BOTTLENECK 3*: Limited equipment quality standards or enforcement, and disincentives for high quality local manufacturing**

Priority: High

Description: Establishing and enforcing quality standards for irrigation equipment including all sized pumps, drip irrigation systems, sprinklers and polyethylene pipes, is critical to ensure low quality equipment is not available on the market which has in the past led to reduced uptake by farmers. In addition, standards can reduce the risks and challenges faced by government agencies and private importers in ensuring procurement of effective equipment[22].

In line with this, a mandatory national standard for pumps was established through adapting international standards based on input from stakeholders. However, despite the introduction of the national pump standards, lower quality pumps are still sometimes being sold in the market due to the following three main reasons:

- Large quantities of pumps, more than 1.2 million from 2005-2013, were imported before the introduction of standards and may still be marketed or resold. In addition, poor quality pumps are still sometimes being imported through illegally.
- There is no laboratory capable of testing pumps and other technologies domestically, and importers reports that they are not always required to show quality certifications before importing or clearing imports with customs. On the first issue, the SMIS projects is currently supporting ECAE to be able to test pump quality against national standards, by fulfilling the equipment requirement and providing training to staff on testing of pumps.
- There is no clearly mandated institution for inspection of quality for locally manufactured irrigation equipment.

In addition, there are no established standards for other major irrigation equipment such as drip kits, sprinklers and pipes. As demand for these technologies is steadily increasing, as are imports by private importers and government, establishing national standards has been identified as a priority.

Even where standards are not in place or fully enforced, various incentives are already in place to incentive local manufacturing of quality equipment. For instance, according to the amended investment law the manufacturing sector is provided with multiple incentives including tax holidays and free access

[22]HHI value chain strategy (2013)

to land. At the same time various stakeholders have raised the challenge that manufacturing of high quality equipment is not incentivized or inadvertently disincentivizedby lack of local laboratories that can test and certify locally manufactured equipment, as well as weaknesses in specification and evaluation of technical and other requirements in public procurement processes.

INTERVENTION H6:**Establish national standards for irrigation equipment including drip kits, sprinklers and polyethylene pipes, similar to pumps**

Priority: High

Objectives/Description: The enforcement of pump standards has faced many challenges at its initial stage. However, it is expected to be an indispensable document during procurement of pumps if it is properly applied and enforced. By the same token establishing standards, either mandatory or voluntary, on other major irrigation equipment is expected to have the same impact in the procurement process and assisting Smallholder farmers differentiate quality products.

The main activities under this intervention are designing and implementing national standards for priority irrigation equipment, building capabilities to test equipment, developing a system for enforcing standards and creating awareness on the standards to relevant government institutions and the private sector.

Environment and gender mainstreaming: To be updated

Owner and involved parties: ESA and ECAE are the owner of this intervention. Other agencies involved in the implementation include MoT, producers and importers.

Cost: <1 M (The major cost item: Training of staff to undertake equipment testing)

Timeline: 12-18 months

INTERVENTION H7:**Enforce national standards through incentivizing investment in laboratories, building capacity of existing labs and of MoT and ECAE for enforcement**

Priority: High

Objectives/Description: Enforcement of national pump standard should be given high priority considering the impact it has on the sector. The initiatives to strengthen the ECAE testing lab need to be accelerated. In addition strong advocacy needs to happen among relevant regional stakeholders to enhance the enforcement of pump standard.

The major activity under this intervention are developing an investment pitch document of quality testing facilities and providing necessary incentives to entice investment, building capacity of existing labs and accrediting private labs to conduct independent review and conducting awareness creation with relevant parties (e.g. MoT, commercial banks).

Environment and gender mainstreaming: To be updated

Owner and involved parties: Owners of this intervention are ESA and ECAE. SMIS, MoT, commercial banks, pump manufacturers and ERCA are also involved in the implementation.

Cost: 1-5 M (Major cost items: Training ECAE on testing of pumps)
Timeline: 6-18 months and ongoing

INTERVENTION H8:**Introduce guidelines, standard technical specifications and criteria for public irrigation equipment procurement**

Priority: High

Objectives/Description: The major gap with the current procurement procedure is the lack of consideration for factors such as installation services, technology awareness building, pre-sale and after sales service and limited capacity in conducting robust technical investigation. Accordingly, this intervention is focused in solving this gap by developing a comprehensive procurement guideline in line with the government's procurement policy. In addition the guideline needs to take into account the national pump standards.

This intervention has three major activities. The first one is updating the current procurement process based on learnings of successful procurement processes adding additional considerations such as installation, awareness building, and pre-sale and after sale service). The second activity is ensuring procurement of spare parts in standard government packages. The third activity is building capacity of pump purchasing agencies on bid analysis and technical investigation of pumps.

Environment and gender mainstreaming: To be updated

Owner and involved parties: Major owners of this intervention are RBoAs, Regional BoWRs and irrigation authorities. The public procurement agency is also involved in the implementation.

Cost: <1 M (Major cost items: Study conducted to develop standard procurement procedures, training of pump purchasing agencies)
Timeline: 6-12 months

***BOTTLENECK 4*: Insufficient skilled human resources and high turnover in public institutions**

Priority: High

Description: Many public agencies face significant human resources shortfall. As can be seen from the table below many government agencies, such as WWCES, government bureaus, universities, etc., either have few experienced staff or are facing high turnover rates each year.

Human resource status in government agencies working in irrigation[1]

Agency	Unfilled roles	Insufficient headcount	Staff with >3 years experience	Turnover rate per year
Tigray BoWR	3%	20%	5%	22%
Oromia WWDSE	>25%	>25%	<25%	>25%
Gambella BoWR	n/a	n/a	<25%	>25%
Diredawa BoWR	>25%	>25%	<25%	>25%
SNNP irrigation development agency	64%	25%	n/a	27%
Amhara BoWR	20%	50%	10-15%	10-30%
Amhara BoA	0%	15%	20%	35%
Beninshangul BoA-irrigation team	<25%	>25%	<25%	>25%
Average	**26%**	**28%**	**13%**	**28%**

Figure 48: Human resource status in government agencies working in irrigation

Many stakeholders mention the following factors for making the sector unattractive to work on:

- Low compensation rates in public agencies make retention of experienced staff difficult
- Job opportunities in irrigation are limited. This is due to the large funding gap in the sector and job opportunities being limited to the public sector.
- Undergraduate and graduate programs in irrigation are few and quality of programs needs improvement. Most of the university programs need to be improved by giving greater focus to basic technical skills and scheme management
- Many irrigation engineers go to other fields after graduation

All of the activities and interventions in the sector are not going to be successful if there is no strong human resource base in the implementing government agencies.

INTERVENTION H9: **Strengthen university curriculums and research on irrigation engineering and management, water management and drainage, irrigation technologies and irrigation agriculture**

Priority: High

Objectives/Description: To enhance the quality of graduates, university programs specialized in irrigation should be strengthened. The current programs are focusing more on the engineering aspect of irrigation and less on the agronomic aspects. Moreover, programs combining both engineering and agronomic aspects of irrigation are not available in Ethiopian universities. Most of these programs also do not consider water management and drainage issues.

Research conducted in universities should also be given sufficient focus. This can be done by increasing the budget allocated for research in irrigation and drainage, and the number of researchers in these universities. Research areas should also include farmer problems and extension system priorities.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention will be MoE, MoST and Universities. MoANR and MoWIE are involved parties.

Cost: 1-5M (major cost items: revising curriculum and hiring researchers)
Timeline: 24-48 Months

6.1.2 Bottlenecks with medium priority interventions

***BOTTLENECK 4*: Insufficient skilled human resources and high turnover in public institutions**

Priority: High

Description: Many public agencies face significant human resources shortfall. As can be seen from the table below many government agencies, such as WWCES, government bureaus, universities, etc., either have few experienced staff or are facing high turnover rates each year.

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Amhara BoWR	20%	50%	10-15%	10-30%
Amhara BoA	0%	15%	20%	35%
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- Undergraduate and graduate programs in irrigation are few and quality of programs needs improvement. Most of the university programs need to be improved by giving greater focus to basic technical skills and scheme management
- Many irrigation engineers go to other fields after graduation

All of the activities and interventions in the sector are not going to be successful if there is no strong human resource base in the implementing government agencies.

INTERVENTION M1: **Introduce partnership programs with international partners for knowledge and experience sharing with government staff and other local stakeholders to build local capacity**

Priority: Medium

Objectives/Description: To enhance the capacity and skill of staff capacity building programs can lay a pivotal role. The capacity building programs need to be regular and customized according to the needs of stakeholders. Furthermore, experience sharing either with local enterprises or foreign is expected to have comparable effect as capacity building program.

The main activities under this intervention are conducting need based capacity building program to major stakeholders in irrigation, promoting linkages among local water works enterprises and irrigation technology supply chain actors and encouraging partnerships and cooperation with foreign governments and organizations in scheme development.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owner of this intervention is MoWIE-Irrigation and Drainage Directorate and MoANR - SSID. Other public and private institutions working on irrigation are also involved.

Cost: 1-5 M (Major cost item: Conducting experience sharing events)

Timeline: 6-12 months

***BOTTLENECK 5*:** **Lack of policy and regulatory framework for groundwater usage and drilling**

Priority: Medium

Description: Various studies state that Ethiopia is endowed with significant groundwater resources. However, the use of this resource at a national level is very limited. While different factors can be attributed to the limited utilization of groundwater, lack of policy and regulatory framework for use of groundwater resources is certainly one of the main contributing factors.

Lack of policy is evident by limited coverage of groundwater related content in the major policy documents including the water sector policy. Poor regulatory framework has also led to unregulated use of groundwater resources, endangering its sustainability. Hence, a strong policy and legal framework is required to mitigate this issue.

A strong groundwater policy should look into developing groundwater resources while ensuring their sustainability. Best case experiences demonstrate that achieving the above objective requires four main elements - groundwater information, standards and guidelines, well drilling and sustainable groundwater use. The following figure describes the main elements and sub-elements of groundwater policy:

Groundwater information	• Lithological productivity • Topographic setting • Groundwater quality
Standards & guidelines	• Exploration of groundwater • Development of groundwater • Management of groundwater
Well drilling	• Drilling permits and licensing • Pumping permits (well spacing, discharge, depth, power) • Monitoring of drilling and pumping permits
Sustainable ground water use	• Integrating groundwater development with land use planning • Recharging groundwater • Controlling groundwater pollution • Using groundwater effectively

Figure 50: Main elements and sub-elements of groundwater policy

To identify the existing gaps in policy framework, relevant regional and federal institutions were asked about the level of coverage of the above main elements in their respective government policies. The following table illustrates the summary of response received from the regions.

Policy element	Federal Policy	Regional Policies
Groundwater information	✓	n/a
Standards & guidelines	✓	✓
Well drilling	✓	✓
Sustainable ground water use	✓	✗

✓ Content fully included ✗ Content not included ✓ Content partially included

Figure 51: Coverage of groundwater policy elements in federal and regional policies

The above analysis clearly shows the limited coverage of major policy items in federal and regional policies. This has resulted in the following challenges:

- High resolution groundwater mapping done only for 13% of the country at scale of 1:50,000. GSE developed 78% groundwater mapping with scale of 1:250,000 which can only be used at regional level not at a woreda/kebele level
- Lack of comprehensive groundwater map the main reason for large number of well failure
- National standard and/or guideline to regulate the use of groundwater resources is non-existent
- Guidelines for well drilling permit are either not known or not being followed properly.

Solving the afore-mentioned problems would require the following interventions to happen:

***INTERVENTION M2:*Develop policy and supporting regulations, directives and guidelines for sustainable exploitation and rechargeable management of groundwater**

Priority: Medium

Objectives/Description: As mentioned above, development of groundwater requires a separate policy framework encompassing the concept of sustainable exploitation. This document needs to be based upon previous policies, including water policy. This policy document will also serve as important reference for other technical guidelines on the utilization of groundwater.

This intervention has two main activities: Developing groundwater use national standards and guidelines at sub-basin, basin and national level and endorsing legal enforcement mechanism including fines for non-abiding users.

Environment and gender mainstreaming: To be updated

Owners and involved parties: MoWIE-groundwater directorate, regional BoWRs and irrigation authorities/ Basin authorities, Ethiopian Geological Surveyand private and public well drillers.

Cost: <1 M (major cost items: Study conducted to analyse previous groundwater policy and development of revised policy framework)

Timeline: 6-12 months

***INTERVENTION M3:*Enhance monitoring and information exchange for groundwater including information related to abstraction control, aquifer behavior and pollution prevention**

Priority: Medium

Objectives/Description: The availability of updated data related to groundwater such as amount of abstraction, aquifer behaviour and pollution control is crucial for the enforcement of legal framework on groundwater utilization. Up-to-date data can be collected by regular monitoring of groundwater resources and their utilization. In addition, effective information exchange will reinforce monitoring of groundwater resources.The implementation of this intervention is expected to result in a monitoring and follow-up system to monitor ground water resource development.

To implement the intervention there are two key activities: Creating/Re-initiating web based platform where data can be stored timely and, agreeing on institutional responsibilities for maintenance and allocating budget for regular monitoring of web-based platform.

Environment and gender mainstreaming: To be updated

Owners and involved parties: MoWIE-groundwater directorate, regional BoWRs and irrigation authorities/ Basin authorities, Ethiopian Geological Survey and private and public well drillers.

Costs: 10-50 M (major cost items: design and development of ICT based platform, training of officials on operation and maintenance)

Timeline: 24-36 months and ongoing

***BOTTLENECK 6*: Weak federal and regional institutional arrangements for coordination, planning, implementation and management of irrigation and drainage related initiatives**

Priority: Medium

Description: In most of the regional governments (such as Amhara, Tigray and Beninshangul) and in the federal government, the responsibility of scheme development is shared depending on the scale of irrigation project. However, the institutional arrangement for irrigation is different at federal and

regional level. Large scale scheme, greater than 3000 ha of command area, and/or medium scale scheme, greater than 200 ha command area, development is under the federal or regional bureaus of water, irrigation and electricity. The responsibility of small scale, less than 200 ha of command area, usually falls under the bureau of agriculture or ministry of agriculture. The bureaus of agriculture are also responsible for providing extension support in irrigated agriculture. On the other hand, regions such as Oromia, SNNP and Somali have established their own regional irrigation agencies. Though the mandate of these agencies is different, they are entirely responsible for irrigation and scheme development.

To further understand this issue stakeholders were asked on institutional responsibilities across four major activities in scheme development. These are awareness creation and promotion of irrigation, scheme prioritization and planning including budgeting, scheme design and construction and scheme management, operation and maintenance. The following three figures present the summary of institutional responsibilities at federal, regional and zone/woreda offices respectively.

Major activities	Responsible Parties			Weaknesses in institutional arrangements
	Federal	Regional	Zone/Woreda	
Awareness creation and promotion of irrigation	• MoANR • MoWIE	• BoANR • BoWR	• ZoANR • WoANR	• Ineffective coordination between federal and regional bodies in the development of irrigation manuals
Scheme prioritization and planning incl. budgeting	• MoWIE			• Weak coordination between MoWIE and MoANR during prioritization and design
Scheme design and construction	• MoWIE • Design and construction enterprises (Large) • Private consultants, contractors and supervisor (local and international)	• Design and construction enterprises (compete for project)		• Responsibility of developing LSI vs. SSI schemes not clearly delineated between MoWIE and regional BoWR
Scheme management, operation and maintenance	• Basin authorities	• BoWR-Regional Scheme project offices	• WUAs • Irrigation cooperatives	• Basic authorities taking on management role, though outside of mandate and capacity • Responsibilities of government institutions and WUAs not clearly defined in scheme management and maintenance • Coordinating mechanism between BoWIE and BoA on providing technical support to WUAs not clearly defined

Figure52: Institutional arrangement for schemes planned and constructed by Federal agencies

Major activities	Responsible Parties			Weaknesses in institutional arrangements
	Federal	Regional	Zone/Woreda	
Awareness creation and promotion of irrigation	• MoANR	• BoANR	• ZoANR WoANR	• Ineffective coordination between federal and regional bodies in the development of irrigation manuals
Scheme prioritization and planning incl. budgeting		• BoWR, OIDA (Large command area) • BoANR, OIDA (Small command area)		• Week coordination between MoWIE and MoANR during scheme prioritization and study
Scheme design and construction		• BoWR, OIDA (Large) • BoANR, OIDA (Small) • Design and construction enterprises (Large) • Private consultants and contractors (Both)		• Frequent shifting of responsibilities in small scale irrigation schemes leading lack of stable institutional capacity and loss of institutional memory
Scheme management, operation and maintenance		• BoWR, OIDA (Large) • BoANR, OIDA (Small)	• WUA • Irrigation coops	• Responsibilities of government institutions and WUAs not clearly defined in scheme management and maintenance • Coordinating mechanism between BoWIE and BoA on providing technical support to WUAs not clearly defined

Figure53: Institutional arrangement for schemes planned and constructed by Regional agencies

Major activities	Responsible Parties			Weaknesses in institutional arrangements
	Federal	Regional	Zone/Woreda	
Awareness creation and promotion of irrigation	• MoANR	• BoANR	• ZoANR • WoANR	• Ineffective coordination between federal and regional bodies in the development of irrigation manuals
Scheme prioritization and planning incl. budgeting		• BoWR	• ZoWR • WoWR	• Week coordination between MoWIE and MoANR during scheme prioritization and study
Scheme design and construction			• ZoWR • WoWR • Private consultants and contractors	• Lack of technical and financial capacity of Zonal or Woreda Offices of Water Resources to independently design and construct schemes
Scheme management, operation and small maintenance			• ZoWR • WoWR • WUAs • Irrigation coops	• Responsibilities of government institutions and WUAs not clearly defined in scheme management and maintenance • Coordinating mechanism between BoWIE and BoA on providing technical support to WUAs not clearly defined

Figure54: Institutional arrangement for schemes planned and constructed by Zonal or Woreda offices

As can be inferred from the above tables, challenges faced by government agencies differ based on their institutional set-up and the hierarchical powers of government agencies (e.g. Federal MoWIE against Zonal or WoredaBoWR). Nonetheless, the following three challenges can be ascribed to every government institution across all levels.

- Lack of or ineffective coordination between agricultural agencies and water sector agencies and between the federal and regional bodies.
- Frequent shifting of responsibilities at federal and regional level. This is especially true for SSI as their responsibilities shifted multiple times between bureaus of water and agriculture at regional level. Moreover, the shift in responsibilities was not conducted in an effective manner

leading to loss of institutional memory (e.g. organization experience and knowhow) and unclear division of responsibilities after handover.

- Weak institutional capability in terms of human resource, technical and financial capacity. This is especially true at the zonal and woreda level

To address this issue the following intervention is recommended.

INTERVENTION M4: **Undertake comprehensive analysis of institutional roles and capabilities in the sub-sector and advocate for implementation of recommendation and maintenance of institutional stability**

Priority: Medium

Objectives/Description: A deep dive institutional analysis is required to assess the current roles and capabilities of the government agencies involved in irrigation. The assessment should serve us a guiding document for future decisions in institutional arrangement of irrigation bodies.

This intervention has three main proposed activities. The first activity is identifying appropriate stakeholders to undertake comprehensive assessment of institutional roles at federal agencies, regional bureaus, enterprises and, federal and regional linkages. The next activity is presenting the recommendation of the assessment to key stakeholders and setting up a stakeholder working group to follow-up on implementation. The third activity is mobilizing funds to implement the recommendation outlined in the assessment.

Environment and gender mainstreaming: To be updated

Owners and involved parties: MoWIE-Irrigation and Drainage Directorate / Regional BoWRs and irrigation authorities, MoANR – SSI Directorate , MoWIE-basin directorate, other public institutions

Cost: 1-5M (major cost items: Hiring an independent agency to conduct the study)

Timeline: 12-24 months

***BOTTLENECK 7*: Insufficient budget allocated to sector and cost-sharing with other sectors**

Priority: Medium

Description: The financial resource allocation to irrigation is not sufficient when compared to the required resource to achieve the national targets. The shortage in financial resources is evident in federal and government agencies. The following figure presents the allocated budget for the MoWIE-Irrigation and Drainage Directorate against the required budget to achieve the GTP I targets.

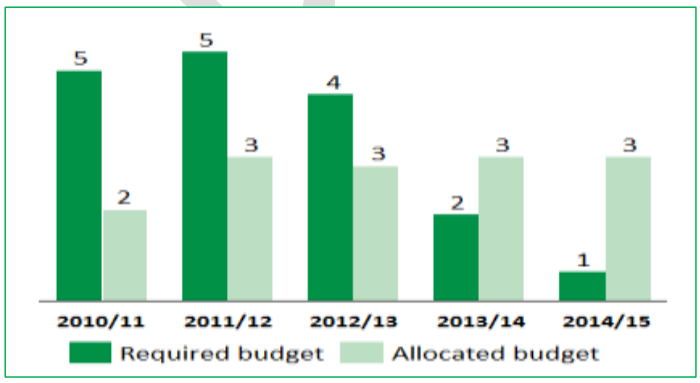

Figure55: Budget allocation to MoWIE against the required to achieve irrigation target (in BN ETB):

As can be seen from the figure in the last two years of the GTP I period the allocated budget is more than the required. However, this was due to revision in GTP II targets for the last two years. Similarly, most of the regional government agencies are forced to revise their targets due to insufficient budget allocated to the sector.

Furthermore, cost sharing for irrigation scheme development is non-existent. This is due to two factors. The first reason is lack of institutional framework to implement cost-sharing and lack of willingness by other sectors and stakeholders to participate in financing irrigation development.

To solve the issue insufficient budget allocation in the sector, there were initiatives carried out by government agencies. One of them was the establishment of the national water resource development fund with irrigation included as one pf the major components. The fund was set-up by the MoWIE in 2002 with other partners such as development partners supporting it. The projects registered good success in structuring a strong project pipeline throughout the country and aligning development partners' initiatives and funding processes[23].

INTERVENTION M5: **Introduce a large-scale national fund for smallholder irrigation and drainage development drawing on the existing water sector fund and consolidating funding from various governance and development partners**

Priority: Medium

Objectives/Description: irrigation has been given higher focus in the next five years. This is expected to increase the financial allocation to the sector. However, achieving the GTP II irrigation targets requires searching additional financial resources. It also requires alignment and engagement of many stakeholders' to play their part in providing fund to the sector.

The main activities of this intervention are increasing allocation of budgetary funds to irrigation and devise a mechanism to effectively use the water fund, undertaking diagnostic study for establishment of development fund., engaging donors and development partners in setting-up irrigation funds and funding the development of schemes and exploring cost-sharing arrangements

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention areMoWIE-Irrigation and Drainage Directorate, regional BoWRs and irrigation authorities. Donors and development partners are also involved in the implementation of the intervention.

Cost: 1-5 M (Major cost items:Conferences and workshops conducted to engage donors and development partners, study conductedto design an irrigation fund)

Timeline: 24-36 months

INTERVENTION M6: **Ensure the accountability and proper utilization of funding and other resources allocated for smallholder irrigation and drainage development**

Priority: Medium

Objectives/Description: Most of the time financial resource utilization principles such as accountability and transparency are embodied with in the activities of government bureaus. But additional measures can be taken to enhance the efficient utilization of finances in the sector. These measures should focus in developing the capacity of government agencies in developing effective plans and programs. In addition the usual accountability system needs to be strengthened.

[23] http://www.solutionsforwater.org/solutions/ethiopias-water-resource-development-fund-to-provide-financing-to-municipal-utilities

This intervention has two main activities. The first activity is developing the capacity of government agencies on prioritization of programs, effective planning and budget allocation. The second activity is enforcing regular financial reports and review by government donors.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-irrigation directorate, MoANR - SSID, RBoAs, Regional BoWRs and irrigation authorities. The Public procurement agency,

Cost: <1 M (Major cost items: Training of government staff)

Timeline: 6-12 months

6.2. Research and extension

6.2.1 Bottlenecks with high priority interventions

***BOTTLENECK9*: Insufficient focus, budget and staff allocation to research on irrigation and drainage, irrigated agriculture, gender and irrigation, and on-farm water management, in the research system**

Priority: High

Description: As most of the research undertaken by Ethiopian Institute of Agricultural Research (EIAR) and Regional Agricultural Research Institutes (RARIs) focuses on crop and livestock commodity areas, the focus given to irrigation related research is very low. Interviews conducted with agricultural research institutes reinstates the low focus given to irrigation research. This is clearly indicated by the low proportion of budget and human resource allocated to irrigation related research.

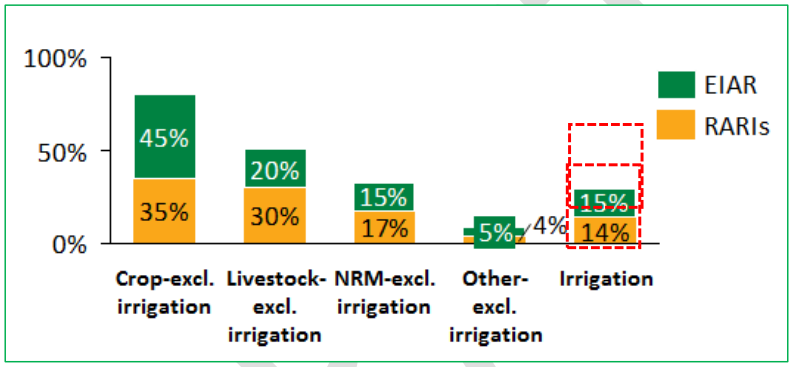

Figure56: Investment by research institutes on irrigation

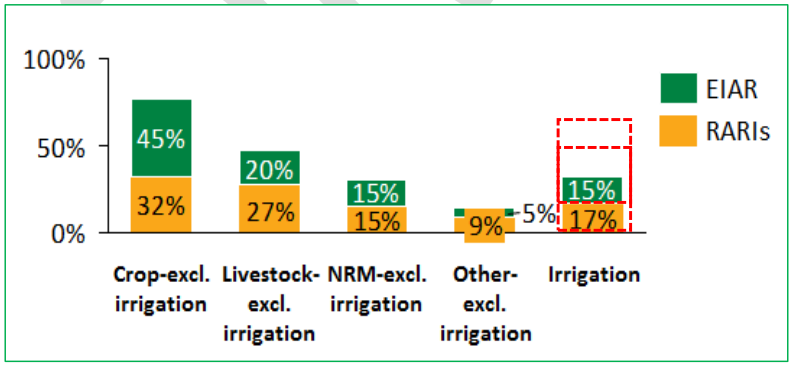

Figure57: Irrigation research personnel in research institutes

As a result, the research outputs and latest technologies released by the research institutes are very limited. The extension system has shortage of manuals on irrigation and irrigated agronomy as the priorities for extension are not aligned with priorities of research institutes.

INTERVENTIONH10:**Allocate increased budget for the construction of irrigation research centres and increase the operational and management budget including hiring new researchers with advanced degrees in research centres**

Priority: High

Objectives/Description: To increase focus on irrigation research, necessary research facilities and equipment should be built and operated in the agricultural research institutes. A typical irrigation research centre requires water resource facilities, irrigation practices field and laboratories but these facilities do not exist in most of the agricultural research institutes in Ethiopia. So constructing water resource facilities and equipping laboratories with necessary equipment will play a big role in strengthening research in irrigation.

Sufficient budget should be allocated by the agricultural research institutes to undertake construction and operation and maintenance of irrigation research centres.

In addition, qualified researchers with BSc, MSc or PHD degrees should be hired to produce high quality research outputs. To undertake hiring, the required scientific, technical and administrative criteria for hiring qualified staff should be identified first.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer for this intervention will be the EIAR and RARIs. MoANR, World Bank, IFAD, USAID and Embassies are involved parties.

Cost: 10-50M (major cost items: construction of canal, storage, conveyance and on-farm distribution technologies, operation and management, salary of new staff)

Timeline: 12-36 Months

BOTTLENECK 10: **Limited development and promotion of dedicated extension packages on irrigation and drainage, water use and management, and integration of content in crop extension packages, including due to insufficient qualified experts and irrigation-focused DAs at local levels**

Priority: High

Description: The extension service for smallholder farmers in Ethiopia is mainly focused on crop agronomy. It is mainly related to trainings given on farm input usage, production and post-harvest. Although some aspects of irrigation are considered in the trainings, they are usually embedded within the crop agronomy. This shows that there is no dedicated training on irrigation.

Limited availability of dedicated trainings on irrigation decreased farmers' productivity and damaged a large size of land due to salinity problems. The main reasons for no dedicated trainings are limited availability of dedicated irrigation manual packages and irrigation-focused DA's.

Although there are some manuals developed by MoANR on irrigation technology and irrigated agronomy, Ethiopia lacks dedicated and comprehensive extension manuals. For Irrigation technology, the small scale irrigation development irrigation manual is the main document for extension trainings. The irrigated crop manuals for horticulture and cereals are also developed but those packages are not sufficiently detailed and comprehensive compared to the manuals by FAO and other countries extension packages.

In the same way, the number of experts and DAs with irrigation expertise is very limited. Even though there are irrigation DAs in some of the regions, the trainings they are given are not different from the DAs in other area of agriculture.

The following interventions are recommended to solve this bottleneck.

INTERVENTION H11: **Add additional content to the SSID extension manual in key areas and develop crop specific packages for the major crops and disseminate them to regional level**

Priority: High

Objectives/Description: The main extension guide and training manual for irrigation are small scale irrigation development, construction and handling manual developed by the MOANR. This manual serves as a reference material for DAs and SMEs working on irrigation related extension services. Most of the regionally developed manuals also referenced this manual for their main source of content. The SSIDCH manual includes the following main contents:

- Introduction
- Water source options for small scale irrigation
- Construction of small scale irrigation schemes
- Irrigation water distribution methods
- Operation and maintenance of small scale irrigation schemes
- Irrigation water pumps operation and management
- Irrigation water management and drainage
- Cost of irrigation schemes and structure of water users associations

Although the manual covers fair amount of content areas, it misses some other important areas when compared to India's, Bangladesh's and FAO's manuals on irrigation. These additional contents should be added in the SSIDCH manuals to make it robust and exhaustive. Beside these contents the manual should also include site specific irrigation water requirement and irrigation scheduling.

Content not included in the existing manuals are listed below:

Basic content areas

- Water quantity measurement and estimation as well as quality of water and salinity measurement
- Basics of supplementary irrigation
- Technology specific installation and operation of irrigation systems

Advanced content areas

- Irrigation practices and scheduling (more advanced approaches than only referencing FAO recommendations)
- Drainage systems and drainage of irrigated land
- Effective use of water, recycling, wastewater
- Gender awareness and mainstreaming
- Shallow well spacing- (Other ground water development topics)

For irrigated crop packages, there are existing packages for horticultures and some cereals (maize, wheat and rice) developed by MoANR. The horticulture package should be refined to include water quality requirement, irrigation scheduling (for some crops), suitable water application method, and seasonal water storage and seed multiplication (focusing on irrigation intervals, duration for irrigation, irrigation methods and techniques, temperature and quality of water tolerated by seeds). Similar to horticulture, the maize, wheat and rice packages should also be developed further. As there are currently no irrigated crop packages developed for some cereals, pulses, oil seeds and other crops, new packages should be designed for them.

The main activities in this intervention are adding 3 basic and 5 advanced content to the SSIDCH manual, detailing the horticulture and cereal (wheat, maize and rice) manuals, developing new manuals for tef, barley, priority pulses and oilseeds and other crops (e.g. Coffee, cotton, forage) and finally translating and disseminating to the regions.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoANR, RBoAs& OIDA. EIAR and RARIs are involved parties

Cost: 1-5M (major cost items: content development, publishing costs)

Timeline:6-12 Months

***INTERVENTION H12:*Accelerate hiring and training of DAs/SMEs planned in GTP 2 and increase the frequency and length of theoretical and practical trainings as well as annual experience sharing events in each region**

Priority: High

Objectives/Description: Delivering more focused and targeted trainings on irrigation to DAs and SMEs is required. Although irrigation DAs exist in Tigray, they don't have a pure irrigation background and they don't work differently from the other DAs. Therefore, irrigation specific DAs and SMEs should be hired and trained.

The Ethiopian government included hiring and training of DAs and SMEs as one of the targets in GTP 2. Actions should be made to accelerate the implementation of the plan. Following recommendations should be taken into consideration to make sure the DAs and SMEs are sufficiently trained:

- Length of training period should be expanded.
- Both theoretical and practical trainings should be provided
- Experience and knowledge sharing platforms should be facilitated

The main activities in this intervention are hiring and training DAs and SMEs, improving the curriculum to focus on irrigation technics, water application, efficiency, irrigated crop management, risk management, operation and maintenance of drainage facilities and gender specific issues and facilitating DA to DA or SME to SME experience sharing events.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoANR, RBOAs and OIDA. EIAR,RARIs, Universities, Initiatives /programs are involved parties

Cost: 5-10M ETB (major cost items:salary for DA and SME, training costs, curriculum improvement costs)

Timeline:12-18 Months

***BOTTLENECK 11:*Limited use of additional awareness creation and extension service delivery channels, and low availability of site-specific advisory services for smallholders**

Priority: High

Description: Although most countries use an institutionalised government structure to deliver extension supports, they also use additional awareness creation and extension delivery channels. For example, ICT based awareness raising, involving NGO's and private sector players and experience sharing forums were successfully used in Bangladesh, India and Egypt. In addition, media campaigns to raise awareness on irrigation were used in Egypt to reach millions of farmers.

Though these channels proved successful in other countries, their practice is limited so farin Ethiopia. Some efforts by different programs and institutions are made to reach farmer through those channels but those are either at their pilot stage or not successful. DA based trainings and supports still are the only way majority of farmers are reached. Especially when it comes to awareness creation and extension irrigation, it could be said little has been done.

Considering the impact and ease of the above awareness raising and extension service delivery channels, strategic interventions should be made to enhance the use of those channels and reach a large number of smallholder farmers easily.

INTERVENTION H13: **Develop SMS and media based campaign to promote irrigation to farmers, expand irrigation content on 8028 system and promote heavily**

Priority: High

Objectives/Description: Short Message Service (SMS) and media campaigns are among the popular channels used to promote agricultural practices and innovations. This is evident that many countries including Ethiopia uses these channels to reach out large amount of farmers. Countries like Bangladesh and Egypt largely uses television programs to promote irrigation and other agricultural aspects of their country.[24]

Irrigation, as a big part of agricultural practice, should be promoted heavily using media and SMS campaigns. Radio programs, documentaries and advertisements focusing on irrigation should be produced regularly as most of Ethiopian farmers use radio as their main information source. SMS text should also be used to disseminate information as most farmers have the access to mobile phone. Beside SMS and media campaigns, the irrigation content in the 8028 interactive voice record (IVR) system should be expanded.

The main activities in this intervention are identifying key promotion areas, drafting and producing text messages, using FM/community radio programs to deliver the promotions and adding additional content on the 8028 IVR system.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owner's for this intervention are RBoAs, OIDA, MoANR, and ATA. Ethiotelecom, Local FM radio stations are involved parties

Cost:5-10M (major cost items: production costs, SMS costs, IVR expansion costs)

Timeline: 6-12 Months and ongoing

INTERVENTION H14: **Develop an ICT based solution for site specific advisory on crop water requirements and irrigation scheduling**

Priority: High

Objectives/Description: In Ethiopia, crop water requirement and irrigation scheduling advisory service is provided through the DA system. SMEs and DA's do analysis on crop water requirement and schedule based on the data they get from FAO website. This way of advisory is not much effective as a single DA reaches a large number of farmers. A single farmer do not have the access to know the crop water requirement and schedules that are specific to its farm.

ICT based advisory is developed in many countries for site specific crop water requirement and scheduling. This usually combines the use of satellite data on climate, soil and crop and the use of ICT tools to analyse the data and get outputs. Farmers receive the final outputs through mobile phone or other ICT solutions. This makes the advisory service faster and easily accessible by farmers. Therefore an ICT based advisory on crop water requirement and schedule should be developed to enhance the efficiency of farmer's water usage during irrigation.

[24] 1. Contribution of Television Channels in Disseminating Agricultural Information for the Agricultural Development of Bangladesh: A Case Study, Mohammed Khalid Alam&Md. ArmanulHaque, January 2014.
2. Public Awareness on Water Scarcity, GreenCom , Egypt

IWMI had undertaken a study on irrigational potential mapping and is currently working on various models to support technology selection. ATA has also created a high-level model to analyse the irrigation potential of the nation, as well as the corresponding impact of realizing that potential by taking into consideration the available water sources. IWMI's irrigation potential data and ATA's scientific approach can be combined to build a more detailed and robust model to provide site specific advisory at woreda level on crop water requirement and irrigation scheduling.

The main activities in this intervention are comparing feasibility of different ICT solutions (Including the IVR service), developing and promoting the most feasible solution, piloting it and finally scaling it up.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoANR, ATA, MoWIE, RBoWRs. IWMI, ATA, Irrigation experts, RBoAs, OIDA and Basin development bureau (BDB) are involved parties.

Cost:5-10M (major cost items: study and development of ICT tool, pilot and implementation)

Timeline: 12-18 Months

INTERVENTION H15:**Increase training and in-kind support to model farmers to use and promote irrigation and drainage good practises**

Priority: High

Objectives/Description: Although in-kind support and trainings are given to model farmers, these trainings and support given to farmers should be increased. The support should also extend to farmers who have successfully practiced irrigation. Besides supporting model farmers, they should be used in irrigation promotion campaigns.

The main activities in this intervention are facilitating opportunities for model farmers twice a year, providing equipment and crop inputs, acknowledge model farmer by giving them awards and certificates and using model farmers as "ambassador" to endorse irrigation and boost farmers mobilization/buy in.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoANR, RBoAs, OIDA and BDB. Equipment suppliers, NGO's and program/initiatives are involved parties.

Cost:1-5M (major cost items: equipment costs, crop inputs cost, awards cost)

Timeline:6-12Months and ongoing

6.2.2 Bottlenecks with medium priority interventions

BOTTLENECK 11:**Limited use of additional awareness creation and extension service delivery channels, and low availability of site-specific advisory services for smallholders**

Priority: High

Description: Although most countries use an institutionalised government structure to deliver extension supports, they also use additional awareness creation and extension delivery channels. For example, ICT based awareness raising, involving NGO's and private sector players and experience sharing forums were successfully used in Bangladesh, India and Egypt. In addition, media campaigns to raise awareness on irrigation were used in Egypt to reach millions of farmers.

Though these channels proved successful in other countries, their practice is limited so farin Ethiopia. Some efforts by different programs and institutions are made to reach farmer through those channels but those are either at their pilot stage or not successful. DA based trainings and supports still are the

only way majority of farmers are reached. Especially when it comes to awareness creation and extension irrigation, it could be said little has been done.

Considering the impact and ease of the above awareness raising and extension service delivery channels, strategic interventions should be made to enhance the use of those channels and reach a large number of smallholder farmers easily.

INTERVENTION M7: Introduce a coordinated plan for development partners and the private sector to engage in awareness creation and extension support / supplementation

Priority: Medium

Objectives/Description: The involvement of development partners and the private sector in awareness raising and extension services play a big role in reaching a large number of farmers. As most development partners and private sector players have both the technical and financial capacity, they can even reach farmers living in remote areas. World Bank and IFAD funded programs like the AGP and PASIDP have worked a lot in giving extension support to farmers.

In order to maximize the role development partners and the private sector are playing, a coordinated plan and awareness raising campaigns should be developed to engage them in extension services.

The main activities in this intervention are identifying relevant development partners and private sector players, developing the coordinated plan, validating the plan through workshops and implementing the plan accordingly.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoANR, RBoAs and OIDA. Development partners and private sector bodies are involved parties.

Cost: <1M (major cost items: conducting workshops/conferences)

Timeline:6-12 Months and ongoing after

INTERVENTION M8: Expand use of irrigation-specific days/weeks including new technology demonstrations and farmer to farmer experience sharing events at woreda level

Priority: Medium

Objectives/Description: Irrigation days weeks are celebrated annually in different countries. In India, irrigation awareness week is celebrated in discussion, trainings, workshops, exhibitions visits and demonstrations on irrigation management.[25] In Egypt, conferences and demonstrations on irrigation are the largest part of the water week celebrations.[26] A large number of individual farmers, water user associations and subject matter specialists were part of these irrigation week celebrations. These events helped in raising awareness of farmers about irrigation technologies and practices.

In Ethiopia, the practice is usually under the umbrella of the general field day celebrations. There are no days or weeks dedicated to irrigation specifically except for Amhara region, which has an irrigation launch day. Such a practice should be introduced in every region as it boosts farmer's awareness on irrigation. The irrigation day/week can include the following activities:

- New technology demonstrations
- Discussions which include explanations of the social and economic benefits of involving women in irrigation schemes

[25] STRATEGIES FOR SAVING WATER IN IRRIGATION – AN EXPERIENCE IN MAHARASHTRA STATE, INDIA, S.V. Sodal
[26] Water Users Associations in Egypt, Irrigation Improvement Project (IIP), Usaid El-Hanbali, March 2003

- Exhibitions
- Model farm visits etc.

The main activities in this intervention are facilitating annual irrigation days/weeks, making sure women and men are benefiting equitably and facilitating farmer to farmer experience sharing events.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoANR, RBoA and OIDA. Individual farmers, ATA, Universities, development partners, programs/initiatives, RARIS are involved parties

Cost: 10-50M (major cost items: irrigation day/week facilitating costs, farmer to farmer event facilitation costs)

Timeline:6-12 Months and ongoing after.

***BOTTLENECK 12:* Limited accurate information on the water resources available for irrigation, geological data, current schemes and usage patterns**

Priority: Medium

Description: Although there have been efforts made by different bureaus and organizations to collect and map information on water resources, scheme inventories and usage patterns, most of the information is still incomplete or not easily accessible. A comprehensive information platform that includes all geographical areas, all water sources and all scales of irrigation has not been developed so far in Ethiopia.

Lack of comprehensive information led planners, designers and contractors to devote large amount of budget and time in making detail investigations to understand the available water sources, geological conditions and existing schemes. It also makes planning and implementation of 'integrated watershed management approach' difficult.

***INTERVENTION M9:*Accelerate the satellite-based shallow and deep groundwater mapping efforts to finish within 1 and 10 years, respectively**

Priority: Medium

Objectives/Description:

Shallow ground water potential in Ethiopia is currently being mapped by HHI team in ATA. Although the mapping process is ~30% complete, it should be accelerated to ensure completion within the planned timeline. The deep ground water mapping should also start soon and finish within 10 years from its initiation. Both shallow and ground water mapping should correspond to command area and beneficiaries. This intervention also includes the preparation of ground water atlas with well fields delineated.

To accelerate the mapping process, the institutional conflicts on the mandate to map the ground water should be clarified and agreed on by all the stakeholders. Additional funds and budget should be allocated to speed up the mapping process and made available to the different parties through GIS.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoWIE and ATA. Geological survey of Ethiopia (GSE) and AAU are involved parties

Cost:50-100M (major cost items: mapping costs)

Timeline:12 Months (for Shallow groundwater); 10 years (for deep groundwater)

INTERVENTION M10: **Introduce an Irrigation Management Information System to consolidate all water resource and potential data and analysis, soil and other data, and scheme inventories and usage patterns, and make broadly accessible with regular updates**

Priority: Medium

Objectives/Description: As most of the water resource and potential data available in the country is scattered across different institutions, it is not easily accessible by the users. Thus, all available data should be brought together and consolidated in a technology solution like a website.

In order to create a strong technology solution, existing data gaps should be identified once consolidation of all the available information is done. Partners should be engaged in closing the data gaps. Full analysis of irrigation potential, current usage and national scheme inventory should also be undertaken.

After the technology solution is implemented and promoted, a process for collecting data on ongoing basis should be put in place. This is process should also make sure that the technology solution is updated upon the availability of latest data.

The main activities for this intervention are identifying and developing technology solution capable of presenting all irrigation relevant data, collection of relevant data, identifying gaps and working with partners to close gaps (including full analysis of irrigation potential and current usage, national scheme inventory), encoding data collected, Implementing and promote the solution and putting in place a process to collect data on on-going basis and updating revision..

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoWIE and ATA. RBoWRs, IWMI, universities, GSE, NMA, and RARIs are involved parties

Cost:1-5M (major cost items: website developing cost, data collection cost)

Timeline:48-60 Months

BOTTLENECK 13: **Limited linkages between research and extension for priority setting and use of research outputs in extension services**

Priority: Medium

Description: Even though there are some irrigation related manuals and technologies already developed by agricultural research institutes and universities, little has been done in disseminating those manuals and technologies to the end users(farmers & agro-pastoralists). This is mainly because of weak linkage between research and extension.

Different regions have different level of linkage in four critical areas - joint planning, effective handover, ongoing support and feedback. But the overall linkage of research and extension appear to be weak. For most of the regions, there has not been an effective hand over of research outputs and feedback.

INTERVENTION M11: **Strengthen annual joint planning sessions and quarterly feedback (follow up) sessions to evaluate the progress of research and extension assignments at national and regional levels**

Priority: Medium

Objectives/Description: In order to bring strong linkage between research and extension systems, they should be linked in a number of areas. According to the different agricultural research institutes and extension departments, the linkage is much weaker in handover and feedback than in other areas. Thus, effective handover and feedback mechanism should be prioritized and a standard linkage mechanism should be applied throughout the country.

Annual joint planning session on irrigation with all major stakeholders should be facilitated to align on plans and priorities. Activities related to institution planning and performance framework should also be considered in these joint planning sessions.

Besides the joint planning sessions, quarterly follow up (feedback) sessions should be facilitated to evaluate the progress on both the research and extension assignments.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention will be MoANR, EIAR and RARIs. Farmers and development agencies are involved parties

Cost:< 1M (major cost items: conducting joint planning session)

Timeline:6-12 Months

INTERVENTION M12:**Institute a survey mechanism in which DA's periodically conduct surveys on farmer problems and needs, collect feedback and discuss findings in joint planning activities between research and extension**

Priority: Medium

Objectives/Description: Even though the different agricultural research institutes are working to address farmer problems and needs, their research themes are not mainly driven from feedbacks from farmers. This is mainly because there is no system to conduct survey and collect feedback on farmer problems. Therefore, a survey mechanism in which DAs conduct surveys on farmers should be institutionalised within the regional bureau of agricultures.

The main activities in this intervention are training DAs on how to conduct surveys on farmers demand, conducting surveys, analysing surveys and discussing them in joint planning sessions.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners of this intervention are the regional bureau of agriculture and Oromia irrigation development authority (OIDA). EIARs, RARIs, MoANR, Agricultural research institutes and universities are also involved.

Estimated cost:1M (major cost items: training costs, surveying costs)

Timeline: 6-12 Months and ongoing

INTERVENTION M13:**Make all research outputs available to the extension system through an online information sharing platform**

Priority: Medium

Objectives/Description: One of the reasons for weak linkage between research and extension is no mechanism to share research outputs with the extension system. Although there are platforms like the ADPLAC meetings and training of trainers which are used to share research outputs, these meetings and workshops are infrequent and information shared is not holistic. Many of the research outputs are still kept shelved in the research institutes and do not reach the extension system.

To overcome this problem, an online information sharing platform should be introduced. There are different online based information sharing tools being used in different countries. For example, Egypt, Uganda, Nigeria and other counties are using VERCON (Virtual Extension and Research Communication network), an online information sharing platform developed by FAO. This network helped to overcome the physical, administrative, knowledge and communication barriers that can hinder interactions between researchers and extension agents.

The main activities of this intervention are comparing feasibility between the different online platforms available, identifying the most feasible option and customising it as per the requirement, encouraging researchers to upload research outputs and putting in place an annual process which controls the aggregation of research outputs on the platform.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are EIAR, RARIs and universities a. MoANR and RBoAs are involved parties.

Cost:< 1M ETB (major cost items: online platform development cost, ongoing operation and maintenance of the online platform)

Timeline: 6-12 Months

6.3. Scheme planning, design, construction and management

6.3.1 Bottlenecks with high priority interventions

***BOTTLENECK 16*: Lack of standardized approach and contract, technical and project mgmt. capacity across public institutions for prioritizing, planning, budgeting, design, construction, contract mgmt. handover, supervision and monitoring of schemes**

Priority: High

Description: Full scheme development passes through multiple stages from prioritization and design up to management and monitoring. Through all this process standardized approach is essential. Most of the time standardization is achieved through developing technical guidelines and creating awareness among stakeholders. The following two figures present a summary of the major activities of the regions.

Scheme design & management activity	Major activities / processes incl. community participation	Major standardization / related challenges	Major capacity gaps
Prioritization and planning including budgeting	• Potential project and scheme identification • Top-down planning (from federal, regional and zonal/woreda levels) and evaluation of community demand • Technical and financial feasibility / return, social and environment assessment to prioritize schemes	• Different prioritization criteria used by federal agencies, and by regions • Limited involvement of the community	• Lack of experienced staff • Human and financial resource limitation • Limited availability of data
Scheme design	• Reconnaissance study of scheme area • Detailed scheme feasibility study of hydrology, geology, soil, agronomy, socio-economy, water shed management • Detailed engineering design including headwork, canal network and irrigation command area system layout • Operation and maintenance manual preparation (*Amhara region*)	• Limited consideration of on-farm and scheme level drainage in design • Logistics problem	• Ineffective community engagement and study of local needs / issues • Lack of technical capacity in designing firm • Gap in in institutional capacity and week commitment from leadership • Design is not site specific
Scheme construction	• Construction planning • Civil works construction • Electro-mechanical installation (Large scale) • Handover of schemes to WUA	• Low cost bid evaluation criteria lead to low quality in construction • Lack of effective partnership between client, contractor and consultant • Week design quality delays construction • Limited capacity of WUA	• Lack of skilled manpower in quality and quantity • Late response for design amendment • Capacity of supervisor is week • Lack of capacity building programs for contractors (technical, financial, machineries..etc)

Figure58: Standardization approach for major scheme development activities (1/2)

Scheme design & management activity	Major activities / processes incl. community participation	Major standardization / related challenges	Major capacity gaps
Monitoring and supervision during construction	• Frequent quality control and assurance • Cost control • Time management	• No counterpart engineer assigned from the client side • Ineffective construction management	• Lack of experienced staff in contract management
Ongoing management	• Water scheduling and distribution • Day to day operation of scheme infrastructures and equipment's	• water distribution not regularly implemented	• Lack of technical capacity on management of schemes
Maintenance and rehabilitation	• Routine maintenance incl. grass cutting from canal, silt removal, maintenance of electro-mechanical equipment's • Periodic maintenance (repairing electro-mechanical equipment's and repairing civil structures etc) • Rehabilitation assessment	• Sedimentation is a major issues for existing schemes • Responsibilities of maintenance not clearly defined among institutions • Insufficient documentation about the project	• Lack of financial resources to conduct routine maintenance • No support provided to farmers during maintenance of schemes (i.e., machines, financial)
Monitoring and supervision during operation of scheme	• Monitoring of irrigation infrastructure • Monitoring of water application and water use	• Basin authority doing maintenance due to insufficient capacity of scheme project offices	• Capacity of WUA not strong enough to conduct routine monitoring • Limited capacity of scheme project offices
Scheme inventory and performance assessment	• Data collection on scheme • Physical inspection of scheme • Performance testing of scheme	• Limited interest to conduct scheme inventory and performance assessment	• Financial resources not available to conduct scheme performance assessment • Scheme inventory study not supported with modern technologies such as GPS and water flow measuring devices

Figure59: Standardization approach for major scheme development activities (2/2)

The figures clearly demonstrate that standardization approach in each scheme development activity is not being followed due to factors such as weak capacity (e.g. financial, human resource and technical) of clients, contractors and consultants, lack of reliable data, lack of technical capacity in contract management and due to limited capacity of WUAs.

Most of the above mentioned challenges can be mentioned by developing guidelines across all major scheme development activities, developing collaboration among stakeholders in every stage of scheme development and by conducting capacity building programs to involved parties.

INTERVENTION H16: Develop standard criteria and guidelines for prioritizing of new schemes while also ensuring maintenance of existing schemes

Priority: High

Objectives/Description: Prioritization of schemes is a major element of scheme development in which great emphasis is required if it is to be successful. A successful prioritization process should be comprehensive by looking at different factors. The factors that are necessary for prioritization of scheme are wide-ranging including, but not limited to, economic, environmental and social considerations. Others factors that need to be considered are availability of project management capacity and integration of the principle of MUS (Multiple water use system). In addition, from resource efficiency perspective maintenance of current schemes need to be given precedence over development of new schemes.

This intervention has five main activities. 1) Setting-up a technical expert committee from federal and regional bureaus to develop a standardized guideline for prioritization of schemes development with high consideration for community involvement. 2) Distributing the draft guideline to regions and donors (e.g. World Bank) to incorporate their feedback. 3) Publishing prioritization guideline and making it accessible for everyone. 4) Incorporating the guideline into the standard process of basin authorities (e.g. during joint planning of schemes) and assign them to monitor the application of the guideline. 5) Include the adoption of the guideline as one of the precondition for financing of schemes and align major funders for this purpose.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR-SSI directorate and regional BoWRs and irrigation authorities. MoWIE-basin directorate, basin authorities, AGP, Regional BoANRand development partners and donors are also involved.

Cost: <1 M (major cost items:study conducted to develop the guideline)

Timeline: On-going

***INTERVENTION H17:*Strengthen joint planning and execution of scheme development and management between agricultural and water agencies**

Priority: High

Objectives/Description: Lack of collaboration between irrigation agencies and agricultural agencies has led to many challenges in scheme development especially in scheme operation and maintenance. In some cases, underperformance of schemes, caused by scheme plans not taking into consideration the agricultural aspect, is a result of weak collaboration between both parties. To curb this problem robust dialogue mechanism need to be set up between irrigation agencies and agricultural agencies. In addition both parties need to cooperate in joint planning and/or joint management of projects.

This intervention has four main activities. 1)Strengthen agricultural water task force by expanding it up to woreda level and assigning institution to oversee the taskforce. 2) Arrange quarterly meeting between regional/federal bureaus of agriculture and water resource. 3) Support the development of joint irrigation plan by integrating different plans and bringing together stakeholders into joint sessions. 4) Involve agriculture bureau experts in prioritization and design of schemes built by water bureaus.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR-SSI directorate, regional BoWRs and irrigation authorities and Regional BoANR.

Cost: 1-5 M (major cost items: conducting joint planning sessions of agricultural water task force)

Timeline: 6-12 months and on-going

***INTERVENTION H18:* Require agencies to include all costs including operation and maintenance, rehabilitation, monitoring and information dissemination in funding for schemes**

Priority: High

Objectives/Description: An irrigation scheme development plan needs to be broad enough to cover all the elements of effective irrigation scheme. Usually detailed future plans relating to operation and maintenance, rehabilitation and human resource development are overlooked. However, these elements need to be mainstreamed if scheme development is effective from start to finish. Moreover, adequate documentation of all the necessary documents is crucial especially during irrigation handover. Implementing the above mentioned items requires more focus from government agencies in terms of allocating more fund and human resource to these activities.

This intervention has four main activities. 1) Promote government agencies to include diverse set of experts (e.g. data management, gender, environmentalist, socio-economics, and other experts) in the project team for scheme development. 2) Develop capacity of government agencies on preparation of comprehensive project proposal for scheme development. 3) Make the allocation of funds for scheme development dependent on the mentioned components. 4) Develop a strong M&E and impact analysis system.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR-SSI directorate and regional BoWRs and irrigation authorities. The involved parties are MoFED, regional BoFEDs and development partners and donors.

Cost: <1 M (The major cost item: conducting training for staff)

Timeline: 6-12 months

***INTERVENTION H19:*Strengthen contract management, scheme design, construction and maintenance capacity of public institutions through increased on-the-job and external training**

Priority: High

Objectives/Description: Poor quality of design and construction is one of the factors frequently mentioned reasons for underperformance factors. Low quality delivery by firms is due to external factors and most importantly internal factors which includes lack of operational capacity. Water works enterprises (i.e. consulting construction firms) are constrained by factors such as limited human and financial resources and lack of technical capacity. Developing capacity through different programs of enterprises in different aspects has the potential to mitigate this issue.

This intervention has five main activities. 1) Providing regular on-job training to staff on relevant topics. 2) Creating linkage between universities and supporting institutions (e.g. construction project management institute).3) Conducting experience sharing events with successful local or foreign firms. 4) Hiring foreign expertise to accelerate transfer of knowledge. 5) Establish a reward mechanism for hose firms/individuals who have demonstrated good achievement.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR-SSI directorate and regional BoWRs and irrigation authorities. Universities and construction management institute are also involved.

Cost: 1-5 M (major cost items: staff training, experience sharing events)

Timeline: 6-12 months and on-going

***INTERVENTION H20:*Establish national standards for design, construction, operation and maintenance, and performance assessment of schemes**

Priority: High

Objectives/Description: Similar to prioritization of schemes standardizing the process of developing designs and construction will have immense benefits to the success of a scheme. In addition, these guidelines can be a great tool in the tendering process of consultants and contractors by serving as a document of reference by which the bidders are judged. Community participation in every aspect of scheme development should also be given high priority. This is achieved through mainstreaming specific activities related to community participation in every process of scheme development.

This intervention has four main activities. 1) Set-up a technical expert committee for federal and regional bureaus to develop a standardized guideline for design, construction, operation and other aspects of irrigation development with high consideration for community involvement in every step of scheme development. 2) Devise a mechanism to make use of local knowledge and resources (documenting local knowledge) and use it as an input in the development of the guideline. 3) Create awareness among relevant public and private institutions concerning use of the guidelines. 4) Adopt the standards and guidelines as an evaluation documents for approval or rejection of irrigation and drainage projects.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR-SSI directorate and regional BoWRs and irrigation authorities. Development partners and donors are also involved.

Cost: < 1 M (major cost items: study conducted to develop the guideline)

Timeline: 12-24 months

***BOTTLENECK 17:*Limited use and benefits of irrigation due to crop value chain bottlenecks related to improved inputs, extension, production, aggregation, storage and market linkages**

Priority: High

Description: There is low demand by farmers to invest in irrigation equipment and facilities because of crop related bottlenecks. So far, the integration of irrigation with crop value chain related interventions has been limited. Many of the crop related bottlenecks are mentioned by water user associations and individual farmers as the main challenges they face while using irrigation.

	Highest priority bottlenecks identified	Full Irrigation (High Value Crops)				Supplementary Irrigation		
		Horticulture	Coffee	Sesame	Fodder	Cereals	Pulses & Oilseeds	Fodder
1	Low availability of quality improved seed & seedlings	High	High	Med	High	Med	High	High
2	Low availability of organic, inorganic & blended fertilizers	High	High	High	High	High	High	High
3	Low availability of agrochemicals, biopesticides & equipment	High	Med	Med	Med	Med	Med	Med
4	Low availability of market-oriented extension services	High	Med	Med	High	High	High	Med
5	Low availability of mechanization services	Low	Low	Med	High	High	Med	High
6	Low availability of input & on-farm operations financing solutions	High	High	High	High	Med	Med	Low
7	Low availability of market information, platforms & facilities	High	Med	Med	High	High	High	Low
8	Limited quality-based pricing differentiation in the market	High	High	Med	Med	Med	Med	Low
9	Limited development of food safety, quality & traceability systems	High	Med	High	Med	Med	Med	Low
10	Low availability and high cost of appropriate transport & storage	High	Low	Low	Med	Med	Med	Med
11	Limited management and operational capacity of cooperatives	High	Med	Med	High	High	High	Med
12	Low availability of equipment, aggregation & trade finance	High	Low	Low	High	High	High	Med
13	Limited agroprocessing and packaging investment & capacity	High	Med	High	Low	Low	Med	Low
14	Limited use and effectiveness of contract farming arrangements	High	High	Med	Med	Low	Low	Low
15	Limited market linkages & access to secure, higher-value markets	High	Med	Med	High	Med	Med	Med
16	Limited integration of irrigation and crop VC related interventions	High	Low	Low	Low	Med	Low	Low

Figure 60: Major crop value chain bottlenecks identified for different crops

Commented [s18]: Description of this bottleneck being reworked to reflect SteerCo and recent feedback

***INTERVENTION H21:*Ensure integrated planning and implementation of crop value chain related interventions with scheme planning, design, delivery and mgmt.**

Priority: High

Large and medium irrigation schemes in Ethiopia are constructed by MoWIE and RBoWRs and most of the small scale schemes are constructed by the MoANR and RBoANRs. From what is understood from the interview with these institutes, there is less integration between them in scheme planning, design and construction. This left the crop value chain interventions not considered during irrigation scheme development. The schemes are either not designed to grow high value crops or they are too far from market areas.

The different institutes mandated to construct irrigation schemes should work closely to integrate crop value chain related interventions in scheme planning, design and construction. This increase the

demand by farmers to invest and participate in irrigation practices. It also lets farmers grow high value and high production crops which ensures their food security and economic advantage.

The main activities in this intervention are developing a framework to assess crop value chain related needs and integrate them in scheme design (Including HHI) , promote the integration of these frameworks in scheme planning process by MoWIE, RBoWIEs, MoANR and RBOAs and ensure involvement of MoANR / RBoANRs in scheme planning and design.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The owners for this intervention are MoWIE, RBoWRs and MoANR-SSID. All agriculture sector stakeholders are involved parties.

Cost: <1M ETB (The major cost item is standard assessment framework development cost)

Timeline: Ongoing

***BOTTLENECK 18*: Low scheme performance and deferred maintenance**

Priority: High

Description: Majority of the schemes are faced with underperformance and maintenance deferral. Especially most of the oldest schemes have issues with deferred maintenance thereby leading to underperformance. The following two figures present a summary of the status on scheme performance and deferred maintenance.

Region	Performing well	Performing below capacity	Non-functioning
Tigray	70%	20%	10%
Oromia	15%	55%	30%
SNNP	59%	31%	10%
Amhara	91%	8%	1%
Gambella	15%	55%	30%
National	**50%**	**34%**	**16%**

Figure 61: Performance of schemes in major regions

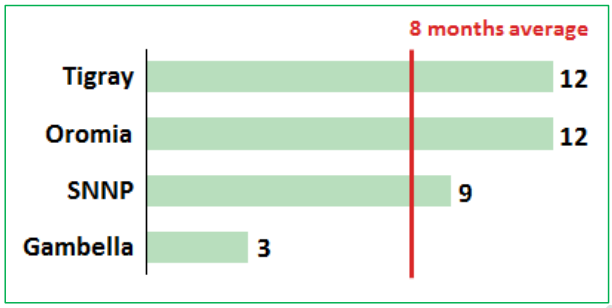

Figure 62: Average maintenance deferral for regions

Per the above figure on average around 50% of the schemes are underperforming while there is 8 months of maintenance deferral. This has economic and environmental implications if it is not properly addressed. The economic implication arises from incremental cost of maintenance due to not conducting maintenance on time and loss in benefit from irrigation because the scheme is underperforming. The environmental implications arise from the threat of different hazards (e.g. flooding) that the scheme can cause.

Multiple factors are mentioned for the deferred maintenance and scheme underperformance with the following being the major ones:

- Poor design and construction
- Inefficient use of irrigation water by farmers resulted in schemes covering less irrigated land than initially planned
- Management arrangements often ineffective to ensure strong scheme performance

Financing arrangements insufficient to fund timely maintenance

INTERVENTION H22: **Develop guidelines and procedures for scheme performance mgmt., inspection, maintenance, safety checks, and training technicians, specifying responsibilities of WUAs and government, and develop and roll out reporting system for WUAs**

Priority: High

Objectives/Description: One of the options for enhancing the attention given to maintenance and performance management is developing standard guideline and procedure and integrating with in the sets of guidelines on scheme development. Further, to ensure sustainability of irrigation and drainage infrastructure, its operation and maintenance should be taken up by both WUA and government. WUA should be trained to undertake routine maintenance and day-to-day management of scheme. A manual that guides WUAs in this process as well as clearly outlines their responsibilities with respect to scheme maintenance will reduce maintenance deferral. Moreover, government should support WUAs by sharing maintenance responsibilities, and conducting safety checks and audits to monitor the overall scheme performance.

This intervention has three main activities: 1) Set-up committee of technical experts to develop manual and guideline of scheme performance and maintenance. 2) Developing an irrigation scheme transfer manual also covering responsibilities of management and maintenance or irrigation infrastructure. 3) Discussing and agreeing with WUAs on irrigation and Drainage transfer contract or agreement. 4) Building the capacity of government agency responsible for maintenance of schemes.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owner of this intervention areMoWIE-irrigation & Drainage directorate, MoANR-SSI Regional BoWRs and irrigation authorities. WUAs will also involve in the implementation.

Cost: < 1M (major cost items: training of government agencies and WUAs)

Timeline: 12-24 months and on-going

***BOTTLENECK 19*: Ineffective licensing and tendering process for private consultants and contractors to undertake scheme design and construction, and poor designs and delayed scheme delivery due to low capacity of consultants and contractors**

Priority: High

Description: Numerous public and private water works enterprises are involved in irrigation scheme design and construction. These enterprises have played a large role in the scheme based irrigation development. In addition their impact in the economic development of the rural sector is significant. For instance, these firms create job opportunities for rural youth and develop the skills and technical capacities. However, internal and external factors have limited their growth and indirectly affected the irrigation sector.

The main external factors which affect the effectiveness of those enterprises are the tendering and licensing process. Both processes are plagued by the following common problems:

- Limited enforcement of procedural requirements in licensing and tendering process
- Proper investigation not conducted while giving license and renewal of license or during tendering process due to lack of technical capacity
- Limited transparency and frequent bias

Besides external factors internal factors are also significant in limiting the growth of the industry. The major factor in this aspect is of sufficient capacity by design and construction firms. The major capacity gaps in the design firms are due to few experienced senior engineers and delayed payment from clients. On the other hand, lack of machineries and equipment for construction, insufficient feasibility study by the consultant and delayed handover of planned area was mentioned as the major capacity gaps. These capacity gaps have most of the time led to a delay or even default. The following figure summarizes for private and public consultants and contractors.

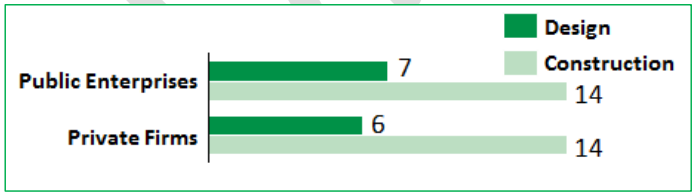

Figure63: Average delays in scheme design and construction (months)

Above mentioned factors coupled with other problems have led to delayed delivery or termination of schemes in the GTP I period. The following figure illustrates the achievement of irrigation targets against GTP I plan by region.

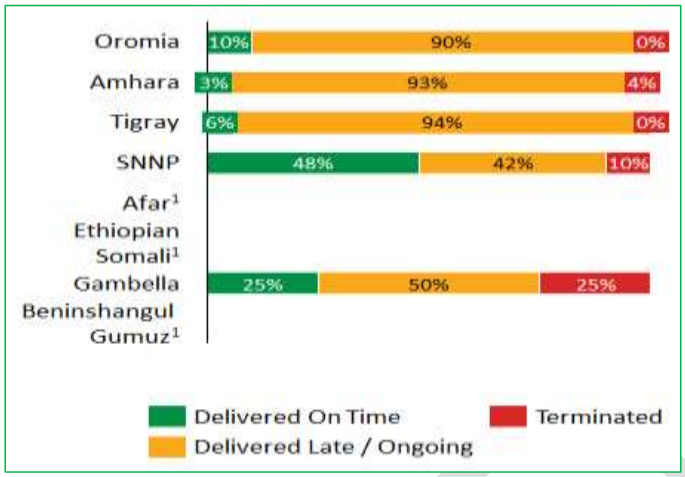

Figure 64: Percentage of planned schemes delivered by region during GTP 1[27]

The major factors hampering successful delivery of schemes can be summarized in to three groups:

- **Project management/supervision issues:** The main causes here are Lack of experienced project managers/supervisors and limited use of private supervisors (outsourced)
- **Design issues:** The main causes here are low capacity of private and public consultants and the fact that scheme design don't consider the actual situation in the ground
- **Construction issues:** The main causes here are low capacity of private and public consultants, issues related with right of way and limited interest of enterprises in remote scheme locations

INTERVENTION H23: **Develop guidelines, standard technical specifications and criteria for tendering of consultancy and construction services and strengthen adherence to procedures**

Priority: High

Objectives/Description: The efficiency and effectiveness of the tendering procedure is negatively affected by inconsistent procedure and limited technical capacity in bid analysis. To mitigate this problem it is essential to develop standard guideline while giving appropriate consideration for criteria's such as past performance of bidder. It is also necessary that the standard tendering process need to be aligned with the government policy in this area. Apart from developing the guideline ensuring that it is implemented by relevant government agencies is of paramount importance.

This intervention has three main activities. 1) Set-up committee of technical experts to develop improved tendering guidelines based on past learnings and experiences from international tendering standards. 2) Enhance the capacity of bidding committee (e.g. members should be experienced staff experts). 3) Promote investigation of bid documents and results by a third party.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR-SSI directorate and regional BoWRs and irrigation authorities. Public and private institutions working on irrigation will also be involved in the implementation.

[27]Data was unavailable for Afar, Somali and BeninshangulGumuz

Cost: <1 M (major cost items: study conducted to develop the guideline)

Timeline: 6-12 months

***BOTTLENECK 20*: Low capacity of Water User Associations / Irrigation Cooperatives**

Priority: High

Description: The legal framework for WUAs was established recently through the WUA proclamation (2014). The regions are also establishing their own WUA regional proclamations. In these proclamations the responsibilities of WUAs are clearly articulated. However, the level of implementation of these activities is relatively weak.

Major tasks	Major activities	Level of Impl.
Governance	• Set internal WUA/irrigation cooperative rules and regulations	◔
	• Elect members of the governing body	◔
	• Prepare year end financial reports	◔
	• Determine appropriate irrigation fees	◔
Management	• Prepare and monitor annual/seasonal water plan distribution	◔
	• Provision of scheduled irrigation water	◑
	• Inspection of irrigation infrastructure and equipment	◔
	• Conduct routine, seasonal and emergency maintenance	◔
	• Undertake construction and reconstruction work (if necessary)	◔
	• Collect irrigation fees from members	◔
	• Sanction non-paying members	◔
	• Arbitrate conflicts between members	◔
	• Train members on irrigation practices	◔

Figure65: Major tasks of WUAs and current levels of implementation

There are multiple factors which negatively affect the level implementation of the main activities of WUAs. The following are the major ones:

- Policy and institutional issues: This includes absence of regulatory body to organize and manage WUAs, WUA regulations not yet enacted, compulsory membership not yet implemented and lack of sufficient training and support from local experts and Das
- Capacity issues: This includes lack of technical and financial capacity of WUAs to conduct required maintenance and limited enforcement capacity of WUAs
- Implementation issues: This includes Water fees are not applied in most scheme, actual water allocation don't follow the prescribed water distribution plan to issues such as upstream-downstream conflicts and frequent theft of water in schemes

***INTERVENTION H24:*Establish large-scale capacity building program(s) for WUAs on scheme and financial mgmt., revenue generation and other topics, with strong NGO involvement**

Commented [s19]: To be aligned with TADs

Priority: High

Objectives/Description: WUAs are not implementing their major tasks because they lack capacity to do so. WUAs have limited human resource capabilities and limited technical knowhow to manage, maintain

and operate schemes. They are also constrained by limited financial access. This demonstrates the critical responsibility for the government to provide capacity building programs. Yet other countries experience has clearly shown that without the participation of NGOs and development partner's government is going to be effective to all WUAs in the country.

This intervention has six main activities. 1) Establish national/regional body within MoWIE/BoWR to oversee, manage, and organize WUAs. 2) Support the involvement of NGOs and development partners in providing capacity building programs to WUAs. 3) Identify the major capacity gaps within WUAs and conduct training program accordingly. 4) Support WUAs by providing equipment's (e.g. computers, water measuring devices). 5) Provide post-training follow-up (e.g. assess the implementation of training content, reward WUAs which demonstrate good performance in implementing the training content). 6) Conduct experience-sharing activities among WUAs.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR – SSI, regional BoWRs and irrigation authorities. WUAs are also involved in the implementation.

Cost: 10-50 M (major cost items:training costs, cost of computers, water measuring devices and other devices given to WUAs)

Timeline: on-going

INTERVENTION H25: **Make available grants or low interest loans for WUAs to fund their activities**

Priority: High

As water user association are not profit making associations, they require financing and credit solutions until they will be financially independent. Beside the financial grants discussed in intervention C.5.1, credit services with low interest loans should be facilitated for them. This makes finance available for them any time even if they are not provided with financial grants. It also encourages to effectively collect membership and water fees to repay their loans.

Cooperatives and farmer groups also need credit services as their financial capacity is not strong enough to satisfy their member's equipment demand. This imply the low interest loan product should be extended to them.

Low interest loan requires subsidization of the interest by government institutes. Therefore, federal ministries like MoWIE and MoFED should allocate sufficient budget for the wholesale fund and for the interest subsidies.

The main activities in this intervention are discussing with key government stakeholder on the structure of low interest rate product, implementation of the loan product and popularization of it among WUAs, cooperatives and farmers groups.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The main owners for this intervention are MoFED, MoWIE, MoANR-SSID. WUAs, irrigation cooperatives and farmer groups are involved parties.

Cost:> 50M (major cost items: stakeholder validation cost and the wholesale fund itself)

Timeline: 6-12 Months and ongoing

6.3.2 Bottlenecks with medium priority interventions

***BOTTLENECK 19*: Ineffective licensing and tendering process for private consultants and contractors to undertake scheme design and construction, and poor designs and delayed scheme delivery due to low capacity of consultants and contractors**

Priority: High

Description: Numerous public and private water works enterprises are involved in irrigation scheme design and construction. These enterprises have played a large role in the scheme based irrigation development. In addition their impact in the economic development of the rural sector is significant. For instance, these firms create job opportunities for rural youth and develop the skills and technical capacities. However, internal and external factors have limited their growth and indirectly affected the irrigation sector.

The main external factors which affect the effectiveness of those enterprises are the tendering and licensing process. Both processes are plagued by the following common problems:

- Limited enforcement of procedural requirements in licensing and tendering process
- Proper investigation not conducted while giving license and renewal of license or during tendering process due to lack of technical capacity
- Limited transparency and frequent bias

Besides external factors internal factors are also significant in limiting the growth of the industry. The major factor in this aspect is of sufficient capacity by design and construction firms. The major capacity gaps in the design firms are due to few experienced senior engineers and delayed payment from clients. On the other hand, lack of machineries and equipment for construction, insufficient feasibility study by the consultant and delayed handover of planned area was mentioned as the major capacity gaps. These capacity gaps have most of the time led to a delay or even default. The following figure summarizes for private and public consultants and contractors.

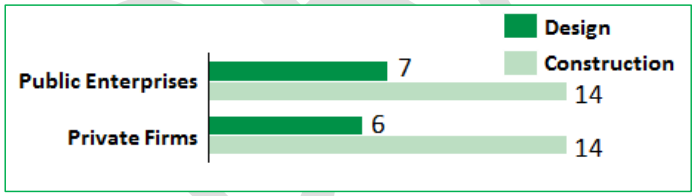

Figure 66: Average delays in scheme design and construction (months)

Above mentioned factors coupled with other problems have led to delayed delivery or termination of schemes in the GTP I period. The following figure illustrates the achievement of irrigation targets against GTP I plan by region.

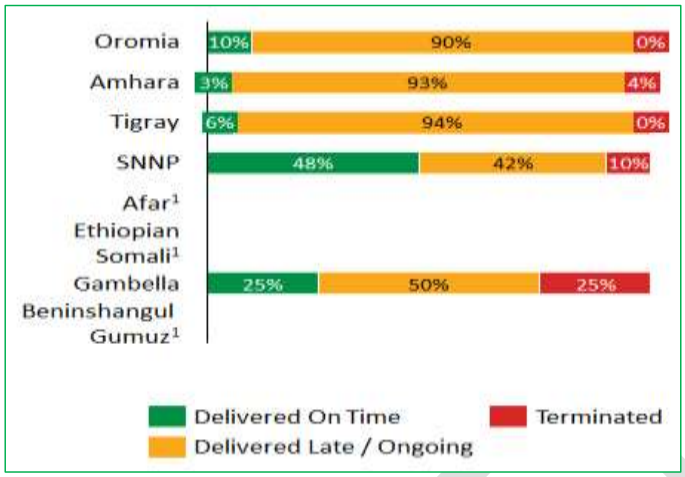

Figure 67: Percentage of planned schemes delivered by region during GTP 1[28]

The major factors hampering successful delivery of schemes can be summarized in to three groups:

- **Project management/supervision issues:** The main causes here are Lack of experienced project managers/supervisors and limited use of private supervisors (outsourced)
- **Design issues:** The main causes here are low capacity of private and public consultants and the fact that scheme design don't consider the actual situation in the ground
- **Construction issues:** The main causes here are low capacity of private and public consultants, issues related with right of way and limited interest of enterprises in remote scheme locations

INTERVENTION M14: **Ensure licenses are revised and certified every year and proper investigation of consultants and contractors is conducted annually by increasing budget and oversight of these processes, and developing national and regional databases of consultants and contractors including past performance**

Priority: Medium

Objectives/Description: The MoWIE or the RBoWRs are responsible for revising the licences of consultants and contractors in a specified interval. However, this process is deemed to ineffective and biased due to the limited focus given and lack of a centralized system to monitor consultancy and construction firms. If this process is to be efficient and effective two major things need to happen. The first thing is granting due focus to license revision process by allocating more resources. The second activity should be developing a data management and monitoring system specifically for consultancy and construction firms.

In this regard, this intervention has three main activities. 1) Enhance the human resource, financial and technical capacity of government agencies to support robust on-ground investigation of consultancy and construction firms. 2) Develop a national database template and popularize it with the regions and other agencies, also develop a reporting and communication mechanism. 3) Conduct baseline study of water works enterprises to support improvement of the licensing guideline and for the database. 4) Revise license renewal procedures.

Environment and gender mainstreaming: To be updated

[28]Data was unavailable for Afar, Somali and BeninshangulGumuz

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoWIE-permit directorate and regional BoWRs and irrigation authorities. MoANR-SSID and other public and private institutions are also involved.

Cost: 1-5 M (major cost items: hire new staff, training, annual license renewal)

Timeline: 6-12 months

***BOTTLENECK 20*: Low capacity of Water User Associations/ Irrigation Cooperatives**

Priority: High

Description: The legal framework for WUAs was established recently through the WUA proclamation (2014). The regions are also establishing their own WUA regional proclamations. In these proclamations the responsibilities of WUAs are clearly articulated. However, the level of implementation of these activities is relatively weak.

Major tasks	Major activities	Level of Impl.
Governance	• Set internal WUA/irrigation cooperative rules and regulations	◔
	• Elect members of the governing body	◔
	• Prepare year end financial reports	◔
	• Determine appropriate irrigation fees	◔
Management	• Prepare and monitor annual/seasonal water plan distribution	◔
	• Provision of scheduled irrigation water	◑
	• Inspection of irrigation infrastructure and equipment	◔
	• Conduct routine, seasonal and emergency maintenance	◔
	• Undertake construction and reconstruction work (if necessary)	◔
	• Collect irrigation fees from members	◔
	• Sanction non-paying members	◔
	• Arbitrate conflicts between members	◔
	• Train members on irrigation practices	◔

Figure 68: Major tasks of WUAs and current levels of implementation

There are multiple factors which negatively affect the level implementation of the main activities of WUAs. The following are the major ones:

- Policy and institutional issues: This includes absence of regulatory body to organize and mange WUAs, WUA regulations not yet enacted, compulsory membership not yet implemented and lack of sufficient training and support from local experts and Das
- Capacity issues: This includes lack of technical and financial capacity of WUAs to conduct required maintenance and limited enforcement capacity of WUAs
- Implementation issues: This includes Water fees are not applied in most scheme, actual water allocation don't follow the prescribed water distribution plan to issues such as upstream-downstream conflicts and frequent theft of water in schemes

INTERVENTION M15: **Provide incentives to WUAs to regularly conduct maintenance of schemes, e.g. preferential treatment in providing loans and capacity building of WUAs, maintaining schemes in good condition until full handover to WUAs**

Priority: Medium

Objectives/Description: Studies in different countries point out that providing incentives to WUAs to conduct regularly maintenance. The major incentives discussed in the studies are providing preferential treatment to WUAs who have good performance and also keeping schemes in good condition until handover to WUAs. By the same token if these interventions are correctly implemented they are expected to give positive results as they have achieved in other countries.

This intervention has three main activities. 1) Integrate maintenance related data into the scheme inventory and the ICT system for performance management. 3) Ensure that schemes are transferred in good condition to WUA or install some kind of financial arrangement with WUAs if the schemes are not in good condition. 3) Provide preferential treatment (e.g. loan or capacity building).

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, MoANR – SSID and regional BoWRs and irrigation authorities. WUAs are also involved in the implementation.

Cost: <1 M (major cost items: Loan and/or training for WUAs)

Timeline: 12-18 months

INTERVENTION M16: **Support the establishment of federation of WUAs especially for large scale schemes**

Priority: Medium

Objectives/Description: The federal WUA proclamation (2014) states that Federation of WUAs can be established per the agreement of member WUAs and the scheme management office. The proclamation especially puts the necessity to support the establishment of federation of WUAs during full transfer of an irrigation scheme. Though this might seem a longshot for Ethiopia considering the recent passage of the WUA proclamation but it is expected have a very large impact in strengthening the capacities of WUAs.

This intervention has four main activities. 1) Develop the capacity of WUAs in overall management of schemes. 2) Bring together WUAs in a scheme and create awareness on a federation of WUAs. 3) Set-up timeline for a full handover of an irrigation scheme. 4) Facilitate establishment of WUAs Federation. 5) Support the federation by providing financial support, building human resource capabilities and by providing equipment's (e.g. computers, water measuring devices).

Environment and gender mainstreaming: To be updated

Owner and involved parties: The main owners of this intervention are MoWIE-Irrigation and Drainage Directorate, scheme project offices and regional BoWRs and irrigation authorities. WUAs and MoANR are also involved in the implementation.

Cost: 5-10 M (major cost items: training, cost of providing computers, water measuring devices, etc.)
Timeline: 24-36 months

6.4. Technology supply chains

6.4.1 Bottlenecks with high priority interventions

***BOTTLENECK 25*:High tariffs and lack of availability of FOREX for importing pumps, parts, other equipment, and raw materials**

Priority: High

Description: Import tariff accounts for a sizable amount of the final price on irrigation technologies. For instance, a total 37% import tax is levied on engine pumps. This includes 23% import tax and 15% VAT. The figure below illustrates the tariff rates for major irrigation equipment.

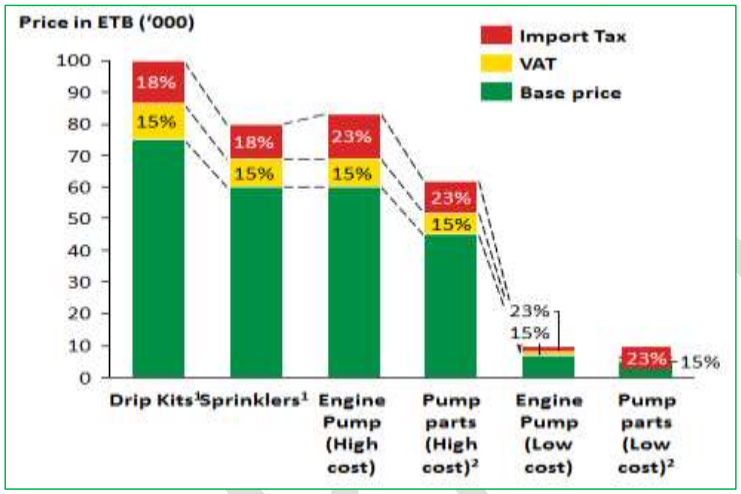

Figure 69: Import tariff and price for irrigation equipment

The current tariffs for irrigation technology are a major obstacle to promoting adoption among smallholder farmers, especially where credit is relatively inaccessible. The significant price increase in technology has been described as prohibitively high by retailers and irrigation service providers, who are disincentivized to build a reliable, demand-driven supply chain for irrigation pumps.[29] A related challenge is the low availability of foreign exchange for this sub-sector as irrigation equipment is not currently prioritized in foreign exchange allocation with other agricultural inputs such as fertilizer. As a result, importing irrigation equipment often takes between 3 and 6 months due to delays in opening letter of credit.

[29]HHI strategy

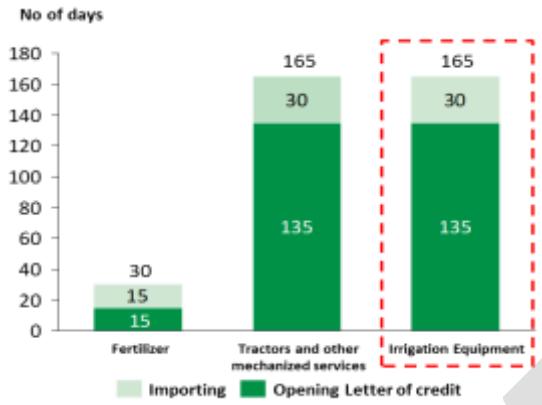

Figure 70: Length of importing time for fertilizer, machineries and irrigation equipment[30]

INTERVENTION H26: Undertake policy analysis on optimal import tariff for equipment, and advocate for implementation of recommendations

Priority: High

Objectives/Description: A detailed policy analysis is required to determine the optimal tariff rate for pump and associated raw materials and parts. The implementation of the recommendation requires the buy-in of policy makers. Therefor senior policy makers need to be engaged from the start. In addition, strong advocacy coupled with awareness creation to realize changes in the tariff rates.

The major activities under this intervention are doing policy analysis of optimal import tariff rates for irrigation pump, pump raw material and pump parts and presenting the analysis recommendation to policy makers to inform decision on pump tariff.

Environment and gender mainstreaming: To be updated

Owner and involved parties: The major owners are MoWIE-Irrigation and Drainage Directorate and MoANR-SSI directorate. ATA and regional BoWRs and irrigation authorities are also involved in the implementation.

Cost: <1 M (Major cost items: setting-up a project team to do the analysis, conducting the policy analysis study)

Timeline: 6-12 months

INTERVENTION H27: Prioritize FOREX allocation for equipment, parts and raw material imports

Priority: High

Objectives/Description: Facilitating imports of irrigation equipment and spare parts is essential for the development of the private sector supply chain and in general, for increasing the adoption rate of irrigation technology nationally. Due to a lack of sufficiently big domestic industry producing quality inputs, manufacturers, wholesalers and retailers are unable to provide adequate technical support to smallholder farmers. The prioritization of FOREX allocation for irrigation technology along with other agricultural inputs would allow timely imports of such equipment and spare parts and thus, promoting the development of the sector as a whole.

[30] Source: ATA interviews with stakeholders (2016).

This intervention will entail: 1) conducting a policy analysis showing the benefits of including the irrigation sector among those prioritized for the allocation of FOREX; 2) validating the analysis with stakeholders and presenting it to the government for consideration; 3) Follow up of the endorsement and implementation

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources. MoWIE-Irrigation and Drainage Directorate and ATA will be the other parties involved.

Costs: <1 MN (major cost item: Study conducted as part of policy analysis, stakeholder validation)

Timeline: 6-12 months.

***BOTTLENECK 26*:Limited investment in multiplication, wholesaling and retailing of equipment including due to lack of access to finance**

Priority: High

Description: The irrigation technology supply chain is characterised by the low involvement of the private sector, that is, there are few domestic private manufacturers, wholesalers and retailers of irrigation technology. There are two main reasons behind this limited presence: 1) the low national adoption rate of irrigation technology leading the private sector to believe that there is little room for profitable investments in multiplication, wholesaling and retailing; 2) the lack of financial resources necessary to make these investments. Moreover, these few domestic manufacturers are often not able to produce irrigation technology according to quality and uniform standards. For instance, manual pump manufacturing is mostly undertaken by domestic workshops with poor quality control.[31] This implies that locally produced irrigation equipment frequently breaks and/or cannot be used as it doesn't meet minimum standards. Therefore, such equipment, including spare parts, needs to be mostly imported, resulting in significantly higher costs for the private sector. In fact, when purchased via private supply lines, taxes (import tariffs and VAT) on irrigation equipment can reach up to 40% of the import CIF value. These factors discourage private investments in multiplication, wholesaling and retailing. As a consequence, the farmers currently adopting irrigation technology have to go to Addis Ababa or even to bordering countries like Sudan to buy the necessary spare parts. In turn, the low availability of this services reduce even more the uptake of irrigation technology.

This bottleneck represents a key impediment to scaling the availability of irrigation equipment and eventually to farmers' access, uptake and sustainable use of these technologies. Therefore, to solve the above-mentioned reasons causing such bottleneck, seven high priority interventions have been identified as follows: four interventions provide the necessary support for raising the private sector's interest in irrigation technology and three interventions aim at increasing the needed financial resources for the development of a successful private sector supply chain.

***INTERVENTION H28:*Promote joint ventures with international firms and/or technology transfer programs with partner countries and NGOs**

Priority: High

Objectives/Description: Ensuring an adequate supply of technical expertise is essential for increasing the multiplication of irrigation equipment. For instance, private firms and NGOs promote innovative business models by developing and marketing new technologies that entrepreneurs can use to establish

[31] Agricultural Transformation Agency (2014).*Transforming the supply of irrigation pumps in Ethiopia*. Working Draft, page 23.

and run profitable small-scale businesses.[32] Hence, partnerships and/or technology transfer programs will provide the needed knowledge and skills to manufacture quality irrigation equipment and input and will also help to create viable business opportunities in the sector.

This intervention should include three main activities: 1) the definition and prioritization of all areas where joint venture support would be helpful; 2) the identification of foreign and domestic development partners interested to support joint ventures and technology transfer programs; 3) the provision of targeted analytical, financial, legal and negotiation support for the start-up of joint ventures and technology transfer programs.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources.

Costs: 1-5 MN (major cost items: training of staff on different activities, reaching out to potential foreign and domestic partners)

Timeline: 6 months (set-up); ongoing activities.

INTERVENTION H29: **Provide business, technical and financial support to wholesalers and retailers willing to invest in retailing in rural areas**

Priority: High

Objectives/Description: Widespread access to wholesale and retail services is fundamental for ensuring uptake and sustainable use of irrigation technology. Supporting wholesalers and retailers interested in opening rural branches or sending agents in rural areas will provide smallholder farmers currently unable to travel outside their area with access to irrigation equipment. This will not only encourage adoption rates by smallholder farmers but also will promote the development of a successful private sector supply chain and hence, new employment opportunities.

This intervention will require the following activities: 1) Define of the menu of support areas (e.g. business model development and sales), the development of support material and, to put in place modalities for support delivery. 2)Identify of potential recipients and the diagnostics of their capacity along support dimensions before launching the program. 3) Close follow up of the program implementation

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources and the Regional Bureaus of Agriculture/Irrigation agencies. MoWIE, RBoWIE and NGOs are the other parties involved.

Costs: <1 MN (major cost items:content development of support material, training).

Timeline: 12-18 months (set-up); ongoing activities.

INTERVENTION H30: **Increase credit access for existing or nascent manufacturers, wholesalers and retailers willing to scale up own business**

Priority: High

Objectives/Description: To promote the development of a private supply chain of irrigation technology and related services, suitable financial products should be made available to interested existing or nascent manufacturers as well as to wholesalers and retailers. An increased availability of financial

[32] For more information, see http://www.ifc.org/wps/wcm/connect/f6fdcd8047e252ca9d05fd299ede9589/Jain+Temporary.pdf?MOD=AJPERESand http://kickstart.org/.

solutions for the irrigation sector will encourage private investments which, in turn, will positively affect irrigation adoption rates among farmers.

This intervention will entail: 1) discussing existing and potential funding options and eligibility criteria for credit provision with the Development Bank of Ethiopia, leasing financial providers and other financial institutions providing credit guarantee schemes; 2) agreeing on a list of financial products to make available to the irrigation and drainage sector; 3) organizing awareness creation events for manufacturers, wholesalers and, retailers on the financial products and schemes.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources and the Regional Bureaus of Agriculture.

Costs: 1-5 MN (major cost item:organization awareness creation events).

Timeline: 12-18 months (set-up); ongoing activities.

INTERVENTION 31:**Facilitate linkages between wholesalers and retailers, cooperatives and farmer common interest groups, and financial institutions for equipment purchase and financing**

Priority: High

Objectives/Description: Linking wholesalers and retailers in major cities with unions and cooperatives in rural areas would at the same time help both the private sector in expanding into new markets and unions and cooperatives to have better access to irrigation equipment and inputs. This interventions aims at raising the interest of the private sector in irrigation by providing them the necessary demand and giving access to irrigation technology to farmers that cannot travel to major cities or even to bordering countries.

This intervention will require the following activities: 1) Identify potentialinterested actors (wholesalers and retailers in major cities and unions/coops in rural areas); 2) Analyze existing linkage mechanisms and eventual bottlenecks; 3) Design of solutions for mitigating these problems; 4) Validate the designed solutions or sub-interventions; 5) Link participants through formal introductory and periodic meetings, the informal provision of contact information and, the provision of high-level support to these meetings.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources and the Regional Bureaus of Agriculture.

Costs: <1 MN (major cost items: Study to analyse potential linkage, organising workshops/conferences to link participants)

Timeline: 6-12 months (set-up); ongoing activities.

BOTTLENECK 27: **High cost of equipment and labour and limited access to finance for smallholder farmers**

Priority: High

Description: The cost of agricultural input package is fairly expensive for a typical small holder farmer. To use irrigation, small holder farmers are expected to invest in irrigation equipment and its operation and maintenance. This makes it expensive for the farmer to afford irrigation equipment without access to finance.

Based on the interviews conducted with different financial institutes throughout Ethiopia, limited access to credit service is available for farmers to purchase irrigation equipment. Microfinance institutions like DECSI and OCCSO have been providing loan to small holder farmers to purchase irrigation equipment.

Public irrigation equipment manufacturers like METEC have also been providing irrigation equipment to be paid over years. But all those accesses are not sufficient to cover millions of small holder farmers.

Beside the limited access to credit for individual farmers, the provision of loans and grants for water users associations, irrigation cooperatives and farmer groups have also been low. This is mainly because there are no legally organized water users associations in the county.

INTERVENTION H32: **Introduce dedicated wholesale lending, guarantee schemes, or revolving funds for financing irrigation equipment and related inputs for farmers through MFIs, RuSACCOs, cooperatives and/or farmer common interest groups**

Priority: High

Objectives/Description:: Easing credit access for farmers to allow them to purchase irrigation equipment and related inputs is of high importance for both increasing irrigation technology adoption rates and for creating the necessary demand for the development of the private sector. Relevant financial support can take a range of forms such as increased wholesale lending, guarantee schemes for farmers, group lending and/or voucher systems as well as financial products for operation and maintenance of irrigation equipment. The establishment of a revolving fund will significantly contribute to the promotion of investments in the irrigation sector by farmers. The design of the repayment schedules of such financial products should be aligned with varied irrigation-agriculture harvests.

This intervention will entail: 1) discussing existing and potential funding options for irrigation equipment and related inputs and eligibility criteria with interested financial institutions and validating feasibility of these options; 2) agreeing on required funding, guarantee schemes and financial products for farmers; 3) establishing the wholesale lending, guarantee schemes, and financial products, and 4) organizing awareness creation events for farmers on the financial products and schemes.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources and the Regional Bureaus of Agriculture. FIs, NBE, Development partners, MoWIE-Irrigation and Drainage directorate and SACCOs are other involved parties.

Costs: 5-10 MN ETB (the main cost item is the organization of awareness creation events).

Timeline: 12-18 months (set-up); ongoing activities.

6.4.2 Bottlenecks with medium priority interventions

BOTTLENECK 26: **Limited investment in multiplication, wholesaling and retailing of equipment including due to lack of access to finance**

Priority: High

Description: The irrigation technology supply chain is characterised by the low involvement of the private sector, that is, there are few domestic private manufacturers, wholesalers and retailers of irrigation technology. There are two main reasons behind this limited presence: 1) the low national adoption rate of irrigation technology leading the private sector to believe that there is little room for profitable investments in multiplication, wholesaling and retailing; 2) the lack of financial resources necessary to make these investments. Moreover, these few domestic manufacturers are often not able to produce irrigation technology according to quality and uniform standards. For instance, manual pump manufacturing is mostly undertaken by domestic workshops with poor quality control.[33] This implies that locally produced irrigation equipment frequently breaks and/or cannot be used as it doesn't meet minimum standards. Therefore, such equipment, including spare parts, needs to be mostly imported, resulting in significantly higher costs for the private sector. In fact, when purchased via private supply lines, taxes (import tariffs and VAT) on irrigation equipment can reach up to 40% of the import CIF value. These factors discourage private investments in multiplication, wholesaling and retailing. As a consequence, the farmers currently adopting irrigation technology have to go to Addis Ababa or even to bordering countries like Sudan to buy the necessary spare parts. In turn, the low availability of this services reduce even more the uptake of irrigation technology.

This bottleneck represents a key impediment to scaling the availability of irrigation equipment and eventually to farmers' access, uptake and sustainable use of these technologies. Therefore, to solve the above-mentioned reasons causing such bottleneck, seven high priority interventions have been identified as follows: four interventions provide the necessary support for raising the private sector's interest in irrigation technology and three interventions aim at increasing the needed financial resources for the development of a successful private sector supply chain.

INTERVENTION M17: **Introduce finance and technical support program for well drilling service providers and irrigation equipment rental service providers**

Priority: Medium

Objectives/Description: Promoting finance and technical support for well-drilling and irrigation services would encourage irrigation technology adoption by farmers. Pilot studies in Ethiopia have demonstrated that once trained in technical well drilling and in business management skills and, given access to finance to cover the high initial capital costs, private sector well drilling businesses can operate profitably.[34]

Concerning irrigation technology, rental service providers represent a valid option for farmers who cannot afford to pay upfront for highly priced irrigation technology such as engine pumps. The irrigation service providers (ISPs) rent a pump set at a fixed rate to an individual or to a group of farmers and provide operational and maintenance services for the pump set for a fixed period of time. Such rental services allow small-scale entrepreneurs to earn a profit, smallholder farmers with not enough financial resources to access irrigation technology and associated services and, farmers with enough capital to test such technology before making large investments.[35]

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[33] Agricultural Transformation Agency (2014).*Transforming the supply of irrigation pumps in Ethiopia*. Working Draft, page 23.
[34] Weight, E., Yoder, R., and Keller, A. (2013).Manual Well Drilling Investment Opportunity in Ethiopia (IWMI Working Paper 155).Retrieved from International Water Management Institute website: http://www.iwmi.cgiar.org/Publications/Working_Papers/working/wor155.pdf.
[35] Agricultural Transformation Agency (2014).*Transforming the supply of irrigation pumps in Ethiopia*. Working Draft.

This intervention would requireidentification of support areas and potential recipients, conduct of diagnostics of their capacity along support dimensions, validation of the approach with different stakeholders, mobilization of funding for different activities and launching of the program.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources and the Regional Bureaus of Agriculture.

Costs: 5-10 MN (major cost item: Diagnostics study of potential recipients and their capacity).

Timeline: 6 months (set-up); ongoing activities.

BOTTLENECK 28: **Limited availability of manual and mechanized well drilling services, irrigation equipment rental services, and skilled maintenance service providers**

Priority: Medium

Description: Manual and mechanized well drilling services are not widely available in Ethiopia and they are mostly provided by public enterprises. There are typically nolocal private service providers that can be hired to manually drill irrigation wells.[36] Similarly, the available number of well drilling machines is mostly publicly-owned and not sufficient to meet the needs of the irrigation sector.[37] In addition existing well drilling service providers often lack the necessary technical skills resulting in poor quality of well construction.[38] This limited human resource capacity in well drilling is also due to the lack of adequate education and training in well drilling at different levels.

The availability of maintenance services for irrigation technology hasalso been historically low in Ethiopia.[39]A 2013 survey conducted in 96 AGP woredas revealed that smallholder farmers struggle to locate maintenance service providers and consequently, this lack of aftersales services is the primary contributor to pump failure.[40] In particular, even though sometimes unions, cooperatives or DAs undertake maintenance services, they lack the technical skills to effectively maintain large and small scale equipment. Low availability of well drilling and maintenance services has a significant negative effect on the access and uptake of irrigation technologies by smallholder farmers.

INTERVENTION M18: **Improve content and delivery of well drilling courses in universities and in technical TVET institutions**

Priority: Medium

Objectives/Description: Public universities and TVET institutions can play a pivotal role to meet the significant capacity requirement of well drilling services of Ethiopia. Improving the current offer of education and training by such institutions will provide the required expertise needed to develop a viable private sector technology supply chain and, ultimately, the dissemination of irrigation technologies across the countries. Enhancing the well drilling course content and delivery at the university level will not only provide expertise at the senior level but also provide the needed instructors at TVET institutions for junior well drillers. Hence, the increase in the availability of well driller service providers will contribute to the increase in the national irrigation adoption rates.

First, the implementation of this intervention will require to design the content and delivery of well drilling courses appropriate to the needs of the national irrigation sector. Secondly, an assessment of

[36]Weight, E., Yoder, R., and Keller, A. (2013).Manual Well Drilling Investment Opportunity in Ethiopia (IWMI Working Paper 155).Retrieved from International Water Management Institute website: http://www.iwmi.cgiar.org/Publications/Working_Papers/working/wor155.pdf.
[37] Agricultural Transformation Agency (2014).*Transforming the supply of irrigation pumps in Ethiopia*. Working Draft.
[38]*Idem*.
[39]*Idem*.
[40]*Idem*.

the current capacity of universities and TVET institutions to deliver these courses will be conducted. Thirdly, modalities (e.g. design enhanced curriculum) for filling any eventual gap will be designed and put in place.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be MoANR – SMIS in collaboration with Ministry of Education and Ministry of Water, Irrigation and Electricity.

Costs: <1 MN (major cost item: Content redesign, training of teachers/professors).

Timeline: Ongoing activities.

INTERVENTION M19: **Improve content and delivery of irrigation technology maintenance courses in Agricultural TVET institutions**

Priority: Medium

Objectives/Description: Education and training in maintenance services for irrigation technology is fundamental for sustaining its uptake and usage by smallholder farmers. Agricultural TVET institutions are typical for training skilled technicians such as in the area of drilling and mechanical skills. However, while ATVET institutions offer courses in maintenance services for irrigation technology, these courses do not often provide the necessary theoretical and in particular, practical knowledge to form technicians capable of adequately maintaining such technology. Hence, improving their current offer of irrigation technology maintenance service course in terms of both content and delivery will highly contribute to meet the capacity requirement for well-trained maintenance service providers and in this way, to spur growth in irrigation adoption rates.

As above mentioned for well drilling courses, the implementation of this intervention will require to design the content and delivery of maintenance courses appropriate to the needs of the national irrigation sector. Secondly, an assessment of the current capacity of ATVET institutions to deliver these courses will be conducted. Thirdly, modalities (e.g. design enhanced curriculum) for filling any eventual gap will be designed and put in place.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be MoA-SSID in collaboration with Ministry of Education and Ministry of Water, Irrigation and Electricity.

Costs: <1 MN (major cost items:content design, training of professors/teachers).

Timeline: 12-18 months (set-up); ongoing activities.

INTERVENTION M20: **Provide trainings and accreditation on installation, operation, maintenance and repair of irrigation equipment to private garages**

Priority: Medium

Objectives/Description: Private garages, widespread across the country, provide a range of mechanical services, including maintenance and repair of agricultural machinery. Hence, they already have skills on maintenance that can be leveraged to provide the same services for irrigation technology. Thus, not only private garages will not require intensive retraining on operation, installation, maintenance and repair of irrigation equipment but given their widespread presence, local provision of maintenance services will become timely. Hence, such garages will greatly contribute to overcome a critical barrier in the uptake and sustainable use of irrigation technology by smallholder farmers.

This intervention will require the following activities: 1) designing training curriculum, related materials and delivery modalities for training delivery (theoretical and practical sessions); 2) identifying potential

recipients, conducting diagnostics of their capacity and providing training as relevant; 3) providing accreditation to qualified recipients to ensure consistent quality.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources, Regional Bureaus of Agriculture and MoWIE – Irrigation and Drainage Directorate.

Costs: <1 MN (major cost items:designing training curriculum, related materials and delivery modalities).

Timeline: 12-18 months (set-up); ongoing activities.

INTERVENTION M21:**Increase accessibility of maintenance services across the country by leveraging the Ethiopia Agricultural Business Corporation (EABC)'s permanent and mobile workshops**

Priority: Medium

Objectives/Description:AISC has about 500 employees with a wide range of expertise including mechanical and agricultural engineers. In addition, one ofAISC's core businesses is to provide maintenance services of agricultural machineries. It conducts a well-equipped central workshop for maintenance services with appropriate human capacity. AISC has also unique mobile maintenance workshops that can provide services across the country. Hence, once provided for any eventual gap, leveraging the maintenance and repair services undertaken by AISC will ensure the provision of needed assistance to the irrigation sector with wide national coverage.

This intervention should include: 1) discussing and agreeing on collaboration modalities with AISC; 2) assessing and building the current capacity of AISC to deliver irrigation technology maintenance services; 3) creating and launching an implementation plan; 4) conducting periodic monitoring and evaluation of ongoing work.

Environment and gender mainstreaming: To be updated

Owners and involved parties: The lead implementer of this intervention will be the Ministry of Agriculture and Natural Resources and the Regional Bureaus of Agriculture.

Costs: 10-50 MN (major cost items: training of AISC staff, developing irrigation technology services).

Timeline: 12-18 months (set-up); ongoing activities.

APPENDICES

A1. Steering Committee, Technical Committee and stakeholder engagement details

The project was overseen by a Steering Committee, chaired by State Minister of Natural Resources, MoANRD, W/roFreneshMekuria, with members from MoANRD, ATA, MoWIE, MoLF and FCA. The specific role and responsibility of the steering committee members was to provide overall steering, direction and decision-making at key points in projectwhen issues were escalated from the Technical Committee, and to sign-off of the final deliverable (i.e. this document).

In order to ensure development of an effective and technically sound strategy, a Technical Committee was also formed comprising of key stakeholders within the irrigation sector, including representatives from MoANRD (SSID, Extension advisory and training Directorate, Smallholder Horticulture Directorate,SMIS,AGP,FCA), MoWIE, MoLF, EIAR, FAO, IWMI, and ATA (SIWD Team, Extension Team, Gender Teams). Regional bureaus of agricultural, water resources and irrigation authorities were also invited to participate in Technical Committee meetings. The Technical Committee was chaired by MoANRD SSI Director Ato Elias Awol.

The specific roles and responsibilities of the Technical Committee members were to:

- Validate the approach and methodology followed by the project team in developing the strategy
- Support identification of relevant stakeholders to be engaged through interviews, workshops and in other forums
- Support strong attendance of invitees at workshops and key meetings by utilizing their stakeholder relationships and encouraging attendance
- Provide technical input, relevant documents, and data required, or facilitate technical input and document and data provision from other staff at their organizations
- Review and validate outputs produced by the project team
- Ensure strong alignment with ongoing and planned programs and initiatives at their organizations and at other organizations with which they are familiar.

Two workshops were carried out during the development of this strategy. The purpose of the workshops was to consult a wide range of stakeholders, collect data and validate outputs of the project.A large number of stakeholders participated in these workshops and provided input to the strategy. The agendas of the workshops are provided below, followed by a list of invitees and attendees.

Workshop 1: Project Launch National stakeholders Workshop

- Opening remarks
- Workshop objectives, agenda and project overview
- Presentation: Priority bottlenecks and supporting analysis
- Plenary discussion
- Small group discussion: Validating priority bottlenecks and developing initial set of priority interventions
- Report back and plenary discussion
- Closing remarks

Workshop 2: Project Validation National Stakeholders Workshop

- Opening remarks
- Opening remarks and participant introductions

- Presentation 1
  - Overview project background, objectives, scope and approach
  - Present structure of the strategy document, vision and strategic objectives
  - Present irrigation potential and impact analysis
  - Review prioritized bottlenecks
- Plenary discussion
- Presentation 2
  - Present program components, roadmaps and intervention details (supporting analysis, activities, owners / involved, costs, timelines)
- Small group discussion by program component
- Validate roadmaps and intervention details
- Small group report back
- Plenary discussion
- Closing remarks

Workshop 1 and 2 Invitees and Attendees

Commented [s20]: Workshop 2 details to be added after workshop

	Institution	Launch Workshop	Validation Workshop
1	MoANR SSI Directorate	✓	
2	MoARNR Extension Directorate	✓	
3	MoANR Extension advisory and training	✓	
4	MoANR SSI Directorate	✓	
5	MoANR NRM	✓	
6	MoANR Horticulture Directorate	✓	
7	MoANR Mechanization Directorate	✓	
8	MoANR Women Affairs Directorate	✓	
9	MoANR AGP	✓	
10	MoANR PASIDP	✓	
11	MoWIE Ground Water Directorate		
12	MoWIE Irrigation and drainage Directorate	✓	
13	MoWIE Irrigation and drainage Directorate		
14	MoWIE Geo- Information Directorate	✓	
15	MoWIE Hydrology and Water Quality Directorate		
16	MoWIE Basin Development Studies Directorate		
17	Ministry of Livestock & Fisheries		
18	Ministry of Livestock & Fisheries	✓	
19	Federal Cooperative Agency	✓	
20	Ministry of Trade		
21	Ministry of science and Technology		
22	Minstry of Education		
23	Ethiopian Standards Agency		
24	Ethiopian Conformity Assessments Enterprise	✓	
25	Oromia Irrigation Development Authoritty		
26	Ethiopian Institute of Agricultural Research		
27	Melkasa Agricultural Research Center (EIAR)		

	Institution	Launch Workshop	Validation Workshop
28	Holeta Agricultural Research Center		
29	Oromia Agricultural Research Institute		
30	Tigray Agricultural Research Institute	✓	
31	Amhara Agricultural Research Institiute	✓	
32	SNNPRs Agricultural Research Institiute	✓	
33	Asosa Agricultural Research Center	✓	
34	Afar Pastoral and Agro-pastoral Research Institiute	✓	
35	Somali Pastoral and Agro-pastoral Research Institute		
36	Gambela Agricultural Research Institute	✓	
37	Oromia Bureau of Agriculture		
38	Amhara Bureau of Agriculture and Rural Development		
39	Tigray Bureau of Agriculture and Rural Development	✓	
40	Tigray Bureau of Agriculture and Rural Development		
41	SNNPRs Bureau of Agricultue and Rural Development	✓	
42	BenishangulGumuz Bureau of Agriculture and Rural Development		
43	Afar Pastoral Agricultural and Rural Development Bureau		
44	Somali Bureau of Agriculture and Rural Development		
45	Diredawa Bureau of Agriculture and Rural Development	✓	
46	Gambela Bureau of Agriculture and Rural Development	✓	
47	Harari Regional Agricultural and Rural Development Bureau		
48	Tigray Bureau of Water Resources	✓	
49	Amhara Water Resources Development Bureau		
50	Oromia Bureau of Water Resources		
51	SNNPRs Water Resources Development Bureau	✓	
52	BenishangulGumuz Water Resources Development Bureau		
53	Afar Bureau of Water Resources		
54	Somali Bureau of Water Resources		
55	Gambela Water, Mines and Energy Resources Development Bureau		
56	Diredawa Bureau of Water Resources	✓	
57	Addis Ababa Water and Sewarage Authority	✓	
58	Baherdar Agricultural Mechanization Center		
59	MekeleAgricultiral Research Center		
60	Sodo Agricultural Research Center		
61	Weliso Agricultural Research Center		
62	Bako Agricultural Research Center	✓	
63	Arbaminch University		
64	Bahirdar University		
65	Mekelle University	✓	
66	Hawasa University		
67	Haramaya University	✓	
68	Jijiga University		
69	ATA Tigray ACC		

	Institution	Launch Workshop	Validation Workshop
70	ATA Oromia ACC		
71	ATA SNNP ACC		
72	ATA Amhara ACC		
73	OMNI		
74	Netafim	✓	
75	Davis &Shirtliff Trading P.L.C	✓	
76	HAGBES PLC		
77	Ambassel Trading House		
78	ESFRE Trading	✓	
79	Wondo		
80	Biselex Ethiopia PLC	✓	
81	F.D.R.E Metals and Engineering Corporation (METEC)		
82	AMIO Engineering PLC	✓	
83	Biruh Tesfa Irrigation and Water Technology PLC		
84	Adama Agricultural Machinery Industry	✓	
85	SelamChilderen's Village (TRIAE)	✓	
86	Cooperative Bank of Oromiya		
87	OMO Microfinance Institution S.Co		
88	Amhara Credit and Sacing Institution (ACSI)		
89	Oromia Credit and Saving Share Company (OCSSCO)		
90	Dedebit Credit and Saving Institution SC (DECSI)		
91	Asegid Ephrem		
92	Shiferaw Bekele	✓	
93	Demisew Abate		
94	Metaferia Consulting Eng.	✓	
95	DestaHorecha	✓	
96	AsfawAfera		
97	Sorsa Consult	✓	
98	Water Works Design and Supervision Enterprise	✓	
99	Ethiopian Water Works Construction Enterprise		
100	Oromia Water Works Design and Supervision Enterprise	✓	
101	Oromia Water Works Construction Enterprise	✓	
102	Amhara Water work Construction Enterprise		
103	Amhara Design and Supervision Enterprise		
104	South Water Works Construction Enterprise	✓	
105	SNNPR's Water Works Design and Supervision Enterprise	✓	
106	Tigray Water Works Study Design and Supervision Enterprise		
107	Tigray Water Works Construction Enterprise	✓	
108	Benishangul Water Works Construction Enterprise	✓	
109	Afar Water Works Construction Enterprise		
110	Afar Water Works Design and Supervision Enterprise		
111	Somali Water Works Construction Enterprise		

	Institution	Launch Workshop	Validation Workshop
112	Somali Design and Supervision Enterprise		
113	Somali Irrigation and Basin Development Bureau	✓	
114	Water Works Design and Supervision		
115	IWMI	✓	
116	FAO	✓	
117	IWMI		
118	IFAD/PASDIP		
119	SMIS Project	✓	
120	SMIS Project		
121	IDE	✓	
122	JICA	✓	
123	World Bank		
124	GIZ	✓	
125	USAID		
126	DANIDA		
127	USAID		
128	Dutch Development Corporation		
129	CIDA		
130	PCDP		
131	ORDA		
132	REST		

A2. Irrigation potential and impact analysis modelling details

Detailed methodology

This section describes the detailed approach of the irrigation potential assessment analysis and the steps followed to determine the impact of realizing that irrigation potential. The complete irrigation potential estimation and corresponding impacts are computed through the use of an excel model, in the steps outlined below:

1. Collection, validation and processing of primary data
2. Identification of irrigation technologies, grouping into irrigation technology packages and costing accordingly
3. Identification of list of crops to consider throughout the analysis
4. Identification of possible irrigation technology packages for shortlisted crops through technical compatibility and economic analyses
5. Estimation of Absolute Potential for irrigation in each woreda based on technically feasible *water source – crop – irrigation technology*combinations and woreda land data
6. Determination of irrigation potential at each woreda level through identification of best *water source – crop – irrigation technology* combinations to scale up based on technical compatibility and economic analyses
7. Estimation of increase in production and revenue if economic potential irrigation is realized
8. Estimation of economic feasibility of using supplementary irrigation for shortlisted crops based on consideration of availability of water during critical growing period of crops

1. Collection, validation and processing of primary data

Woreda level detailed data was sourced and/or analysed from different sources for use in the impact assessment model. The table below depicts in detail the data sets, their sources and corresponding analyses that have been computed to attain woreda level details.

Section	Data		Data Source	Data Sourced
Geographic area specific data	**Primary soil type in woreda**		MoANR	National soil map shape file
	Average slope in woreda		CSA	Woreda level average land slope
	Average farm size In woreda		CSA	Woreda level farmed land (permanent + temporary crops)
Water source specific data per woreda	**Ground Water**	**PH**	GSE	1:250,000 scale hydrogeological map of Ethiopia
		SAR	GSE	
		TDS	GSE	
		EC	GSE	
		Average Discharge Potential	GSE	
	Surface Water	**PH**	MOWIE	Basin Station data with water quality readings
		SAR	MOWIE	

		TDS	MOWIE	
		EC	MOWIE	
		Average Discharge Potential	MOWIE	Basin Station data (179 stations) with Min, Max and Average discharge readings for ~10 years (the duration varies across stations)
	Rain Water	**Average depth available**	CSA	Woreda level annual rainfall data for 15 years
Crop Specific data at Regional Level	**Crop Yield**		ATA ACC planning, CSA	Zonal average and model farmer yields per crop for 2015
	Price of seed		Regional ATA Office	Regional average prices per crop for 2015
	Number of harvests		Regional ATA Office	Regional average number of harvests per crop
	Farm-gate prices		CSA 2 year average values (2013–2015)	Regional average farm-gate / producer prices per crop
	Labor and mechanization cost		Regional ATA or BoA Office	Regional average daily labor cost for 2015
	Price of Fertilizers (ETB/Kg)		Regional ATA or BoA Office	Regional fertilizer price per crop for 2015
	Price of agro-chemicals (ETB/Kg)		Regional ATA or BoA Office	Regional average price per crop for 2015
	Land rental/property tax (ETB/ha)		Regional ATA or BoA Office	Regional land tax rates

Figure71: Data, data source and type used in impact assessment

Four of the raw data sets required extensive processing before inputting to the main model:

- Surface water potential estimation at a woreda level
- Ground water potential and quality estimation at a woreda level
- Dominant soil type at a woreda level
- Crop yield estimation at a woreda level

1. Surface water potential estimates at a woreda level

The Basin station data gathered from MOWIE have been analysed as follows:

- Raw basin data contains a Min, Max and Average discharge readings for multiple years
- The average of the monthly Min values is first taken and then the average of the annual value is then computed for use in the model; the Min reading is used as a conservative approach, given there is a large amount of variability in the readings from each station and the Min reading given the most accurate picture of water available on a consistent basis

- Station readings mapped on GIS and overlaid with administrative boundaries of Woreda
- Varying buffer zones per station modeled to allocate discharge at woreda level – 50KM buffer used for analysis
- In cases of multiple discharge rates per woreda (i.e. woreda falls in buffer zone of multiple stations), maximum flow considered rather than summation

Figure72: Basin Stations and corresponding boundaries (Source: ATA SIWD team)

2. Ground water potential and quality estimation at a woreda level

The Hydro geological map collected from GSE is analyzed as follows:

- Raw data is a GIS map that shows ground water discharge potential and water quality on an aerial spread
- GIS mapping used to overlay hydrogeological map with woreda administrative boundaries
- Woreda discharge potential mapped based on the discharge potential areal spread that it falls under
- In cases of multiple discharge rates per woreda (i.e. woreda falls in areal coverage of multiple discharge potentials), weighted average of discharge potential and area coverage considered

3. Dominant soil type at a woreda level

The national soil type shape file received from MOA is analysed as follows.

- Raw data is a shape file that shows the areal coverage of the soil types nationally
- The soil map is overlaid with woreda level administrative boundaries
- The map is clipped out into one clipping per woreda along the woreda administrative boundaries
- The dominant soil type within each clipping selected to be the dominant soil type for the respective woreda

4. Crop yield estimation at a woreda level

Crop yield data collected from CSA and the GTP II productivity targets have been analysed as follows:

- CSA data collected shows zonal level current farmer yields
- GTP II current and five year target yields used to determine the percentage increase in productivity that is expected per crop
- The crop level average productivity increment used to model five year target yields for all zones based on the reported current yield from CSA
- A 20% increase in average farmer yield modelled to account for the advantage of advanced water management possible with irrigation
- Average research yields from regional research centres used as caps to define the maximum limit for increased productivity per crop
- Projected zonal yields considered for use in determination of irrigation potential estimation as well as the corresponding impact assessment

Lastly, after processing all the data, where a specific data element was missing for any particular woreda, default values were used as shown in the following table based on the average or median value observed for other woredas.

Section	Data		Default Values	Rationale
Geographic area specific data	Primary soil type in woreda		Lithosol (Leptosols)	Highest share of land coverage nationally (14.7%)
	Average slope in woreda		14%	Average of woreda level slope
	Average farm size in woreda		1.22 ha	National Average
Water source specific data per woreda	Ground Water	PH	7.3	Median of observations
		SAR	0.5 (Meq./l)	Median of observations
		TDS	402 (Mg/l)	Median of observations
		EC	475 (µs/cm)	Median of observations
		Average Discharge Potential	4.3 (l/s)	Average of observations
	Surface Water	PH	7.48	Average of observations
		SAR	-	-
		TDS	178 (mg/l)	Average of observations
		EC	349 (µs/s)	Average of observations
		Average Discharge Potential	17.5(Cu. Meter/sec)	Average of observations
	Rain Water	Average depth available	1,131 mm / year	Average of observations
Crop Specific data at	Crop Yield		Crop specific; based on average zonal values	25th percentile of zonal yield data per crop

Regional Level	Price of seed	Crop specific; based on average regional values	National Average
	Number of harvests	Crop specific; based on average regional values	National Average
	Farm-gate prices	Crop specific; based on average regional values	National Average
	Labor and mechanization cost	Crop specific; based on average regional values	National Average
	Price of DAP	15(ETB/Kg)	National Average
	Price of Urea	12(ETB/Kg)	National Average
	Price of KNO3	31(ETB/Kg)	National Average
	Price of NPS	14(ETB/Kg)	National Average
	Price of agro-chemicals	17(ETB/Kg)	National Average
	Land rental/property tax	107.5(ETB/ha)	National Average

Figure73: Default values used for woredas with missing information

2. Identification of irrigation technologies, grouping into irrigation technology packages and costing accordingly

- Six water delivery stages defined across the irrigation process
  - Headworks – Structures used to collect/divert water from its source
  - Storage – Storage units that serve to store water for long and/or short intervals
  - Seepage Protection – technologies that are used to line the different structures and prevent/reduce seepage
  - Water distribution – Structure used to distribute water collected and/or stored to the different farm plots
  - Water application – systems used to apply the water on to the plot. These are the main irrigation systems
  - Drainage systems – different methods used to drain the excess water from the farm plots post irrigation
- List of technologies identified for each water delivery stage through desk research and refined through expert input

Water Delivery Stage	Sub-Category	Irrigation Technology
Collection / Diversion / Headworks	Surface Water Diversion / Collection	Dam (Small Earth Dams)
		Diversion Weir
		Spring Cupping
	Rainwater Harvesting	Roof water harvesting
		Runoff Harvesting
	Groundwater Headworks	Wells

Storage Technologies		Cistern
		Elevated Tank
		Pond
		Reservoir
		Tank
Seepage Protection Technologies		Lining with cement
		Lining with clay
		Lining with conventional plastic
		Lining with Geomembranes
		Stone Pitching (Wet Joint)
Distribution [+] [Lifting Technologies]	Distribution	Canal
		Pipes
	Lifting Technologies (Pumps)	Diesel Pump
		Electric Pump
		Hydraulic-ram Pump
		Manual Pump
		Petrol Pump
		Solar Pump
Water Application Technologies	Surface	Basin
		Border
		Furrow
	Pressure Irrigation	Drip
		Sprinkler
Drainage Technologies	Surface drainage systems	Cross slope
		Parallel
		Random
	Sub-surface drainage systems	Deep open drains

Figure 74: Irrigation Technologies considered by water delivery stage

- Technically compatible technologies across the different water delivery stages are grouped together into 4,166 Irrigation Technology Packages. An irrigation technology package is hence a self-sustaining irrigation system that includes all the necessary equipment from sourcing the water to disposing of excess water after irrigation.
- Irrigation Technology Packages costed as a group based on
    - Individual technology costs – Package cost taken to be the sum of the cost of the individual components
    - Individual technology service life – Package service life taken to be the largest service life among the constituent technologies
    - Technologies with shorter service lives within a package considered to be replaced at completion of service life
        - Headwork structures to have extensive renovation at completion of service life
        - Other technologies to be replaced with due consideration of salvage values

The table below summarizes the average initial investment cost per hectare and the average service life for the aforementioned irrigation technologies. The analysis done in this strategy does take into account the benefits of scale towards the cost of irrigation technologies. Annual Operation and Maintenance costs are taken to be 10% of the initial investment costs where they apply.

Irrigation Technology	Average Initial Investment Cost (ETB/ha)*	Average Service Life (years)
Dam (Small Earth Dams)	386,000	30

Diversion Weir	60,600	20
Spring Cupping	15,000	20
Roof water harvesting	2,540	5
Runoff Harvesting	3,400	5
Wells	24,320	20
Cistern	6,660	5
Elevated Tank	16,650	15
Pond	614	5
Reservoir	Cost included in design and construction of dam	30
Tank	16,650	10
Lining with cement	4,035	5
Lining with clay	2,466	3
Lining with conventional plastic	729	5
Lining with Geomembranes	20,863	5
Stone Pitching (Wet Joint)	2,466	7
Canal	14,000	13
Pipes	25,000	10
Diesel Pump	23,170	7
Electric Pump	762	10
Hydraulic-ram Pump	22,440	5
Manual Pump	9,600	5
Petrol Pump	23,170	7
Solar Pump	6,600	10
Basin	3,600	1
Border	9,600	1
Furrow	8,000	1
Drip	180,000	5
Sprinkler	80,000	7
Cross slope	320	5
Parallel	800	5
Random	480	5
Deep open drains	8,789	5

3. Identification of list of crops to consider throughout the analysis

For simplicity of the impact assessment, a list of crops are selected based on two criteria:

- Annual Revenue per hectare possible with GTP II Year 5 Target Yields and maximum number of harvests per crop> 120,000 ETB/ha. The table below summarizes the top 8 crops selected based on this criteria, termed High Value Crops (HVCs) here.

#	Crops	Revenue per hectare (1 harvest) (ETB/ha)	Maximum number of harvests per year	Annual Revenue per hectare (ETB/ha)
1	Green Pepper	246,357	3	739,072

2	Garlic	201,529	2	403,058
3	Onion	111,103	3	333,308
4	Potato	79,585	3	238,755
5	Tomato	76,836	3	230,507
6	Carrot	56,332	3	168,995
7	Sweet potato	70,063	2	140,126
8	Lentil	41,540	3	124,620

Figure 75: Selected High Value Crops and annual revenue per hectare

- Number of farmers growing the crops > 3mn, based on CSA 2013/14 Agricultural Survey. The table below shows the list of 8 crops selected based on this criteria, termed High Production Crops (HPCs) here.Tef can be categorized as both a high value crop and a high production crop based on these criteria. However as seen in the later results, the model yield for Tef is a smaller increment above current average yield as compared to other high value crops listed and therefore the cost-benefit of irrigation is much closer to HPCs rather than HVCs. Sesame has a significantly lower number of farmers, but is considered in the analysis due to its strategic importance.

#	Crops	Number of Farmers
1	Maize	8,809,221
2	Tef	6,613,090
3	Sorghum	4,788,499
4	Bread Wheat	4,746,231
5	Coffee	4,546,785
6	Barley	4,461,616
7	Haricot bean	3,342,891
8	Sesame	689,977

Figure 76: Selected High Production Crops

4. Identification of possible irrigation technology combinations for shortlisted crops through technical compatibility and economic analyses

For the selected list of 16 crops and 4,166 irrigation technology packages, all possible *crop – irrigation technology* combinations are formed and assessed technically and economically to determine the top list of Irrigation technology packages to work with

- Technical compatibility analysis is based on water application efficiency of irrigation technology packages – this is basically determined by the water application technology in a package and the water application system optimal to a crop. A hypothetical example is the possibility of irrigating rice through basin irrigation but not with sprinkler irrigation
- Economic analysis is undertaken through calculation of discounted ROI that takes into consideration:
    - Annual crop revenue driven by farm gate prices
    - Annual crop input costs – seeds, fertilizers, agro-chemicals,
    - Irrigation package cost – considering initial investment, annual O&M cost and salvage value
- At the end of this analysis, the list of irrigation technology packages is reduced from 4166 to 45 I order to reduce computation complexity in the model.

5. Estimation of Absolute Potential for irrigation in each woreda based on technically feasible *water source – crop – irrigation technology* combinations and woreda land data

The analysis in step #4 above is further refined to determine the *crop – irrigation technology package* combinations to consider for each of the 3 water sources per woreda that give the largest area coverage possible. In other words, this step selects the combination with the lowest crop water requirement crop and the highest water application efficiency irrigation technology package for each of the three water sources to determine the maximum irrigation potential of each. This is done through use of various data mapped at woreda level:

a. Geography specific data
    - Slope – in technical analysis of using an irrigation technology package in certain terrains. Due to engineering characteristic of technologies, there are slope limitations for use of irrigation equipment on difficult slopes. For example: as slope increases, basin systems become obsolete while sprinkler systems still stay functional
    - Soil type – depending on the porosity of soil – and hence the percolation rate of water – higher efficiency irrigation technologies are recommended from in the interest of water conservation and management
    - Total land – This is used to help determine the maximum irrigation potential of each water source per woreda considering all the land can potentially be cultivated in the future. This helps define the Absolute Irrigation Potential (Total Land) scenario.
    - Projected cultivated land (20% of total land) – This is a more realistic target of where the cultivated land coverage can reach in the next five years and is used to define the Absolute Irrigation Potential (Farmed Land) scenario.
b. Water specific data
    - Water quality – to determine if the water is good enough to be used for irrigation
    - Water quantity – core determinant for irrigation potential
c. Crop specific data
    - Crop Water Requirement - To calculate area of land that can be irrigated with the crop given the water available per woreda

The analyses produces a list of three 'water source – irrigation technology – crop' combinations for each woreda (i.e., one combination each for surface water, ground water and rainwater) based on the lowest water requirement, and therefore the highest amount of land that can be irrigation with each water source. National Absolute Potential for irrigation is then calculated as the sum of the total land that can be irrigated in each woreda and capped by total land in the woreda to produce the 'Absolute Potential (Total Land)' results, or by the projected cultivated land in the woreda in five years' time to produce the 'Absolute Potential (Farmed Land)' results. The projected cultivated land is taken as 20% of the total land in the woreda.

6. Determination of irrigation potential at each woreda level through identification of best *water source – crop – irrigation technology* combinations to scale up based on technical compatibility and economic analyses

The analysis in step #5 above is further refined to determine the best *crop – irrigation technology* combination to consider for each of the 3 water sources per woreda from an economic perspective. This step takes into consideration additional crop-specific data such as input cost, farm gate price and yield to determine cost and revenue streams of crops as well as the additional production and revenue that arise from realization of irrigation potential.

Similar to step #5, the analysis produces a list of three 'water source –crop – irrigation technology' combinations for each woreda (i.e., one combination each for surface water, ground water and rainwater). However rather than based on the lowest water requirement (and therefore maximizing the potential irrigation land), the model selects the package with the highest discounted ROI per hectare for each water sources. The discounted ROI for each combination is driven by the revenues from the crop being produced and the costs of the irrigation as well as the costs of inputs for crop production.

Economic Potential for irrigation is then calculated based on an allocation methodology as follows:

- The combination with the highest ROI is scaled up to cover as much land as possible until either the available water corresponding to the water source for the combination is depleted or the projected cultivable land in the woreda is fully irrigated.
- If the available water of the first combination is fully utilized before the projected cultivated land of the woreda is fully irrigated, then the combination with the second highest ROI will be scaled up with similar approach as above until projected cultivable land is fully irrigated or until all the available water runs out.
- If the available water of the second combination is fully utilized before the projected cultivated land is fully irrigated, then the third (and last) combination is scaled up with the same logic until either woreda is fully irrigated or until all the available water runs out.

Economic Potential Irrigation is the sum of the irrigation land resulting from the three allocation steps above.

7. Estimation of increase in production and revenue if economic potential irrigation is realized

a. Additional yield and production is driven by the additional number of harvests possible with irrigation
b. Multiplication of the additional production with the price of each crop will give the additional revenue stream possible
c. To determine the revenue per farmer from the national total revenue and the economic potential irrigation
    - Number of farmers calculated based on national average farm size per farmer
    - Revenue per farmer calculate through consideration of the number of farmers and the national revenue
    - The number of farmers used in all three HVC/HPC scenarios is based on the 50%/50% scenario since that has the largest Economic Potential for national irrigation, i.e. for scenarios with lower Economic Potential a smaller number of farmers would take up irrigation given the same average farm size while the remaining farmer will not take up irrigation

8. Estimation of economic feasibility of using supplementary irrigation for shortlisted crops based on consideration of availability of water during critical growing period of crops

Supplementary irrigation feasibility is estimated for the identified list of crops based on consideration of

a. The available amount of water (essentially rainfall) at the critical growing period of the crops
b. Varying percentage of rainfall availability is considered assuming linear relation of crop yield to the amount of rainfall during critical growing period (0% rainfall – 0 yield and 100% rainfall – 100% yield)
c. For the cases where rainfall is insufficient, supplementary irrigation addresses the deficit in yield and, hence, produces a revenue stream aligned to that share of yield

d. The final results show the economic feasibility of supplementary irrigation for the various crops at different levels of rain water availability

Additional results not presented in main section of the report

Region	Surface Water Potential			Ground Water Potential			Rain Water Potential			Total Irrigation Potential		
	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential
Afar	0.1	0.03	0.02	0.1	0.1	0.05	0.04	0.04	0.02	0.2	0.2	0.1
Amhara	1.2	1.0	0.4	1.1	1.1	1.0	1.1	1.1	0.8	3.5	2.9	2.1
Benshangul	0.1	0.04	0.02	0.1	0.1	0.02	0.1	0.1	0.02	0.2	0.1	0.1
Gambella	0.1	0.03	0.02	0.1	0.03	0.01	0.03	0.03	0.003	0.2	0.1	0.03
Harrari	0.001	0.001	0.00	0.01	0.01	0.01	0.003	0.003	0.003	0.01	0.01	0.01
Oromia	2.8	2.1	0.6	2.3	2.1	1.2	2.4	2.3	1.0	7.5	5.2	2.8
SNNP	0.7	0.6	0.2	1.0	0.9	0.6	0.6	0.6	0.4	2.3	1.6	1.2
Somali	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.03	0.5	0.5	0.2
Tigray	0.4	0.3	0.03	0.2	0.2	0.17	0.1	0.1	0.08	0.7	0.6	0.3
National	5.6	4.3	1.3	5.2	4.7	3.1	4.5	4.4	2.4	15.0	11.1	6.8

Figure77: Regional Irrigation Potential for all water sources under5% HVC /95% HPC scenario

Region	Surface Water Potential			Ground Water Potential			Rain Water Potential			Total Irrigation Potential		
	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential
Afar	0.1	0.03	0.02	0.1	0.1	0.1	0.04	0.04	0.02	0.2	0.2	0.1
Amhara	1.2	1.0	0.5	1.1	1.1	1.0	1.1	1.1	0.7	3.5	2.8	2.2
Benshangul	0.1	0.04	0.02	0.1	0.1	0.03	0.1	0.1	0.02	0.2	0.1	0.1
Gambella	0.1	0.03	0.02	0.1	0.03	0.01	0.03	0.03	0.003	0.1	0.0	0.03
Harrari	0.001	0.001	0.0	0.01	0.01	0.01	0.003	0.003	0.002	0.01	0.01	0.01
Oromia	2.8	2.0	0.8	2.3	2.1	1.4	2.4	2.3	0.9	7.4	5.0	3.1
SNNP	0.7	0.5	0.2	1.0	0.9	0.7	0.6	0.6	0.3	2.3	1.5	1.3
Somali	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.03	0.5	0.5	0.3
Tigray	0.4	0.3	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.7	0.5	0.4
National	5.5	4.1	1.8	5.2	4.6	3.6	4.5	4.4	2.1	14.9	10.6	7.4

Figure78: Regional Irrigation Potential for all water sources under 25% HVC / 75% HPC scenario

Region	Surface Water Potential			Ground Water Potential			Rain Water Potential			Total Irrigation Potential		
	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential	Abs. Potential (Total land)	Abs. Potential (Farmed land)	Economic potential
Afar	0.1	0.03	0.02	0.1	0.1	0.1	0.04	0.04	0.02	0.2	0.2	0.1
Amhara	1.2	0.9	0.5	1.1	1.0	1.0	1.1	1.1	0.5	3.5	2.6	2.0
Benshangul	0.1	0.03	0.03	0.1	0.1	0.02	0.1	0.1	0.02	0.2	0.1	0.1
Gambella	0.1	0.02	0.02	0.1	0.0	0.01	0.03	0.02	0.003	0.1	0.0	0.03
Harrari	0.001	0.001	0.0003	0.01	0.01	0.01	0.003	0.003	0.002	0.01	0.01	0.01
Oromia	2.8	1.9	0.8	2.3	2.0	1.3	2.4	2.3	0.7	7.2	4.6	2.9
SNNP	0.7	0.5	0.3	1.0	0.8	0.7	0.6	0.6	0.3	2.2	1.4	1.2
Somali	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.03	0.5	0.5	0.3
Tigray	0.4	0.3	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.7	0.5	0.4
National	**5.5**	**3.8**	**1.9**	**5.1**	**4.4**	**3.5**	**4.5**	**4.3**	**1.7**	**14.6**	**9.9**	**7.0**

Figure79: Regional Irrigation Potential for all water sources under50% HVC /50% HPC scenario

Region	Production for 5% HVC (M Qt)			Production for 25% HVC (M Qt)			Production for 50% HVC (M Qt)		
	Current yield	Target Non-irrigated yields	Irrigated Yields with multiple harvests	Current yield	Target Non-irrigated yields	Irrigated Yields with multiple harvests	Current yield	Target Non-irrigated yields	Irrigated Yields with multiple harvests
Afar	0.03	0.1	6	0.2	0.3	15	0.4	1	18
Amhara	4.1	6	77	21	29	182	39	53	223
Benshangul	0.1	0.1	4	0.3	0.5	10	1	1	15
Gambella	0.02	0.03	1	0.1	0.2	3	0.3	0.4	5
Harrari	0.04	0.1	0.4	0.2	0.3	1	0.4	1	1
Oromia	6.7	9	110	36	49	260	69	93	318
SNNP	2.9	4	45	16	22	147	30	41	199
Somali	1.0	2	27	7	11	59	15	25	74
Tigray	0.8	1	12	5	8	36	11	17	47
National	***16***	***22***	**282**	***86***	***121***	**713**	***165***	***232***	**900**

Figure 80: Regional HVC production for different percentage of land coverage

Region	Production for 95% HPC (M Qt)			Production for 75% HPC (M Qt)			Production for 50% HPC (M Qt)		
	Current yield	Target Non-irrigated yields	Irrigated Yields with multiple harvests	Current yield	Target Non-irrigated yields	Irrigated Yields with multiple harvests	Current yield	Target Non-irrigated yields	Irrigated Yields with multiple harvests
Afar	0.3	1	2	0	1	2	0.2	0.4	2
Amhara	8	13	126	6	11	109	4	7	88
Benshangul	0.2	0.4	2	0.2	0.4	2	0.2	0.3	1
Gambella	0.1	0.1	0.4	0.1	0.1	0.4	0.05	0.1	0.3
Harrari	0.05	0.1	0.3	0.04	0.1	0.3	0.02	0.04	0.3
Oromia	17	28	134	15	24	119	9	15	98
SNNP	8	12	67	7	11	58	4	7	46
Somali	1	1	4	1	2	4	1	1	3
Tigray	1	2	15	1	2	14	1	1	12
National	***35***	***57***	**350**	**30**	**50**	**309**	***19***	***31***	**250**

Figure 81: Regional HPC production for different percentage of land coverage

Region	Production for 5% HVC / 95% HPC (m Qt)			Production for 25% HVC / 75% HPC (m Qt)			Production for 50% HVC / 50% HPC (m Qt)		
	Current yield	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*
Afar	0.3	1	8	1	1	17	1	1	20
Amhara	12	19	202	28	40	291	43	59	311
Benshangul	0.3	1	6	1	1	12	1	1	16
Gambella	0.1	0.2	1	0.2	0.3	3	0.3	0.5	5
Harrari	0.1	0.1	1	0.2	0.4	1	0.4	0.6	1
Oromia	24	37	244	51	73	379	78	108	416
SNNP	11	16	112	23	32	205	35	48	244
Somali	2	3	31	7	13	62	16	26	77
Tigray	2	3	27	6	10	50	11	18	59
National	***50***	***79***	***632***	***117***	***170***	***1,022***	***184***	***263***	***1,150***

Figure 82: Regional total production for different land split scenarios

Region	Net Revenue for 5% HVC (B ETB)			Net Revenue for 25% HVC (B ETB)			Net Revenue for 50% HVC (B ETB)		
	Current yield	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*
Afar	0.2	0.5	4	1	3	10	2	6	12
Amhara	21	29	246	111	151	547	202	276	662
Benshangul	0.3	0	3	2	2	8	4	5	12
Gambella	0.1	0	3	1	1	6	1	2	9
Harrari	0.04	0.1	0.4	0.2	0.3	1	0.4	1	1
Oromia	37	50	387	201	271	941	380	512	1,181
SNNP	17	24	148	96	130	423	181	245	537
Somali	1	2	25	7	11	54	15	24	68
Tigray	2	3	34	10	18	104	20	37	144
National	***79***	***108***	***850***	***428***	***588***	***2,094***	***805***	***1,108***	***2,625***

Figure 83: Regional HVC share of Annual Net revenue considering cultivation of Economic Irrigation Potential

Region	Net Revenue for 95% HPC (B ETB)			Net Revenue for 75% HPC (B ETB)			Net Revenue for 50% HPC (B ETB)		
	Current yield	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*
Afar	2	3	2	2	3	2	1	2	2
Amhara	58	100	117	48	81	102	29	49	82
Benshangul	2	3	3	1	2	2	1	2	2
Gambella	0.4	1	1	0.4	1	1	0.3	1	1
Harrari	0.3	0.4	0.1	0.2	0.4	0.1	0.1	0.2	0.1
Oromia	89	145	129	77	125	115	48	78	96
SNNP	34	54	61	30	47	54	19	30	43
Somali	4	8	6	4	8	6	3	6	6
Tigray	5	9	13	5	10	12	3	6	10
National	***195***	***323***	***332***	***167***	***278***	***294***	***105***	***175***	***240***

Figure 84: Regional HPC share of Annual Net revenue considering cultivation of Economic Irrigation Potential

Region	Net Revenue for 5% HVC / 95% HPC (B ETB)			Net Revenue for 25% HVC / 75% HPC (B ETB)			Net Revenue for 50% HVC / 50% HPC (B ETB)		
	Current yield	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*	*Current yield*	*Target Non-irrigated yields*	*Irrigated Yields with multiple harvests*
Afar	2	4	6	3	6	12	3	8	13
Amhara	80	129	363	159	233	649	231	325	744
Benshangul	2	3	6	3	5	10	5	7	14
Gambella	1	1	4	1	2	7	2	3	10
Harrari	0.3	1	1	0.4	1	1	1	1	1
Oromia	126	195	516	278	396	1,056	428	591	1,277
SNNP	52	78	209	125	177	476	199	274	579
Somali	5	10	31	11	19	60	18	31	73
Tigray	6	12	47	15	28	116	24	44	154
National	***274***	***431***	***1,181***	***595***	***865***	***2,388***	***911***	***1,283***	***2,865***

Figure 85: Regional total Annual Net revenue considering cultivation of Economic Irrigation Potential

A3. Bottlenecks with specific relevance or focus on environmental and gender issues

Commented [s21]: This section to be edited this weekend to make points clearer.

ENVIRONMENTAL

Policy & Institutions

1. Insufficient adherence to the National WRM and Irrigation Policies and Strategies, Master Plans, basin and watershed based management approaches
    - Insufficient adherence leads to unsustainable exploitation of water resources and damage on the nearby ecosystem. In addition if scheme development is not correlated with watershed management it negatively affects the mitigation capacity of the users and also has negative impact associated with ineffective scheme such as siltation and loss of water.

2. Limited implementation of policy and regulatory framework on water user associations (WUA), water rights and fees, land related issues and cost recovery
    - Limited implementation of policies at grass root level has direct impact on sustainable use of water resources especially by reducing water efficiency. Limited implementation of the policies will also create issues related to water rights and land use issues.

3. Limited equipment quality standards or enforcement, and disincentives for high quality local manufacturing
    - Leads to import of below par irrigation equipment which are usually less water and energy efficient. In addition standard for other equipment can increase the demand for more energy and water efficient equipment such as drip and sprinkler.

4. Insufficient skilled human resources and high turnover in public institutions
    - Lack of technical expertise on environmental issues leads to limited or ineffective mainstreaming of environment in the process of irrigation development.

5. Lack of policy and regulatory framework for groundwater usage and drilling
    - Lack of groundwater policy framework will lead to unsustainable exploitation and pollution of groundwater resource.

6. Weak federal and regional institutional arrangement for coordination, planning, implementation and management of irrigation and drainage related initiatives
    - Strong institutional arrangement is the basis for effective mainstreaming of environmental issues during irrigation and drainage scheme development. However, weak institutional arrangement and ineffective coordination between different public institutions will hamper implementation of climate friendly initiatives.

7. Insufficient budget allocated to sector and cost-sharing with other sectors
    - Environmental issues are usually overlooked in scheme planning when the financial resource allocated is not sufficient. One example for this can is most of the existing irrigation schemes have no or ineffective drainage mechanism.

8. Limited legislative and enforcement mechanisms to prevent discharge of toxic substances and effluences in water resources
    - Unregulated discharge of water effluents will have a huge impact on water quality. If the discharge is especially happening by upstream farmers it will affect the production of downstream farmers.

Research & Extension

9. Insufficient focus, budget and staff allocation to applied research on irrigation, irrigated agriculture, gender and irrigation, and on farm water management, in the research system

- Limited focus on irrigation research decreases the adoption of irrigation by smallholder farmers. This especially hampers the adoption of irrigation technologies and agronomic practises which are environmentally sound. In other words, limited research topics like water efficient technologies and effective water management will reduce their adoption by farmers. This will have direct impact on environmental sustainability of irrigation development.

10. Limited development and promotion of dedicated extension packages on irrigation and drainage, water use and management, and integration of content in crop extension packages, including due to insufficient qualified experts and irrigation-focused DAs at local levels

- Limited development of extension packages and especially inadequate integration of environmental issues will make delivery of extension services difficult if not impossible hence leading to limited adoption by farmers.

11. Limited use of additional awareness creation and extension service delivery channels, and low availability of site-specific advisory services for smallholders

- Weak extension provision in irrigation has led to limited adoption of irrigation equipment's including climate friendly equipment's and modern agronomic practises. The environmental impact from the weak extension provision includes inefficient water utilization, soil salinity, water logging and pollution of water resources.

12. Limited accurate information on the water resources available for irrigation, geological and other relevant data, current schemes and usage patterns

- Irrigation scheme development has significant impact on existing natural resources and the ecosystem. If there is no accurate information the decision on scheme development will be misguided leading to a significant damage on the environment.

13. Limited linkages between research and extension for priority setting and use of research outputs in extension services

- Limited linkage between research and extension will lead limited adoption of research outputs which have positive impact on the environment by the extension. On the other hand it might also lead to less priority given to environmental issues by research if extension and research are not aligned.

15. Lack of technology transfer mechanisms to improve capacity of research institutes, manufacturers and importers to support improved technology development

- Existing local manufacturers and research institutes lack the technical capacity to produce eco-friendly equipment's which requires significantly advanced technological capacity. One option to mitigate it is to create technology transfer programs. But if such links are not created those firms will not be incentivized to produce eco-friendly products.

Scheme Planning, Design, Construction & Management

16. Lack of standardized approach and contract, technical and project mgmt. capacity across public institutions for prioritizing, planning, budgeting, design, construction, contract mgmt. handover, supervision and monitoring of schemes

- In most of the scheme development in the country environmental factor is not given due attention including during planning of scheme and prioritization. In addition due limited technical capacity in design and construction some of the existing schemes have negative environmental impact. Some of the negative environmental impact arising from this includes siltation, soil salinity and high water loss.

17. Limited use and benefits of irrigation due to crop value chain bottlenecks related to improved inputs, extension, production, aggregation, storage and market linkages

- Limited investment in irrigation and hence limited adoption of it will increase vulnerability of farmers to climate shocks such as erratic rainfall. Crop value chain related bottlenecks have a significant impact on decision of farmers to adopt irrigation technology.

18. Low scheme performance and deferred maintenance

- Low performing schemes and schemes with deferred maintenance are more likely to be cause negative environmental impact such as soil salinity and water loss. They are most likely to be vulnerable to siltation.

19. Ineffective licensing and tendering process for private consultants and contractors to undertake scheme design and construction, and poor designs and delayed scheme delivery due to low capacity of consultants and contractors

- The environmental impact of this bottleneck is closely associated with the first bottleneck of this program area. Ineffective licencing and tendering capacity will more likely benefit weaker water works enterprises. This leads to poor design and construction which has negative environmental impact mentioned earlier.

20. Low capacity of Water User Associations/ Irrigation Cooperatives

- If WUAs don't have sufficient capacity they are less likely to implement their major activities including irrigation water management and maintenance. This will have negative impact on environment associated with low performing schemes such as inefficient utilization of water, soil salinity and siltation.

21. Insufficient community consultation and participation in scheme planning, design, construction and handover

- Insufficient involvement of community in scheme development has significant impact on environmental sustainability of schemes. The first factor is related to weakened sense of ownership associated with limited involvement of the community. This in turn leads to unsustainable management of schemes by the community/WUA (e.g. inefficient water management). The other factor is associated with soil and conservation activity managed by the community. If scheme development and soil/water conservation activities are not linked it will have significant impact on the sustainability of a scheme.

23. Limited availability of electricity, high cost of fuel, to power schemes in rural areas in particular for groundwater pumping

- Most of the irrigation and drainage schemes require electricity to power pumps and associated irrigation equipment. In addition groundwater drilling also requires electricity power. Limited availability of electricity will lead to less irrigation development or use of substitute power options which have negative environmental footprint.

Technology Supply Chains

25. High tariffs and lack of availability of FOREX for importing pumps, parts, other equipment, and raw materials

- High tariff on irrigation equipment will lead to less use of modern irrigation technologies by farmers. This will lead to lesser water efficiency overall. Lack of FOREX will also result in weaker supply chain of these modern irrigation equipment's.

26. Limited investment in multiplication, wholesaling and retailing of equipment including due to lack of access to finance

- Limited investment in the technology supply chain can affect environment in two ways. The first is weak technology supply chain will lead to limited adoption of irrigation by farmers hence reducing resilience of farmers to climatic shocks. On the other hand, weak supply chain will have greater impact on the production and distribution of climate friendly irrigation equipment.

27. High cost of equipment and limited access to finance for smallholders

- On the other side high cost of equipment also leads to limited adoption of irrigation. This has similar effect to the first bottleneck on this program area by making farmers more vulnerable to climate shocks.

28. Limited availability of manual and mechanized well drilling services, irrigation equipment rental services, and skilled maintenance service providers

- Limited availability of well drilling service providers will hamper the effort of utilizing groundwater resources. This will especially affect farmers/areas with no other sources of water reducing resilience to climate shocks especially erratic rainfall.

31. Limited availability / reliability of electricity, and high cost of fuel, to power individual pumps and other equipment

- The limited availability and reliability of electricity in rural areas has made engine pumps the most preferred equipment by farmers and equipment's which use electricity such as sprinkler and electric pump less preferable. Though it may be less significant at current state the use of engine pump has a negative impact on the environment.

GENDER

Policy & Institutions

2. Limited implementation of policy and regulatory framework on water user associations (WUA), water rights and fees, land related issues and cost recovery

- Gender related issues need to be given sufficient focus in water use related policies. This is especially necessary in the areas of increasing participation of women participation in WUAs and ensuring equal access to water and land. Limited

implementation of these policy frameworks will lower the benefit women get from irrigation an drainage development

Research & Extension

9. Insufficient focus, budget and staff allocation to applied research on irrigation, irrigated agriculture, gender and irrigation, and on farm water management, in the research system

- Existing research in irrigation has gap in addressing gender specific issues which in turn lower adoption of irrigation by women farmers. The factors that affect limited research in gender specific irrigation research are inadequate focus given to irrigation research especially to gender specific research.

10. Limited development and promotion of dedicated extension packages on irrigation and drainage, water use and management, and integration of content in crop extension packages, including due to insufficient qualified experts and irrigation-focused DAs at local levels

- Limited development of extension packages and especially inadequate integration of gender issues will make delivery of extension services difficult if not impossible. This leads to limited adoption of irrigation by women farmers.

11. Limited use of additional awareness creation and extension service delivery channels, and low availability of site-specific advisory services for smallholders

- Weak extension provision has huge negative impact on adoption of modern irrigation by farmers. If women farmers are not introduced to modern and appropriate irrigation practise and technologies by the extension system they are likely use irrigation.

13. Limited linkages between research and extension for priority setting and use of research outputs in extension services

- Limited linkage between research and extension will lead limited adoption of research outputs which benefit women farmers. On the other hand it might also lead to less priority given to gender issues by research if extension and research are not aligned.

Scheme Planning, Design, Construction & Management

16. Lack of standardized approach and contract, technical and project mgmt. capacity across public institutions for prioritizing, planning, budgeting, design, construction, contract mgmt. handover, supervision and monitoring of schemes

- Insufficient integration of gender specific issues in every stage of scheme development will make it harder for women farmers to fully reap benefit of irrigation. Insufficient integration usually happens due to lack of technical capacity and limited focus.

17. Limited use and benefits of irrigation due to crop value chain bottlenecks related to improved inputs, extension, production, aggregation, storage and market linkages

- Crop value chain related bottlenecks have more negative effect on women farmers than their male counter parts. This is manifested in limited access to input hence less productivity and limited access to market. Subsequently, those crop value chain bottlenecks have an even greater negative impact on women farmers' decision to invest in irrigation.

20. Low capacity of Water User Associations/ Irrigation Cooperatives

- Low capacity of WUAs reduces effective irrigation application by farmers because they are net getting the usual service from WUAs including water provision to their farmlands. In addition limited involvement of women farmers in the administration of WUAs will make it difficult to address women specific issues within the governance of WUAs.

21. Insufficient community consultation and participation in scheme planning, design, construction and handover

- One of the approaches to integrate gender issues into scheme development is by enhancing participation of women in community consultation platforms. Through these platforms necessary information can be gathered about the needs and current capabilities of women which in turn inform the integration modality of gender related issue. However, insufficient participation by women farmers will make the process of integration ineffective.

Technology Supply Chains

25. High tariffs and lack of availability of FOREX for importing pumps, parts, other equipment, and raw materials

- High import tariffs increase the retail price making irrigation equipment expensive for many Smallholder farmers especially poorer farmers. Women farmers are going to be highly affected because they constitute a significant share of poor families relative to their size.

27. High cost of equipment and limited access to finance for smallholders

- Similar to the above bottleneck high cost of equipment will make investment in irrigation less attractive for women farmers. The situation regarding access to finance is even worse for female farmers making equipment purchase by women farmers difficult.

28. Limited availability of manual and mechanized well drilling services, irrigation equipment rental services, and skilled maintenance service providers

- Limited availability of well drilling service providers will hamper the effort of utilizing groundwater resources. This will especially affect women farmers with no other sources of water reducing the potential benefit from irrigation. Good access to maintenance service provision is necessary if women farmers are to fully benefit from irrigation. However, the overall status of maintenance service provision is poor. In addition the maintenance services provided are not suitable to the needs of women farmers. For instance there are no mobile maintenance service providers.

31. Limited availability / reliability of electricity, and high cost of fuel, to power individual pumps and other equipment

Investment in modern irrigation equipment's will depend on reliable and easily available energy source. This is also true women farmers. But lack of those will force women farmers not to use irrigation or purchase equipment's which are inefficient and less compatible for women farmers to use.

A4. Additional analysis of systemic bottlenecks and strategic interventions

[Placeholder section for useful analysis not included in main body of document; reassess what is included here after refining other sections]

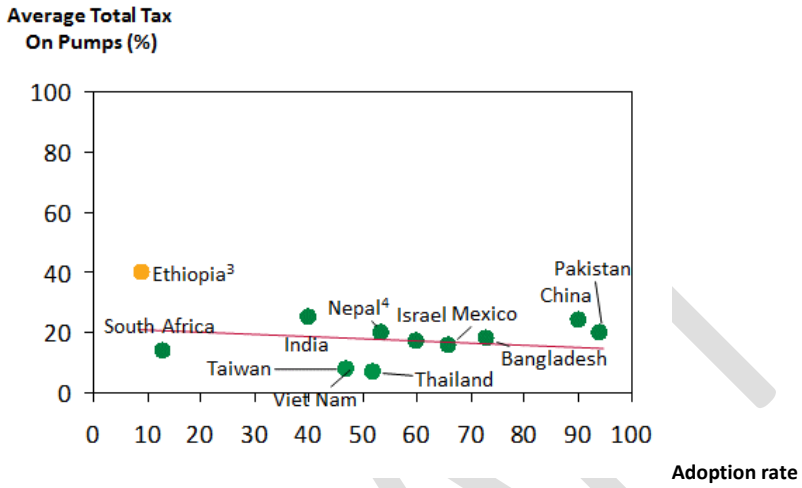

Figure86: Correlation of price of pump with irrigation adoption rates

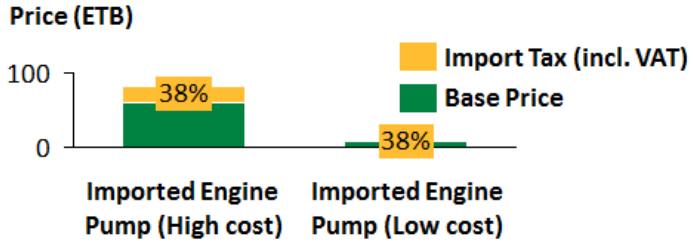

Figure87: Base price and import tax in imported engine pump

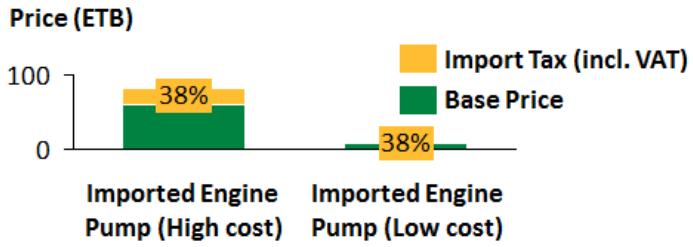

Figure88: Cost break down of assembled motor pump

	Cost sharing	Implemented
Stakeholders and partners	Community	✓
	Local government	✓
	Private sector	✗
	External support agencies and NGOs	✓
	Consumers	✗
Water user sectors	Power and Energy	✗
	Industry	✗
	Health	✗
	Education	✗
	Road	✗

Figure89: Cost sharing arrangements for irrigation development

Major information required		Responsible body			Data availability	Comment
		Federal	Regional	Woreda		
Water resources available for irrigation	Available surface water resources	**MoWIE, NMA**				Available but Needs timely update
	Available ground water resources and recharge estimates	**MoWIE**				Estimates are not realistic and the mapping is not finalized yet
	Available rain water resources	**MoWIE, NMA**				NMA[1] has updated data but not easily accessible
	Irrigation potential by water resources	**MoWIE**	**Regional BoWIE**			No recent realistic studies done on irrigation potential
Geospatial data	Geological map/data	**Geological survey of Ethiopia**				current geological map covers 62% of the country . There is ongoing project to increase it to 80% . However, the current geological map is not favorable for understanding of regional groundwater potential
	Topographical map/data	**Ethiopia Mapping Agency**				Updated topography data easily accessible from EMA[2]
	Climatic data	**NMA**				NMA[1] has updated data but not easily accessible

Major information required		Responsible body			Data availability	Comment
		Federal	Regional	Woreda		
Water works designers and contractors database	Water works contractors and designers information system covering capacity and information on previous and current projects by the firms	**MoWIE**	**Regional BoWIE**			The federal and regional water bureaus don't have a database on the profile of the contractors and designers
Current irrigation schemes	Distribution of current irrigation schemes in the country	**MoWIE**	**Regional BoWIE**			Some regions have their own scheme inventory, FAO and IWMI developed a national scheme inventory but this has not been updated
	Performance of irrigation schemes	**MoWIE**	**Regional BoWIEs and BoA**[1]			Study of performance of irrigation scheme covered within the scheme inventories
Irrigation usage and administration patterns	Irrigation systems/technologies used		**Regional BoA**	**WoredaBoAs**		Lack of inventory on schemes or available in scattered way
	Scheme administration including fee and charge		**Regional BoA**	**WoredaBoAs**		No available data on water fees and other management aspects for schemes

	Information on WUAs including financial data and number of membership	**MoWIE/ FCA[2]**	**Regional BoWIE**	**WoredaBoWIEs**		Except for membership number there is no available detailed data on WUAs

Figure90: Data availability on major information required

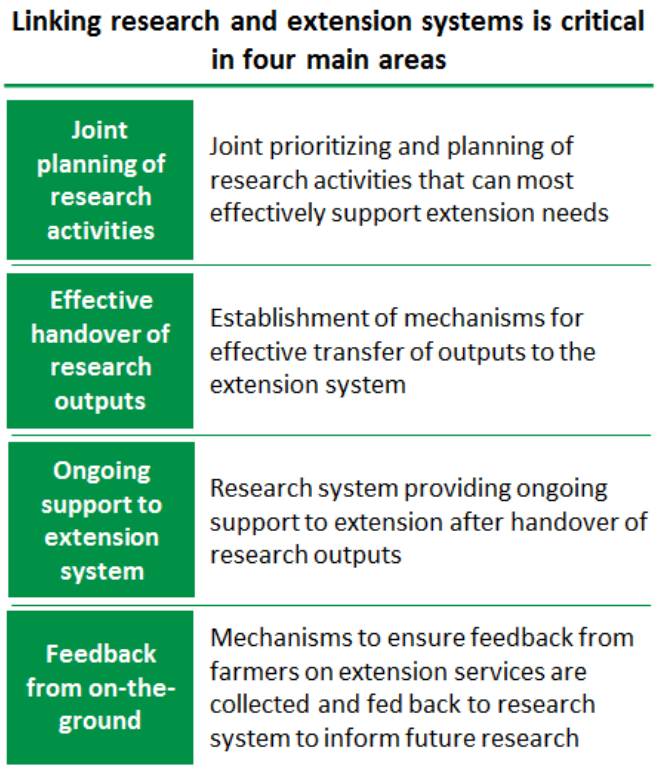

Figure91: Areas of linkage of for research and extension

Regions	Joint planning	Effective handover	Ongoing support	Feedback
Afar	✓	✗	✓	✓
Amhara	✓	✗	✓	✓
B. Gumuz	✓	✓	✓	✓
Gambella	✓	✓	✓	✓
Oromia	✓	✓	✓	✓
Somali	✓	✓	✓	✓
SNNP	✓	✓	✓	✓
Tigray	✓	✓	✓	✓

Federal	✓	✓	✓	✓

✓ *Strong linkage* ✓ *Medium linkage* ✓ *Weak linkage* ✖ *No linkage*

Figure92: Linkage status in the different agricultural research institutes

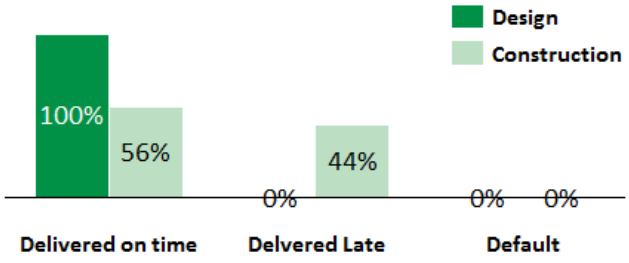

Figure93: Project performance by private consultants and contractors (e.g. Tigray)

Scheme design and infrastructure	Infrastructure work such as dams, canals, weirs, primary water source equipment, manholes, etc. to distribute water to farms
Equipment purchasing	Equipment / other expense for on-farm application of water (pump, sprinkler, drip, furrow, basin, etc.)
Operation	Ongoing operational costs for irrigation such as fuel for pumps, labor costs if any, scheme management cost
Maintenance	Costs incurred to maintain the irrigation scheme/equipment either for preventive, major or minor maintenance
Crop Inputs & Labor	Additional crop input and labor cost incurred for increased production with irrigation

Figure94: Irrigation related, crop input and labour cost items

Cost Item to Farmer	Infrastructure costs paid by government with no cost recovery	Infrastructure costs paid by government with cost recovery

Command Area	<50 Hectares	>50 Hectares	<50 Hectares	>50 Hectares
Initial Cost	**36K (4k-231)**	**11K (2K-182K)**	**36k (4K-231K)**	**11K (2K-231K)**
Infrastructure	0	0	0	0
Equipment	36K (4k-231K)	11K (2k-182K)	36K (4K-231K)	11K (2K-182K)
Annual Cost	**24K (4k-727K)**	**22K (4k-706K)**	**29K (5k-862K)**	**27K (5K-740K)**
Operation & Maintenance	10K (2K-664k)	9K (2K-643K)	10K (2k-664K)	9K (2K-643K)
Crop Inputs and Labor	14K (2k-63K)	14K (2k-63K)	14K (2K-63K)	14K (2K-63K)
Infra. cost recovery	0	0	5K (1K-35K)	4K (1K-34K)
Year 1 Cost	**60K (8K-960K)**	**33K (6K-888K)**	**65K (9K-1000K)**	**38K (7K-922)**

Figure95: Median costs (ETB/ha) for different technology packages

Financing options	Farmer level	WUA/Coop level	Major source of funds	Eligibility requirement	Repayment rates	Case studies	Farmer feasibility	WUA /Coop Feasibility
Normal interest loan	✓	✓	• MFIs, Banks	• Feasibility study • Collateral • Gov. guarantee	• Low	• NA	◔	◑
Group lending	✓	×	• Banks, MFIs & CF buyers	• None	• High	• Bangladesh - Grameen Bank	●	NA
Voucher	✓	×	• MFIs, CF Buyers	• None	• High	• Kenya- Ahero scheme	◕	NA
Rental/ lease	✓	×	• Equipment/Well owners	• Initial rental payment	• High	• Bangladesh -GKF	◕	NA
In-kind repayment	✓	×	• Banks, CF Buyers	• None	• High	• Bangladesh -GKF	○	NA
Low interest loan	✓	✓	• Gov't, NGOs and MFIs	• Collateral (Optional)	• Medium	• Kenya- large scale schemes	◑	●
Gov't/NGO Grants	✓	✓	• Gov't(Federal/ • Regional) ,NGOs	• None	• NA	• Ethiopia- Raya Vally	◑	◕

Figure96: Assessment of different financing options for individual farmers, WUAs, Coops and farmer group

MFI	Product	Partners	Application requirements	Collateral requirements	Credit / farmer (ETB)	Interest rate	Farmers served	Tenor	Default Rate
ACSI	**Irrigation Group Loan (3-7 farmers)**	• AmbaselBoA, WoA	• Woreda feasibility study and famer selection	• None	2.5 - 5K	15%	678	2 yrs	<1%
	Regular loans	• None	• Business plan	• Property • Gov. employee guarantee • Other guarantee	Max 27M	13% - 18%	NA	5 yrs	0%
DECSI	**Irrigation Group Voucher**	• BoA, WoA • Tech. MSE	• 1-page business plan	•	20K - 60K	15%	150k		<5%
	Irrigation Individual Voucher	• BoA, WoA • Tech. MSE	• 1-page business plan	• Gov. guarantee • Deposit req. for larger credit	20K - 60K	15%	NA	3-4 yrs	<5%
	Regular Loans	• None	• Business plan & feasibility	• Physical collateral	200k-10M	15%	13-14		
ADEDAY	**Irrigation Group Loan**	• DECSI	• 3-7 women	• None		14% (For women) 20.5% (Groups)	16k		<5%
OCSSCO	**Group Loan (General)**	• BOA	• Upon approval of low income and motivation of loan	• None	Max 15K	17%	700k-800k HH /yr	1 yr	1%
	Regular loans	• None	• Business plan	• Collateral	No limit	13%	NA	3 yrs	10%

OMO	•
	•

Figure97: Irrigation related loan services given by MFIs in Ethiopia

Region	Manufacturing	Wholesaling/ Retailing	Installation/ Well drilling	Spare Parts & Maintenance
Addis	High	High	High	High
Afar	n/a	n/a	n/a	n/a
Amhara	n/a	n/a	n/a	n/a
B. Gumuz	n/a	n/a	n/a	n/a
Dire Dawa	Medium	Medium	Medium	Medium
Gambella	None	Low	Low	Low
Harari	n/a	n/a	n/a	n/a
Oromia	n/a	n/a	n/a	n/a
Somali	n/a	n/a	n/a	n/a
SNNP	n/a	n/a	n/a	n/a
Tigray	Medium	Medium	Low	Low

Figure98: Supply chain development in the 11 regions

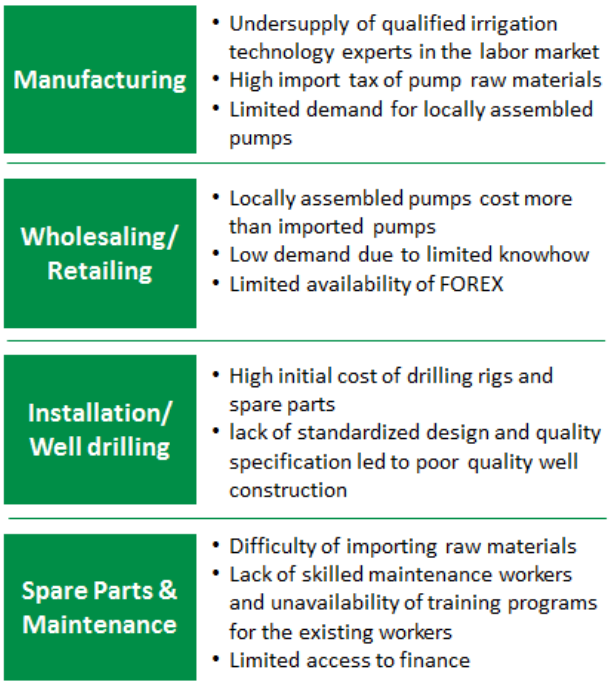

Figure99: Technical and financial constraints limiting investment in technology supply chains

Region	Structure of the Extension Team at each level			
	Regional	***Zonal***	***Woreda***	***Kebele***
Tigray	• Irrigation agronomy • Irrigation technology • Fruits • Post harvest	• Irrigation • Agronomy • Fruit • Post harvest	• Irrigation • Agronomy • Fruit • Post harvest	• Agronomy • Irrigation • Livestock • Cooperative
Oromia	• Horticulture • Irrigation • Crop protection • Agronomy • Input facilitation • Post harvest • Communication	• Horticulture • Irrigation • Crop protection • Agronomy • Input facilitation • Post harvest • Communication	• Horticulture • Irrigation • Crop protection • Agronomist • Input facilitation • Post harvest • Communication	• Agronomy • Water distribution • Maintenance
Amhara	• Horticulture • Irrigated agronomy • Crop protection • Post harvest • Communication	• Process owner • Irrigated agronomy • Horticulture agronomist • Post harvest	• Process owner • Irrigated agronomy • Horticulture • Agronomy • Post harvest	• Horticulture • Agronomy • Irrigation
SNNPR's	• Cooperative • Crop Protection • Communication	• NA	• Cooperative • Crop Protection • Communication	• Crop • Hortivulture • Livestock • Natural resource • Bee keeper Expert • False Banana Expert

Region	Structure of the Extension Team at each level			
	Regional	*Zonal*	*Woreda*	*Kebele*
Somali	• Process owner • Communication • Cooperative • Crop protection • Horticulture • Agronomy • Input facilitation • Livestock	• Input facilitation	• Process owner • Communication • Cooperative • Crop protection • Horticulture • Agronomy • Input facilitation • Livestock	• Process owner • Communication • Cooperative • Crop protection • Horticulture • Agronomy • Input facilitation • Livestock

Figure100: Structure of the extension team in 5 Regions

Federal / Regional Institution	Irrigation package	Irrigated crop package			
		Horticulture	Cereals	Pulses & Oilseeds	Other
Federal Research/Extension	• SSID, Water harvesting for irrigation – (EIAR Melkassa, Werer) • Crop water requirement, water utilization, Irrigation technologies – (Holeta)	• Tomato, Potato, Onion, Cabbage, Pepper, Onion – (Melkassa&Holeta)	• Maize (EIAR) • Maize, Rice Wheat (MoA) • Barley –(Holeta) • Teff-(Debrezeit)	• Faba bean & Haricot bean-(Holeta)	• Coffee – (Jimma Research institute) • Forrage& cotton-(Melkasa&Holeta)
Regional Research	•	•	•	•	•

Oromia	• Irrigation technology and water usage packages –(ORARI) • Drip & Sprinkler – (Haramaya University)	• Onion , Tomato , Potato , Green beans, peas , avocado, papaya- (ORARI)	• Maize (ORARI)	• Ground nut-(Haramaya University)`	• NA
Amhara	• Water utilization • Water harvesting • (ARARI)	• Potato, Onion, peper,Cabbage ,Garlic and Green bean(ARARI)	• Wheat, Maize, Malt ,Sorghum, barley, Cotton- ARARI)	• Ground nuts, Sesame, chick pea and filed pea-ARARI	• Cotton
Tigray	• Solar pumps (In process) and water application (TARI, Mekele University)	• Mango, Grapes & Cactus (TARI)	• Maize, Teff , barley ,wheat (TARI)	• Sesame, Chickpea –(TARI)	• NA
SNNP	• Cop water requirements and evaluation of irrigation methods, Impact study of irrigation schemes ,Situation analysis of irrigation potential of the regions-(SARI)	• Tomato, onion, cabbage-(SARI)	• Maize-(SARI)	• NA	• NA

Federal / Regional Institution	Irrigation package	Irrigated crop package			
		Horticulture	Cereals	Pulses & Oilseeds	Other
Afar	• Efficient utilization of water(On going),	• Onion and tomato-(APARI)	• Maize-(APARI)	• Sesame-(APARI)	• Panicum (Forage)-(APARI)

	Amendment of salt affected Soils- (APRAI)				
Somali	•	•	•	•	•
Gambella	•	•	•	•	•
BenishangulGumez	• Irrigation technology-(Asosa ARI)	• Potato and papaya- (Asosa ARI)	• Rice, Maize-(Asosa ARI)	• Soya bean (Asosa ARI)	• NA

Figure101: Packages/manuals developed by agricultural research institutes regarding irrigation

Federal / Regional Institution	Irrigation package	Irrigated crop package			
		Horticulture	Cereals	Pulses & Oilseeds	Other
Regional Extension					
Oromia	• Water saving technologies, On-farm water application • Supplementary irrigation for Maize	• Onion, tomato, potato, green beans, peas, avocado, papaya, apple-	• Maize, Teff	• NA	• Coffee
Amhara	• Water utilization • Water harvesting techniques	• Potato, Onion, cabbage, Fruits	• Wheat, maize, Malt barley	•	• Coffee
Tigray	• Water pump usage, water application methods & Efficiency , Supplementary irrigation	• Mango, grape and cactus, guava, onion, Swiss hand, pepper, lettuce, tomato, apple,	• Maize, Teff, Wheat	• Chickpea, Sesame	• NA
SNNP	• Water utilization • Water Saving technologies	• Tomato, Onion, Cabbage, Potato, Garlic, Papaya,	• Maize	• Chickpea	• Coffee

		Banana, Mango, Apple			
Somali	• Water saving technologies & water pump usage	• Onion, tomato, potato, beans, papya	• Maize, Sorghum, wheat & barley	• cowpea	• NA
Gambella	• Water pumps	• Onion, Tomato & Cabbage	• Maize	• NA	• NA
BenishangulGumez	• Water utilization	• Tomato	• Maize	• NA	• NA

Figure102: Extension manuals adapted by the regional extension directorates

Region	Extension delivery mechanism				
	Media Campaigns	**ICT-based Solutions**	**NGO's / PS / Volunteers**	**Experience sharing forums**	**Irrigation days / weeks**
Tigray	• Radio programs • Documentaries	• 8028	• SMIS, AGP	• Experience sharing at Woreda and zonal level	• Field days
Oromia	• Radio programs	• 8028	• AGP	• Experience sharing at kebele, woreda, zonal and regional level	• Field days
Amhara	• Radio programs • Amhara TV	• 8028	• AGROBIG,SLM,ILRI,IFAD ,SMIS	• Irrigation conference at kebele level	• Launching days • Field days

SNNP	• South radio & TV • Documentaries	• 8028	• AGP,SMIS,SLM,IFAD	• Experience sharing forums at region and woreda level	• Field day
Somali	• ESTV • Radio program	• NA	• FAO, PCDP	• Experience sharing at Keble, Woreda, zonal and regional level	• Field day
Afar	• N/A	• N/A	• N/A	• N/A	• N/A
Gambella	• Gambela TV	• NA	• SLMP,EAAPP	• Experience sharing at Woreda and Kebele level	• NA
BenishangulGumuz	• Radio program(88.3)	• N/A	• N/A	• Experience sharing at kebele,woreda ,zonal & regional level	• Field day

Figure103: Extension delivery mechanisms in different region

A4. Details of major programs

Commented [s22]: Graphics in this section to be updated

AGRICULTURAL GROWTH PROGRAM

PROJECT OBJECTIVES

- **Main focus:** Three major components of AGP including Rural infrastructure, which includes small scale irrigation activities:
  1. SSI infrastructure development
  2. Water harvesting and Micro-irrigation technologies
  3. Irrigation water use and management
  4. Watershed management
- **Duration:** Phase I (2010-2015), Phase II (2015-2020)
- **Geography:** *Phase I* - 96 high potential woredas in Amhara, Tigray, Oromia and SNNPR), ***Phase II*** - Phase I woredas+ 61 additional woredas including Gambella, B. Gumuz, Harar and Diredawa
- **Beneficiaries:** 56k farmers
- **Donor:** AECID, CIDA, UNDP, USAID, World Bank, FAO, Netherlands, Italy
- **Funds:** *Phase I* – ~USD 90 M; *Phase II* - ~USD 200 M
- **Implementing Partners:** AGP-MADE, AGP-LMD, CASCAPE, ATA, RBoWR and RBoA

ACHIEVEMENTS

- AGP I has overachieved its targets:
  - ***Planned*** *21000 ha*
  - ***Achieved*** *- 23000 ha*
- Training of trainers conducted for regional and woreda experts
- Support meeting is conducted every quarter with WUAs

MAIN CHALLENGES

- Frequent institutional instability in government agencies
- Lack of quality assurance mechanism in SSI projects
- Lack of support from government to private and public water works enterprise
- Weak contract management process in irrigation development

KEY LEARNINGS

- The tendering process for design consultants and contractors need to be separate
- Farmers and WUAs need to be supported initially for few years before full handover takes place
- There needs to be a strong team of technical experts (i.e. engineers, surveyors, hydrologists) for effective contract management of irrigation schemes
- Effective coordination among stakeholders and strong lobby system resulted in WUA proclamation

Figure104: AGP I/II program profile

PASIDP

PROJECT OBJECTIVES

- **Main focus:** Reach 62,330 men/women headed households in food insecure areas by expanding irrigation infrastructures & developing 12,020 ha of irrigated land to ensure food security, improve nutrition and increase incomes
- **Duration:** Phase I (2008 - 2106), Phase II being planned
- **Geography:** ***Phase I*** - 82 woredas across Tigray, Amhara, Oromia & SNNPR; ***Phase II*** -
- **Beneficiaries:**62,330 food insecure rural households / 311,000 individuals)
- **Donor:** IFAD, Ethiopian Government & beneficiary households
- **Funds:** ***Phase I*** - ~ US$ 57.76M, ***Phase II***
- **Implementing Partners:** Regional Bureaus of Water and Agriculture

ACHIEVEMENTS

- Helped in capacity building of 82 Woreda and 29 Zonal governmental staff and offices. The program has organized 175 water user associations, with capacity building on all Water User Associations initiated and are currently being strengthened
- Completed the construction of 107 schemes while 116 other schemes are under construction
- Developed a land size of 20,817 ha using irrigation which is ~173% of the planned size i.e 12,020 ha
- Benefited 58,959 households which is ~95% of the planed number of beneficiaries i.e 62330

MAIN CHALLENGES

- Limited capacity in terms of human resource, logistics and materials for training
- WUA's associations lack of legal entity
- Delay in construction of schemes due low quality of study, design, construction, management & supervision

KEY LEARNINGS

- Trainings for farmers ,Water users associations ,Farmer research groups , government officials and stakeholders workshops play an important role on improvement and success of irrigation development
- In parallel to the trainings , the establishment and strengthening of water users association is critical for equity distribution of water and sustainability of irrigation schemes
- The Establishment of farmer research groups plays an important role in identifying on ground problems of the farmers and make a relevant interventions by engaging farmers themselves. It also helps in disseminating new technologies easily

Figure105: MoANR-PASIDP program profile

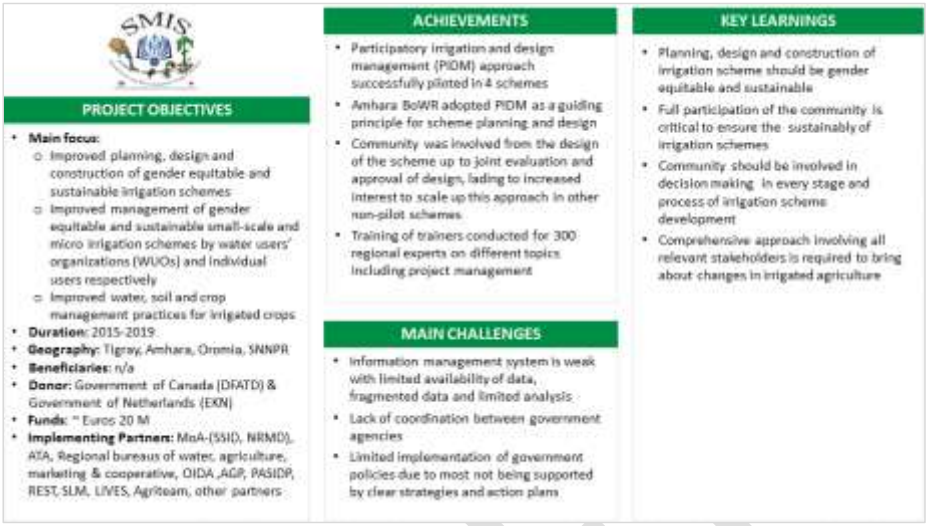

Figure106: MoANR-SMIS program profile

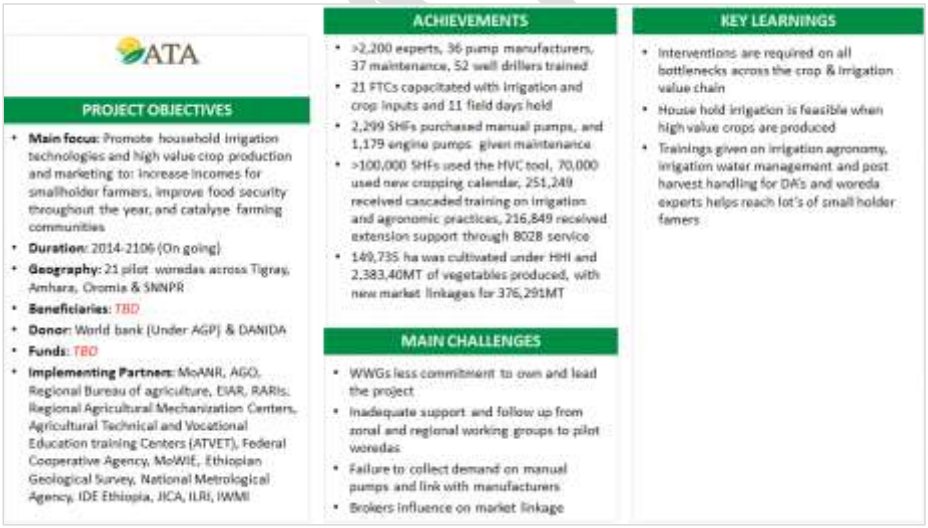

Figure107: ATA-HHI Value chain program profile

Figure108: IWMI program profiles (multiple programs)

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