NATIONAL SMALLHOLDER IRRIGATION AND DRAINAGE STRATEGY

JANUARY, 2019 G.C.
2011 E.C.

NATIONAL SMALLHOLDER IRRIGATION AND DRAINAGE STRATEGY

January, 2019 G.C.
2011 E.C.

STATEMENT FROM THE STATE MINISTER OF AGRICULTURE

The Government of Ethiopia's Agriculture and Rural Development Policy and Strategies (2003), Agriculture Sector Policy and Investment Framework (2009), and Climate Green Resilient Economy Strategy (2013), among other major policy and strategy documents, lay out the importance of expanding irrigated agriculture for enhancing production and productivity, food security, and commercialization of smallholder agriculture as well as building resilience to climate change. The Government has therefore set a clear long-term target of ensuring access to at least one water source for every household for full or supplementary irrigation.

During the First Growth and Transformation Plan, federal ministries, regional governments, and development partners very actively promoted and supported development of irrigation, drainage and integrated agricultural water management towards this goal. The Ministry of Agriculture specifically established the Small Scale Irrigation Directorate and led the development and implementation of different strategies such as the Small-scale Irrigation Capacity Building Strategy, Household Irrigation Strategy, and Smallholder Horticulture Strategy, and programs such as Agricultural Growth Progamme, Participatory Small Scale Irrigation Development Project, and Small Scale and Micro Irrigation Support project.

These and other efforts are expected to increase the irrigated area to 4 million hectare and effectively benefit 10 million smallholder farmers at the end of Growth Transformation Plan phase 2. The Second Growth and Transformation Plan targets further increase inland irrigated through small-scale schemes and 80% of all smallholder farmers having access to at least one source of water for irrigation and 50% supported to use the full package for modern irrigation. AGP II, PASIDP II, and other federal and regional initiatives have been designed to contribute to achievement of these goals. The sub-sector continues however to face a number of systemic challenges that must be addressed for sustainable irrigation and drainage development.

The National Smallholder Irrigation and Drainage Strategy has been developed to guide investment and efforts focused on addressing these systemic challenges over the next five to ten years. The document has been jointly prepared by the Ministry of Agriculture, the Ministry of Water, Irrigation and Electricity, along with a wide range of partners and stakeholders. The strategy focuses on priority areas of intervention for rapidly scaling up irrigated agriculture across the country in a sustainable manner, and provides a clear roadmap and governance and management structure for implementation. The total estimated cost across all interventions two years back is 370 to 450 million ETB, with 75% comprising 35 high priority interventions and the remaining 25% comprising

18 medium priority interventions; yet considering current scenarios, the required budget may increase by 30%.

Development of this strategy has required close collaboration among diverse institutions across federal and regional governments, research and higher learning institutions, development partners and the private sector. I encourage all stakeholders to continue their strong engagement and heavily support the timely and effective mobilization of resources and implementation of the prioritized interventions presented here. Together we will be able to significantly improve the livelihoods of smallholder farmers, strengthen resilience to climate variability and change, and contribute to achievement of middle income status for Ethiopia.

H.E. Dr. Kaba Urgessa
State Minister, Ministry of Agriculture

STATEMENT FROM THE STATE MINISTER OF WATER, IRRIGATION AND ELECTRICITY

The National Water Resource Management Policy and Water Sector Strategy were established almost seventeen years ago to guide sustainable development and management of the country's major basins, groundwater and rainwater resources. Since that time various government institutions including the Ministry of Water, Irrigation and Electricity, the Ministry of Agriculture, Regional Governments, and other partners including local communities, have been working closely together to expand availability and access to irrigation for both commercial and smallholder agriculture.

Various supporting policies have been passed at federal and regional levels, basin development master plans have been established, and institutional enhancements have been made. Substantial progress has also been made in mapping the country's water resources and a significant number of new large, medium and small-scale irrigation and drainage schemes have been established during Plan for Accelerated and Sustained Development to End Poverty and GTP I. An even larger expansion of irrigated land has been planned and embarked on GTP II with a strong focus on smallholder farmers and pastoralist communities through both large and small-scale schemes.

Ensuring water availability and access for the vast majority of farmers, effective and sustainable water management for agricultural production and productivity, and resilience against weather shocks and climate change, will however require overcoming a number of critical challenges. The development of an effective National Smallholder Irrigation and Drainage Strategy is therefore a very important step towards implementation of the National Water Resource Management Policy and Water Sector Strategy and achievement of the Government of Ethiopia's goals in the GTP II period and beyond. This comprehensive strategy document addresses critical policy and institutional gaps, limited research and extension activities, weaknesses in scheme planning, design, construction and management, and insufficient technology availability and affordability.

The Ministry of Water, Irrigation and Electricity, and the Ministry of Agriculture, have agreed to work with stakeholders to develop a complimentary national strategy for commercial irrigation and drainage, which together with the smallholder focused strategy will ensure strong alignment and coordination between the smallholder and commercial irrigation and drainage development. Implementation of these strategies will be critical to ensure sustainable use of the country's water resources for irrigation, water supply, sanitation, and other purposes, in particular through proper consideration and application of watershed management based approaches.

In the development of the current strategy, input from diverse government bodies, research and higher learning institutions, private sector companies and development partners has been vital to ensure all stakeholders are aligned and can work together towards a common goal. I congratulate all parties involved for the success of this effort, and urge partners and stakeholders to show a similar level of engagement in the implementation of the priority interventions presented in the document over the coming 5 to 10 years.

H.E. Dr. Abreha Adugna
State Minster, Ministry of Water, Irrigation and Electricity

ACKNOWLEDGEMENTS

The 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 which supported the development of this strategy is provided in Appendix A1.

TABLE OF CONTENTS

LIST OF FIGURES

ACRONYMS

AAU	Addis Ababa University
AGP	Agricultural Growth Program
ATA	Agricultural Transformation Agency
BDB	Basin Development Bureau
BoA	Bureaus of Agriculture
BoANR	Bureaus of Agriculture and Natural Resource
BoWR	Bureaus of Water Resources
DA	Development Agents
DECSI	Dedebit Credit and Saving Institution
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
HHI	Household Irrigation
HPC	High Production Crops
HVC	High Value Crops
ICT	Information Communication Technology
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
ILSSI	Irrigation Laboratory and Small Scale Irrigation
IRBM	Integrated River Basin Management
IVR	Interactive Voice Record
IWMI	International Water Management Institute
JBIC	Japan Bank for International Cooperation
LIVES	Livestock and Irrigation Value Chain for Ethiopian Smallholders
MFI	Micro-Finance Institutes
MIS	Management Information System

MLE	Monitoring, Learning and Evaluation
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoFED	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
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PASIDP	Participatory Small Scale Irrigation Development Project
RARI	Regional Agricultural Research Institutes
ROI	Return on Investment
RuSACCO	Rural Savings and Credit Cooperatives
SACC	Saving and Credit Cooperative
SIWD	Sustainable Irrigation And Watershed Development
SME	Subject Matter Experts
SMIS	Small Scale and Micro-Irrigation Support
SMS	Short Message Service
SNNPR	Southern Nations Nationalities and Peoples Region
SSID	Small-Scale Irrigation Directorate
SSIDCH	Small Scale Irrigation Development, Construction and Handling
TVET	Technical and Vocational Education and Training
USAID	United States Agency for International Development
VERCON	Virtual Extension And Research Communication Network
WUA	Water Users Association
WWCE	Water Works Construction Enterprise

PART 1

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 Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and the first growth and transformation plan (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 (HHI) technologies. The total amount of land under small-scale irrigation, for example, is estimated to have grown and reached over 1.5 million hectares at the end of GTP I. The second growth and transformation plan (GTP II) targets rapidly further extending land irrigated by small-scale schemes and ensuring that 80% of all smallholder 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 is allocated in national and regional government budgets and programs such as Agricultural Growth Program (AGP) II and Participatory Small Scale Irrigation Development Project (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 crops (HVC) value chains remain underdeveloped, making it economically impossible for farmers to afford and fully benefit from irrigation and commercialization. Many farmers are using some form of supplementary irrigation, but few apply 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.

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), *GTP I* (2010), *Small scale irrigation capacity building strategy* (2011), *Climate Green Resilient Economy Strategy* (2013), *GTP II* (2015)

2 *GTP II* (2015), page 124

The Ministry of Agriculture (MoA), the Ministry of Water, Irrigation and Electricity (MoWIE), the Ethiopian Agricultural Transformation Agency (ATA), and other partners, initiated development of this National Smallholder Irrigation and Drainage 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.

While the interventions proposed here therefore have been aggressively planned out over a five year time horizon, the implementation of the strategy may likely extend over the next 10 years depending on how quickly resources can be mobilized and implementation proceeds. A separate strategy focused on commercial irrigation and drainage should also be developed to guide that segment of the sub-sector. Together these two documents can form the overall National Irrigation and Drainage Strategy to 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: *Transforming agricultural production from its dependence on rain-fed practices by creating reliable irrigation system in which smallholder farmers have access to at least one option of water source to increase production and productivity as well as enhance resilience to climate change and thereby ensure food security, maintain increasing income and sustain economic growth.*

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

Strategic objectives:

- Strengthen government policies and institutions to effectively transform the irrigation and drainage sub-sector for male and female 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 male and female 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 male and female smallholder farmers
- Promote effective and sustainable use and maintenance of irrigation and drainage technologies, water resources, and on-farm water / salinity management, by male and female smallholder farmers
- Ensure specific needs of lower income and female farmers including married women are well-addressed

1.2. Potential of Irrigation and Drainage for Agricultural Growth and Transformation

Estimating the potential for smallholder 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 geographical information system (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 (ROI) 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 HVC 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 HVC 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 HVC and high production crops (HPC) in five years' time, applied at woreda level and then 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). Throughout the analysis only smallholder cultivated land is considered rather than commercial agriculture or irrigation[4].

Figure 1 presents the 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 considering the economic feasibility of irrigation. The estimates made

---

3 *Does investment in motor pump based smallholder irrigation lead to financially viable input intensification and production? Economic assessment of investments in motor pump based smallholder irrigation, Gebrehaweria Gebregziabher et. al., IWMI, 2015, does look at the economic return from a farmer perspective of investing in HHI pumps; Financial viability of groundwater irrigation and its impacts on livelihoods of smallholder farmers: The case of eastern Ethiopia, Hagos et. al., Water Resources and Economics 7, 2014 looks at the financial viability of boreholes and dug wells; Profit and financial risk in the smallholder irrigated agriculture of Ethiopia, Kindie Getnet et. al., ILRI, 2015, look a profitability of different commodities with use of irrigation; Trend Assessment and Technical Estimation of Investment cost of irrigation in Ethiopia, MoANR, 2012, looks at NPV and ROI of various types of schemes and technology combinations.*

4 *Exclusion of commercial agriculture should not reduce accuracy of the results presented as the water resources available in the country are significantly larger than the total land expected to be cultivated within 5 or 10 years.*

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 vs. 5.4 million[5].

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 (O&M) is accounted for. As can be seen in Figure 2 shows the estimate varies between 6.8 and 7.4 million hectares. Using the estimate of ~2.7 million hectares of smallholder land irrigated today, these results imply that an additional 4.1 to 4.7 million hectares land could be irrigated with positive economic returns.

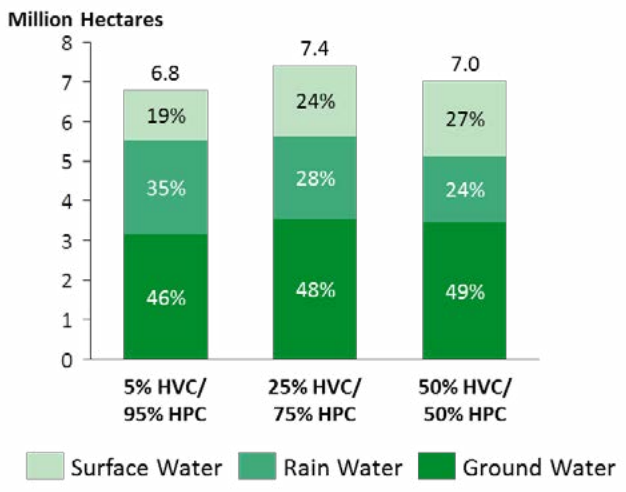

Figure 2: National Economic Potential for irrigation estimate split by water source for each scenario

In Figure 2, the increase in Economic Potential as the share of HVC increases from 5% to 25% reflects the increase in economically attractive irrigation opportunities as more farmers take up HVC 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

5 *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 in each woreda.*

less expensive groundwater and rainwater resources are fully utilized. 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.

GTP II lays out Year 5 target yields per harvest under rain-fed agriculture for all crops that average ~50% greater than the current yields. In the present analysis, yields per harvest are conservatively modelled to increase by 20% with irrigation on average, due to better application of water to crop root zone during critical growth period and other periods, with 1 to 3 total harvests per year under irrigation. The total impact of irrigation on production therefore varies between 1.2 times (+20% with only 1 harvest) and 3.6 times (+20% with 3 harvests) depending on the crop and associated number of harvests per year. As shown in the next table, realization of the economic irrigation potential under the three HVC / HPC scenarios reported in Figure 2 can translate to an annual production increment of 195%-199% over GTP II Year 5 target yields under rain-fed agriculture, at a national level[6]. This increase is significantly larger than the national production increment of GTP II Year 5 target yields over current yields of 46%-48%. 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 absolute irrigated land potential of the region relative to other regions.

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	1	2.3	8	3	5	17	3	6	20
Amhara	42	62	202	60	89	291	64	95	311
Benishangul	1.1	1.8	6	2.2	4	12	2.8	5	16
Gambella	0.2	0.4	1	1	1	3	1	2	5
Harrari	0.1	0.2	1	0.3	0.4	1	0.3	0.4	1
Oromia	68	96	244	105	148	379	114	160	416
SNNP	22	33	112	40	62	205	48	73	244
Somali	5	8	31	11	17	62	13	22	77
Tigray	6	10	27	12	19	50	15	22	59
National	***147***	***214***	***632***	***234***	***345***	***1,022***	***261***	***385***	***1,150***
% increase	-	***46%***	***195%***	-	***47%***	***196%***	-	***48%***	***199%***

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

6 *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.*

Building on these estimates of incremental production from full cultivation and irrigation of total land estimated under the Economic Potential results for each % HVC / % HPC scenario, Figure 4 presents estimates of the annual net revenue based on farm-gate prices, both at a national level (left hand chart) and per farmer (right hand chart) assuming a maximum of 6.2 million farmers impacted.[7] Equivalent revenue estimates based on current yields and GTP II Year 5 target yields under rain-fed agriculture are also presented in each chart.[8] As highlighted in the charts, the potential economic benefit from irrigation incremental to achieving GTP II Year 5 Target Yields is significant under all scenarios, multiplying annual revenues by between 2.7 times (5% HVC / 95% HPC scenario) to 3.1 times (50% HVC / 50% HPC scenario). At the same time, moving from the 5% HVC / 95% HPC scenario to the 50% HVC / 50% HPC scenario increases the net revenue gain from irrigation by 2.4 times (shaded circle). Together these results imply that full irrigation and cultivation of land estimated under the Economic Potential, along with an increase in the share of land cultivated with HVC to 50%, could increase net revenues based on farm-gate prices by up to ~6.5 times [=2.7*2.4] 6.2 million farmers.

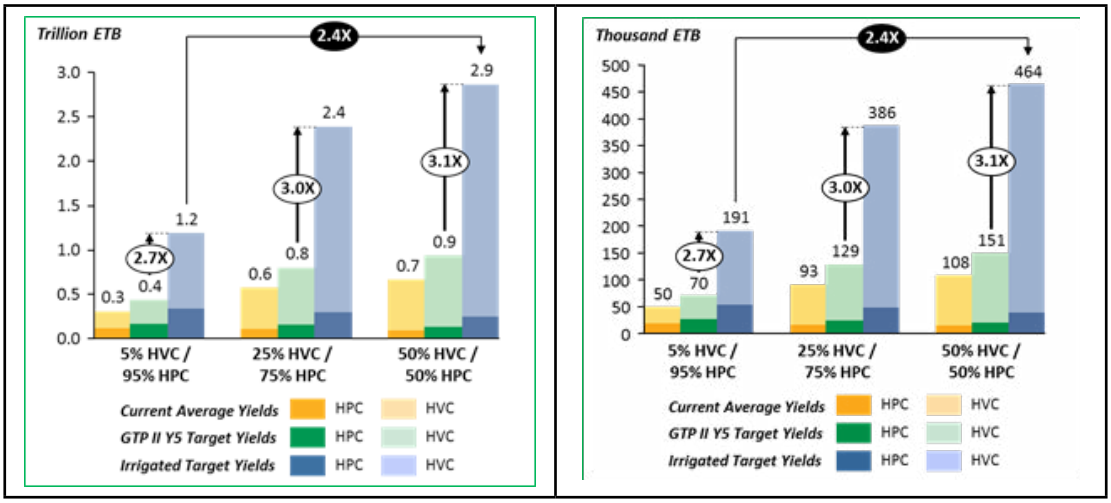

Figure 4: National (left) and per farmer (right) farm-gate net revenue generated under HVC / HPC scenarios

The incremental production and revenue results presented above do not however reflect irrigated yields and production on land that is already irrigated in the country, due to limited data available on land irrigated by woreda and crops produced on this land. Applying the estimate of ~2.7 million hectares of smallholder land irrigated today and assuming that this irrigation is fully utilized, the total annual net revenue gains at national level reported in the left chart of Figure 20 as well as the number of farmers impacted will decrease by up to ~40% [=2.7/6.8]. Full irrigation and

7 *The greatest area of land can be irrigated based on Economic Potential under the 25% HVC / 75% HPC scenario, translating to about 6.2 million farmers assuming an average farm size of 1.2 hectares per farmer. Therefore annual net revenue at national level is divided by this number of farmers (6.2 million) in all HVC/HPC scenarios to generate a comparable per farmer net revenue estimate.*

8 *Under the modelled irrigation scenarios, four HVC crops (Green Pepper, Garlic, Onion, and Sweet Potato) and five HPC crops (Tef, Sesame, Barley, Coffee and Bread Wheat) comprise all cultivated land. Revenue estimates based on current yields and GTP II Year 5 target yields assume the same share of hectares planted by crop as the irrigated scenarios.*

cultivation of land estimated under the Economic Potential that is not currently irrigated, along with an increase in the share of land cultivated with HVC to 50%, could therefore increase net revenues based on farm-gate prices by ~4 times [=2.7*2.4*(1-40%)] the net revenues generated from crop production assuming achievement of GTP II Year 5 target yields, for ~3.8 million famers [=6.2*(1-40%)]. This finding reinforces the need for promotion and support for HVC value chains to significantly increase economic attractiveness and uptake of irrigation and benefits to farmers from irrigation.[9]

Finally, analysis was also undertaken at a crop level for both high value and HPC, 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 HPC in particular. The key findings of these analyses include:

Uptake of irrigation for HPC 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 land growing 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 HPC 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 ROI, 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, weakness or market failure constraining 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.

9 *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 HVC can drive significantly higher uptake of irrigation despite the relatively higher crop water requirements for some HVC.*

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

32 major system bottlenecks were identified in these four thematic areas, with 16 high priority and 5 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. 54 interventions were defined to address the priority bottlenecks, with 35 high priority interventions that are critical to implement to accelerate transformation of the sub-sector and 18 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.

Policy & Institutional Framework	Research & Extension	Scheme Planning, Design, Construction & Management	Technology Supply Chains
1. Establish and strengthen basin authorities and increase focus on smaller schemes 2. Strengthen watershed mgmt. incl. soil and water conservation in basin mgmt. activities 3. Develop more granular resolution basin master plans, conduct timely updates and ensure accessibility through various platforms 4. Introduce an Irrigation Management Information System to consolidate and regularly update water and other relevant data and analysis, scheme inventories and usage patterns, and make broadly accessible 5. Introduce a national fund for smallholder irrigation and drainage development, and consolidate planning and reporting nationally 6. 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 7. Develop and implement phased approach and plan to introduce water fees and cost recovery in all (publicly funded) schemes 8. Establish national standards for irrigation equipment including drip kits, sprinklers and polyethylene pipes, similar to pumps 9. Enforce national standards through incentivizing investment in laboratories, building capacity of existing labs and of MoT and ECAE for enforcement 10. Introduce standard technical specifications for public irrigation equipment procurement 11. Strengthen university curriculums and research on irrigation engineering and scheme mgmt., irrigation technologies and agriculture, water mgmt. and drainage	12. Accelerate the satellite-based shallow and deep groundwater mapping efforts to finish within 1 and 10 years, respectively 13. Develop a national master plan for irrigation related research across the country, and allocate increased budget for the construction of irrigation research centers, operations and management, including hiring researchers with advanced degrees in research centers 14. Add additional content to the SSID extension manual in key areas and develop crop specific manuals for the major crops and disseminate them to regional level 15. 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 16. Develop SMS and media based campaign to promote irrigation to farmers, expand irrigation content on 8028 system and promote heavily 17. Develop an ICT based solution for site specific advisory on crop water requirements and irrigation scheduling 18. Increase training and in-kind support to model farmers to use and promote irrigation and drainage good practices	19. Develop standard criteria and guidelines for prioritizing new schemes while also ensuring maintenance of existing schemes 20. Strengthen joint planning and execution of scheme development and mgmt. between regional agricultural and water institutions 21. Require agencies to include all relevant costs incl. handover, operation and maintenance, rehabilitation, monitoring and information dissemination, in funding for schemes 22. Strengthen contract management, scheme design, construction and maintenance capacity of public institutions through increased on-the-job and external training 23. Establish national standards for design, construction, operation and maintenance, and performance assessment of schemes 24. Ensure integrated planning and implementation of crop value chain related interventions with scheme planning, design, delivery and management 25. 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 26. Develop guidelines and standard technical specifications for tendering consultancy and construction services, strengthen technical capacity and adherence to procedures 27. Establish large-scale capacity building program(s) for WUAs on scheme and financial mgmt., revenue generation and other topics, with strong NGO involvement 28. Make available grants or low interest loans for WUAs to fund their activities	29. Undertake policy analysis on optimal import tariff for equipment, and advocate for implementation of recommendations 30. Prioritize FOREX allocation for equipment, parts and raw material imports 31. Promote joint ventures, co-production and franchising arrangements with international firms and/or technology transfer programs with partner countries and NGOs 32. Provide business, technical and financial support to wholesalers and retailers willing to invest in retailing in rural areas 33. Increase credit access for existing or nascent manufacturers, wholesalers and retailers willing to scale up own business 34. Facilitate linkages between wholesalers and retailers, cooperatives and farmer common interest groups, and financial institutions for equipment purchase and financing 35. 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

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

Policy & Institutional Framework	Research & Extension	Scheme Planning, Design, Construction & Management	Technology Supply Chains
1. Introduce partnership programs with international partners for knowledge and experience sharing with government staff and other local stakeholders to build local capacity 2. Develop policy and supporting regulations, directives and guidelines for sustainable exploitation and rechargeable management of groundwater 3. Enhance monitoring and information exchange for groundwater including information related to abstraction control, aquifer behavior and pollution prevention 4. Undertake comprehensive analysis of institutional roles and capabilities in the sub-sector and advocate for implementation of recommendations and maintenance of institutional stability 5. Ensure the accountability and proper utilization of funding and other resources allocated for smallholder irrigation and drainage development	6. Conduct national level gender analysis to identify constraints impacting awareness and use of irrigation technologies by women, and design, promote and mainstream solutions 7. Introduce a coordinated plan for development partners and the private sector to engage in awareness creation and extension support / supplementation 8. Expand use of irrigation-specific days/ weeks including new technology demonstrations and farmer to farmer experience sharing events at woreda level 9. 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 10. 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 11. Make all research outputs available to the extension system through an online information sharing platform	12. 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 13. 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 14. Support the establishment of federation of WUAs especially for large scale schemes	15. Introduce finance and technical support program for well drilling service providers and irrigation equipment rental service providers 16. Improve content and delivery of well drilling courses in TVET institutions 17. Improve content and delivery of irrigation technology maintenance courses in Agricultural TVET institutions 18. Provide trainings and accreditation on installation, operation, maintenance and repair of irrigation equipment to private garages

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 Ethiopian Birr (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	11	5	80 – 120 M / 24%	20 – 40 M / 7%
Strengthening Research & Extension	Strengthen research critical for development of the sub-sector, the linkage to extension, and extension activities and services	7	6	80 – 120 M / 24%	30 – 50 M / 10%
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 / 17%	15 – 25 M / 5%
Promoting Technology Supply Chains	Promote increased availability, accessibility and affordability of equipment, services and finance	7	4	25 – 45 M / 9%	10 – 20 M / 4%
	TOTAL	***35***	***18***	**280 – 330 M / 75%**	**90 – 120 M / 25%**

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

The total estimated cost across all interventions is 370 to 450 million ETB, with a mid-point estimate of 410 million ETB, with ~75% comprising the 35 high priority interventions (~305 million ETB) that are critical to implement to accelerate transformation of the sub-sector and the remaining 25% comprising the 18 medium priority interventions (~105 million ETB) that should also be implemented resource and time permitting.

1.4. Implementation, Governance and Management

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.

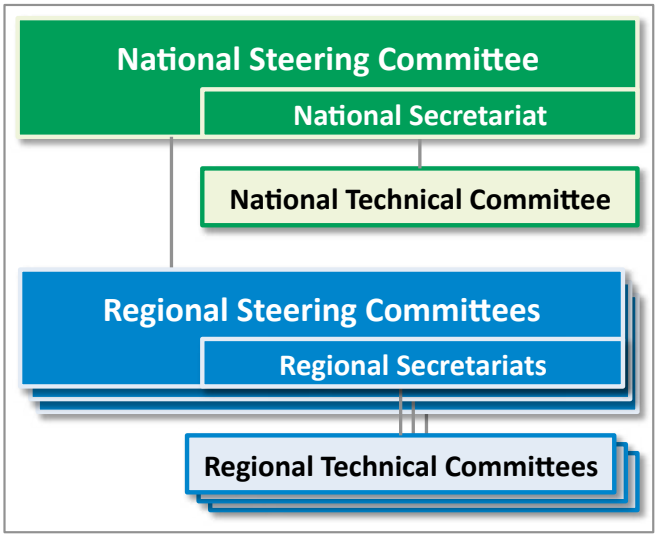

Figure 9: Structure for governance and management of implementation

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 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.

PART 2

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 plans10 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/HHI 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 all smallholder farmers have at least one source of water for irrigation and 50% will be supported to use the full package for modern irrigation11. Substantial funding is allocated 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 HVC value chains remain underdeveloped, making it economically impossible for farmers to afford and fully benefit from irrigation and commercialization. Many farmers are using some form of supplementary irrigation, but few apply 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

10 *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), *GTP I* (2010), *Small scale irrigation capacity building strategy* (2011), *Climate Green Resilient Economy Strategy* (2013), *GTP II* (2015)

11 *GTP II* (2015), page 124

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 MoA, the MoWIE, the Ethiopian ATA, and other partners, initiated development of this National Smallholder Irrigation and Drainage 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/HHI 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. While the interventions proposed here therefore have been aggressively planned out over a five year time horizon, the implementation of the strategy may likely extend over the next 10 years depending on how quickly resources can be mobilized and implementation proceeds.

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 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 strategy focused on commercial irrigation and drainage should also be developed to guide that segment of the sub-sector. Together these two documents can form the overall National Irrigation and Drainage Strategy to 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: *Transforming agricultural production from its dependence on rain-fed practices by creating reliable irrigation system in which smallholder farmers have access to at least one option of water source to increase production and productivity as well as enhance resilience to climate change and thereby ensure food security, maintain increasing income and sustain economic growth.*

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

Strategic objectives:

- Strengthen government policies and institutions to effectively transform the irrigation and drainage sub-sector for male and female 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 male and female 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 male and female smallholder farmers
- Promote effective and sustainable use and maintenance of irrigation and drainage technologies, water resources, and on-farm water / salinity management, by male and female smallholder farmers
- Ensure specific needs of lower income and female farmers including married women are well-addressed

2.3. Approach and Stakeholder Engagement

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

Figure 10: Strategy development approach

The situation analysis (step was undertaken through review of relevant literature[12] 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 Benishangul Gumuz regions. The full list of key informant interviews completed is provided in Appendix A1. Field visits included the following irrigation schemes to supplement various existing analysis of specific schemes in the country[13]:

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

Benishangul Gumuz: Golda irrigation scheme, Hoha irrigation scheme

Details on steps 2, 3 and 4 are provided in Section 4, while step 5 is further described in Section

12 See References section for details on major documents reviewed

13 See for example, *Irrigation practices in Ethiopia: characteristics of selected Irrigation Schemes* Michael M. Girma and Seleshi B. Awulachew, IWMI, 2007; *Water Resources and Irrigation Development in Ethiopia*, Seleshi B. Awulachew et. al.,
IWMI, 2007; *Case study review of investigated irrigation projects in Ethiopia*, W Loiskandl et. al., 2008.

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 Workshop at the end of the project to validate the main content of this document. The mandate and members of the Steering and Technical Committees, as well as the agenda and invitees for the two workshops are provided in Appendix A1.

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 the possible 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 ***Section 3: Summary of systemic bottlenecks and strategic interventions in the sub-sector*** the process of identifying and prioritizing systemic bottlenecks and strategic interventions is explained, along with summaries of the prioritized bottlenecks and interventions, and consideration for mainstreaming environment and gender related issues.

Section 4: Implementation planning, governance and management presents a summary of intervention owners and costs, as well as an implementation roadmap by thematic area. This section also outlines proposed governance, management and monitoring, learning and evaluation frameworks to support successful implementation and sustainability of interventions.

The prioritized bottlenecks as well as the related high and medium priority interventions for each are further detailed in ***Section 5: 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***.

PART 3

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

3.1. Objectives of the Analysis

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 ROI 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.[14] 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

14 *Does investment in motor pump based smallholder irrigation lead to financially viable input intensification and production? Economic assessment of investments in motor pump based smallholder irrigation, Gebrehaweria Gebregziabher et. al., IWMI, 2015, does look at the economic return from a farmer perspective of investing in HHI pumps; Financial viability of groundwater irrigation and its impacts on livelihoods of smallholder farmers: The case of eastern Ethiopia, Hagos et. al., Water Resources and Economics 7, 2014 looks at the financial viability of boreholes and dug wells; Profit and financial risk in the smallholder irrigated agriculture of Ethiopia, Kindie Getnet et. al., ILRI, 2015, look a profitability of different commodities with use of irrigation; Trend Assessment and Technical Estimation of Investment cost of irrigation in Ethiopia, MoANR, 2012, looks at NPV and ROI of various types of schemes and technology combinations.*

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. Throughout the analysis only smallholder cultivated land is considered rather than commercial agriculture or irrigation[15].

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 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 O&M is accounted for. In other words, this estimate of potential focuses on economic feasibility and attractiveness defined through a discounted ROI metric, rather than minimum water requirement / maximum land that can be irrigated by available water.

15 *Exclusion of commercial agriculture should not reduce accuracy of the results presented as the water resources available in the country are significantly larger than the total land expected to be cultivated within 5 or 10 years.*

Irrigation becomes more economically feasible and attractive when production focuses on HVC 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 HVC 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 HVC and 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.

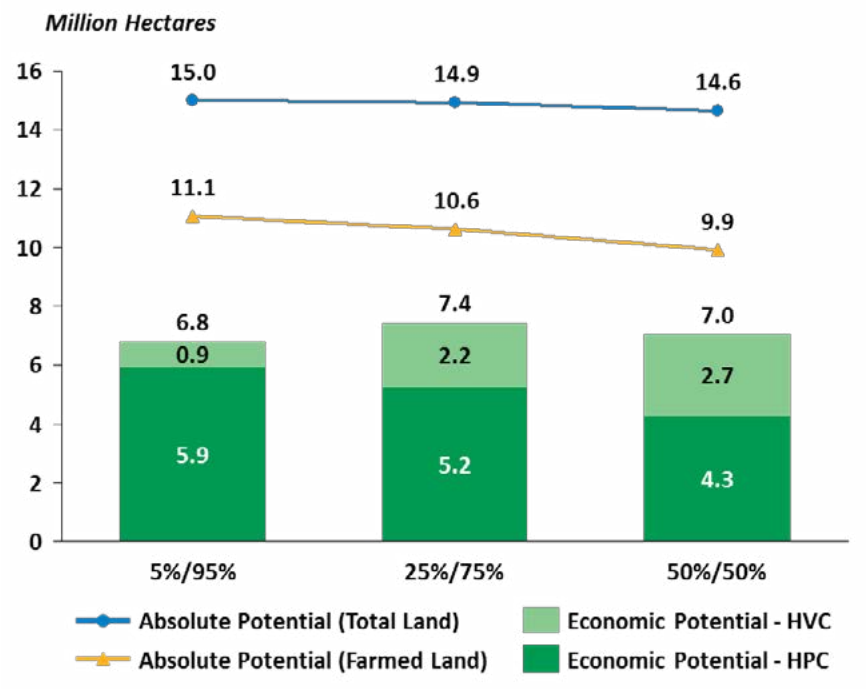

Figure 11: National Irrigation Potential for three scenarios of percentage of HVC and HPC

Absolute Potential (total land) varies between 15.0 million hectares and 14.6 million hectares across the three scenarios, while Absolute Potential (farmed land) varies between 11.1 million hectares and 9.9 million 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 O&M is accounted for. As can be seen in Figure 11, this estimate varies between 6.8 and 7.4 million 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 HVC 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
Benishangul	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**

Figure 12: Indicative regional irrigation potential (million hectares) results on an 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%
Benishangul	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%**

Figure 13: Indicative regional irrigation potential (million 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
Benishangul	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

Figure 14: Indicative regional irrigation potential (million 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%

Figure 15: Indicative regional irrigation potential (million 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.[16]

16 *The estimates 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.*

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 16: 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 (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.

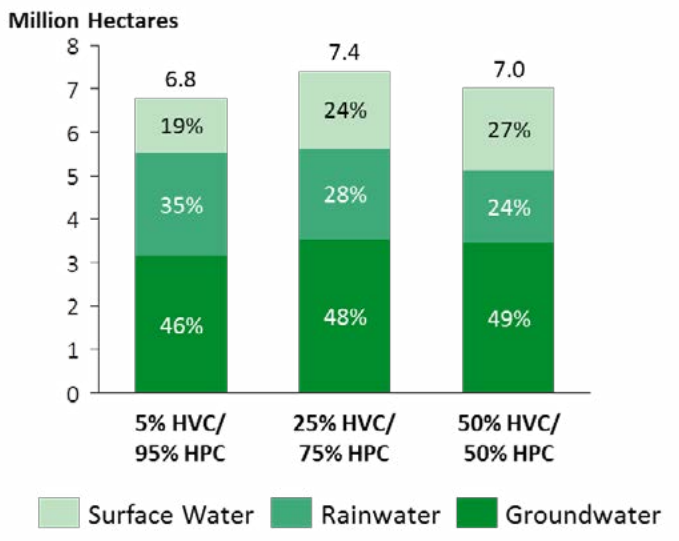

Figure 17: National Economically Feasible Irrigation Potential estimate split by water source for each scenario

Using the estimate of ~2.7 million hectares of smallholder land irrigated today, the results presented in Figure 17 imply that an additional 4.1 to 4.7 million hectares of cultivated land could be irrigated with positive economic returns. Figure 18 below presents the same results with regional disaggregation and compared to the total land irrigated for smallholder farmers as reported by each region. Six regions 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 179% 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	0.01	0.02	0.02	0.03	438%	481%	511%
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	0.002	0.2	0.3	0.3	10,211%	13,760%	15,470%
Tigray	0.23	0.05	0.1	0.1	21%	54%	55%
National	*2.65*	*4.1*	*4.8*	*4.4*	*156%*	*179%*	*165%*

Figure 18: Regional disaggregation of additional irrigated land based on economic potential

3.3. Results of Impact Assessment

The national impact of irrigation can be assessed by considering the production and net 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. GTP II lays out Year 5 target yields per harvest under rain-fed agriculture for all crops that average ~50% greater than the current yields. In the present analysis, yields per harvest are conservatively modelled to increase by 20% with irrigation on average, due to better application of water to crop root zone during critical growth period and other periods, with 1 to 3 total harvests per year under irrigation. The total impact of irrigation on production therefore varies between 1.2 times (+20% with only 1 harvest) and 3.6 times (+20% with 3 harvests) depending on the crop and

associated number of harvests per year.

As shown in the next table, realization of the economic irrigation potential under the three HVC / HPC scenarios reported in Figure 17 above can translate to an annual production increment of 195%-199% over GTP II Year 5 target yields under rain-fed agriculture, at a national level[17]. This increase is significantly larger than the national production increment of GTP II Year 5 target yields over current yields of 46%-48%. 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 absolute irrigated land potential of the region relative to other regions.

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	1	2.3	8	3	5	17	3	6	20
Amhara	42	62	202	60	89	291	64	95	311
Benishangul	1.1	1.8	6	2.2	4	12	2.8	5	16
Gambella	0.2	0.4	1	1	1	3	1	2	5
Harrari	0.1	0.2	1	0.3	0.4	1	0.3	0.4	1
Oromia	68	96	244	105	148	379	114	160	416
SNNP	22	33	112	40	62	205	48	73	244
Somali	5	8	31	11	17	62	13	22	77
Tigray	6	10	27	12	19	50	15	22	59
National	*147*	*214*	*632*	*234*	*345*	*1,022*	*261*	*385*	*1,150*
% increase	-	*46%*	*195%*	-	*47%*	*196%*	-	*48%*	*199%*

Figure 19: Potential increases in production by region under Current, GTP II Year Five Target and Irrigated yields

Building on these estimates of incremental production from full cultivation and irrigation of total land estimated under the Economic Potential results for each % HVC / % HPC scenario, Figure 20 below presents estimates of the annual net revenue based on farm-gate prices, both at a national level (left hand chart) and per farmer (right hand chart) assuming a maximum of 6.2 million farmers impacted.[18] Equivalent revenue estimates based on current yields and GTP II Year 5 target yields under rain-fed agriculture are also presented in each chart.[19] As highlighted in the charts, the potential economic benefit from irrigation incremental to achieving GTP II Year 5 Target Yields is

17 *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.*

18 *The greatest area of land can be irrigated based on Economic Potential under the 25% HVC / 75% HPC scenario, translating to about 6.2 million farmers assuming an average farm size of 1.2 hectares per farmer. Therefore annual net revenue at national level is divided by this number of farmers (6.2 million) in all HVC/HPC scenarios to generate a comparable per farmer net revenue estimate.*

19 *Under the modelled irrigation scenarios, four HVC crops (Green Pepper, Garlic, Onion, and Sweet Potato) and five HPC crops (Tef, Sesame, Barley, Coffee and Bread Wheat) comprise all cultivated land. Revenue estimates based on current yields and GTP II Year 5 target yields assume the same share of hectares planted by crop as the irrigated scenarios.*

significant under all scenarios, multiplying annual revenues by between 2.7 times (5% HVC / 95% HPC scenario) to 3.1 times (50% HVC / 50% HPC scenario). At the same time, moving from the 5% HVC / 95% HPC scenario to the 50% HVC / 50% HPC scenario increases the net revenue gain from irrigation by 2.4 times (shaded circle). Together these results imply that full irrigation and cultivation of land estimated under the Economic Potential, along with an increase in the share of land cultivated with HVC to 50%, could increase net revenues based on farm-gate prices by up to ~6.5 times [=2.7*2.4] for 6.2 million farmers.

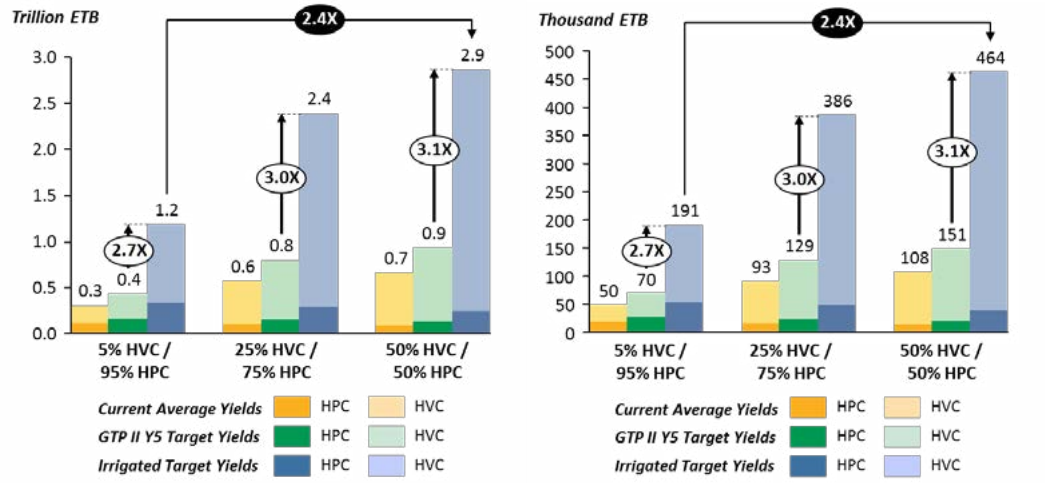

Figure 20: National (left) and per farmer (right) farm-gate net revenue generated under HVC / HPC scenarios

The incremental production and revenue results presented above do not however reflect irrigated yields and production on land that is already irrigated in the country, due to limited data available on land irrigated by woreda and crops produced on this land. Applying the estimate of ~2.7 million hectares of smallholder land irrigated today and assuming that this irrigation is fully utilized, the total annual net revenue gains at national level reported in the left chart of Figure 20 as well as the number of farmers impacted will decrease by up to ~40% [=2.7/6.8]. Full irrigation and cultivation of land estimated under the Economic Potential that is not currently irrigated, along with an increase in the share of land cultivated with HVC to 50%, could therefore increase net revenues based on farm-gate prices by ~4 times [=2.7*2.4*(1-40%)] the net revenues generated from crop production assuming achievement of GTP II Year 5 target yields, for ~3.8 million famers [=6.2*(1-40%)]. This finding reinforces the need for promotion and support for HVC value chains to significantly increase economic attractiveness and uptake of irrigation and benefits to farmers from irrigation.[20]

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 the GTP II Year 5 Target Yields and national average prices and assuming the lowest cost irrigation package is typically used.

20 *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 HVC can drive significantly higher uptake of irrigation despite the relatively higher crop water requirements for some HVC.*

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

Figure 21: Annual average net revenue for irrigation by crop, with and without subsidization

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 yield and price data used in the main modelling given these can vary greatly across the country. 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 HPC 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 as GTP II Year 5 Targets Yields are achieved, as well as beyond this period until higher average yields are achieved for these crops.

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 22, 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 22: Potential HVC farmer revenue gain (ETB/hectare) with supplementary irrigation under rainfall scenarios

Results of the same analysis for a farmer growing HPC 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 ROI, 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

Figure 23: Potential HPC farmer revenue gain (ETB/hectare) 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 to disposal of the excess water post usage, feasible for use within Ethiopia in the next five years based on cost and availability considerations (see Figure 24 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 eight HVC with >120,000 ETB revenue per hectare given GTP II Year 5 Target Yields (national average), and eight HPC with >1million smallholder farmers currently growing these, to focus the analysis on so as to reduce analytical complexity and computational load of the model (see Figure 25 below); [21] 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.

21 *Sesame has a significantly lower number of farmers than the other HPC (See Appendix A2), but is considered in the analysis due to its strategic importance.*

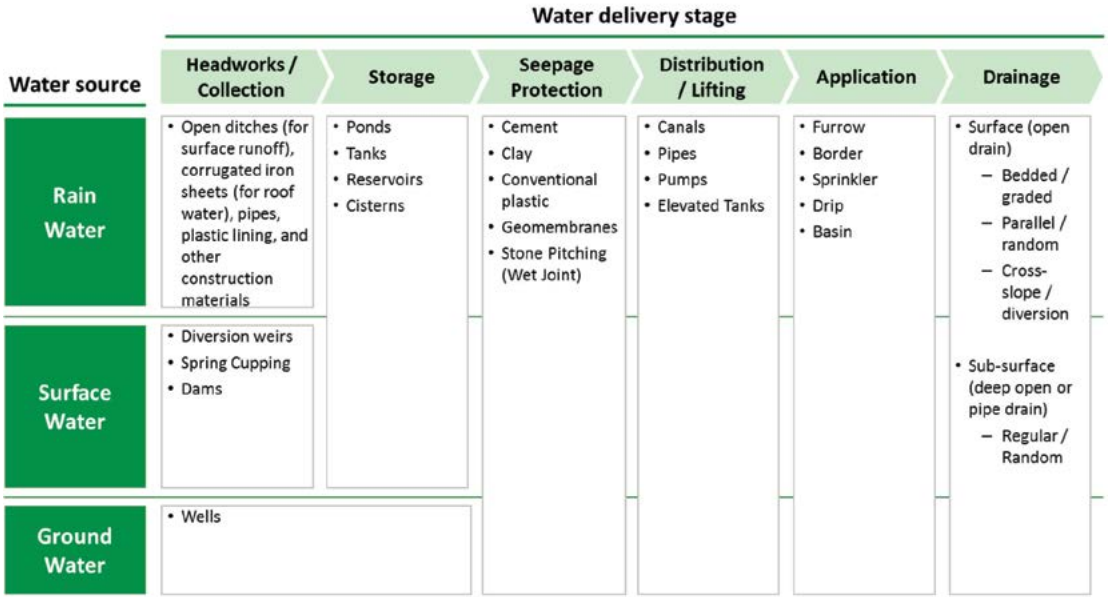

Figure 24: Irrigation technologies considered by water delivery stage

#	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
8	Lentil	124,620		Barley	39,901

Figure 25: 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 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. Consistent with the earlier analyses on which the impact assessment builds, average crop and input prices at regional level are used for estimating revenues. This analysis also assumes GTP II Year 5 Target Yields for all crops, and the results are compared to the revenues generated assuming these yields under rain-fed agriculture and also current yield under rain-fed agriculture. Revenue estimates based on current yields and GTP II Year 5 target yields assume the same share of hectares planted by crop as the irrigated scenarios.

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 compared to current yields. In the present analysis, yields per harvest are conservatively modelled to increase by 20% with irrigation on average, due to better application of water to crop root zone during critical growth period and

other periods. Compared to current yields, this is a further increase over GTP II Year 5 Target Yields of 30% (i.e. 79% - 49%) on average on a single season / harvest basis, as shown below.

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

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 (1.2 hectares). 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 (6.2 million) is based on the 25% HVC / 75% 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 smaller number of farmers can realize this net revenue. Therefore the total number of farmers under the 25% HVC / 75% 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 in no yield and 100% rainfall will result in 100% of the yield. Supplementary irrigation is modelled to have a negative ROI 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.

Twenty percent of total land area in each woreda is 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).

Twenty percent 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 50 kilometer 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

Ten percent 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 using high-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 consideration of water requirements for other sectors such as water supply, as well as potential for transfer of water across basins
- 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
- Further refine crop 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.

PART 4

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

4.1. Identification and Prioritization of Systemic 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, weakness or market failure constraining 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 HHI in Ethiopia* (2012), and *GTP II* (2015). Additional interventions were also identified from five sources:

- Other studies made in the sub-sector by MoA, IWMI, Mekelle University, and others[22]
- Stakeholder interviews and discussions, including with local and global experts
- Review of existing programs and initiatives in the country, including in particular: MoA AGP I: Small-scale Irrigation Development Component, MoA PASIDP, MoA Small Scale and Micro-Irrigation Support (SMIS): Small-scale Irrigation Capacity Building Component, ATA HHI Value Chain Project, IWMI: Africa Rising, Irrigation Laboratory and Small Scale Irrigation (ILSSI), the Livestock and Irrigation Value Chain for Ethiopian Smallholders project (LIVES) and the International Livestock Research Institute (ILRI).[23]
- 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.

22 See References section at the end of this document

23 More detailed information on each program is provided in Appendix A3.

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 16 high, 5 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.

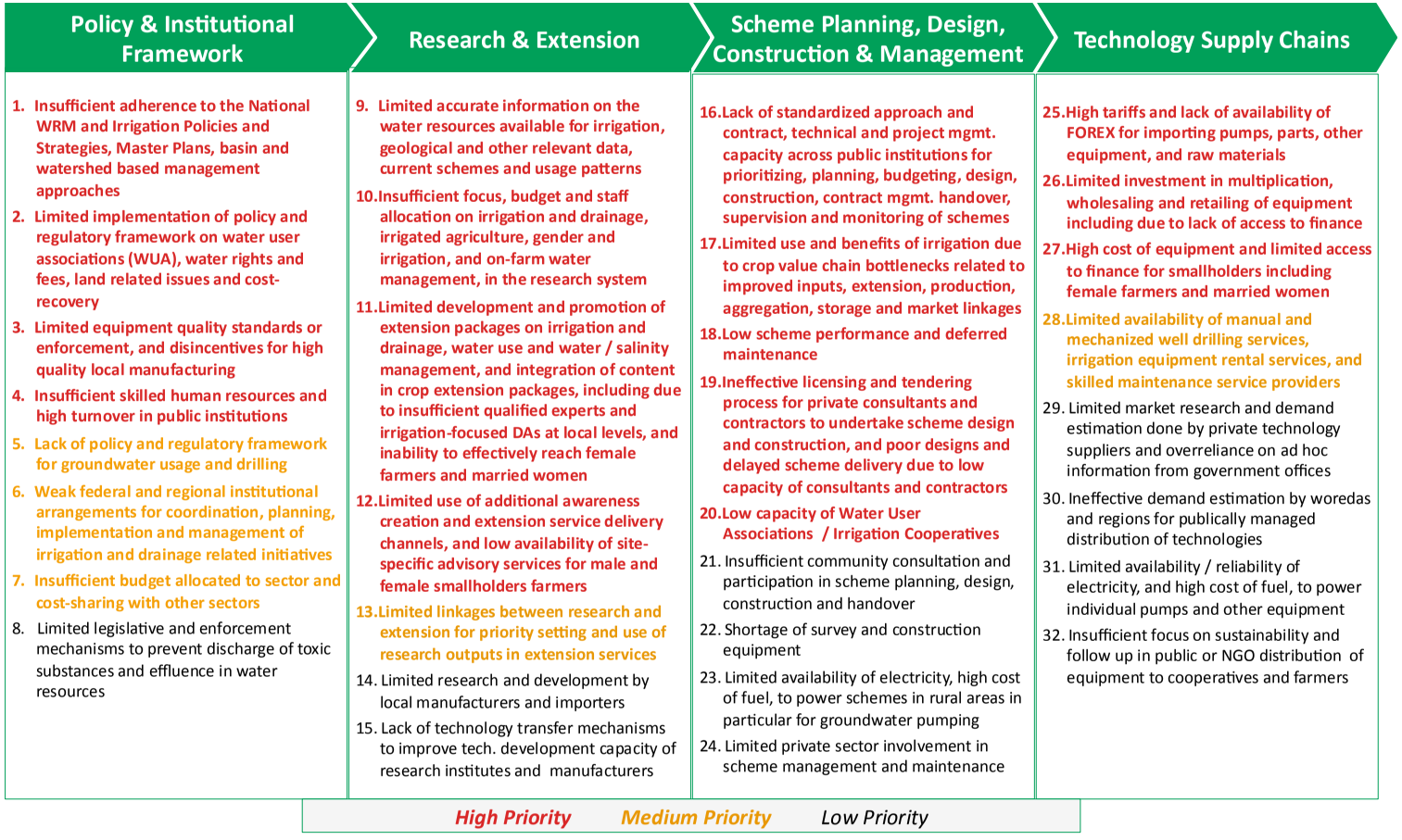

Figure 28: Major bottlenecks in the irrigation and drainage sub-sector with prioritization

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

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

Figure 29: 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[24]. 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.

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

Figure 30: Bottlenecks with heavy bearing / focus on environment sustainability and climate change issues

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. Recent studies for example show that the proportion of female headed households who use irrigation remains about 3% lower than their male counterparts at national level.[25] Policy and institutional frameworks as well as research and extension services often may not address women's participation, access to water and irrigation technologies, or the specific needs of women including through gender-

24 *Climate Green Resilient Economy Strategy* (2013), page 43

25 *Patterns of Agricultural Production among Male and Female Holders: Evidence from Agricultural Sample Surveys in Ethiopia*, Kassa et. al., IFPRI, 2015

sensitive extension approaches as well as 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 and labor.

Enhancing women's participation in these areas is therefore critical to ensure maximum positive impact on them 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.

Area	Relevant bottlenecks
Policy and Institutions	2
Research and Extension	10, 11, 12, 13
Scheme Planning, Design, Construction and Management	16, 17, 20, 21
Technology Supply Chains	25, 27, 31

Figure 31: Bottlenecks that likely impact females more strongly

4.3. Summary of Strategic Interventions

Fifty-three strategic interventions have been developed to address the priority systemic bottlenecks, with 35 high priority interventions that are critical to implement to accelerate transformation of the sub-sector and 18 medium priority interventions that should also be implemented resource and time permitting.

The next figure presents the distirbution by priority and thematic area, with 16 interventions in the Policy and Institutions are, 13 interventions in the Research and Extension and Scheme Planning, Design, Construction and Management areas each, and 11 intervetions in the Technology Supply Chains area.

Bottleneck Priority	Policy and Institutions	Research and Extension	Scheme Planning, Design, Construction and Management	Technology Supply Chains
High priority	11	7	10	7
Medium priority	5	6	3	4
Total	***16***	***13***	***13***	***11***

Figure 32: 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.

Policy & Institutional Framework	Research & Extension	Scheme Planning, Design, Construction & Management	Technology Supply Chains
1. Establish and strengthen basin authorities and increase focus on smaller schemes 2. Strengthen watershed mgmt. incl. soil and water conservation in basin mgmt. activities 3. Develop more granular resolution basin master plans, conduct timely updates and ensure accessibility through various platforms 4. Introduce an Irrigation Management Information System to consolidate and regularly update water and other relevant data and analysis, scheme inventories and usage patterns, and make broadly accessible 5. Introduce a national fund for smallholder irrigation and drainage development, and consolidate planning and reporting nationally 6. 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 7. Develop and implement phased approach and plan to introduce water fees and cost recovery in all (publicly funded) schemes 8. Establish national standards for irrigation equipment including drip kits, sprinklers and polyethylene pipes, similar to pumps 9. Enforce national standards through incentivizing investment in laboratories, building capacity of existing labs and of MoT and ECAE for enforcement 10. Introduce standard technical specifications for public irrigation equipment procurement 11. Strengthen university curriculums and research on irrigation engineering and scheme mgmt., irrigation technologies and agriculture, water mgmt. and drainage	12. Accelerate the satellite-based shallow and deep groundwater mapping efforts to finish within 1 and 10 years, respectively 13. Develop a national master plan for irrigation related research across the country, and allocate increased budget for the construction of irrigation research centers, operations and management, including hiring researchers with advanced degrees in research centers 14. Add additional content to the SSID extension manual in key areas and develop crop specific manuals for the major crops and disseminate them to regional level 15. 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 16. Develop SMS and media based campaign to promote irrigation to farmers, expand irrigation content on 8028 system and promote heavily 17. Develop an ICT based solution for site specific advisory on crop water requirements and irrigation scheduling 18. Increase training and in-kind support to model farmers to use and promote irrigation and drainage good practices	19. Develop standard criteria and guidelines for prioritizing new schemes while also ensuring maintenance of existing schemes 20. Strengthen joint planning and execution of scheme development and mgmt. between regional agricultural and water institutions 21. Require agencies to include all relevant costs incl. handover, operation and maintenance, rehabilitation, monitoring and information dissemination, in funding for schemes 22. Strengthen contract management, scheme design, construction and maintenance capacity of public institutions through increased on-the-job and external training 23. Establish national standards for design, construction, operation and maintenance, and performance assessment of schemes 24. Ensure integrated planning and implementation of crop value chain related interventions with scheme planning, design, delivery and management 25. 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 26. Develop guidelines and standard technical specifications for tendering consultancy and construction services, strengthen technical capacity and adherence to procedures 27. Establish large-scale capacity building program(s) for WUAs on scheme and financial mgmt., revenue generation and other topics, with strong NGO involvement 28. Make available grants or low interest loans for WUAs to fund their activities	29. Undertake policy analysis on optimal import tariff for equipment, and advocate for implementation of recommendations 30. Prioritize FOREX allocation for equipment, parts and raw material imports 31. Promote joint ventures, co-production and franchising arrangements with international firms and/or technology transfer programs with partner countries and NGOs 32. Provide business, technical and financial support to wholesalers and retailers willing to invest in retailing in rural areas 33. Increase credit access for existing or nascent manufacturers, wholesalers and retailers willing to scale up own business 34. Facilitate linkages between wholesalers and retailers, cooperatives and farmer common interest groups, and financial institutions for equipment purchase and financing 35. 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

Figure 33: High priority interventions for the irrigation and drainage sub-sector by thematic area

Policy & Institutional Framework	Research & Extension	Scheme Planning, Design, Construction & Management	Technology Supply Chains
1. Introduce partnership programs with international partners for knowledge and experience sharing with government staff and other local stakeholders to build local capacity 2. Develop policy and supporting regulations, directives and guidelines for sustainable exploitation and rechargeable management of groundwater 3. Enhance monitoring and information exchange for groundwater including information related to abstraction control, aquifer behavior and pollution prevention 4. Undertake comprehensive analysis of institutional roles and capabilities in the sub-sector and advocate for implementation of recommendations and maintenance of institutional stability 5. Ensure the accountability and proper utilization of funding and other resources allocated for smallholder irrigation and drainage development	6. Conduct national level gender analysis to identify constraints impacting awareness and use of irrigation technologies by women, and design, promote and mainstream solutions 7. Introduce a coordinated plan for development partners and the private sector to engage in awareness creation and extension support / supplementation 8. Expand use of irrigation-specific days/ weeks including new technology demonstrations and farmer to farmer experience sharing events at woreda level 9. 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 10. 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 11. Make all research outputs available to the extension system through an online information sharing platform	12. 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 13. 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 14. Support the establishment of federation of WUAs especially for large scale schemes	15. Introduce finance and technical support program for well drilling service providers and irrigation equipment rental service providers 16. Improve content and delivery of well drilling courses in TVET institutions 17. Improve content and delivery of irrigation technology maintenance courses in Agricultural TVET institutions 18. Provide trainings and accreditation on installation, operation, maintenance and repair of irrigation equipment to private garages

Figure 34: 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 on environmental 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#s) and medium (M#s) 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 and Institutions	H1, H2, H3, H4, H5, H6, H7, H8, H9, H11 M1, M2, M3, M4	H4, H5, H6, H7
Research and Extension	H13, H14, H15, H16, H17, H18 M7, M8, M10, M11	H13, H14, H15, H16, H18 M6, M7, M8, M10, M11
Scheme Planning, Design, Construction and Management	H19, H21, H22, H23, H25, H27	H23, H24, H26, H27 M14
Technology Supply Chains	H29, H30, H31, H32, H33, H34, H35 M15, M16	H29, H30, H32, H33, H34, H35

Figure 35: Interventions reflecting mainstreaming of environmental and gender issues

PART 5

5. IMPLEMENTATION PLANNING, GOVERNANCE AND MANAGEMENT

5.1. Implementation Planning

Implementation planning was undertaken for each of the 53 high 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 370 to 450 million ETB, with a mid-point estimate of 410 million ETB, with ~75% comprising the 35 high priority interventions (~305 million ETB) that are critical to implement to accelerate transformation of the sub-sector and the remaining 25% comprising the 18 medium priority interventions (~105 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	11	5	80 – 120 M / 24%	20 – 40 M / 7%
Strengthening Research & Extension	Strengthen research critical for development of the sub-sector, the linkage to extension, and extension activities and services	7	6	80 – 120 M / 24%	30 – 50 M / 10%
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 / 17%	15 – 25 M / 5%
Promoting Technology Supply Chains	Promote increased availability, accessibility and affordability of equipment, services and finance	7	4	25 – 45 M / 9%	10 – 20 M / 4%
	TOTAL	***35***	***18***	**280 – 330 M / 75%**	**90 – 120 M / 25%**

Figure 36: 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. <1 million ETB, 1-2.5 million ETB, 2.5-5 million ETB, 5-10 million ETB, 10-20 million ETB, 20-50 million ETB, 50-100 million ETB, and 100-200 million 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.

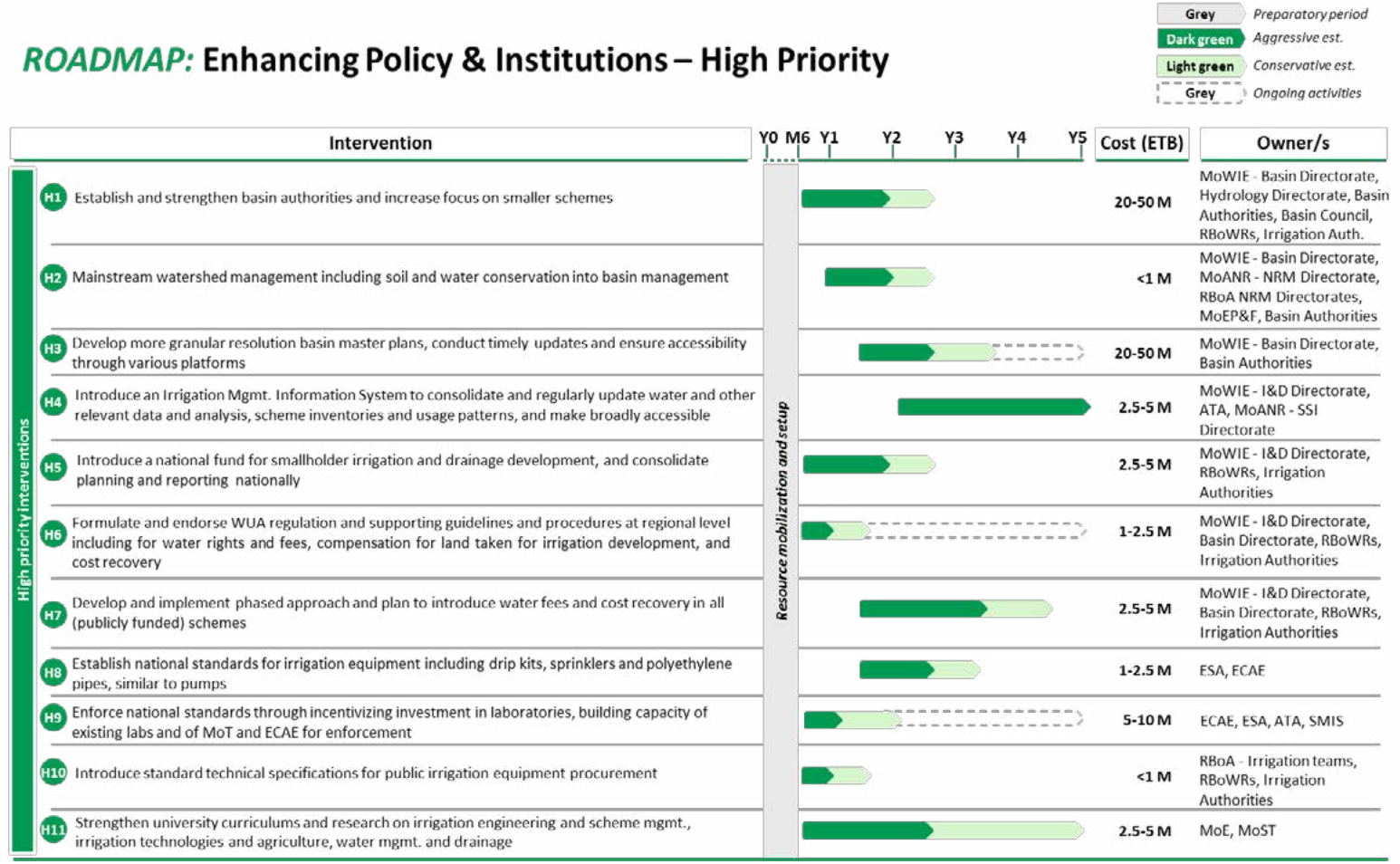

Figure 37: Roadmap – High Priority Interventions I

ROADMAP: Strengthening Research & Extension – High Priority

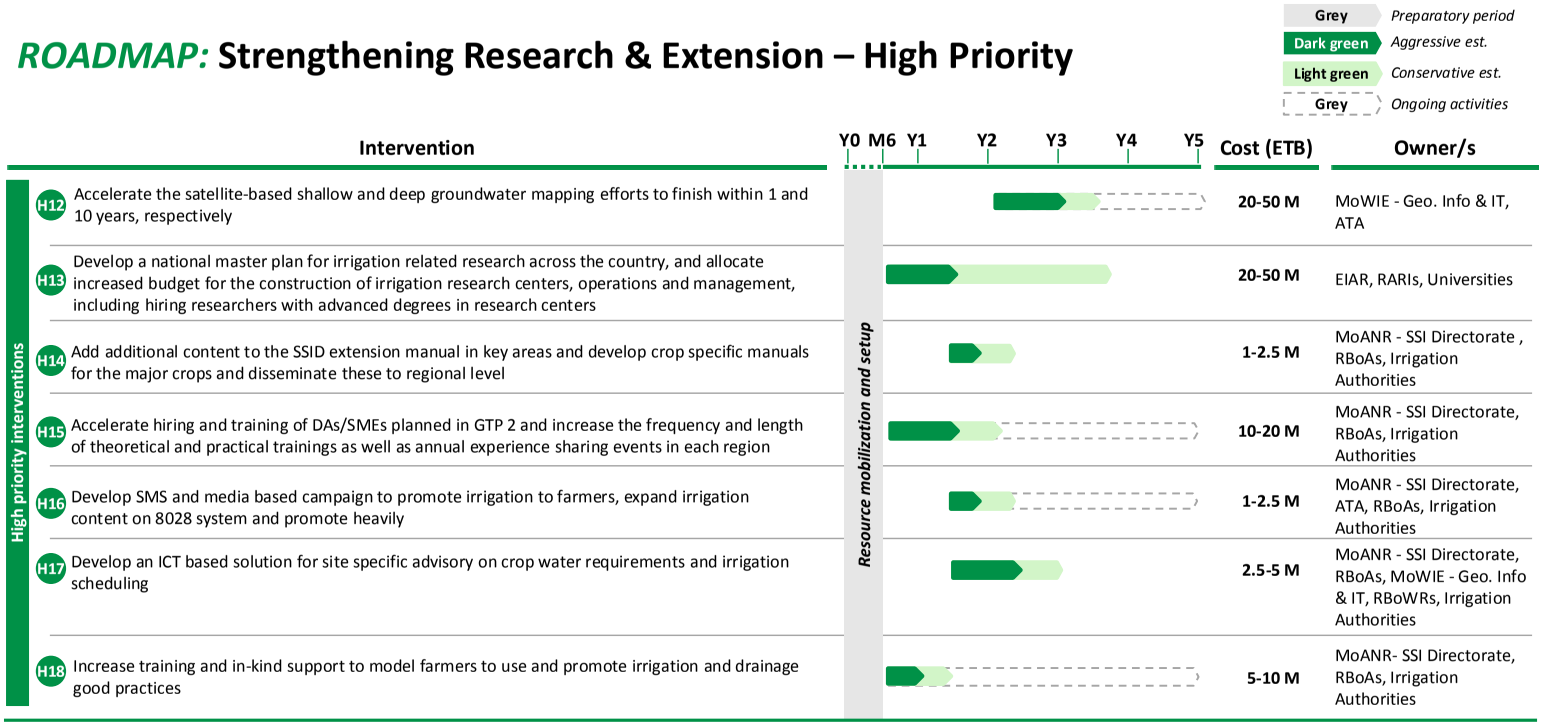

Figure 38: Roadmap – High Priority Interventions II

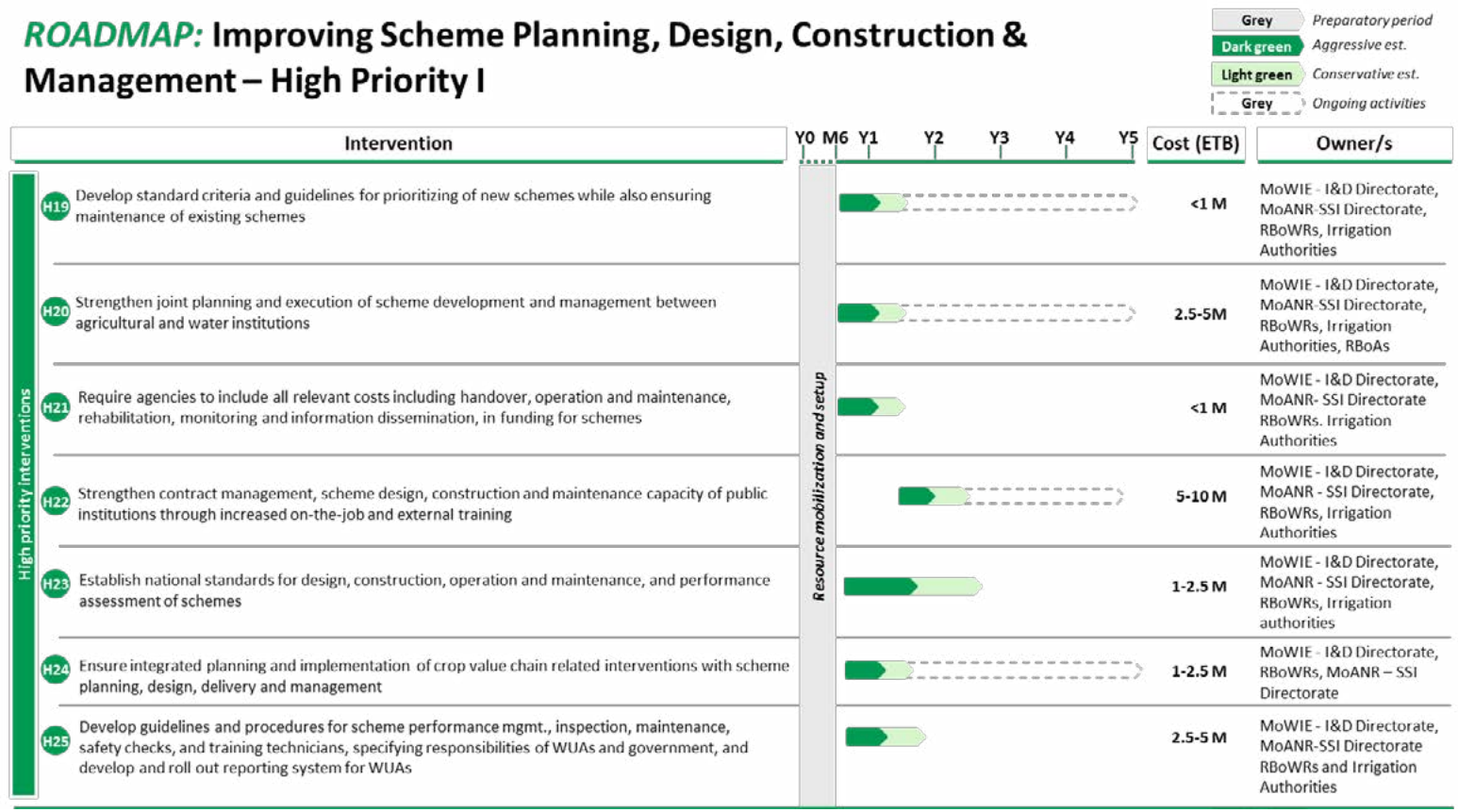

Figure 39: Roadmap – High Priority Interventions III

ROADMAP: Improving Scheme Planning, Design, Construction & Management – High Priority II

Grey – Preparatory period
Dark green – Aggressive est.
Light green – Conservative est.
Grey – Ongoing activities

	Intervention	Y0 M6 Y1 Y2 Y3 Y4 Y5	Cost (ETB)	Owner/s
High priority interventions	H26 Develop guidelines, standard technical specifications and criteria for tendering of consultancy and construction services and strengthen adherence to procedures	Resource mobilization and setup	1-2.5 M	MoWIE - I&D Directorate, MoANR - SSI Directorate, RBoWRs, Irrigation Authorities
	H27 Establish large-scale capacity building program(s) for WUAs on scheme and financial mgmt., revenue generation and other topics, with strong NGO involvement		10-20 M	MoWIE - I&D Directorate, RBoWRs, Irrigation Authorities
	H28 Make available grants or low interest loans for WUAs to fund their activities		20-50 M	MoFED, MoWIE,MoANR RBoWIEs

ROADMAP: Promoting Technology Supply Chains – High Priority

	Intervention	Y0 M6 Y1 Y2 Y3 Y4 Y5	Cost (ETB)	Owner/s
High priority interventions	H29 Undertake policy analysis on optimal import tariff for equipment, and advocate for implementation of recommendations	Resource mobilization and setup	<1 M	MoWIE - I&D Directorate, MoANR - SSI Directorate
	H30 Prioritize FOREX allocation for equipment, parts and raw material imports		<1 M	MoANR – SSI Directorate
	H31 Promote joint ventures with international firms and/or technology transfer programs with partner countries and NGOs		5-10 M	MoANR – SSI Directorate
	H32 Provide business, technical and financial support to wholesalers and retailers willing to invest in retailing in rural areas		5-10 M	MoANR – SSI Directorate, RBoAs, Irrigation Auth.
	H33 Increase credit access for existing or nascent manufacturers, wholesalers and retailers willing to scale up own business		2.5-5 M	MoANR – SSI Directorate, RBoAs
	H34 Facilitate linkages between wholesalers and retailers, cooperatives and farmer common interest groups, and financial institutions for equipment purchase and financing		1-2.5 M	MoANR – SSI directorate, RBoAs
	H35 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		10-20 M	MoANR – SSI directorate, RBoAs, Irrigation Authorities

Figure 40: Roadmap – High Priority Interventions IV

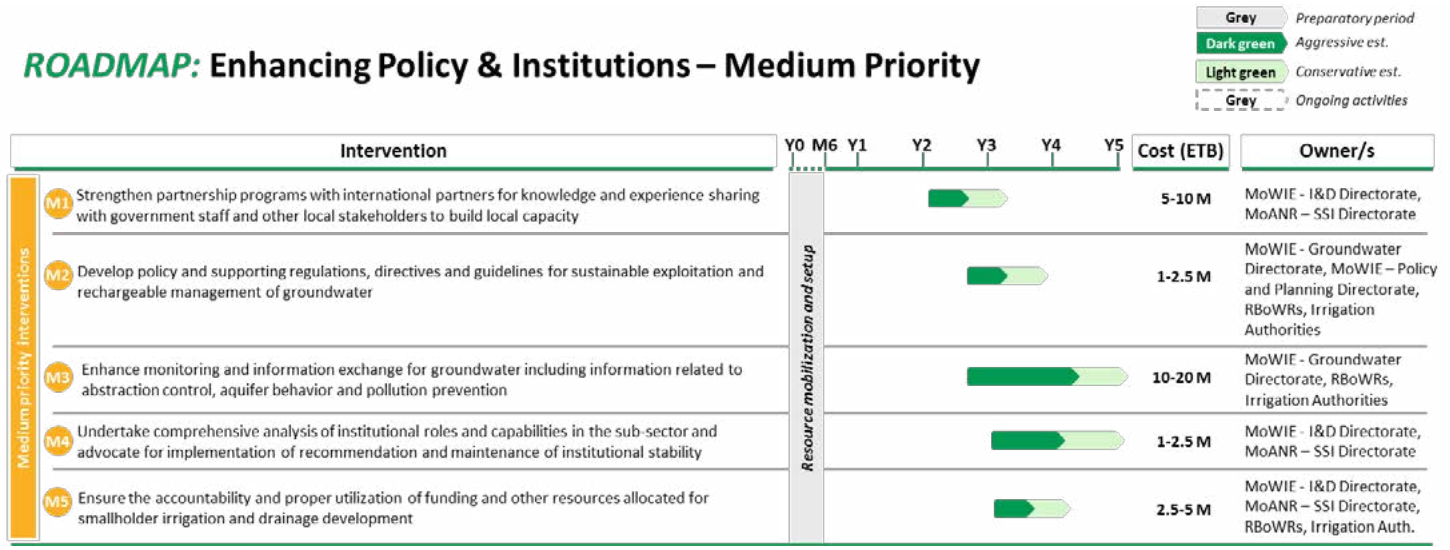

Figure 41: Roadmap – Medium Priority Interventions I

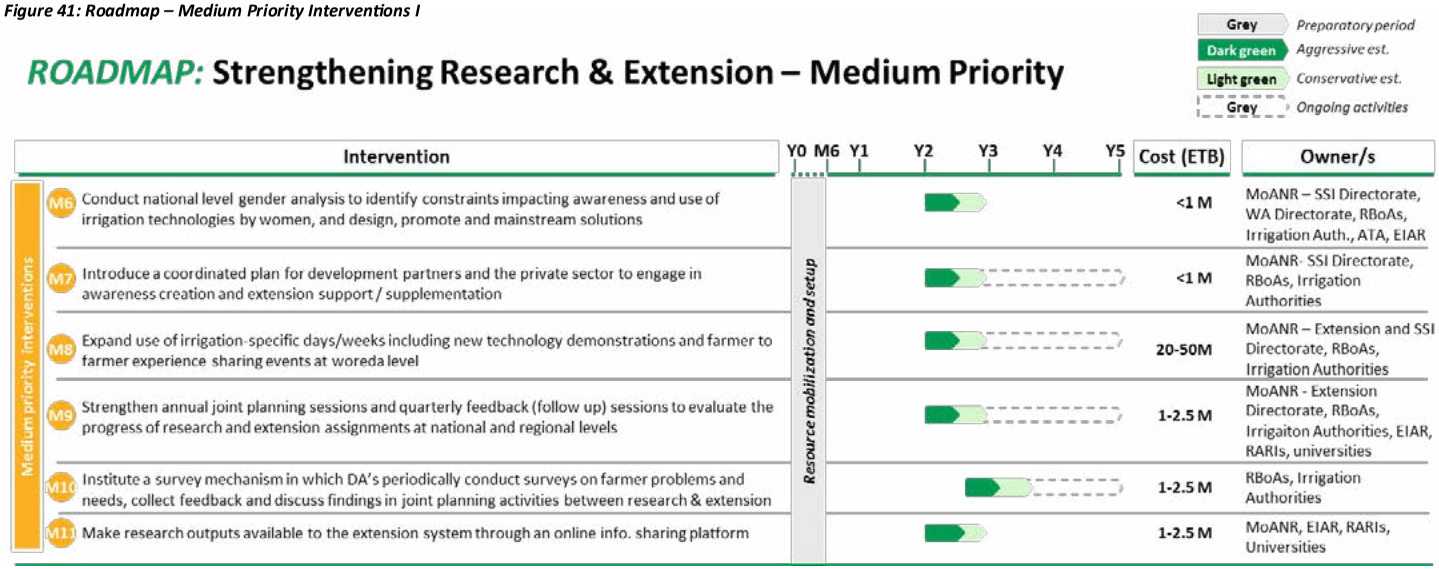

Figure 42: Roadmap – Medium Priority Interventions II

ROADMAP: Improving Scheme Planning, Design, Construction & Management – Medium Priority

Grey – Preparatory period
Dark green – Aggressive est.
Light green – Conservative est.
Grey – Ongoing activities

	Intervention	Y0 M6 Y1 Y2 Y3 Y4 Y5	Cost (ETB)	Owner/s
Medium priority interventions	M12 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 incl. past performance	Resource mobilization and setup	5-10 M	MoWIE- I&D Directorate, MoANR-SSI Directorate, RBoWRs, Irrigation Authorities, MoWIE - Permit Directorate
	M13 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		2.5-5 M	MoWIE – I&D Directorate, MoANR - SSI Directorate RBoWRs, Irrigation Authorities
	M14 Support the establishment of federation of WUAs especially for large scale schemes		5-10 M	MoWIE – I&D Directorate , RBoWRs, Irrigation Authorities, and Scheme Project Offices

ROADMAP: Promoting Technology Supply Chains – Medium Priority

	Intervention	Y0 M6 Y1 Y2 Y3 Y4 Y5	Cost (ETB)	Owner/s
Medium priority interventions	M15 Introduce finance and technical support program for well drilling service providers and irrigation equipment rental service providers	Resource mobilization and setup	5-10 M	MoANR – SSI Directorate, RBoAs, Irrigation Auth.
	M16 Improve content and delivery of well drilling courses in TVET institutions		1-2.5 M	MoE, MoWIE – I&D Directorate, MoANR – SSI Directorate
	M17 Improve content and delivery of irrigation technology maintenance courses in Agricultural TVET institutions		1-2.5 M	MoE, MoWIE – I&D Directorate, MoANR – SSI Directorate
	M18 Provide trainings and accreditation on installation, operation, maintenance and repair of irrigation equipment to private garages		2.5-5 M	MoANR – SSI Directorate, RBoAs, Irrigation Auth., MoWIE – I&D Directorate

Figure 43: Roadmap – Medium Priority Interventions III

5.3. Implementation, Governance and Management

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.

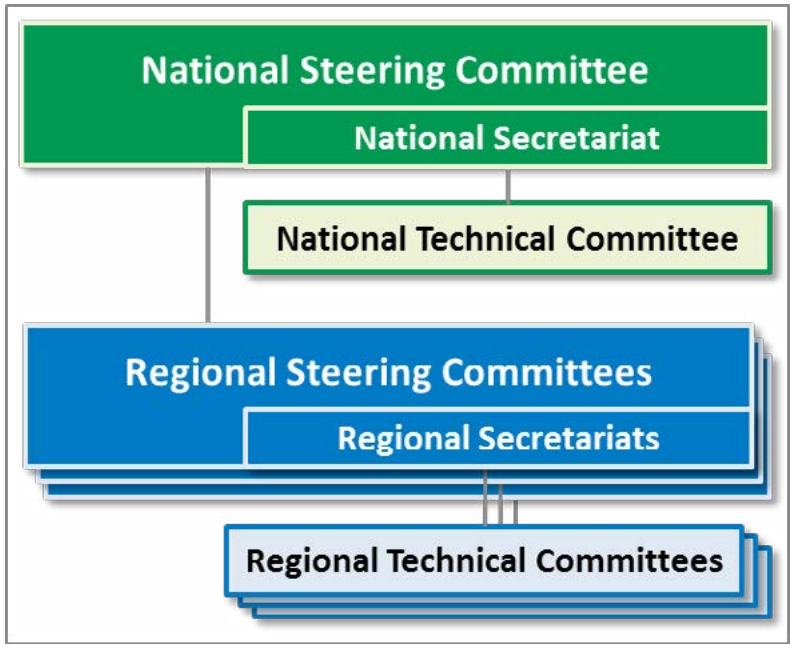

Figure 44: Structure for governance and management of implementation

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 MoA and the State Minister of Irrigation and Drainage from the MoWIE. Members include representatives from the Smallscale Irrigation, Natural Resources Management and Extension directorates at MoA, representatives from the Irrigation and Drainage, Basin and Groundwater Management directorates at MoWIE, regional bureaus of agriculture (BoA), regional bureaus of water resources (BoWR), 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 Smallscale Irrigation Directorate at MoA, working very closely with the other directorates at MoA 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 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 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 (WUA), 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 HVC	• By region, crop, etc. • By sex
6	Value of agricultural loans disbursed to irrigation equipment producers or distributers (including spare-parts), small holder farmers, WUA, cooperatives and unions for specific purpose of financing irrigation inputs	• By type of loan received • By region, crop, etc. • By sex

Outputs

Indicator		Disaggregation
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
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
3	Number of Information Communication Technology (ICT) based support services established and operationalized	• By type of ICT based support service
4	Percentage increase in number of irrigation equipment maintenance service providers	• By type of service provider
5	Number of multi-stakeholder/ information sharing platforms and joint planning forums established and operationalized	• By type of platform / forum • By administrative level, etc.
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
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
8	Number of joint venture and/or technology transfer programs established and operationalized with partner countries, private firms and Non-Governmental Organization (NGO)	• By type of partner • By type of program, etc.

PART 6

6. DETAILED DISCUSSION OF PRIORITIZED BOTTLENECKS AND INTERVENTIONS

6.1. Policy and Institutions

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 an Integrated River Basin Management (IRBM) approach at all levels of government to manage the country's twelve basins. This approach entails coordinating development, management and conservation of water resources and other related resources within the hydrological boundary of a basin in order to maximize the economic and social benefits from water resources in a sustainable and equitable manner. The implementation of IRBM requires effective cross-sectoral stakeholder coordination and strong commitment from the government. The Government of Ethiopia (GoE) has set-up different institutions including three basin authorities, a basin directorate under the MoWIE that is responsible for coordinating and supporting the activities of basin authorities, and a National Basin Council for overall governance. The IRBM also required development of integrated basin master plans, which has been completed for most basins in the country, though required periodic updating of these plans is behind schedule.

Though the policy framework and institutional set-up therefore exist to implement basin management for the majority of basins, the level of implementation and adherence by various government authorities is not strong. 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 level of effectiveness in executing these main requirements. The following table presents a summary of responses provided by

regional BoWR or irrigation authorities in eight regions.

Area	Specific requirements	High	Med	Low	None	*Most Common*
Effective scheme development	River basin based scheme development and design	1	2	4	1	Low
	Joint planning and execution by regions sharing basin	1	1	5	1	Low
Equitable water use	Effective water use for different purposes	1	2	3	2	Low
	Address potential downstream/ upstream user issues	1	5	2	0	***Medium***
Sustainable water use	Sustainable recharge of water	1	1	6	0	***Low***
	Maintenance of water quality	1	1	3	3	***Low/None***
	Sustainable impact on ecosystem	1	1	6	0	***Low***
Effective monitoring and supervision	Early identification and resolution of emerging issues	1	3	4	0	***Low***
	Ongoing data collection on basin to identify issues	0	3	4	1	***Low***

Figure 45: Summary of regions response on the adherence of basin management approach

The following underlying reasons were cited to explain why the level of effectiveness is low in most areas in most regions.

- Regional development plans are not aligned with the national master plan, due to:
    - 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.
- Basin / sub-basin approach is not followed mainly due to unclear processes and approach, and lack of procedures and tools to apply these.

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

INTERVENTION H1: Establish and strengthen basin authorities and increase focus on smaller schemes

Priority: High

Objectives/Description: Basin authorities are established to coordinate the plans and activities of stakeholders in an integrated way. Three out of twelve basin authorities have been established to date, and the MoWIE basin directorate is in the process of establishing four additional basin authorities. The existing basin authorities also have significant capacity gaps including insufficient human resources, and lack of standard procedures, tool and systems, lack of required data due to meteorology stations being old or non-functional and other required data not being collected, focus more on larger schemes, and are often tasked with large-scale scheme management activities which can fall outside their mandates and capacity. This intervention therefore focuses on accelerating the effort to establish four new basin authorities and the remaining five authorities, equipping the existing and new basin authorities with enhanced technical and operational capacity, increasing focus on smaller schemes, clarifying the responsibilities of basin authorities with regards to scheme management and ensuring sufficient resources and capacity to effectively execute these responsibilities.

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, establishing and staffing up the organizational structure of new basin authorities, identifying capacity gaps of existing and basin authorities and providing capacity building programs accordingly, supporting the Basin Authorities to take on data collection activities including hydrology and water quality, reinforcing active engagement 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 ensuring effective identification of issues to be considered as well as more regular meetings of the Council and engagement with regional stakeholders.

Environmental and gender mainstreaming: Establishment and effective functioning of basin authorities is critical for environmentally sound governance of the country's river basins.

Owners and involved parties: MoWIE basin Directorate, National Basin Council, Basin Authorities, Regional BoWR and Irrigation Authorities, Regional Agricultural Research Institutes (RARI), MoWIE Hydrology Directorate, MoA Small Scale Irrigation Directorate (SSID) and National Meteorological Agency (NMA).

Costs: 25-50 million (Major cost items: office infrastructure, transport vehicles, hiring and salaries for staff, development of procedures and tools and related capacity building of staff, technical equipment)

Timeline: 12-18 months

INTERVENTION H2: Strengthen watershed management including soil and water conservation in basin management activities

Priority: High

Objectives/Description: Watershed (i.e. sub-basin) management is not given sufficient focus in basin management activities despite its substantial impact on the sustainability river basins and existing efforts to mainstream soil and water conservation targets into basin development planning. Even where some watershed management activities are underway, these are typically

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

The main activities under this intervention are involving MoA Natural Resource Management (NRM) directorate and regional BoA NRM staff in joint planning and overall management of basins as members of the basin authorities, mainstreaming broader watershed management targets into basin development planning and monitoring, and strengthening watershed management units at woreda/kebele level through greater engagement of NRM staff in the Woreda Office of Agriculture and NRM development agents (DA) at the kebele level.

Environmental and gender mainstreaming: Strengthening watershed management and mainstreaming soil and watershed management targets are critical for environmentally sound governance of the country's river basins.

Owners and involved parties: MoWIE NRM Directorate, Regional NRM Directorate, Ministry of Environment Protection and Forestry, Basin Authorities, MoWIE Basin Directorate, BoWR and Irrigation Authorities.

Costs: <1 million (Major cost items: training of staff in basin authority and lower levels on watershed management, soil and water conservation)

Timeline: 6-12 Months

INTERVENTION H3: Develop more granular resolution basin master plans, conduct timely updates and ensure accessibility through various platforms

Priority: High

Objectives/Description: Basin development master plans serve as the guiding document for achieving integrated and sustainable development within the hydrological boundaries of river basin, and inform the design of specific irrigation schemes. Most regions consulted cite referencing the existing master plans, but argue that these plans are outdated and therefore cannot effectively support basin and watershed management based scheme development. In addition the resolution of the master plans is not sufficiently granular for supporting planning of smaller schemes. Higher resolution master plans therefore need to be developed, and these need to be updated regularly (i.e. every 5 to 10 years) to reflect the changing state of the basin area, but this is not happening due to lack of budget and capacity of basin authorities and the basin directorate to undertake this complex task. In addition, the current plans are not easily accessible in hard or soft copy format by relevant government institutions. To resolve these issues, the MoWIE basin directorate should ensure regular update of master plans and make these more accessible through different platforms.

The main activities under this intervention are developing a plan to develop higher resolution master plans, assigning budget and human resources for this activity, collecting relevant data, and developing the plans; putting in place a schedule, process and budget to ensure timely update of master plans including cost-sharing with regions for this purpose; and disseminating updated plans by providing hardcopies to relevant regional bodies and making soft copies available on the MoWIE and Basin Authority websites or other places.

Environmental and gender mainstreaming: Use of basin master plans that reflect the actual situation of the basin is critical for environmentally sound basin development and scheme design.

Owner and involved parties: MoWIE Basin Directorate, MoWIE Hydrology Directorate, Basin Authorities, regional BoWR, Irrigation Authorities, MoA NRM Directorate, regional BoA, NMA.

Costs: 20-50 million (Major cost items: data collection and analysis to produce more granular master plans, Periodic field visits and assessments to update the master plan, printing and publishing costs, website development and management costs)

Timeline: 12-24 months and ongoing

INTERVENTION H4: Introduce an Irrigation Management Information System to consolidate and regularly update water and other relevant data and analysis, scheme inventories and usage patterns, and make broadly accessible

Priority: High

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 including also relevant agronomic, climate and soil data, should be brought together and consolidated in a technology solution like a web portal with strong data querying, search and GIS capabilities. Efforts are already underway in some regions such as Tigray to put in place such a system, however a consolidated national system is also required that ensures harmonization of data collection and presentation across the country and supports effective decision-making.

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 through a comprehensive, multi-year plan. Full analysis of irrigation potential, current usage and national scheme inventory should also be undertaken, building on recent efforts by IWMI and others. After the technology solution is developed, tested, rolled out 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 building support for then irrigation Management Information System (MIS) through analysis of advantages of having such a system, profiling cases from other countries, and advocating with stakeholders; 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 current usage, national scheme inventory, full analysis of irrigation potential by water source and overall); uploading data collected; testing and promoting use of the system; and putting in place a process to collect data on ongoing basis and updating the system.

Environmental and gender mainstreaming: Availability and widespread access to high-quality environment and gender related data for use in scheme planning and design, monitoring and impact assessment is critical for effective environmental and gender mainstreaming.

Owners and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID, ATA, regional BoWR, with close involvement of universities, geological survey of Ethiopia (GSE), NMA, Ethiopian

Institute of Agricultural Research (EIAR) and RARIs, IWMI and other development partners.

Cost: 2.5-5 million (Major cost items: website developing and data collection costs)

Timeline: 48-60 Months

INTERVENTION H5: Introduce a national fund for smallholder irrigation and drainage development, and consolidate planning and reporting nationally

Priority: High

Objectives/Description: Introduction of a large-scale national fund as seen in other countries for infrastructure or irrigation, will address potential budget shortfalls for smallholder irrigation and drainage development in the GTP II period, support standardization of prioritization of financing for schemes, and facilitate increased consistency and learning across regions, similar to the impact that the small-scale irrigation component of the GTP I AGP has had on schemes it has financed over the last few years. The existing water sector fund at the MoWIE could be enhanced to serve this purpose, or a separate fund structure could be set up modelled for example on the National Road Fund established in Proclamation No. 66/1997 to finance the maintenance of roads and roads safety measures via a dedicated governance structure including a Board reporting to the Prime Minster and an Office of the Fund. Another example of successful domestic experience with such national funds is the former Ethiopian Social Rehabilitation and Development Fund.

Alternatively, the irrigation and drainage development fund could be structured as a public-private partnership with a multistakeholder governance structure, management by a financial institution or dedicated financing vehicle, and contributions from both government and development partners both in terms of funding and technical support. Irrespective of the specific structure, the fund could ensure consistent prioritization of investments through application of standard criteria, consistent planning and design of schemes, and adherence to various best practices. Cost-sharing with other sectors could also be prioritized within the fund.

Further analysis including review of Ethiopian and international experience, and assessment of the various options for scope (e.g. only micro and small-scale schemes, or also larger schemes), size, funding sources, and management of the fund, is the immediate activity required for this intervention. Policymakers and potential partners would then need to be engaged to agree the final design of the fund, followed by resource mobilization and organizational set up.

Environmental and gender mainstreaming: Both environmental standards and gender related targets could be integrated in requirements for schemes financed through the fund.

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, regional BoWR and Irrigation Authorities, MoA Small-scale Irrigation Directorate, with close involvement of development partners.

Cost: 2.5-5 million (Major cost items: study to design the fund, validation activities with policy makers and partners, set up of the fund office / organizational structure)

Timeline: 18-24 months

BOTTLENECK 2: Limited implementation of policy and regulatory framework on WUA, water rights

and fees, land related issues and cost-recovery

Priority: High

Description: In 2001, the GoE formulated the Ethiopian Water Sector Policy as comprehensive guiding policy document on the water sector. This policy aims to enhance and promote all national efforts towards the efficient, equitable and optimum utilization of the available water resources of Ethiopia for rapid socioeconomic development on sustainable basis[26]. The supporting Ethiopian Water Sector Strategy document has a similar goal.

The irrigation sub-sector is one of main components in these policy documents which 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[27]. To implement this objective, significant emphasis is given to development and implementation of the policy and regulatory framework. The following table describes the main policy areas and elements of a robust water use policy and regulatory framework.

Policy Area	Main Policy Elements
Initial Cost Recovery	Equitable cost recovery payments considering benefits and costs
	Transfer of irrigation schemes to WUA
	O&M responsibilities and practices
WUA	Formation of WUA
	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	Resettlement issues
	Consolidation and redistribution of land in command area
	Right of way issues

Figure 46: Main areas and elements of effectively policy and regulatory framework

While all of these elements are addressed in the existing Water Sector Policy, Water Sector

26 *Ethiopian Water Resource Management Policy* (2001)

27 *Ethiopia Water Sector Strategy* (2001)

Strategy, and Water User Association Proclamation at federal level, there are varying levels of policy development and implementation at regional levels. Regional water sector polices including recently endorsed (Amhara, Tigray) and draft (Oromia, SNNP, Gambella) WUA proclamations were therefore assessed against the main elements listed above. Cost recovery is fully addressed in half of these proclamations, while the other four policy areas are fully addressed for four of five regions.

Implementation and enforcement regional policies and WUA proclamations is still however quite limited, including for elements such as land issues and water rights. The following six main challenges have been highlighted by stakeholders and analysis:

Despite inclusion of cost recovery in federal and regional proclamations, it is not being practiced in existing schemes given the economic situation of farmers and difficulty of managing fee collection without strong water user associations, limiting the financial capacity to develop new schemes

No standard approach to determine water fees, limited establishment of formal water user associations, and irregular payment of water fees in schemes

Limited participation of women in water associations, irrigation cooperatives, and other similar organizations, and insufficient consideration of gender-sensitive approach for setting various fees

Frequent resettlement and land redistribution issues, including those impacting female headed households

Frequent conflicts between upstream and downstream users, hindering the performance of schemes and benefits to farmers

Insufficient focus on regulating water use efficiency and water quality in existing policies and implementation efforts.

To address these issues, interventions are focused on strengthening the policy framework and enhancing the implementation capacity of stakeholders.

INTERVENTION H6: 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

Priority: High

Objectives/Description: After the federal WUA proclamation was endorsed, several regions have also drafted and endorsing their own regional WUA proclamations. However, the implementation of the WUA proclamations requires the development of a supporting regulation at regional level as well as guidelines and procedures. In addition robust institutional capacity should be in place to effectively implement the regulation, guidelines and procedures.

The main activities under this intervention are formulating and endorsing a regional WUA proclamation and regulation drafted in line with best practices and ensuring water use efficiency and quality responsibilities of WUA are well addressed, identifying and developing supporting guidelines and procedures required in each region, creating awareness across stakeholders and farmers, and building capacity of relevant government institutions to enforce the regulations,

guidelines and procedures. Please note that activities related to establishment and capacity building of WUA are covered separately in intervention H27 under Scheme Planning, Design, Construction and Management.

Environmental and gender mainstreaming: Regional WUA regulations and supporting guidelines and procedures should sufficiently address environmental issue such as effective operational and maintenance to prevent environmental damage, water use efficiency and water quality maintenance. In addition, women's participation in WUA (i.e. 30% quota of female members of the governance committee) as well as equal protection of land and water rights for women should be clearly mandated and adhered to.

Owners and involved parties: Regional BoWR and Irrigation Authorities, MoWIE Irrigation and Drainage Directorate, MoWIE Basin Directorate, regional BoA, WUA (i.e. informal associations, irrigation cooperatives, and other forms today)

Costs: 1-2.5 million (Major cost items: policy, guidelines and procures development and validation, including efforts at national level to align across regions)

Timeline: 6-12 Months

INTERVENTION H7: Develop and implement phased approach and plan to introduce water fees and cost recovery in all (publicly funded) schemes

Priority: High

Objectives/Description: Introduction of water fees in irrigation scheme is critical to ensure efficient and sustainable use of water resources, and therefore this has been included in federal and regional policies and water fee payments area already being practiced in a number of schemes around the country. A phase approach to introduce water fees in all schemes as well as for HHI, with establishment of water user associations around the country, is required to ensure water fees are implemented based on a standard and consistent approach.

Irrigation scheme infrastructure development requires large up-front financial investment from the public sector, with return accruing to farmers and others actors over the next 5 to 20 years. An effective cost recovery mechanism to recoup the initial investments made, in particular for the government to be able to fund scheme O&M activities for larger schemes and infrastructure, as well as new scheme infrastructure development. While federal and regional policies (including draft WUA proclamations) do mandate cost recovery, currently this is not being implemented in most schemes. Introducing cost recovery for all schemes will not be possible without a heavily phased approach, following clear and transparent principles and criteria for introducing cost recovery in certain schemes considering the economic situation of farmers in the area and potential benefits to them from irrigation, the feasibility of cost recovery payments at different levels and feasible timeline for overall cost recovery, and other relevant issues.

The key activities for this intervention include reviewing existing experience with water fees and cost recovery in the country, developing a detailed approach for determining appropriate water fees and cost recovery fees and when to phase in each type of fee in schemes (or for HHI users) based on clear criteria and evaluation processes, and developing a plan at regional and national levels for creating awareness, piloting and then phasing in appropriate water fees and

cost recovery fees across all irrigation users. The establishment and capacity building of water user associations to drive this process is addressed in intervention H27 under Scheme Planning, Design, Construction and Management.

Environmental and gender mainstreaming: As noted above, introduction of water fees is critical to ensure efficient and sustainable use of water resources. In addition, the approach to determine water and cost recovery fees and criteria and process to phase these in should incorporate appropriate consideration of the specific financial and economic situation of women and female headed households in particular, based on studying experience in Ethiopia and internationally.

Owners and involved parties: MoWIE Irrigation and Drainage Directorate, MoWIE Basin Directorate, regional BoWR and Irrigation Authorities, WUA

Costs: 2.5-5 million (Major cost items: development of guidelines and supporting studies, data collection and assessment of current schemes to determine fee levels and phasing in timelines, and validation with stakeholders)

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 and components (e.g. housing, casings), drip irrigation systems, sprinklers, pivot systems, 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 as well as inefficient use of water resources. In addition, standards can reduce the risks and challenges faced by government agencies and private importers in ensuring procurement of effective equipment[28]. Accordingly, mandatory and voluntary national standards for irrigation pumps have been introduced and enforcement mechanisms including pre-shipment testing and certification have been put in place. Despite the introduction of these 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 illegally without meeting the required standards.[29]

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.

28 *Realizing the Potential of HHI in Ethiopia*, MoANR and ATA, 2013

29 *Water Lifting Irrigation Technology Adoption in Ethiopia: Challenges and Opportunities*, G. Gebregziabher, IWMI, 2012

There is no clearly mandated institution for inspection of quality for locally manufactured irrigation equipment.

In addition, there are no established standards for major on-farm irrigation equipment such as drip kits, sprinklers and polethylene 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 incentivize 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 to land. At the same time various stakeholders have raised the challenge that manufacturing of high quality equipment is not incentivized or inadvertently disincentivized by 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 of irrigation equipment.

INTERVENTION H8: Establish national standards for irrigation equipment including drip kits, sprinklers and polyethylene pipes, similar to pumps

Priority: High

Objectives/Description: The introduction of appropriate mandatory and voluntary standards for irrigation pumps has significantly improved the quality of pumps available on the market and reduced the negative experience of farmers with low-quality pumps which an discourage ongoing use and increased uptake. Voluntary standards have the additional benefit of bringing reliable quality differentiation for buyers. By the same token, establishing standards on other major irrigation equipment that are not yet heavily used can prevent flooding of the market with low quality products as was the case with irrigation pump several years back, and support increased uptake of these technologies going forward. This should include standards for drip kits, sprinklers and pivot systems, emitters, hoses, clamping and fittings, casings, pipe raw materials, and pipe thickness, roundness and tolerance.

The main activities under this intervention are identifying exactly what irrigation equipment standards should be introduced for, defining the standards, and creating awareness of the standards to relevant government institutions, and private sector and other stakeholders.

Environmental and gender mainstreaming: Increasing uptake of drip and sprinkler systems through introducing standards will improve water use efficiency in irrigation compared to furrow systems which are most common today. In addition environmental considerations should be incorporated in defining standards for irrigation equipment including for example use of environmentally-friendly and reprocessable / recyclable materials, and minimum quality to ensure efficient water use.

Owner and involved parties: Ethiopian Standards Agency (ESA), ECAE, Ministry of Trade (MoT), producers and importers.

Cost: 1-2.5 million (Major cost items: training of staff to undertake equipment testing)

Timeline: 12-18 months

INTERVENTION H9: 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 standards – in particular mandatory standards – for irrigation pumps and other equipment should be strengthened given the weaknesses in enforcement highlighted by stakeholders and the potential positive impact for the agriculture sector. Ongoing initiatives to strengthen the ECAE testing lab therefore need to be accelerated, along with increased incentives for investment in existing and new private laboratories. Awareness of involved actors such as financial institutions who issue letters of credit, customs officers and others also needs to be increased. Finally the role of the MoT and other relevant institutions in enforcing mandatory standards for both imported equipment and locally assembled and manufactured equipment should be clarified, and any capacity gaps identified and resolved.

The major activities under this intervention are therefore developing an investment pitch document for quality testing laboratories that highlights existing incentives, exploring with relevant government stakeholders whether additional incentives can be made available, accelerating capacity building of ECAE to undertake quality testing as well as to accredit private labs, engaging stakeholders to increase awareness of the standards and their roles in enforcement, and putting in place capacity building where required in particular for enforcing standards for domestic manufacturers.

Environmental and gender mainstreaming: Same as H8 (see above)

Owner and involved parties: ESA, ECAE, MoA, MoA SMIS, MoT, commercial banks, pump manufacturers and ERCA.

Cost: 5-10 million (Major cost items: capacity building of ECAE and other actors to testing and enforcement)

Timeline: 6-18 months and ongoing

INTERVENTION H10: Introduce standard technical specifications for public irrigation equipment procurement

Priority: High

Objectives/Description: Weaknesses in specification and evaluation of technical and other requirements in public procurement of irrigation equipment that inadvertently disincentivizes higher quality local manufacturing can be addressed through standardizing technical specifications and evaluation in public procurement, and ensuring factors such as installation services, technology awareness creation, pre- and after- sales service, and availability and affordability of spare parts, are included in the tender and properly considered in the evaluation. Accordingly, this intervention is focused on developing irrigation equipment procurement specific guidelines, technical specifications and criteria to supplement the procedures and requirements that already exist as per the GoE's public procurement policies, and building capacity to apply these. The guidelines and specification should strongly reflect the mandatory and voluntary standards proposed in earlier interventions.

The major activities involved in this intervention are to develop guiding standard technical pump bidding specifications and validate these with public and private sector stakeholders, and build awareness and capacity of government agencies that are purchasing equipment to apply these tools in developing tenders, evaluating bids and technically assessing technologies through integrating with existing training programs.

Environmental and gender mainstreaming: N/A

Owner and involved parties: Regional BoA, regional BoWR and Irrigation Authorities, and the Public Procurement Agency may also be closely involved.

Cost: <1 million (Major cost items: developing guidelines and specifications, training staff from major pump purchasing agencies)

Timeline: 6-12 Months

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

Priority: High

Description: As can be seen from the table below many regional government bodies in the irrigation sub-sector, such as government bureaus / teams and water works design or construction enterprises, suffer from human resources capacity gaps with mainly (>=75%) inexperienced staff, high (>=25%) turnover rates, high (>=25%) unfilled roles, or high (>=25%) headcount shortfall.

Region of Responding Agency	Unfilled Roles	Headcount Shortfall	Staff with <3 years Experience	Turnover Rate per Year
Tigray	3%	20%	95%	22%
Oromia	>25%	>25%	>75%	>25%
Gambella	n/a	n/a	>75%	>25%
Diredawa	>25%	>25%	>75%	>25%
SNNP	64%	25%	n/a	27%
Amhara (#1)	20%	50%	85%-90%	10-30%
Amhara (#2)	0%	15%	80%	35%
Beninshangul	<25%	>25%	>75%	>25%
% High	***43%***	***63%***	***100%***	***75%***

Figure 47: Human resource status in seven regional government bodies in the irrigation sub-sector

- Stakeholders highlighted the following factors as driving low human resources recruiting and retention capability:
- Low compensation rates in public agencies make retention of experienced staff difficult
- Limited job opportunities in the sub-sector due to the large funding gap and concentration of opportunities within the public sector
- Undergraduate and graduate programs in irrigation are few and quality of programs needs substantial improvement in basic technical skills and applied areas such as scheme

management.

The sub-sector cannot be strengthened through the other interventions listed in this document without addressing this critical issue of sufficiently strong human resources in government agencies. The GoE is undertaking various efforts across all sectors to improve human resource funding, and recruitment and retention capacity of government agencies. The interventions proposed here therefore focus on improving training in universities, and establishing knowledge and experience sharing programs with international partners to build local capacity.

INTERVENTION H11: Strengthen university curriculums and research on irrigation engineering and scheme management, irrigation technologies and agriculture, water management and drainage

Priority: High

Objectives/Description: To enhance the quality of graduates, university programs specialized in irrigation should be strengthened. Existing programs such as those at Arba Minch University, Mekelle Unviersity, Haramaya University, Addis Ababa University (AAU), and Bahir Dar University are more focused on the engineering aspect of irrigation and less on the agronomic aspects, with few programs combining both areas, or sufficiently covering topics such as agricultural water management, drainage or more applied topics such as scheme management. Graduates of less established programs are cited by stakeholders to lack basic technical skills such as calculating site-specific crop water requirements. Some efforts to address these issues are already underway for example through the Capacity Development of Higher Education in Small-Scale Irrigation project through which Arba Minch University has introduced a new Masters of Science degree in Irrigation Engineering and Management including international exchange and action research on Hare Irrigation Scheme.

Irrigation and drainage focused research conducted in universities also requires increased staff allocation and funding through increased budget allocation, including for applied research on specific challenges faced by smallholder farmers and other areas identified as priorities through the extension system. In addition to identifying and hiring well-qualified local academics, this may require seconding international lecturers.

Environmental and gender mainstreaming: Increased focus on topics such as agricultural water management, drainage and scheme management will contribute to improved sustainability of activities in the sub-sector.

Owners and involved parties: Ministry of Education (MoE), Ministry of Science and Technology (MoST), Universities, with involvement from MoA, MoWIE, regional BoA, BoWR and Irrigation Authorities.

Cost: 2.5-5million (Major cost items: curriculum development, increased budget allocation for teaching and research staff positions, and increased research budgets)

Timeline: 24-48 Months

Bottlenecks with medium priority interventions

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

Priority: High

Description: See description above.

INTERVENTION M1: Strengthen 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: Knowledge and experience sharing programs with international partners can play an important role in increasing capacity of government staff as well as other local stakeholders in the sub-sector, in particular around scheme planning, design, construction and management, and private sector technology assembly and manufacturing. For example bringing experienced, senior staff from public and private organization from abroad to work together and share experience with staff at local organizations, whether on a short-term or regular basis, has proven effective in a number of cases reviewed if the program is well-designed and structured and customized to the needs of each organization.

The main activities under this intervention are conducting an in-depth needs assessment and prioritization of capacity building areas for both local government and private sector organizations, working with international partners to structure knowledge and experience sharing programs based on those that have worked successfully in Ethiopia and other countries in the past, and setting up and coordinating these programs.

Environmental and gender mainstreaming: The programs implemented in this intervention could include a focus on issues such as basin and watershed based scheme planning and design, agricultural water management, water use efficiency and water quality, that are critical for improved sustainability of schemes.

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA Small Scale Irrigation Directorate, MoWIE Research Directorate, with close involvement of other public and private institutions in the sub-sector, professional associations, chambers of commerce, development partners and foreign firms

Cost: 5-10 million (Major cost item: needs assessment(s), expenses related to facilitating knowledge and experience sharing event / placements involving international partners)

Timeline: 6-12 Months for set up and ongoing

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

Priority: Medium

Description: Various studies including the analysis presented in Section 3 of this document have found that Ethiopia is endowed with significant groundwater resources. The Ethiopian Resources Management Policy and Water Sector Strategy lay out the importance of groundwater for the country. However, the use of these resources remains limited. While different factors can be attributed to this, lack of a robust policy and regulatory framework for groundwater use is one of the main contributing factors for lack of investment and growth in this area.[30] Where there is

30 *Agricultural Use of Ground Water in Ethiopia: Assessment of Potential and Analysis of Economics, Policies, Constraints and Opportunities*, Semu Moges, IWMI, 2012; *Ethiopia: Strategic Framework for Managed Groundwater Development,* MoWIE and GW-MATE, 2011

heavier use of groundwater, the unregulated nature of activities by different actors has already started to endanger its sustainability, for example through insufficient borehole and well spacing, or excessive usage preventing discharge.

A robust groundwater policy and regulatory framework should facilitate increased and the same time most sustainable use of groundwater resources, by focusing on four main elements seen in best practice policies internationally:

Policy area	Main policy elements
Groundwater information	Lithological productivity
	Topographic setting
	Groundwater quality
Guidelines and Standards	Exploration of groundwater
	Development of groundwater
	Management of groundwater
Regulated well drilling	Drilling permits and licensing (well spacing, depth)
	Pumping permits (discharge, power)
	Monitoring of drilling and pumping permits
Sustainable water use	Integrating groundwater development with land use planning
	Recharging groundwater
	Controlling groundwater pollution

Figure 48: Main areas and elements of groundwater policy and regulatory framework

Discussions with experts identified gaps in the policy and regulatory framework in all four areas at the federal level and in most regions, with groundwater information, standards and guidelines, and sustainable groundwater use in particular not well covered. In addition stakeholders cited three specific operational challenges stemming from these gaps:

High resolution groundwater mapping done only for 13% of the country at scale of 1:50,000, with groundwater mapping developed by GSE at a scale of 1:250,000 covering 78% of the country but can be used at regional level but is not granular enough for use at a woreda/kebele level

Lack of comprehensive groundwater maps and information results in high frequency of well failures

Stakeholders are either unaware or not properly following regulatory processes for well drilling and pumping permits, though there are ongoing efforts to increase awareness and monitoring in this area in several regions.

Two main interventions are therefore proposed to strengthen the policy and regulatory framework and enforcement in this area. These interventions supplement other interventions prioritized earlier in this section or in later sections that also apply to groundwater resources, for example

related to sustainable water use and related to scheme development.

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

Priority: Medium

Objectives/Description: Development of groundwater resources requires a separate policy framework focused around ensuring sustainable development and use of groundwater resources, including in particular balanced exploitation and recharge of groundwater. This framework should build on the existing Ethiopian Water Resources Management Policy which covers the topic at a high level, and serves as a foundation for development of supporting regulations, directives, guidelines and standards at national and regional levels in the policy areas and main policy elements noted above. Strong enforcement mechanisms such as fines for violations of guidelines and standards should be stipulated in the framework. The roles and responsibilities of relevant bodies should also be clearly specified with any critical institutional gaps addressed, and financial and human resources mobilized to support effective implementation and enforcement of the policy framework.

To implement this intervention, the main activities are to undertake a detailed policy analysis of groundwater policies at federal and regional levels, draft required federal and regional policy documents including regulations, directives and guidelines for use of groundwater resources at sub-basin and basin levels, validate these with stakeholders and have them endorsed by the relevant bodies, and introduce enforcement mechanisms around adherence to guidelines and standards as well as sustainable use of groundwater where required. Groundwater information generation and monitoring of groundwater use in line with the policy framework are covered in the next intervention below and intervention M3 under Strengthening Research and Extension.

Environmental and gender mainstreaming: The primary focus of this intervention is on environmentally sustainable use of groundwater resources.

Owners and involved parties: MoWIE Groundwater Directorate, MoWIE Policy and Planning Directorate, regional BoWR and Irrigation Authorities, Basin Authorities, Geological Survey of Ethiopia, and public and private sector entities active in well drilling.

Cost: 1-2.5 million (Major cost items: policy analysis, drafting and validation; activities related to any new enforcement mechanisms introduced, excluding monitoring which is covered in the next intervention)

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 up-to-date data related to groundwater resources such as amount of abstraction, aquifer behaviour and pollution control is crucial for the enforcement of a robust policy and regulatory framework for sustainable groundwater exploitation. Collecting this data requires regular monitoring of groundwater resources at a local level across the country

and effective information exchange within and across regions through a national level platform. Though groundwater exploitation is still quite limited today, investment in a robust monitoring framework and platform within the next few years will be critical to ensure sustainable use as groundwater use expands.

Major activities therefore include agreeing responsible bodies, processes and data standards for groundwater monitoring and data collection across the country, developing a groundwater focused module within the broader irrigation MIS planned for the country (see intervention M10 under Strengthening Research and Extension), and making the groundwater information widely accessible to relevant government bodies and research institutes.

Environmental and gender mainstreaming: Regular monitoring of groundwater is critical to ensure both sustainable usage of this natural resources, as well as enforce environmental regulations related to water quality and pollution.

Owners and involved parties: MoWIE Groundwater Directorate, regional BoWR and Irrigation Authorities, Basin Authorities, and Geological Survey of Ethiopia.

Costs: 10-20 million (Major cost items: engagement with stakeholders to agree responsible bodies; design and validation of processes and data standards; and development, training of users, ongoing management and maintenance of groundwater module within the broader irrigation MIS)

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 for scheme development is segmented between water and agricultural sector agencies depending on the scale / command area of the irrigation scheme. The water sector agencies are responsible for larger schemes, typically either greater than 50 hectares, 200 hectares or 300 hectares, while the agriculture sector agencies are responsible for smaller schemes. This includes ongoing support for maintenance where provided by government. Support for water user associations generally sits with the water sector, while extension and other ongoing support to farmers sits with the agriculture sector. In other regions (such as Oromia, SNNP and Somali) a dedicated irrigation authority either independent of both sectors (Oromia) or under the water sector (SNNP) oversees development of schemes of all sizes, and may also provide extension and other ongoing support to farmers.

In most cases, the current institutional arrangements are only a few years old or less, and reflect the most recent of several institutional restructurings that have taken place over the last ten years at federal and regionals levels. This frequent institutional change has been cited by many stakeholders in the sector as a source of current institutional weaknesses. To validate and better understand these weaknesses, key institutional responsibilities across four major activities in scheme development were mapped at federal, regional and zonal/woreda levels, and specific institutional weaknesses assessed. The results of this analysis are summarized in the following three figures.

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

Figure 49: 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

Figure 50: 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

Figure 51: Institutional arrangement for schemes planned and constructed by zonal or woreda offices

While weaknesses in institutional arrangements vary at each level, the following three challenges are common across:

Limited engagement and coordination between agricultural agencies and water sector agencies and between the federal and regional bodies

Repeated shifting of responsibilities at federal and regional level, in particular related to small-scale irrigation scheme development, with limited handover between agencies and resulting loss of institutional memory (i.e. organization experience and knowledge) with each shift and unclear division of responsibilities after handover

Weak local level institutional capacity to support scheme development and management in terms of human resources, technical and financial capacity.

To further validate institutional challenges, assess the various institutional arrangements today, and recommend enhancements, the following intervention is proposed.

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

Priority: Medium

Objectives/Description: An in-depth institutional analysis is required to assess the current roles and capabilities of the government agencies involved in the irrigation and drainage sub-sector. The analysis should identify institutional challenges and underlying drivers, assess the various institutional arrangements currently in place at federal and regional levels to understand their advantages and disadvantages, and recommend specific enhancements that can significantly improve the performance of the sub-sector while minimizing institutional change required and supporting long-term institutional stability. While this is a critical intervention, other interventions should not be made dependent on completion of the institutional analysis and implementation of recommendations emanating from it.

This intervention has three main proposed activities. The first activity is identifying an appropriate organization to undertake the institutional analysis. The second activity is to identify a comprehensive set of stakeholders to be consulted during the analysis, and agree the approach and key outputs. The third activity is to socialize the results and recommendations from the analysis and engage policy-makers to agree which recommendations to implement and how to implement these.

Environmental and gender mainstreaming: Improvement of institutional arrangements, in particular between federal and regional levels in the water sector, as well as between the water and agricultural sectors on natural resources management, should consider enhancement of sustainable basin and watershed management approaches and coordination.

Owners and involved parties: MoWIE irrigation and drainage directorate / regional BoWR and irrigation authorities, MoA–SSID, MoWIE-basin Directorate, other public institutions

Cost: 1-2.5 million (Major cost items: stakeholder engagement to inform, validate and implement recommendations of the institutional analysis)

Timeline: 12-24 months

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

Priority: Medium

Description: Recent studies have highlighted the budgetary shortfall for scheme development in Ethiopia, and in the course of developing this strategy financial resource allocation to the irrigation sub-sector is reported as insufficient by a wide range of government stakeholders especially when compared to the resources required to achieve regional and national targets around new scheme development and support required monitoring and maintenance of schemes.[31] This led to significant reduction of targets in various national and regional programs during GTP I, as well as high rates of deferred maintenance of schemes. At the same time limited absorptive capacity likely also contributed to reduced targets and reduced spending, and sub-optimal or inefficient use of available funds was cited by a number of senior government officials at regional level.

To increase budget allocation in the sector, various efforts have been made by government and development partners, including establishment of a national water resource development fund and allocation of several hundred million USD to small scale-irrigation development through the AGP. However, use of the national water resource development fund for irrigation projects has been minimal relative to other areas of the water sector, and cost-sharing with other sectors such as water supply, health, or power and energy has not been put in place due to lack of institutional frameworks for cost-sharing and lack of interest to participate across sectors. Two interventions are therefore proposed here.

INTERVENTION M5: Ensure the accountability and proper utilization of funding and other resources allocated for smallholder irrigation and drainage development

Priority: Medium

Objectives/Description: Principles related to effective and efficient use of financial resource such as accountability and transparency are embedded in the financial management approaches and activities of government agencies. However, a number of government, development sector and private sector stakeholders have raised inefficient use of funds as priority issue, citing examples where poor scheme design, construction, management or maintenance has led to poor performance soon after start of operations, time and cost overruns during construction, and the need for repeated re-tendering of contracts after breach by contractors. Some of these issues stem from capacity gaps in government bureaus (e.g. around contract management and project management), public design and construction enterprises, private consultants and contractors, and water user associations, ineffective handover and arrangements for scheme management and maintenance, or insufficient budgeting or focus on scheme maintenance. These issues are further detailed and addressed later in this document, in the section focused on Scheme Planning, Design, Construction and Management.

However efficiency in use of funds could potentially also be improved through strengthening financial planning, procurement and management procedures, as well as audit and assurance

31 *For example, the Small-scale Irrigation Situation Analysis and Capacity Needs Assessment by the MoANR NRM Directorate with support from GIZ, 2011*

activities. While it has been difficult to procure and assess more granular data that can prove this issue conclusively, an intervention has been included here to comprehensively assess the issues and determine appropriate measures for increasing financially efficiency in scheme development and management at all levels of government. The major activity is therefore to organize a study team with the requisite skills and knowledge to be able to undertake assessment, review exiting financial assessments and audits at federal, regional and local levels, identify common weaknesses in financial management, and recommend enhancements that can be made at each level of government including improved processes and procedures, systems, and capacity building and training of staff required.

Environmental and gender mainstreaming: N/A

Owner and involved parties: The main owners of this intervention are MoWIE-irrigation directorate, MoA-SSID, regional BoA, regional BoWR and irrigation authorities. The public procurement agency,

Cost: 2.5-5 million (Major cost items: assessment study, enhancement of systems, training of staff)

Timeline: 6-12 Months

6 .2. Research and Extension

Bottlenecks with high priority interventions

BOTTLENECK 9: Limited accurate information on the water resources available for irrigation, geological data, current schemes and usage patterns

Priority: High

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, much of this information remains incomplete or not easily accessible. Data in many areas is not available as shown in the next figure, and there is no central platform to hold data that is available and make it easily accessible.

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

🔴 *Very limited* 🟡 *Limited* 🟢 *Substantial*

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**	**Woreda BoAs**	🔴	Lack of inventory on schemes or available in scattered way
	Scheme administration including fee and charge		**Regional BoA**	**Woreda BoAs**	🔴	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**	**Woreda BoWIEs**	🔴	Except for membership number there is no available detailed data on WUAs

🔴 *Very limited* 🟡 *Limited* 🟢 *Substantial*

Figure 52: Status of data and information required and available in the sub-sector

Lack of comprehensive information has made it difficult to accurately estimate the potential for irrigation in the country, the potential impact, as well as the current level of uptake and usage. A number of new studies such as satellite based irrigation mapping by IWMI, and the analysis undertaken during the development of this strategy as presented in Section 3, have tried to bring together and refine available data, however further work is required in both cases to further validate and process the available data as well as ground-truth the results through field level sample testing and validation.

Lack of information has also led planners, designers and contractors to either plan and design schemes without sufficient information, or to devote large amounts of budget and time to undertake detailed investigations and data collection to understand the available water sources, geological conditions and existing usage patterns and challenges. Planning and implementation of 'Integrated River Basin Approach' and watershed management and effective monitoring have also been made more challenging due to a lack of information. Two main interventions have been prioritized in this area.

INTERVENTION H12: Accelerate the satellite-based shallow and deep groundwater mapping efforts to finish within 1 and 10 years, respectively

Priority: High

Objectives/Description:

Shallow ground water potential in Ethiopia is currently being mapped by sustainable irrigation and watershed development (SIWD) 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 include data collection on command area and beneficiaries. This intervention also includes the preparation of ground water atlas with well fields delineated, and the outputs of the mapping efforts described here should be integrated with other data in the irrigation MIS described in intervention M10 below. Ongoing monitoring of groundwater resources for abstraction control, aquifer behavior and pollution prevention is addressed through a dedicated intervention M3 under Policy and Institutions.

To accelerate the mapping process, any institutional uncertainties on the mandate to map the ground water (e.g. federal or regional) should be addressed and agreed on by all stakeholders. Additional funds and budget should be allocated to accelerate the existing mapping efforts and made available to different parties involved in a coordinated and consistent way. A strong coordination and support framework should also be put in place for deep groundwater mapping in particular, as this efforts is currently being led separately by each region with limited central coordination or support including ensuring consistent approaches, assumptions, etc. are used.

Environmental and gender mainstreaming: N/A

Owners and involved parties: The owners for this intervention are MoWIE and ATA. GSE and AAU are involved parties.

Cost: 50-100 million (Major cost items: mapping costs)

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

BOTTLENECK 10: Insufficient focus, budget and staff allocation on irrigation and drainage, irrigated agriculture, gender and irrigation, and on-farm water management, in the research system

Priority: High

Description: The majority of research undertaken by the EIAR and RARIs focuses on crop and livestock commodity production under rain fed agriculture compared to research on irrigated production or irrigation and drainage technologies. From a budgetary perspective, 14% of research institute funding at regional level and 15% at federal level is estimated to be focused on irrigation technologies and irrigated agriculture, while 17% of personnel have some focused on irrigation at regional level and 15% at federal level.

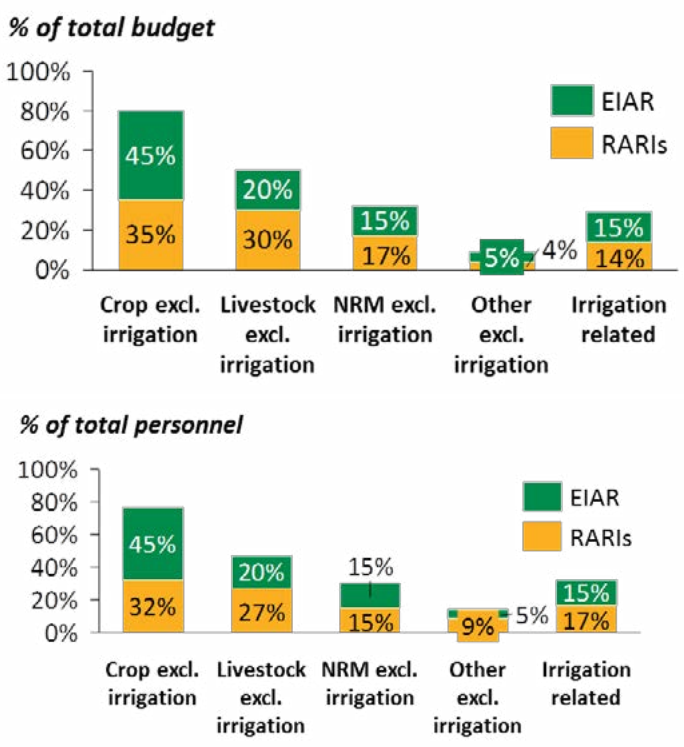

Figure 53: Percentage of budget (left) and personnel (right) allocated to irrigation related research at EIAR and RARI

While 15% of total agricultural research budget allocated to irrigation related research may be appropriate given irrigated production is currently a smaller share of total production than this, research budgets clearly need to be increased if the country to is to reach the potential targets of 25% or 50% HVC production through irrigated agriculture as explored in Section 3.2. Moreover, interviews conducted with four agricultural research institutes reinforced the need for increased investment with a number institutes reporting that their irrigated agriculture related research teams and facilities are already non-functional.

Irrigation related research is also a focus within the engineering or agricultural colleges at several

universities including Arba Minch University, Mekelle University, Haramaya University, AAU and Bahir Dar University. However interviews with a number of these universities highlights that research facilities are quite limited compared to needs as well as international standards, and the majority of graduates go on to employment unrelated to irrigation. According to the universities' representatives, existing water and irrigation laboratories are not fully equipped to support research in critical areas, access to field sites to conduct field research experiments is very limited due to limited availability of land, and field equipment including pumps, drips, sprinklers, and greenhouses, and measurement and monitoring equipment. As a result, applied research and outputs from the research system including development or adaption of new technologies is insufficient to support rapid growth of irrigated agriculture.

The following table presents a summary view on the level of focus of research activities in different areas related to irrigation, as well as the corresponding level of focus on these topics in the extension system, based on interviews with a range of experts in four research centers and two universities.

Topic	Sub-Topic	Research Focus (H/M/L)	Extension Priority (H/M/L)
Irrigation technology	Development, adaption and testing of context-specific irrigation technologies	Low	Low
	Improve efficiency of existing technology	Medium	Low
	Technology installation and maintenance	Low	Low
Irrigation water mgmt.	Scheme performance assessment	Low	Low
	Customized crop water analysis	Medium	Low
	Irrigation scheduling	High	Medium
	Water use efficiency and management	Low	Medium
	Water measurement	Medium	Low
	Recycling of wastewater	Low	Low
Irrigated agriculture	Development of suitable seed varieties	Medium	Medium
	Use of agro-input with irrigation	Medium	Medium
Gender and irrigation	Specific constraints to uptake and use of technologies and practices by women	Low	Low
	Development of gender-friendly irrigation technologies	Low	Low

Figure 54: Major areas of irrigation related research and level of focus within research and extension systems

INTERVENTION H13: Develop a national master plan for irrigation related research across the country, and allocate increased budget for the construction of irrigation research centers, operations and management, including hiring researchers with advanced degrees in research centers

Priority: High

Objectives/Description: To increase focus and coordination on irrigation research, a national master plan for irrigation related research should be introduced, similar to other agriculture sub-sectors. Necessary research facilities and equipment should also be put in place and managed in the agricultural research institutes. A typical irrigation research centre requires water resource facilities, irrigation practices field areas, and laboratories, but these facilities do not exist in most of the agricultural research institutes in Ethiopia. Sufficient budget should be allocated to several agricultural research institutes or universities to undertake construction and O&M of two to three irrigation research centres, and act as centers of excellence in the sub-sector. In addition, an increased number of qualified researchers with advanced degrees and meeting standard hiring criteria should be hired in these research institutions, and land within new schemes should be allocated for research and demonstration plots. Reorganization of the structure of agriculture research institutes to allow more focus on irrigation research may be required to support these activities to be effective.

Environmental and gender mainstreaming: Increased budgets and staff hiring should include prioritization of both research center infrastructure and a minimum number of experts who have specific expertise in sustainability issues as well as gender focused research and programming, in addition to other critical research areas for irrigation. Ongoing prioritization and budgeting of research projects and activities should also encourage focus on these cross-cutting issues within broader research efforts or through dedicated projects.

Owners and involved parties: EIAR, RARIs, Universities, with involvement of MoA, and development partners. MoWIE and regional BoWR / Irrigation Authorities will be involved specifically in allocation of land in new schemes for research and demonstration plots.

Cost: 20-50 million (Major cost items: construction of research facilities, equipment, salaries of new staff, master plan development and validation process)

Timeline: 12-36 Months

BOTTLENECK 11: 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 DA at local levels

Priority: High

Description: The extension system throughout the country primary focuses on crop production under rain-fed agriculture, including agronomic practices, input usage, and post-harvest handling, with irrigation related content mainly embedded within crop agronomy support services. Coverage of irrigation technologies, irrigated agronomy including use of inputs suitable to irrigation, irrigation water management, general and specialized extension related to HVC value chain most suitable for irrigation, and supplementary irrigation, is lacking or low in most areas. Extension

manuals and packages are underdeveloped, meaning that both DA and farmers are lacking basic knowledge. The main documents used in extension trainings today include the recently introduced Small Scale Irrigation Development, Construction and Handling (SSIDCH) manual, and irrigated crop production manuals developed by various federal and regional research institutes.

There is also insufficient focus on irrigation among crop DA given their broad scope of responsibilities. Several regions have started introducing dedicated DA for irrigation and HVC production (i.e. horticulture) in line with GTP II targets to introduce such DA around the country, however the training for these DA today is not sufficiently differentiated from the existing crop focused DA. The training manuals lack sufficient content on irrigation technologies, water management, irrigated agriculture, and gender awareness and mainstreaming. These gaps are contributing to low uptake of irrigation and benefits to farmers, as well as waterlogging, salinity and other soil issues in areas where uptake of irrigation is high (e.g. near major irrigation schemes). The following interventions are recommended to address these gaps.

INTERVENTION H14: Add additional content to the SSID extension manual in key areas and develop crop specific packages for the major crops and disseminate these to regional level

Priority: High

Objectives/Description: The existing SSIDCH extension manual developed at federal level and adapted at regional and local levels serves as the major reference for experts and DA, and covers the following main topics:

- Water source options for small scale irrigation
- Construction of small scale irrigation schemes
- Irrigation water distribution methods
- O&M 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

Benchmarking the content of the SSIDCH manual against Food and Agriculture Organization (FAO) guidance on international best practice, as well as examples from countries such as Bangladesh and India,[32] highlights additional areas that should also be added to the manual:

Basic content areas to be added

- Technology specific installation and operation of irrigation systems and equipment
- Water quantity / flow measurement as well as quality of water and salinity measurement, including related technologies for promotion
- Basics of supplementary irrigation

32 *Irrigation Manuals for Agricultural Extension Workers, Nos 1 to 10,* FAO, 1996; *Manual and Guidelines on Participatory Training and Extension in Farmers' Water Management*, FAO, 2003; *Water User Groups (WUG) Farmers Field School (FFS) Training Guide* for Bangladesh, FAO, 2013; *Farmer friendly handbooks for government schemes and programs*, Indian Ministry of Agriculture (India), August 2012

Advanced content areas to be added

- Site specific irrigation water requirement and irrigation scheduling (more advanced approaches than only referencing FAO recommendations)
- Drainage systems and drainage of irrigated land
- Effective use of water, recycling and reuse of wastewater
- Shallow well spacing (and other ground water development topics)
- Gender awareness and mainstreaming (more focused at the DA than the farmer), and promotion of gender-friendly technologies

In addition to adapting this manual at a regional level, regional bureaus of agricultural have already gone ahead and supplemented the contents in various areas through identifying specific technologies to promote based on research and regional experience. Examples are listed below. These supplements could be used to increase the coverage of the SSDICH manual itself and ensure regional extension resources are more consistent with each other, but also provide regions with additional technology specific packages to promote based on the context and needs of each region.

- Water saving technologies, On-farm water application (Oromia)
- Water utilization and water harvesting techniques (Amhara)
- Water pump usage, Water application and distribution methods and efficiency , Supplementary irrigation (Tigray)
- Water utilization, Water saving technologies (SNNP)
- Water saving technologies, Water pump usage (Somali)
- Water pumps (Gambella)
- Water utilization (Benishangul Gumuz)

Federal and regional research institutes and universities have also developed content on relevant technologies that may not be today used by extension but could be integrated into the federal and regional manuals, for example:

- Water harvesting (EIAR, Melkassa, research institute, Werer research institute)
- Crop water requirements, water utilization, irrigation technologies (Holeta research institute)
- Irrigation technology and water usage (Oromia RARI)
- Drip and sprinkler technologies (Haramaya University)
- Water utilization (Amhara RARI)
- Water harvesting (Amhara RARI)
- Water application (Tigray RARI, Mekelle University)
- Solar pumps (Tigray RARI, Mekelley University)
- Crop water requirements and evaluation of irrigation methods (SNNP RARI)
- Amendment of salt affected soils (APRAI)
- Irrigation technologies (Asosa ARI)

Irrigated crop manuals and packages have also been developed at a federal level by MoA for horticulture, maize, wheat and rice. Again, various manuals have been developed by research

institutes which today may not be used by extension, while regional BoA have developed some crop-specific irrigated production manuals and packages (see graphic overleaf). The various packages for each crop can be harmonized and key content also added to the federal manuals. Specifically, for horticulture, the federal manual should be refined to include water quality requirements and management, irrigation scheduling (for some crops), suitable water application methods, 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 manuals developed for tef, barley, priority pulses and oilseeds and other crops (e.g. coffee, cotton, forage) at federal level or for some regions where these crops are important, new manuals should be developed for these based on joint prioritization among federal and regional extension staff. Lastly, crop-specific manuals should also incorporate agro-ecology specific where possible, in particular in regionally adapted versions.

The main activities in this intervention are therefore:

Agreeing key content to be added to the federal SSIDCFH and irrigated crop production manuals, and which new crops manuals to be developed at federal and regional levels, considering the key gaps identified above and the national and regional priorities for irrigated crop production

Translating these manuals in each region and disseminating to regional level

Developing simple farmer-facing materials on key topics based on these manuals that can be easily reproduced and used by DA with farmers

Environmental and gender mainstreaming: A significant number of topics listed above for inclusion in enhanced extension manuals and packages related to environmental issues such as water use efficiency, effective use of water and drainage to prevent salinity, and water quality. Gender awareness and mainstreaming content targeted at DA as well as promotion of gender-friendly technologies are also highlighted.

Owners and involved parties: MoA, regional BoA and Irrigation Authorities (with extension mandate), with close involvement of relevant research institutions and universities, as well as development partners.

Cost: 1-2.5 million (Major cost items: manual development, publishing and dissemination)

Timeline: 6-12 Months

Institution	Irrigated crop package			
	Horticulture	Cereals	Pulses and Oilseeds	Other
Federal Research	Tomato, Potato, Onion, Cabbage, Pepper (Melkassa and Holeta)	Maize (EIAR) Barley (Holeta) Tef (Debrezeit)	Faba bean, Haricot bean (Holeta)	Coffee (Jimma) Forage, cotton (Melkasa and Holeta)
Regional Research				
Oromia RARI	Onion, Tomato, Peas, Potato, Green beans, Avocado, Papaya	Maize	Ground nut (Haramaya University)`	NA
Amhara RARI	Potato, Onion, Green Bean, Pepper, Garlic Cabbage	Wheat, Maize barley, Sorghum	Ground nuts, Sesame, Chickpea, Field Pea	Cotton
Tigray RARI	Mango, Grapes, Cactus	Maize, Tef, barley, Wheat	Sesame, Chickpea	NA
SNNP RARI	Tomato, onion, cabbage	Maize	NA	NA
Afar RARI	Onion and tomato	Maize	Sesame	Panicum (Forage)
B. Gumuz Asosa RARI	NA	Potato and Papaya	Rice, Maize	Soya bean
Regional Extension (BoAs)				
Oromia	Onion, tomato, potato, green beans, peas, avocado, papaya, apple	*Maize, Tef*	*NA*	Coffee
Amhara	Potato, Onion, cabbage, Fruits	*Wheat, Maize, Malt barley*	*NA*	Coffee
Tigray	Mango, grape and cactus, guava, onion, swiss hand, pepper, lettuce, tomato, apple	*Maize, Tef, Wheat*	*Chickpea, Sesame*	NA
SNNP	Tomato, Onion, Cabbage, Potato, Garlic, Papaya, Banana, Mango, Apple	*Maize*	*Chickpea*	Coffee
Somali	Onion, tomato, potato, beans, papaya	*Maize, sorghum, Wheat, Barley*	*Cowpea*	NA
Gambella	Onion, Tomato and Cabbage	*Maize*	*NA*	NA
B. Gumuz	Tomato	*Maize*	*NA*	NA

Figure 55: Irrigated crop production manuals developed by research institutes and extension departments

INTERVENTION H15: Accelerate hiring and training of DA/Subject Matter Experts (SME) 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:

The GoE has included hiring and training of irrigation-focused DA and SME as one of the targets in GTP 2. Actions should be made to accelerate the implementation of the plan. Although irrigation focused DA already exist in Tigray, they do not have a specific background or training in irrigation. Delivering more focused and targeted trainings on irrigation to these irrigation focused DA and SME is required, as well as providing sufficient knowledge on priority crops for irrigation (e.g. horticulture) and broader value chain issues such as agri-business. The following recommendations should be taken into consideration to make sure the DA and SME 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 the accelerated hiring and training DA and SME, improving the curriculum to focus on irrigation technics, water application and efficiency, on-farm water / salinity management, irrigated crop management, risk management, O&M of drainage facilities and gender specific issues and facilitating DA to DA or SME to SME experience sharing events.

Environmental and gender mainstreaming: As highlighted above, environmental sustainability and gender related issues are important focus areas for improving training and capacity of DA and SME.

Owners and involved parties: The owners for this intervention are MoA, regional BOA and Irrigation Authorities, EIAR,RARIs, Universities, Initiatives /programs are involved parties

Cost: 10-20 million (Major cost items: salary for DA and SME, training costs, curriculum improvement costs)

Timeline: 12-18 Months

BOTTLENECK 12: 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 to more efficiently reach farmers as well as to be able to better reach farmers who may not otherwise have access to extension service including in remote or underserved areas and women. 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 far in Ethiopia. As shown in the next table, 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 yet reaching a large number of farmers. DA based trainings and supports still are the only way majority of farmers are reached. 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, including female headed households and married women.

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	Woreda and zonal levels	Field days
Oromia	Radio programs	8028	AGP	Kebele, woreda, zonal and regional levels	Field days
Amhara	Radio programs Amhara TV	8028	AGROBIG, SLM, ILRI, International Fund for Agricultural Development (IFAD), SMIS	Irrigation conference at kebele level	Launching days Field days
SNNP	South radio and TV Documentaries	8028	AGP, SMIS, SLM, IFAD	Woreda and regional levels	Field day
Somali	ESTV Radio program	NA	FAO, PCDP	Kebele, Woreda, zonal and regional levels	Field day
Afar	N/A	N/A	N/A	N/A	N/A
Gambella	Gambela TV	NA	SLMP, EAAPP	Woreda and Kebele levels	NA
Benishangul Gumuz	Radio program(88.3)	N/A	N/A	Kebele, woreda, zonal and regional levels	Field day

Figure 56: Extension delivery mechanisms being piloted or used different region

INTERVENTION H16: Develop Short Message Service (SMS) and media based campaign to promote irrigation to farmers, expand irrigation content on 8028 system and promote heavily

Priority: High

Objectives/Description: 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.[33]

Irrigation, as an important 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. Efforts across the various media campaigns and systems should be well-coordinated, and content regularly updated. This may require strengthening the extension communication functions at federal, regional and local levels.

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.

Environmental and gender mainstreaming: SMS and media based campaigns should include sustainability related topics (e.g. water use efficiency, on-farm water and salinity management) and sufficient representation of women farmers in the content, and specifically promote access and use by women.

Owners and involved parties: The owner's for this intervention are regional BoA, Irrigation Authorities, MoA, and ATA. Ethiotelecom, Local FM radio stations and universities are involved parties

Cost: 1-2.5 million (Major cost items: production costs, SME costs, IVR expansion costs)

Timeline: 6-12 Months and ongoing

INTERVENTION H17: 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. SME and DA's do analysis on crop water requirement and schedule based on high level recommendations per crop obtained from the FAO. The recommendations therefore do not take into account critical site-specific considerations, and are

33 *Contribution of Television Channels in Disseminating Agricultural Information for the Agricultural Development of Bangladesh: A Case Study*, 2014, Mohammed Khalid Alam and Md. Armanul Haque; *Public Awareness on Water Scarcity,* GreenCom, Egypt

accessible by farmers only if the DA can reach them.

ICT based advisory is developed in many countries for site specific crop water requirement and scheduling. This usually combines the use of site-specific satellite data on climate including weather and rainfall forecasting, soil and crop and the use of ICT tools to analyse the data and get outputs. DA or farmers can directly 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 service on crop water requirements and irrigation scheduling should be developed to enhance the effectiveness and efficiency of farmer's water usage during irrigation.

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.

Environmental and gender mainstreaming: Provision of more accurate crop water requirement and irrigation scheduling information to farmers should support more efficient water use and reduced frequency of salinity issues.

Owners and involved parties: The owners for this intervention are MoA, regional BoA, MoWIE, regional BoWR and Irrigation Authorities. IWMI, ATA, EIAR and RARIs are involved parties.

Cost: 2.5-5 million (Major cost items: study and development of ICT tool, pilot and implementation)

Timeline: 12-18 Months

INTERVENTION H18: 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, ideally on a cost-sharing basis to ensure strong ownership. The support should also extend to farmers who have successfully practiced irrigation or have the desire and capacity to do so to become model farmers for irrigation in particular, including women. Supported farmers should then be encouraged to participate in irrigation promotion campaigns.

The main activities in this intervention are facilitating training opportunities for model and other identified farmers twice a year, providing equipment and crop inputs, acknowledging farmers by giving them awards and certificates, and using successfully farmers as "ambassadors" to endorse irrigation and boost farmers mobilization/buy in through farm visits, irrigation days and other means.

Environmental and gender mainstreaming: Model farmers should be supported to take up irrigation and drainage good practices related to environmental sustainability, for example drip and sprinkler based irrigation, water efficient practices, and low cost technologies for on-farm water management. Selection of model farmers should include a 30% target for female headed households or women in male-headed households.

Owners and involved parties: The owners for this intervention are MoA, regional BoA, Irrigation

Authorities and Basin Development Bureau (BDB). Equipment suppliers, NGO's and program/ initiatives are involved parties.

Cost: 5-10 million (Major cost items: equipment costs, crop inputs cost, awards cost)

Timeline: 6-12 Months and ongoing

Bottlenecks with medium priority interventions

BOTTLENECK 10: Insufficient focus, budget and staff allocation on irrigation and drainage, irrigated agriculture, gender and irrigation, and on-farm water management, in the research system

Priority: High

Description: See earlier description above.

INTERVENTION M6: Conduct national level gender analysis to identify constraints impacting awareness and use of irrigation technologies by women, and design, promote and mainstream solutions

Priority: Medium

Objectives/Description: In Figure 54 above which presented a summary view on the level of focus of research activities in different areas related to irrigation based on interviews with a range of experts, research on gender and irrigation is reported as low. Recent studies show that the proportion of female headed households who use irrigation is ~3% lower than their male counterparts in Ethiopia, and that efforts to increase irrigation uptake through extension and other mediums have increased the probability of participation in irrigation utilization for male-headed households by 27.1% than their female counterparts.[34] There is however very limited data and research on the specific constraints to uptake and use of technologies and practices by women in Ethiopia and in different parts of the country, and limited to no development of gender-friendly irrigation technologies in most research institutions and other relevant organizations. Evidence-based and data-driven research on gender and irrigation is therefore critical to promote equitable uptake and benefits of irrigation technologies, and promote use of irrigation more broadly.

The major activities in this intervention are to set-up a committee of relevant local and international experts to develop a detailed ToR for the national gender analysis ensuring sufficient focus on all critical areas of research, selection of an appropriate team of researchers, completion of the research activity by this team, validation of the research outputs through technical review, and awareness creation and popularization of the results and recommendations of the research across the sub-sector through a national workshop and visits / talks at research and government institutions.

Environmental and gender mainstreaming: The primary objective of this intervention is to support gender mainstreaming across the sub-sector by identifying the major constraints impacting women

34 *Patterns of Agricultural Production among Male and Female Holders: Evidence from Agricultural Sample Surveys in Ethiopia*, Kassa et. al., IFPRI, 2015; *Gender mainstreaming in smallholder agriculture development: A global and African overview with emerging issues from Swaziland*, Dlamini et. Al., African Journal of Agricultural Research, 2014

and assessing potential solutions to address these constraints.

Owners and involved parties: The owners for this intervention are MoA – SSID, Women Affair's Directorate, Gender Teams at regional BoA and Irrigation Auth., ATA, EIAR, with involvement of RARIs, universities and development partners.

Cost: 0-1 million (Major cost items: research field visits, researchers time / salary, popularization workshop and visits)

Timeline: 6-12 Months

BOTTLENECK 12: Limited use of additional awareness creation and extension service delivery channels, and low availability of site-specific advisory services for smallholders

Priority: High

Description: See earlier description above.

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 can play an important role in reaching a large number of farmers. Development partners and private sector players can bring both strong technical and financial capacity, and support reaching farmers living in remote areas. However these efforts in different parts of the country have been largely uncoordinated and therefore less impactful than they could have been.

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.

Environmental and gender mainstreaming: Engagement of development partners and private sector in awareness creation and extension support should include a specific focus on environmental sustainability related issues (e.g. water use efficiency, on-farm water / salinity management) as well as on reaching female headed households and women in male-headed households.

Owners and involved parties: The owners for this intervention are MoA, regional BoA and Irrigation Authorities. Development partners and private sector bodies are involved parties.

Cost: 0-1 million (Major cost items: conducting workshops/conferences)

Timeline: 6-12 Months and ongoing

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 and weeks are held regularly in many different countries. In India, irrigation awareness weeks include discussion, trainings, workshops, exhibitions visits and demonstrations on irrigation management.[35] In Egypt, conferences and demonstrations on irrigation are the largest part of the water week celebrations.[36] A large number of individual farmers, water user associations and subject matter specialists are 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 days for extension. There are no days or weeks dedicated to irrigation specifically except in Amhara region, which has an irrigation launch day each season. Such a practice should be introduced in every region as it boosts farmers' awareness on irrigation. A biannual irrigation day/week can include the following activities:

New technology demonstrations

Exhibitions and audiovisual presentations

Model farm visits

Discussions which include explanations of the social and economic benefits of involving women in irrigation schemes

Distribution of brochures and fliers

Farmer to farmer experience sharing / success story sharing

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.

Environmental and gender mainstreaming: Irrigation specific days / weeks and farmer to farmer experience sharing events should include a specific focus on environmental sustainability related issues (e.g. water use efficiency, on-farm water / salinity management) as well as on participation of women both in demonstrating use of technologies, good practices and success stories, and as attendees in these events.

Owners and involved parties: The owners for this intervention are MoA, regional BoA and Irrigation Authorities. Individual farmers, ATA, universities, development partners, programs/initiatives, EIAR and RARIs are involved parties.

Cost: 20-50 million (Major cost items: irrigation day/week facilitating costs, farmer to farmer event facilitation costs)

35 *Strategies for Saving Water in Irrigation – An Experience in Maharashtra State*, India, S.V. Sodal, 2004

36 *Water Users Associations in Egypt, Irrigation Improvement Project (IIP)*, Usaid El-Hanbali, March 2003; *Egypt Irrigation Improvement Project (IIP) profile*, EMWIS, 2008

Timeline: 6-12 Months and ongoing

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

Priority: Medium

Description: As highlighted earlier, there are a number of irrigation related manuals and technologies developed by agricultural research institutes and universities that have not been communicated or taken up by the extension system. At the same time, extension staff report not having access to sufficient training and technologies to address challenges being raised by farmers including female farmers. This is in part because of weak linkages between research and extension at federal and regional levels. Research extension linkages are defined in terms of four main areas here:

Joint planning of research activities: Joint prioritizing and planning of research activities that can most effectively support extension needs

Effective handover of research outputs: Establishment of mechanisms for effective transfer of outputs to the extension system

Ongoing support to extension system: Research system providing ongoing support to extension after handover of research outputs

Feedback from on-the-ground: Mechanisms to ensure feedback from farmers on extension services are collected and fed back to research system to inform future research

Through discussions with federal regional stakeholders, the effectiveness of linkages in each of these areas was assessed qualitatively, with results summarize in the table below. Weak linkages (red check; 64%) are most frequently reported, followed by strong linkages (green check; 25%), and a few instances of medium linkages (yellow check; 8%) or no linkages (red 'x'; 1%).

Federal / Region	Joint planning	Effective handover	Ongoing support	Feedback
Federal	✓	✓	✓	✓
Afar	✓	✗	✓	✓
Amhara	✓	✗	✓	✓
B. Gumuz	✓	✓	✓	✓
Gambella	✓	✓	✓	✓
Oromia	✓	✓	✓	✓
Somali	✓	✓	✓	✓
SNNP	✓	✓	✓	✓
Tigray	✓	✓	✓	✓

✓ *Strong linkage* ✓ *Medium linkage* ✓ *Weak linkage* ✗ *No linkage*

Figure 57: Strength of research extension linkage at federal and regional levels

Three interventions are proposed to address the overall level of weak linkages reported.

INTERVENTION M9: 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.

Environmental and gender mainstreaming: (To be added)

Owners and involved parties: The owners for this intervention will be MoA, regional BoA, Irrigation Authorities, EIAR, RARIs and universities. Farmers and DA are involved parties

Cost: 1-2.5 million (Major cost items: conducting joint planning session)

Timeline: 6-12 Months

INTERVENTION M10: Institute a survey mechanism in which DA's periodically conduct surveys on farmer demand, 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 focus is not mainly driven based on feedback from farmers. This is mainly because there is no system to conduct survey and collect feedback on farmer problems. At the same time public sector supply chains for irrigation are not well-informed by a structured demand assessment process. Therefore, a survey mechanism through which DA can regularly assess demand and other information from farmers should be institutionalised within the regional BoA.

The main activities in this intervention are training DA on how to conduct surveys on farmers demand, conducting the surveys, validating and remediating data quality issues, analysing surveys, making demand information available to relevant government offices, and discussing results in joint planning sessions between research and extension.

Environmental and gender mainstreaming: Surveys should ensure strong participation of women, include sufficient focus on environmental sustainability related issues (e.g. water use efficiency, on-farm water / salinity management), and specific challenges faced by female farmers on reaching female headed households and women in male-headed households.

Owners and involved parties: The owners of this intervention are the regional BoA and Irrigation Authorities. EIARs, RARIs, MoA, Agricultural research institutes and universities are also involved.

Estimated cost: 1-2.5 million (Major cost items: training costs, surveying costs)

Timeline: 6-12 Months and ongoing

INTERVENTION M11: 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 centralized, effective mechanism to share research outputs (e.g. policy briefs, recommendations, etc.) 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 Virtual Extension and Research Communication Network (VERCON), 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.

Environmental and gender mainstreaming: Increasing access to research outputs should improve knowledge and understanding of environmental sustainability and gender related issues. In addition, the information sharing platform should include specific areas focused on these topics to encourage engagement with the related research outputs.

Owners and involved parties: The owners for this intervention are MoA, EIAR, RARIs and universities. Regional BoA and Irrigation Authorities are involved parties.

Cost: 1-2.5 million (Major cost items: online platform development cost, ongoing O&M of the online platform)

Timeline: 6-12 Months

6.3. Scheme Planning, Design, Construction and Management

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: Scheme development is undertaken in multiple stages from prioritization, planning and design through supervision and monitoring. While there is some level of standardization in this process at federal and regional levels, stakeholders have consistently raised a lack of standardization as well as capacity in public institutions as priority bottlenecks in the sub-sector. The figures below summarize the major activities at each stage of scheme development, standardization and related challenges, and capacity gaps consistently identified through stakeholder interviews, document review and field visits.

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*)	• Lack of simple, standard designs available to adapt • Limited consideration of on-farm and scheme level drainage in designs • Logistics problems in accessing sites	• Lack of technical capacity in public of private organizations leading scheme design • Ineffective community engagement and study of local needs / issues • Design is not sufficiently site specific
Scheme construction	• Construction planning • Civil works construction • Electro-mechanical installation (Large scale)	• Lack of standard technical specifications in tendering leads to low quality in construction • Lack of effective partnership between client, contractor and consultant, and ineffective contract management	• Lack of skilled manpower in quality and quantity • Late response for design amendment • Lack of capacity building programs for contractors (technical, financial, machineries, etc)

Figure 58: Major activities during scheme development, standardization challenges and capacity gaps (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
Handover and ongoing management	• Handover of schemes to WUA • Water scheduling and distribution • Day to day operation of scheme infrastructure and equipment	• Water distribution not regularly implemented	• Lack of technical capacity on management of schemes among WUAs or public institutions
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

Figure 59: Major activities during scheme development, standardization challenges and capacity gaps (2/2)

This analysis highlighted both lack of established standards due to few guidelines and technical manuals and limited awareness creation and collaboration mechanisms among stakeholders, as well as various underlying capacity gaps whether financial, human resources, data or technical gaps among clients, contractors, consultants and the community (including water user associations). Five interventions are listed below to address these standardization and capacity weaknesses.

INTERVENTION H19: 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 critical element of scheme development to ensure efficient use of funds and maximum impact for smallholders and the country. A successful prioritization process should be comprehensive by looking at critical factors including, but not limited to, economic, environmental and social considerations. Others factors that also need to be considered are availability of project management capacity and integration of the principle of multiple use system (MUS). In addition, from resource efficiency perspective, maintenance of current schemes should be given precedence or appropriate priority over development of new schemes.

MoWIE and regional BoWR / Irrigation Authorities use various prioritization criteria and processes today. The MoA SSID is also working on guidelines for prioritization of small scale irrigation schemes. A comprehensive guideline covering smallholder focused schemes of any command area should be developed for use at all levels. This intervention therefore has four main activities. First, a technical expert committee from federal and regional bureaus should be established to develop a standardized guideline for prioritization of schemes development with high consideration for community involvement. Second, draft guideline should be distributed to regions and development partners (e.g. World Bank) to incorporate their feedback, and then published and disseminated. Next, the guideline should be integrated into the standard process of basin authorities (e.g. during joint planning of schemes) and the basin authorities should be responsible for ensuring the prioritization guidelines are effectively applied for all irrigation schemes developed in the basin. Last, major government and development partner funders of irrigation schemes should be required to adopt the guideline as a precondition for financing of schemes.

Environmental and gender mainstreaming: Environmental and social (including gender related) considerations are an important components of prioritization criteria and process, and should therefore be well-reflected in the guidelines.

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID and regional BoWR and Irrigation Authorities, with close involvement of MoWIE Basin directorate, Basin Authorities, MoA-AGP, regional bureaus of agriculture and natural resources (BoANR), and development partners.

Cost: <1 million (Major cost items: study conducted to develop the guideline)

Timeline: Ongoing

INTERVENTION H20: Strengthen joint planning and execution of scheme development and management between agricultural and water institutions

Priority: High

Objectives/Description: Lack of collaboration between irrigation agencies and agricultural agencies has led to many challenges in scheme development especially in handover to the community, O&M. In some cases, underperformance of schemes, caused by scheme plans and design not taking into consideration agricultural and NRM plans and needs, 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, improved handover and/or joint management of projects.

This intervention has four main activities. The agricultural water task force should be strengthened by extending it to woreda level and assigning an institution to oversee the taskforce. Quarterly meetings between regional/federal BoA and water resources should be held and the development of a joint irrigation plan by integrating different plans through joint planning sessions should be facilitated. Finally, agriculture bureau experts should be involved in prioritization and design of schemes developed by water resource bureaus, in addition to handover and ongoing management and support activities.

Environmental and gender mainstreaming: N/A

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID, regional BoWR and Irrigation Authorities, regional BoANR

Cost: 2.5-5 million (Major cost items: conducting joint planning sessions of agricultural water task force)

Timeline: 6-12 Months and ongoing

INTERVENTION H21: Require agencies to include all relevant costs including handover, O&M, rehabilitation, monitoring and information dissemination, in funding for schemes

Priority: High

Objectives/Description: An irrigation scheme development plan should be comprehensive enough to ensure major resource shortfalls to not occur during design, construction, management or maintenance. However detailed planning and budgeting related to O&M, rehabilitation and human resource development are overlooked. Moreover, adequate documentation is crucial especially during irrigation handover. Implementing the above mentioned items requires more focus from government agencies in terms of allocating funds and human resource to these activities.

This intervention has four main activities. 1) Promote government agencies to include diverse set of experts in the project team for scheme planning and development. 2) Develop standard templates and capacity of government agencies for preparation of comprehensive project proposals for scheme development. 3) Make the allocation of funds for scheme development dependent on fully planned, costed and budgeted proposals. 4) Put in process checks to protect ongoing budgets allocations for handover, O&M, rehabilitation, monitoring and information dissemination of existing schemes from being reallocated to new scheme development or other priorities.

Environmental and gender mainstreaming: Environmental sustainability of water resources and land in irrigation schemes areas is frequently adversely impacted by poor handover, delayed operational and maintenance, lack of monitoring, and slow rehabilitation. Strengthening financing for these areas should support improved scheme management including environmental management and impacts.

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID, and regional BoWR and irrigation authorities, with close involvement of MoFEC, regional BoFECs and development partners.

Cost: <1 million (Major cost item: conducting training for staff)

Timeline: 6-12 Months

INTERVENTION H22: 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 main reasons frequently cited for delayed delivery and underperformance of schemes. Low quality design and construction by enterprises is due largely to internal factors which includes lack of project management and operational capacity, but also insufficient budgeting for design, logistical challenges of designers in accessing sites, and capacity challenges limiting effective community engagement. Construction enterprises are constrained by factors such as limited human and financial resources and lack of technical capacity. From the client side (i.e. BoWR and Irrigation Authorities) contract management capacity is not well-developed, and therefore enterprises as well as private consultants and contractors are not proactively and aggressively managed to contracts as per public procurement policies and guidelines. Given the predominance of capacity issues, this intervention focuses on addressing capacity gaps across these main public sector actors.

This intervention has five main activities. Priority training needs should be identified and provision of regular on-job training to staff on relevant topics should be initiated or increased. Linkages between universities and supporting institutions (e.g. construction project management institute) and public institutions for knowledge and experience sharing should be created. Experience sharing events with successful local or foreign organizations in the sub-sector should be organized. Foreign experts should also be brought into public institutions on a time-delimited basis to accelerate transfer of knowledge. Finally, stronger recognition and reward mechanisms for those firms or individuals who have demonstrated good achievement should established.

Environmental and gender mainstreaming: Poor scheme design, construction and maintenance often contribute to inefficient or otherwise environmentally damaging use of water and land resources in irrigation schemes. Strengthening contract management, scheme design, construction and maintenance capacity can therefore improve environmental management and impacts.

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID, regional BoWR and Irrigation Authorities, with close involvement of universities, other professional education institutes and associations, and development partners.

Cost: 5-10 million (Major cost items: staff training, experience sharing events)

Timeline: 6-12 Months and ongoing

INTERVENTION H23: Establish national standards for design, construction, O&M, and performance assessment of schemes

Priority: High

Objectives/Description: Similar to prioritization of schemes, standardizing the process of developing designs and construction can bring significant benefits including economics of scale across agencies, reduced costs for design and construction activities, more consistent and improved tendering as well as quality control of activities, ensuring scheme designs are not overly complicated and follow good practices, and facilitate stronger community engagement as well as mainstreaming of environmental and gender considerations.

This intervention has three main activities. A technical expert committee for federal and regional bureaus should be established to develop standards and guidelines for design, construction, operation and other aspects of irrigation development with strong consideration for community involvement in every step of scheme development, appropriate social and environmental safeguards as well as mechanisms for quality control. The committee should first review existing standards and guidelines available in the country, and then determine how to refine these revise and refine these. Local knowledge and resources should also be an important input to this process. Once the standards and guidelines are developed, awareness among relevant public and private institutions concerning use of the standards and guidelines should be created, and ongoing training support should be provided as required. The standards and guidelines should also be incorporated into the evaluation process for approval of irrigation and drainage projects, as well as contract management of design and construction, O&M activities and auditing, and performance assessment.

Environmental and gender mainstreaming: Poor scheme design, construction and maintenance often contribute to inefficient or otherwise environmentally damaging use of water and land resources in irrigation schemes. Strengthening contract management, scheme design, construction and maintenance capacity can therefore improve environmental management and impacts. In addition, schemes may be designed or constructed in a way that reduces access to women (e.g. if farmers have to operate a heavy door to access water via a canal). National standards prioritizing simple, user-friendly designs can prevent such barriers to access.

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID, regional BoWR and Irrigation Authorities, Design and Construction Enterprises, with close involvement of private sector actors and development partners.

Cost: 1-2.5 million (Major cost items: study conducted to develop the guidelines, stakeholder validation, guideline dissemination and related training)

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 value chain related bottlenecks especially as government support systems such as seed production and distribution, fertilizer distribution, and extension, to date have had very limited focus on HVC most amenable for use with irrigation. Many members of water user associations and irrigation cooperatives, as well as other individual farmers and stakeholders interviewed, mentioned these bottlenecks as major challenges to uptake and investment in irrigation. A number of previous studies similarly highlight crop value chain related bottlenecks or limited access to finance (covered later in this document) as the major barriers to uptake of irrigation and benefits

from irrigation for smallholders.[37] As female farmers either in female headed households or married women typically have lower access to inputs, finance and extension in major value chains, bottlenecks in HVC value chains have been shown by various studies to also disproportionately impact them.[38]

The graphic below provides a high-level summary of the major crop value chain bottlenecks identified through extensive review of previous studies as well as stakeholder interviews, considering both domestic and export market requirements. These bottlenecks cut across the value chain from inputs through to marketing, and are particularly severe for very HVC such as fruits and vegetables which are not addressed by existing national strategies for cereals, pulses, oilseeds and other crops.

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

High Priority *Medium Priority* *Low Priority*

Figure 60: Major crop value chain bottlenecks identified for use of irrigation with different crops

There is an existing national strategy for fruits and vegetables that addressed a number of these bottlenecks, and several regional agricultural bureaus as well irrigation authorities such as Oromia Irrigation Development Agency in Oromia region have developed standalone strategies to promote interventions for crop value chains in an integrated way with smallholder irrigation and

37 See for example, Does investment in motor pump based smallholder irrigation lead to financially viable input intensification and production? Economic assessment of investments in motor pump based smallholder irrigation, Gebrehaweria Gebregziabher et. al., IWMI, 2015, or Profit and financial risk in the smallholder irrigated agriculture of Ethiopia, Kindie Getnet et. al., ILRI, 2015

38 Patterns of Agricultural Production among Male and Female Holders: Evidence from Agricultural Sample Surveys in Ethiopia, Kassa et. al., IFPRI, 2015

drainage development.[39] Looking across these and other HVC value chain analyses and projects in the country and abroad, a number of potential interventions for each major bottleneck are shown below that could serve as a starting point for a broader menu of options that can be integrated with smallholder irrigation and drainage development projects based on the specific focus crops and challenges faced by local farmers.

	Highest priority bottlenecks	Potential interventions *(not exhaustive)*
1	Low availability of quality improved seed & seedlings	• Support community based and local private sector seed producers to access early generation seed and increase seed production • Strengthen linkages to private seed importers and marketing agents • Support contract farming schemes with input provision
2	Low availability and use of appropriate fertilizers	• Ensure use of site-specific fertilizer recommendations in fertilizer supply and distribution • Support contract farming schemes with input provision
3	Low availability of agrochemicals, biopesticides & equipment	• Strengthen linkages to private importers and marketing agents • Support contract farming schemes with input provision
4	Low availability of market-oriented extension services	• Provide supplementary training to DAs on market-oriented topics • Support cooperative unions to cascade specialized extension to farmers
5	High cost of labor and low availability of mechanization services	• Support cooperative unions and private service providers of mechanization • Promote equipment-sharing models through coops. and farmer groups
6	Low availability of input & on-farm operations financing solutions	• Expand use of input credit vouchers • Facilitate access to finance through RuSACCOs and MFIs loan schemes
7	Low availability of market information, platforms & facilities	• Establish collection centers, primary markets and urban wholesale marketing centers with modern facilities, services and systems • Establish mobile market information systems and transaction platforms
8	Limited quality-based pricing differentiation in the market	• Integrate quality-based pricing and information in market centers and information systems • Train farmers and intermediaries on quality management
9	Limited development of food safety, quality & traceability systems	• Establish national food safety standards and train value chain actors • Promote development and use of low-cost electronic traceability systems
10	Low availability and high cost of appropriate transport & storage	• Support cooperatives to acquire transport and storage facilities • Promote low-cost on-farm storage technologies • Incentivize private sector transport and storage providers (including cold chain) and provide training on quality management
11	Limited management and operational capacity of cooperatives	• Provide training, infrastructure and systems to cooperatives • Support professionalization and performance-based compensation
12	Low availability of equipment, aggregation & trade finance	• Support expansion of leasing and trade finance solutions by MFIs and commercial banks through guarantees and other risk-sharing mechanisms
13	Limited agroprocessing and packaging investment & capacity	• Incentivize investments in processing and packaging facilities • Support linkages between processors and aggregators to increase supply
14	Limited use and effectiveness of contract farming arrangements	• Undertake awareness creation of contract farming with value chain actors • Facilitate establishment of contracts though providing standard tools and support contract delivery and dispute resolution through problem-solving
15	Limited market linkages & access to secure, higher-value markets	• Establish collection centers, primary markets and urban wholesale marketing centers with modern facilities, services and systems • Support direct market linkages and contracts with supermarkets

Figure 61: Illustrative menu of interventions for major crop value chain bottlenecks for HVC

39 *Smallholders Horticultural Development Strategy*, FDRE MoANR, 2013; *OIDA Strategic Plan*, 2015, OIDA

Rather than embed an additional strategy for such value chains within this document, or recommend development of an enhanced national strategy on fruits and vegetables with greater integration of irrigation related solutions, one main intervention is recommended here to ensure that crop value chain related bottlenecks are addressed in a context-specific way within each irrigation scheme rather than address broader systemic issues in HVC value chains.

INTERVENTION H24: Ensure integrated planning and implementation of crop value chain related interventions with scheme planning, design, delivery and management

Priority: High

Objectives/Description: Large and medium irrigation schemes in Ethiopia are constructed by MoWIE and regional BoWR and most of the small scale schemes are constructed by the MoA and regional BoA. In regions with an Irrigation Authority, that entity may play both roles. In either of these cases, planning of interventions related to crops to be produced in the irrigated area is often not started until after the scheme construction is underway or even subsequent to handover of the scheme to community members. In particular, ensuring strong access to inputs, specialized extension support, and market linkages is often addressed more in an ad hoc or tactical way as issues are raised from the farmers. This was observed in the majority of scheme field visits undertaken for development of this strategy, though in the case of the Koga irrigation scheme planning of interventions for horticulture value chains was strongly integrated with scheme planning and development from early on and the scheme project office continues to provide support to farmers in areas such as provision of quality input and construction of aggregation and collection centers.

The different institutions mandated to construct irrigation schemes should work closely to integrate crop value chain related interventions at the same as and in an integrate way with scheme planning, design and construction timelines. This will not only increase the demand by farmers to invest and participate in irrigation schemes, it will also ensure a quick benefit for farmers, greater focus in the community on O&M, and the ability to bring in water and cost recovery fees earlier.

The main activities in this intervention are developing a standard framework to assess crop value chain related needs and a menu of standard interventions that can be applied, and ensuring integration of these tools in in joint scheme (including HHI promotion) planning and budgeting processes involving MoWIE, regional BoWR, MoA, regional BOA, and irrigation authorities

Environmental and gender mainstreaming: As show in various recent studies, crop value chain related interventions do not appear to reach women as effectively as men. For example, extension services often do not reach women, access to inputs and finance is lower for women, and access to markets also appears more restricted for women.[40] Therefore, implementation of this intervention should include sufficient focus on ensuring that crop value chain related interventions are designed and implemented in way that ensures they effectively reach female farmers in irrigation schemes, with specific targets for women and regular monitoring and impact assessment to support adjustments in approach where required.

40 Patterns of Agricultural Production among Male and Female Holders: Evidence from Agricultural Sample Surveys in Ethiopia, Kassa et. al., IFPRI, 2015

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

Cost: 1-2.5 million (Developing a standard set of tools for assessing and putting in place interventions to address crop value chain related bottlenecks for a given scheme, disseminating these tools to relevant agencies and providing socialization / training where required)

Timeline: 6 to 12 Months

BOTTLENECK 18: Low scheme performance and deferred maintenance

Priority: High

Description: Many schemes in most regions low performance due to design, construction and management / operation issues including excessive of water by users, as well as deferred maintenance. Even newer schemes – whether large or small scale – see a significant drop in actual irrigated area versus planned at launch or within the first 1-2 years. The following two figures present a summary of the status on scheme performance and deferred maintenance by region, for regions that were able to provide this data.

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 62: Performance of schemes in major regions

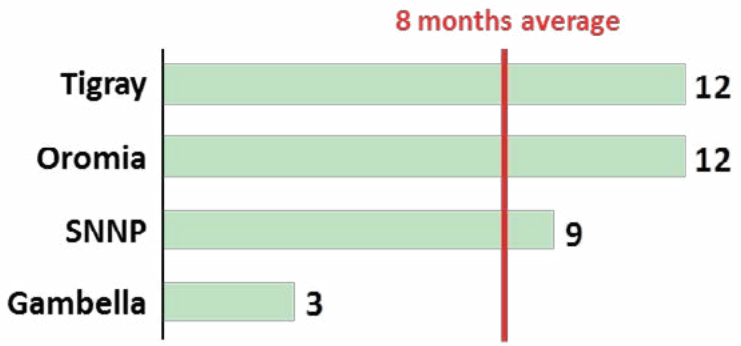

Figure 63: Average maintenance deferral for regions

On average around 50% of the schemes are underperforming while there is 8 months of maintenance deferral. These issues clearly have economic implications and also environmental implications if not properly addressed. The economic implication arises from lost benefits from lower use of irrigation than planned / designed, and typically higher costs for rehabilitation or replacements after poor maintenance. The environmental implications arise from the threat of different hazards (e.g. flooding) that the scheme can cause, as well as inadvertent changes to the environment from blocking waterways through siltation and other issues stemming from poor maintenance. Maintenance is frequently deferred due to unclear or ineffective arrangements for scheme management and maintenance, or lack of budget and capacity to undertake timely maintenance for example in regional bodies that are asked to focus more on new scheme development. In addition to earlier interventions in this section which address these issues, one additional intervention is proposed.

INTERVENTION H25: Develop guidelines and procedures for scheme performance mgmt., inspection, maintenance, safety checks, and training technicians, specifying responsibilities of WUA and government, and develop and roll out reporting system for WUA

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. Some efforts in this area have already been started by the SMIS Project. Further, to ensure sustainability of irrigation and drainage infrastructure, O&M should be taken up by both WUA and government. WUA should be trained to undertake routine maintenance and day-to-day management of scheme, as well as regularly report performance and maintenance status. A manual that guides WUA in this process as well as clearly outlines their responsibilities with respect to scheme maintenance will reduce maintenance deferral, as will put in place a reporting system for WUA. Moreover, government should support WUA by sharing maintenance responsibilities where appropriate (and as is already happening), and conducting safety checks and audits to monitor the overall scheme performance.

This intervention has five main activities, starring with the setting up of a committee of technical experts to develop manual and guideline of scheme performance and maintenance. An irrigation scheme transfer manual also covering responsibilities of management and maintenance or irrigation infrastructure should then be developed. Standard irrigation and drainage transfer contracts or agreements should be developed and validated with WUA and other relevant stakeholders. Capacity building support to government agencies responsible for maintenance of schemes should also be provided. Last, simple process and system for WUA to report on current performance and maintenance status should be developed, piloted and then scaled up.

Environmental and gender mainstreaming: Poor scheme performance management and maintenance can contribute to inefficient or otherwise environmentally damaging use of water and land resources in irrigation schemes. Strengthening this area can therefore improve environmental management and impacts.

Owner and involved parties: MoWIE Irrigation and Drainage directorate, MoA SSID, regional BoWR and Irrigation Authorities, with close involvement of WUA and development partners.

Cost: 2.5-5 million (Major cost items: training of government agencies and WUA on processes and reporting system)

Timeline: 12-24 months and ongoing

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 constrained the irrigation and drainage sub-sector.

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

- Poor reconnaissance and /or prefeasibility level study information available before tendering leading to improper site selections, and limited availability and quality of information on water and land resources
- 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 bias reported by government and private stakeholders

Besides external factors internal factors are also significant in limiting the growth of the industry. The major factor is insufficient capacity of public and private design and construction firms, due in large part to few experienced senior engineers and delayed payment from clients. On the other hand, lack of machineries and equipment for construction, inadequate feasibility studies undertaken by consultants and delayed handover were also mentioned as important capacity gaps. These capacity gaps often lead to a delay in scheme delivery or even default by the contractor. The following figure summarizes recent performance for private and public consultants and contractors in six regions, showing the range of average delay by region reported for scheme design and scheme construction as well as the average across regions.

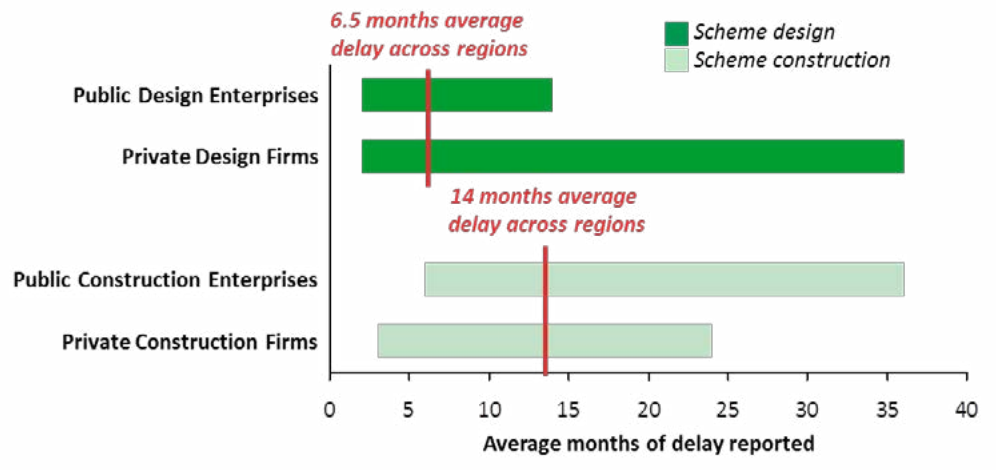

Figure 64: Average delays in scheme design and construction across regions (months)

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.

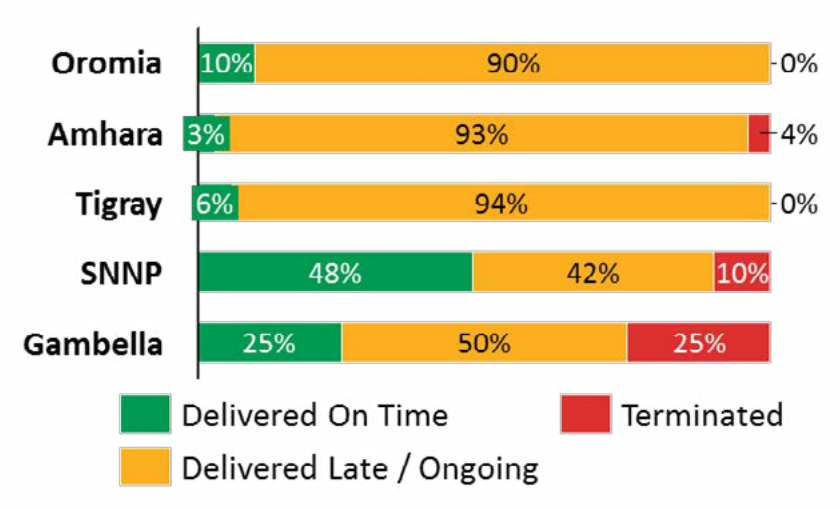

Figure 65: Percentage of planned schemes delivered by region during GTP 1[41]

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 do not consider the actual situation in the ground
- Construction issues: The main causes here are low capacity of private and public

41 *Data was unavailable for Afar, Somali and Beninshangul Gumuz*

consultants, right of way issues, and limited interest of enterprises in remote scheme locations

INTERVENTION H26: 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 poor reconnaissance and /or prefeasibility level study information available before tendering, inconsistent application of procedures, and limited technical capacity in bid analysis. To mitigate this problem it is essential to develop standard guidelines while giving appropriate consideration for criteria's such as past performance of bidder, fully 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 and requires capacity building as well as stronger quality control / audit through random checks.

This intervention has three main activities. A committee of technical experts should be established to review any existing guidelines, specifications and criteria already developed, and build on these to develop improved reconnaissance and prefeasibility requirements before tendering (for feasibility studies or design studies), and tendering guidelines based on past learnings and experiences from international tendering standards. The capacity of bidding committee should be enhanced through increase requirements (e.g. members should be experienced experts) and strengthened training. Audit and random checks on procurement processes should be increased, and recommendations coming out of these audits should be implemented in the timely manner.

Environmental and gender mainstreaming: N/A

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID, regional BoWR and Irrigation Authorities, with close involvement of development partners and consultation of public and private water works enterprises.

Cost: 1-2.5 million (Major cost items: study conducted to develop the guidelines, training, increased audit activities)

Timeline: 6-12 Months

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

Priority: High

Description: The legal framework for WUA was established recently through the WUA proclamation (2014). The regions are also establishing their own WUA regional proclamations. In these proclamations the responsibilities of WUA are clearly articulated. However, the level of implementation of these activities with existing organizations playing the role of WUA (e.g. irrigation cooperatives) is still very early stage. Specifically, WUA should be able to effectively take on the following governance and management activities:[42]

42 *Establishing and Strengthening Irrigation WUA in Ethiopia: A Manual for Trainers, Philippe Lempériere et. al, IWMI, 2014*

Governance

- Set internal rules and regulations
- Elect members of the governing body
- Determine appropriate fees for members / users
- Ensure effective financial management and accuracy of year-end financial reports
- 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 fees from members and undertake other revenue generating activities
- Sanction non-paying members
- Arbitrate conflicts between members
- Train members on irrigation practices
- Undertake day to day financial management
- Prepare year-end financial reports

Beyond lack of clarify around their legal status and roles, there are a number of underlying drivers why these organizations cannot effectively take on these activities:

Policy and institutional issues: This includes absence of regulatory body to organize and manage WUA, WUA regulations not yet enacted, compulsory membership not yet implemented and lack of sufficient training and support from local experts and DA

Governance issues: Insufficient representation and participation of women in governance and management bodies

Capacity issues: This includes lack of technical and financial capacity of WUA to conduct required maintenance and limited enforcement capacity of WUA, including due to high turnover of staff

Implementation issues: Water fees are not applied in most scheme, actual water allocation does not follow the prescribed water distribution plan, leading to issues such as upstream-downstream conflicts and frequent theft of water in schemes

INTERVENTION H27: Establish large-scale capacity building program(s) for WUA on scheme and financial mgmt., revenue generation and other topics, with strong NGO involvement

Priority: High

Objectives/Description: A large-scale capacity building program is required to rapidly strengthen the large number of WUA expected to be established during GTP II to manage irrigation schemes. International experience in countries such as India, Egypt and Azerbaijan among others has clearly shown that there is a large role for government in this area, however participation of NGOs and development partners is also critical given the scale of work required and the need for WUA to

quickly become economically viable non-profits separate from government.[43] Capacity building should focus both on management as well as provision of minimum infrastructure, systems and equipment (including water flow measurement technologies), and may also be required for WUA support institutions in addition to WUA themselves.

This intervention has six main activities, starting with establishing national/regional body within MoWIE/BoWR to oversee, manage, and organize WUA. Concurrently, supporting the involvement of NGOs and development partners in providing capacity building programs to WUA, including capacity building to these support institutions (as required) should be prioritized. Subsequently, the major capacity gaps within WUA need to be identified and training programs need to be conducted accordingly. In addition, WUA need to be supported by providing equipment's (e.g. computers, water measuring devices) and providing post-training follow-up (e.g. assess the implementation of training content, reward WUA which demonstrate good performance in implementing the training content). Last, experience-sharing activities among WUA need to be conducted.

Environmental and gender mainstreaming: Capacity building of WUA on ensuring sufficient participation of women in governance, management and membership is an important component of this intervention, and should include targeting capacity building efforts at women within WUA.

Owner and involved parties: MoWIE Irrigation and Drainage Directorate, MoA SSID, regional BoWR and Irrigation Authorities, and WUA, with close involvement of local NGOs and other development partners.

Cost: 10-20 million (Major cost items: developing capacity building programs and modules, training costs, cost of infrastructure and systems, water measuring devices and other devices given to WUA)

Timeline: ongoing

INTERVENTION H28: Make available grants or low interest loans for WUA to fund their activities

Priority: High

Objectives/Description: To finance establishment, ongoing capacity building and development, and day-to-day operations of water user association, short and long term financing and credit solutions are critical. Even after a WUA is largely financially independent, large-scale maintenance of infrastructure replacement or rehabilitation may need to be financed externally. Grant-based or low interest, long duration loans have proven effective in other cases to effectively support WUA and should also be prioritized in Ethiopia at national and regional levels.

The main activities in this intervention are discussing with key government stakeholders and financial institutions on the appropriate structures required to make available low interest rate loans, which will then need to be funded, and popularized with WUA. Grant based finance will need to also be designed by government along with development partners, and grant and credit based support will need to be harmonized, for example grants offered to new WUA for initial start-up

43 *Capacity Development for Integrated Water Resources Development and Management in India*, World Bank, 2015; *Review of World Bank engagement in the Irrigation and Drainage Sector in Azerbaijan*, World Bank, 2013; *Egypt Irrigation Improvement Project, Implementation Completion Report Review*, World Bank, 2007.

while low interest loans offered to established WUA with a minimum track record of performance.

Environmental and gender mainstreaming: N/A

Owners and involved parties: Ministry of Finance And Economic Development (MoFED), MoWIE Irrigation and Drainage Directorate, MoA SSID, regional BoWR and Irrigation Authorities, financial institutions (including Micro-Finance Institutes (MFI)) and development partners.

Cost: 20-50million (Major cost items: stakeholder validation cost and the wholesale fund itself)

Timeline: 6-12 Months and ongoing

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: See description above.

INTERVENTION M12: 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 regional BoWR are responsible for revising the licences of consultants and contractors in a specified interval. However, a variety of stakeholders cited inefficiencies and potential biases in this process due to the limited focus given and lack of a centralized system to track performance of consultancy and construction firms especially across regions. If this process is to be efficient and effective two major changes are required. The first is granting due focus to license revision process by allocating more resources in terms of budget and staff time in public institutions, and strengthening the procedures and controls. The second change is to introduce a national system to record performance of consultancy and construction firms, with built in controls to ensure accuracy of information.

In this regard, this intervention has four main activities. The first activity is enhancing the human resource, financial and technical capacity of government agencies to support robust on-ground investigation of consultancy and construction firms. This needs to be followed-up by a baseline study of water works enterprises to support improvement of the licensing guideline and for the database. Afterwards, the procedures and controls recommended by the baseline study need to be strengthened. Effective implementation of this intervention requires updating/ developing a national database template and popularizing it with the regions and other agencies and also develop a reporting and communication mechanism.

Environmental and gender mainstreaming: N/A

Owner and involved parties: MoWIE-Irrigation and Drainage Directorate, MoWIE-Permit directorate and regional BoWR and irrigation authorities, with consultation of private enterprises and associations involved.

Cost: 5-10 million (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: See description above.

INTERVENTION M13: Provide incentives to WUA to regularly conduct maintenance of schemes, e.g. preferential treatment in providing loans and capacity building of WUA, maintaining schemes in good condition until full handover to WUA

Priority: Medium

Objectives/Description: Studies in different countries point out that providing incentives to WUA to conduct regularly maintenance can be critical for effective performance of these entities. The major incentives discussed in the studies are providing preferential treatment to WUA who have good performance and also keeping schemes in good condition until handover to WUA. 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. The first activity is integrating maintenance related data into the scheme inventory and the irrigation MIS for performance management. Ensuring that schemes are transferred in good condition to WUA or install some kind of financial arrangement with WUA if the schemes are not in good condition also needs to go hand in hand with the first activity. WUA which regularly conduct maintenance of schemes can be supported by providing preferential incentives (e.g. loan or capacity building).

Environmental and gender mainstreaming: N/A

Owner and involved parties: MoWIE-Irrigation and Drainage Directorate, MoA–SSID and regional BoWR and irrigation authorities. WUA are also involved in the implementation.

Cost: 2.5-5 million (Major cost items: Loan and/or training for WUA)

Timeline: 12-18 months

INTERVENTION M14: Support the establishment of federation of WUA especially for large scale schemes

Priority: Medium

Objectives/Description: The federal WUA proclamation (2014) states that a federation of WUA can be established per the agreement of member WUA and the scheme management office. The proclamation especially puts the necessity to support the establishment of federation of WUA

during full transfer of an irrigation scheme for large scale schemes. Establishing a federation can also make a significant contribution to the development of WUA themselves through sharing resources across WUA to support their development. .

This intervention has three main activities, building on the earlier intervention to develop WUA capacity. To accelerate the process of establishment of federations of WUA involved in large-scale schemes it is necessary to bring together WUA and create awareness of the benefits of establishing a federation and developing an overall timeline for when the scheme could be fully handed over to this entity. The legal and organizational establishment of the federations then needs to be supported through providing standard bylaws, organization structure and staffing, and supporting establishment of governance structures and hiring of professionals (where required). Facilitating linkages to financial institutions and other sources of financial support, training, and infrastructure and equipment provision / acquisition (e.g. computers, water measuring devices) can then be undertaken.

Environmental and gender mainstreaming 30% requirement for female membership of the governance committee of federation should be put in place similar to the 30% quota of female members of the governance committee of WUA noted earlier.

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

Cost: 5-10 million (Major cost items: training, cost of providing computers, water measuring devices)

Timeline: 24-36 months

6.4. Technology Supply Chains

Bottlenecks with high priority interventions

BOTTLENECK 25: High tariffs and lack of availability of Foreign Exchange (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.

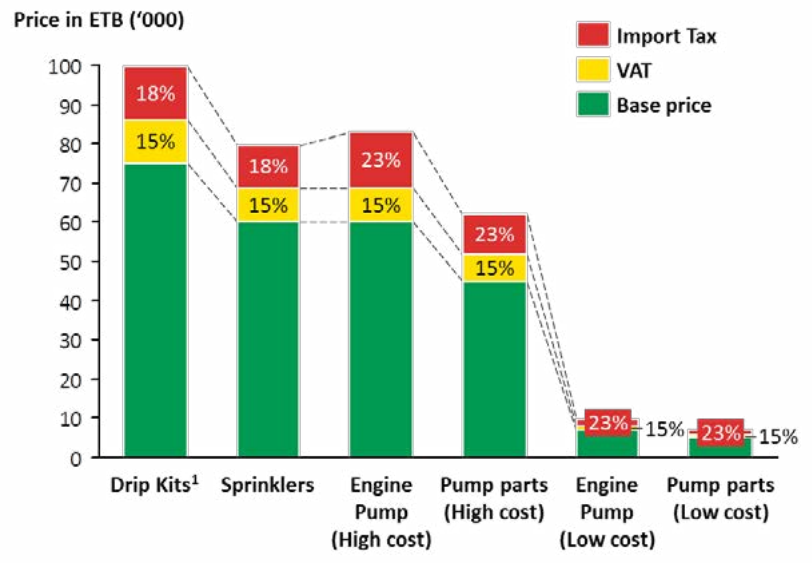

Figure 66: Import tariff and price for irrigation equipment

The current tariffs for irrigation technology are a major obstacle to promoting adoption among smallholder farmers, especially where credit is relatively inaccessible. Lower income and female farmers with lower financial assets and access to credit are at a particular disadvantage. Low adoption results both in less use of irrigation (e.g. pumps), as well as less efficient use of water in the case of sprinklers and drip kits. 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.[44] Domestic assemblers are similarly disincentivized as they are subject to these tariffs on key imported parts which drive over 90% of the final assembled pump cost / price.

Looking across benchmark countries as presented in the next graphic[45], Ethiopia has the highest such tariff and the lowest adoption rate of irrigation pumps. Countries such as Zambia and Bangladesh have been able to show significant increases in uptake of irrigation equipment after reducing or eliminating tariffs, and India 50% subsidy on micro-irrigation systems has been credited as a major driver of the high uptake of drip irrigation systems in that country and growth of large manufacturers such as Jain Irrigation Systems.[46] However, the correlation between tariffs and uptake rates requires greater analysis to confirm the relationship between them.

44 *Realizing the Potential of HHI in Ethiopia, MoANR, ATA, 2012*

45 *FAO AQUASTAT (http://www.fao.org/nr/water/aquastat/main/index.stm); Additional import tax data from 'dutycalculator.com'; Ethiopia adoption rate data based on information from AQUASTAT, IWMI and MoWIE; Nepal tariff data from National Ministry of Finance (http://www.customs.gov.np/en/uc_search.html)*

46 *Improving the motor pump supply chain in Zambia, IWMI, 2012; Transforming the supply of irrigation pumps in Ethiopia. Working Draft, Ethiopian ATA, 2014; Inclusive Business Case Study: Jain Irrigation Systems Limited (JSIL), IFC, 2014*

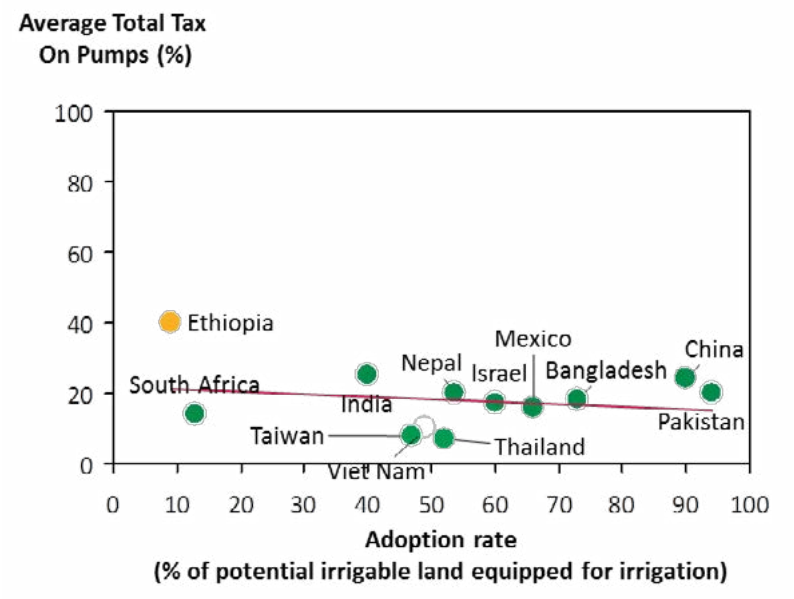

Figure 67: Correlation of tariff / tax on pumps with irrigation adoption rates

A related challenge is the low availability of FOREX for this sub-sector as irrigation equipment is not currently prioritized in FOREX 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 which would otherwise only take 1 month. Interventions are proposed below to both address high taxes as well as low Forex availability for pump importers and assemblers.

INTERVENTION H29: 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 structure and rate(s) for pump and associated raw materials and parts. The optimal tariff structure and rate(s) should consider how to maximize uptake, as well as local manufacturing and assembly activities.

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.

Environmental and gender mainstreaming: Reducing price of irrigation equipment such as drip kits and sprinklers will contribute to high water use efficiency in smallholder irrigation. Reducing prices of equipment more broadly should support increased uptake by female farmers who typically have lower assets and access to finance.

Owner and involved parties: MoWIE-Irrigation and Drainage Directorate, MoA-SSID, ATA, Ministry of Industry, MoFEC, ERCA, regional BoWR and Irrigation Authorities, private sector actors.

Cost: <1 million (Major cost items: conducting the policy analysis study, validation of results with stakeholders and engagement with policy makers)

Timeline: 6-12 Months

INTERVENTION H30: Prioritize FOREX allocation for equipment, parts and raw material imports

Priority: High

Objectives/Description: Facilitating imports of irrigation equipment, spare parts, and components and raw materials for manufacturing and assembly, 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 large 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, as well as increased assembly and manufacturing activities, and thus promote the development of the sector as a whole.

This intervention has three activities. The main activity is conducting a policy analysis showing the benefits of including the irrigation sector among those prioritized for the allocation of FOREX. The recommendations of the analysis should be validated with stakeholders and presented to the government for consideration. Follow-up on the endorsement and implementation of the recommendations will also be required.

Environmental and gender mainstreaming: Increasing availability of irrigation equipment such as drip kits and sprinklers will contribute to high water use efficiency in smallholder irrigation. Increasing availability of equipment more broadly should support increased uptake by female farmers who typically have lower assets and access to finance.

Owners and involved parties: MoWIE-Irrigation and Drainage Directorate, MoA-SSID, ATA, Ministry of Industry, MoFEC, regional BoWR and Irrigation Authorities, private sector actors

Costs: <1 million (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.[47] This implies that locally produced irrigation equipment frequently breaks and/or cannot be used as it does not 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 cost of insurance and freight. These factors discourage private investments in assembly, manufacturing, 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 these services reduced 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.

Manufacturing	• Undersupply of qualified irrigation technology experts in the labor market • High import tax of pump raw materials • Limited demand for locally assembled pumps
Wholesaling/ Retailing	• Locally assembled pumps cost more than imported pumps • Low demand due to limited knowhow • Limited availability of FOREX
Installation/ Well drilling	• High initial cost of drilling rigs and spare parts • Lack of standardized design and quality specification led to poor quality well construction
Spare Parts & Maintenance	• Difficulty of importing raw materials • Lack of skilled maintenance workers and training programs • Limited access to finance

Figure 68: Technical and financial constraints limiting investment in technology supply chains

INTERVENTION H31: Promote joint ventures, co-production and franchising arrangements 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 can promote innovative business models by developing and marketing new technologies

47 *Transforming the supply of irrigation pumps in Ethiopia. Working Draft, Ethiopian ATA, 2014.*

that entrepreneurs can use to establish and run profitable small-scale businesses, such as the KickStart International project in Kenya and Tanzania[48] Hence, partnerships (i.e. joint ventures, co-production and franchising arrangements) 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 includes three main activities, the first one being the definition and prioritization of all areas where partnership support would be helpful. This will be followed up by the identification of development partners interested to support partnership and technology transfer programs. The third activity is the provision of targeted analytical, financial, legal and negotiation support for the start-up of partnership and technology transfer programs.

Environmental and gender mainstreaming: Reducing price and increasing availability of irrigation equipment such as drip kits and sprinklers will contribute to high water use efficiency in smallholder irrigation. Reducing price and increasing availability of equipment more broadly should support increased uptake by female farmers who typically have lower assets and access to finance.

Owners and involved parties: The lead implementer of this intervention will be the MoA.

Costs: 2.5-5 million (Major cost items: training of staff on different activities, reaching out to potential foreign and domestic partners)

Timeline: 6 months (set-up); ongoing

INTERVENTION H32: 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 three activities. The first activity is defining the menu of support areas (e.g. business model development and sales), developing support materials and putting in place modalities for support delivery. Before launching the program, potential recipients should be identified and the diagnostics of their capacity along support dimensions completed. Last, to successfully implement the program, close follow-up also needs to be put in place.

Environmental and gender mainstreaming: Increasing availability of irrigation equipment such as drip kits and sprinklers will contribute to high water use efficiency in smallholder irrigation. Increasing availability of equipment more broadly should support increased uptake by female farmers who typically have lower assets and access to finance.

Owners and involved parties: The lead implementer of this intervention will be the MoA and the

48 *For more information, see http://kickstart.org/*

regional BoA/Irrigation agencies. MoWIE, RBoWIE and NGOs are the other parties involved.

Costs: 2.5-5 million (Major cost items: content development of support material, training)

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

INTERVENTION H33: 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. This should include small manufacturers of water lifting and water saving technologies like solar pumps and drip units. Increased availability of financial solutions for the irrigation sector will encourage private investments which, in turn, will positively affect irrigation adoption rates among farmers.

This intervention will entail, first, 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. The discussions with financial providers should lead to an agreed list of financial products to make available to the irrigation and drainage sector. Finally, the agreed financial products should be introduced to manufacturers, wholesalers and, retailers by organizing awareness creation events.

Environmental and gender mainstreaming: Increasing availability of irrigation equipment such as drip kits and sprinklers will contribute to high water use efficiency in smallholder irrigation. Increasing availability of equipment more broadly should support increased uptake by female farmers who typically have lower assets and access to finance.

Owners and involved parties: The lead implementer of this intervention will be the MoA and the regional BoA.

Costs: 2.5-5 million (Major cost item: organization awareness creation events)

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

INTERVENTION 34: 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 start with identification of potential interested actors (wholesalers and retailers in major cities and unions/coops in rural areas) and analysis of existing linkage mechanisms

and eventual bottlenecks. The analysis should support effective design of solutions for mitigating these problems. The recommended solutions or sub-interventions need to be validated with relevant stakeholders. The last activity is linking participants through formal introductory and periodic meetings, the informal provision of contact information and, the provision of high-level support to these meetings.

Environmental and gender mainstreaming: Increasing availability of irrigation equipment such as drip kits and sprinklers will contribute to high water use efficiency in smallholder irrigation. Increasing availability of equipment more broadly should support increased uptake by female farmers who typically have lower assets and access to finance.

Owners and involved parties: The lead implementer of this intervention will be the MoA and the regional BoA.

Costs: 1-2.5 million (Major cost items: Study to analyse potential linkage, organising workshops/ conferences to link participants)

Timeline: 6-12 Months (set-up); ongoing

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

Priority: High

Description: There are various direct costs associated with use of irrigation by smallholders, including infrastructure, equipment, labor / fuel for operation, maintenance, and crop input related costs. These costs can often be prohibitive and prevent uptake of irrigation by farmers, especially where large capital outlay may be required in the initial period. The next figure provides an estimate of the year 1 cost per farmer for both larger and smaller schemes and assuming either no cost recovery on infrastructure costs initially paid by government or full cost recovery over 10 years. The total year 1 costs range from 33,000 ETB to 65,000 ETB on average, with a wide range around these based on the type of infrastructure and equipment used in the scheme and by the farmer. This cost level is clearly prohibitive for many smallholder farmers in the country.

Cost 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)**
O&M	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)
Infrastructure 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)***

Figure 69: Median costs (ETB/hectare) for different technology packages

Interviews conducted with different financial institutes throughout Ethiopia reveal that while there are various recent initiative to make credit available to farmers for irrigation, access remains limited. Specifically, microfinance institutions like Dedebit Credit and Saving Institution (DECSI) and Oromia Credit and Saving Share Company (OCSSCO) are providing loans to smallholder farmers to purchase irrigation equipment as shown in figure 70. Public irrigation equipment manufacturers like Metals And Engineering Corporation have also been providing irrigation equipment to be paid over years. These various programs are relatively new and not yet at the scale to support millions of smallholder farmers. At the same time, farmers with lower assets and income generating potential, including female farmers, are often underserved by these solutions.

In addition to 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 were until recently no legally organized water users associations in the county. Extensive review was undertaken of access to finance solutions in other countries at both an individual farmer level and for water user associations. Findings are summarized in Figure 71 below.

MFI	Product	Partners	Application requirements	Collateral requirements	Credit / farmer (ETB)	Interest rate	Farmers served	Tenor	Default Rate
ACSI	Irrigation Group Loan (3-7 farmers)	• Ambasel BoA, 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%	n/a	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%	n/a	3-4 yrs	<5%
	Regular Loans	• None	• Business plan & feasibility	• Physical collateral	200k-10M	15%	13-14	n/a	n/a
ADEDAY	Irrigation Group Loan	• DECSI	• 3-7 women	• None	n/a	14% (For women) 20.5% (Groups)	16k	n/a	<5%
OCSSCO	Group Loan (General)	• BOA	• Upon approval of low income and motivation of lonee	• None	Max 15K	17%	700k-800k HH /yr	1 yr	1%
	Regular loans	• None	• Business plan	• Collateral	No limit	13%	NA	3 yrs	10%

Figure 70: Irrigation related loan services given by MFI in Ethiopia

Financing options	Farmer level	WUA level	Major source of funds	Eligibility requirement	Repayment rate (typical)	Case studies	Farmer feasibility	WUA Feasibility
Regular interest loan	✓	✓	• MFIs, Banks	• Feasibility study • Collateral • Gov. guarantee	• < 95%	• n/a	◔	◑
Group lending	✓	✗	• Banks, MFIs & CF buyers	• None	• > 99%	• Bangladesh - Grameen Bank	●	n/a
Voucher	✓	✗	• MFIs, Contract farming buyers	• None	• > 99%	• Kenya-Ahero scheme	◕	n/a
Rental/ lease	✓	✗	• Equipment/ Well owners	• Initial rental payment	• > 99%	• Bangladesh-Grameen Krishi Found.	◕	n/a
In-kind repayment	✓	✗	• Banks, Contract farming buyers	• None	• > 99%	• Bangladesh-Grameen Krishi Found.	○	n/a
Low interest loan	✓	✓	• Gov't, NGOs and MFIs	• Collateral (Optional)	• 95% to 99%	• Kenya-large scale schemes	◑	●
Gov't/NGO Grants	✓	✓	• Gov't (Federal/ Regional), NGOs	• None	• n/a	• Ethiopia-Raya Vally	◑	◕

Low ○ *High* ●

Figure 71: Assessment of different financing options for individual farmers, WUA, Coops and farmer group

INTERVENTION H35: Introduce dedicated wholesale lending, guarantee schemes, or revolving funds for financing irrigation equipment and related inputs for farmers through MFI, Rural Savings and Credit Cooperatives (RuSACCO) and/or farmer common interest groups

Priority: High

Objectives/Description: Easing credit access for farmers to allow them to access 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, including for female farmers that typically face greater constraints to accessing finance. 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 O&M 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 has four main activities. The first step in setting-up the lending scheme, guarantee schemes or revolving fund involves discussions with interested financial institutions on existing and potential funding options for irrigation equipment and related inputs and eligibility criteria for borrowers. Once one or more funding modalities are agreed, these need to be designed in detail. The specific financial products or schemes then can be established. Finally awareness creation among farmers will be critical to organize to both make farmers aware of the available financing options as well as address concerns farmers may have in utilizing these.

Environmental and gender mainstreaming: Increasing availability of finance for farmers to access irrigation equipment such as drip kits and sprinklers will contribute to high water use efficiency in smallholder irrigation. The design of the access to finance solutions should ensure specific constraints faced by women such as in the credit process are well-addressed.

Owners and involved parties: The owners of this intervention are MoA, regional BoA and Irrigation Authorities. Financial institutions, NBE, development partners, MoWIE Irrigation and Drainage Directorate, Federal Cooperatives Agency and SACCOs are other involved parties.

Costs: 5-10 million (Major cost items: various stakeholder workshop and engagement events, costs associated with establishing financing mechanisms, costs of guarantees, and aware creation efforts).

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

Bottlenecks with medium priority interventions

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. [49] There are typically no local private service

49 *Transforming the supply of irrigation pumps in Ethiopia (Working Draft), Ethiopian ATA, 2014.*

providers that can be hired to manually drill irrigation wells in many areas, and where there are service providers they often lack the necessary technical skills resulting in poor quality of well construction. Available well drilling machines are mostly publicly-owned and not sufficient to meet the needs of the irrigation sector. 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 is also low in Ethiopia. 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.[50] In particular, even though sometimes unions, cooperatives or DA 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. Four main interventions are therefore proposed to address this bottleneck.

INTERVENTION M15: 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.[51] Irrigation equipment rental service providers also represent a valid option for farmers who cannot afford to pay upfront for highly priced irrigation technology such as engine pumps. These service providers typically rent out pumps 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 insufficient financial resources to access irrigation technology and associated services, and farmers with enough capital to test such technology before making large investments.

This intervention requires identification of support areas and potential recipients, conducting a diagnostic study of existing capacity along support dimensions, designing financial support and technical capacity building programs, validation of the approach with different stakeholders, and delivering the programs.

Environmental and gender mainstreaming: Training to well drilling service providers should include environmental sustainability issues related to use and recharge of groundwater resources.

Owners and involved parties: The owners of this intervention are MoA, regional BoA and Irrigation Authorities.

Costs: 5-10 million (Major cost item: diagnostic study, program design and validation, program delivery).

---

50 *Transforming the supply of irrigation pumps in Ethiopia (Working Draft)*, Ethiopian ATA, 2014.

51 *Manual Well Drilling Investment Opportunity in Ethiopia*, Weight, Yoder, and Keller, 2013.

Timeline: 6 months (set-up); ongoing

INTERVENTION M16: Improve content and delivery of well drilling courses in universities and in ***Technical and Vocational Education and Training (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 national irrigation adoption rates.

First, the implementation of this intervention will require designing the content and delivery of well drilling courses appropriate to the needs of the national irrigation sector. Second, an assessment of the current capacity of universities and TVET institutions to deliver these courses should be conducted. Third, modalities (e.g. design enhanced curriculum) for filling any eventual gap will be designed and put in place.

Environmental and gender mainstreaming: Training to well drilling service providers should include environmental sustainability issues related to use and recharge of groundwater resources.

Owners and involved parties: The owners of this intervention are MoA SSID and SMIS project, MoE, MoWIE, with close involvement of universities.

Costs: 1-2.5 million (Major cost item: Content redesign, training of teachers/professors).

Timeline: Ongoing

INTERVENTION M17: 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 mentioned above for well drilling courses, the implementation of this intervention will designing the content and delivery of maintenance courses appropriate to the needs of the national irrigation

sector. Second, an assessment of the current capacity of ATVET institutions to deliver these courses will be conducted. Third, modalities (e.g. design enhanced curriculum) for filling any eventual gap should be designed and put in place.

Environmental and gender mainstreaming: N/A

Owners and involved parties: The owners of this intervention are MoA SSID and SMIS project, MoE, MoWIE, with close involvement of universities.

Costs: 1-2.5 million (Major cost items: content design, training of professors/teachers)

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

INTERVENTION M18: 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. Firstly, training curriculum, related materials and delivery modalities for training delivery (theoretical and practical sessions) should be designed. The second activity is identifying potential recipients, conducting diagnostics of their capacity and providing training as relevant. The last activity is providing accreditation to qualified recipients to ensure consistent quality.

Environmental and gender mainstreaming: N/A

Owners and involved parties: The owners of this intervention are MoA SSID, regional BoA, Irrigation Authorities, and MoWIE Irrigation and Drainage Directorate.

Costs: 2.5-5 million (Major cost items: designing training curriculum, related materials and delivery modalities)

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

APPENDIX A1:

STEERING COMMITTEE, TECHNICAL COMMITTEE AND STAKEHOLDER ENGAGEMENT DETAILS

The project was overseen by a Steering Committee, chaired by State Minister of Natural Resources, MoAD, W/ro Frenesh Mekuria, with members from MoA, ATA, MoWIE, Ministry of Livestock And Fisheries (MoLF) and the Federal Cooperative Agency (FCA). The specific role and responsibility of the steering committee members was to provide overall steering, direction and decision-making at key points in project when 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 MoAD (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 BoA, water resources and irrigation authorities were also invited to participate in Technical Committee meetings. The Technical Committee was chaired by MoAD SSID 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.

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

	Institution
1	MoA SSID
2	MoA Extension Directorate
3	MoA Extension advisory and training
4	MoA SSID
5	MoA NRM
6	MoA Horticulture Directorate
7	MoA Mechanization Directorate
8	MoA Women Affairs Directorate
9	MoA AGP
10	MoA PASIDP
11	MoA SMIS
12	MoWIE Ground Water 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 and Fisheries
18	Federal Cooperative Agency
19	Ministry of Trade
20	Ministry of Science and Technology
21	Ministry of Education
22	Ethiopian Standards Agency
23	Ethiopian Conformity Assessments Enterprise
24	Oromia Irrigation Development Authority
25	Ethiopian Institute of Agricultural Research
26	Melkasa Agricultural Research Center (EIAR)
27	Holeta Agricultural Research Center
28	Oromia Agricultural Research Institute
29	Tigray Agricultural Research Institute
30	Amhara Agricultural Research Institute
31	Southern Nations Nationalities and Peoples Region (SNNPR) RARI
32	Asosa Agricultural Research Center
33	Afar Pastoral and Agro-pastoral Research Institute
34	Somali Pastoral and Agro-pastoral Research Institute
35	Gambela Agricultural Research Institute
36	Oromia Bureau of Agriculture

	Institution
37	Amhara Bureau of Agriculture and Rural Development
38	Tigray Bureau of Agriculture and Rural Development
39	SNNPR Bureau of Agriculture and Rural Development
40	Benishangul Gumuz Bureau of Agriculture and Rural Development
41	Afar Pastoral Agricultural and Rural Development Bureau
42	Somali Bureau of Agriculture and Rural Development
43	Diredawa Bureau of Agriculture and Rural Development
44	Gambela Bureau of Agriculture and Rural Development
45	Harari Regional Agricultural and Rural Development Bureau
46	Tigray Bureau of Water Resources
47	Amhara Water Resources Development Bureau
48	Oromia Bureau of Water Resources
49	SNNPR Water Resources Development Bureau
50	Benishangul Gumuz Water Resources Development Bureau
51	Afar Bureau of Water Resources
52	Somali Bureau of Water Resources
53	Gambela Water, Mines and Energy Resources Development Bureau
54	Diredawa Bureau of Water Resources
55	Addis Ababa Water and Sewerage Authority
56	Baherdar Agricultural Mechanization Center
57	Mekele Agricultural Research Center
58	Sodo Agricultural Research Center
59	Weliso Agricultural Research Center
60	Bako Agricultural Research Center
61	Arbaminch University
62	Bahirdar University
63	Mekelle University
64	Hawasa University
65	Haramaya University
66	Jijiga University
67	ATA Tigray Office
68	ATA Oromia Office
69	ATA SNNP Office
70	ATA Amhara Office
71	OMNI
72	Netafim
73	Davis and Shirtliff Trading P.L.C

	Institution
74	HAGBES PLC
75	Ambassel Trading House
76	ESFRE Trading
77	Wondo
78	Biselex Ethiopia PLC
79	F.D.R.E Metals and Engineering Corporation
80	AMIO Engineering PLC
81	Biruh Tesfa Irrigation and Water Technology PLC
82	Adama Agricultural Machinery Industry
83	Selam Children's Village (TRIAE)
84	Cooperative Bank of Oromia
85	Oromia Microfinance Institution S.Co
86	Amhara Credit and Savings Institution
87	Oromia Credit and Saving Share Company
88	DECSI SC
89	Asegid Ephrem
90	Shiferaw Bekele
91	Demisew Abate
92	Metaferia Consulting Eng.
93	Desta Horecha
94	Asfaw Afera
95	Sorsa Consult
96	Water Works Design and Supervision Enterprise
97	Ethiopian Water Works Construction Enterprise (WWCE)
98	Oromia Water Works Design and Supervision Enterprise
99	Oromia WWCE
100	Amhara Water work Construction Enterprise
101	Amhara Design and Supervision Enterprise
102	South WWCE
103	SNNPR Water Works Design and Supervision Enterprise
104	Tigray Water Works Study Design and Supervision Enterprise
105	Tigray WWCE
106	Benishangul WWCE
107	Afar WWCE
108	Afar Water Works Design and Supervision Enterprise
109	Somali WWCE
110	Somali Design and Supervision Enterprise

	Institution
111	Somali Irrigation and BDB
112	Water Works Design and Supervision
113	IWMI
114	FAO
115	IFAD
116	IDE
117	JICA
118	World Bank
119	GIZ
120	United States Agency for International Development (USAID)
121	DANIDA
122	USAID
123	Dutch Development Corporation
124	CIDA
125	PCDP
126	ORDA
127	REST

APPENDIX 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

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**		MoA	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

Section	Data	Data Source	Data Sourced
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/hectare)	Regional ATA or BoA Office	Regional land tax rates

Figure 72: 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 – 50 kilometer 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

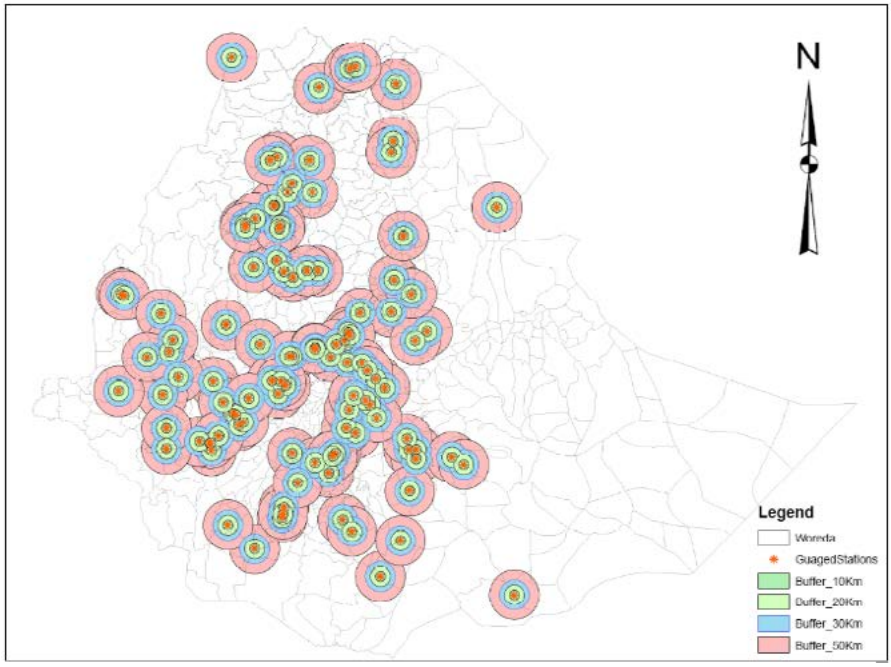

Figure 73: Basin Stations and corresponding boundaries (Source: ATA SIWD team)

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

Section	Data	Default Values	Rationale
Crop Specific data at Regional Level	Crop Yield	Crop specific; based on average zonal values	25th percentile of zonal yield data per crop
	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/hectare)	National Average

Figure 74: Default values used for woredas with missing information

5. 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

Water Delivery Stage	Sub-Category	Irrigation Technology
Drainage Technologies	Surface drainage systems	Cross slope
		Parallel
		Random
	Sub-surface drainage systems	Deep open drains

Figure 75: 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 O&M costs are taken to be 10% of the initial investment costs where they apply.

Irrigation Technology	Average Initial Investment Cost (ETB/hectare)*	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

6. 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/hectare. The table below summarizes the top eight crops selected based on this criteria, termed HVC.

#	Crops	Revenue per hectare (1 harvest) (ETB/hectare)	Maximum number of harvests per year	Annual Revenue per hectare (ETB/ hectare)
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 76: Selected HVC and annual revenue per hectare

Number of farmers growing the crops > 3 million, based on CSA 2013/14 Agricultural Survey. The table below shows the list of eight crops selected based on this criteria, termed HPC). 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 77: Selected HPC

7. 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.

8. 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.

9. 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.

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

d. Additional yield and production is driven by the additional number of harvests possible with irrigation

e. Multiplication of the additional production with the price of each crop will give the additional revenue stream possible

f. 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

11. 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

g. The available amount of water (essentially rainfall) at the critical growing period of the crops

h. 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)

i. 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

j. 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 document

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**

Figure 78: Regional Irrigation Potential for all water sources under 5% 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**

Figure 79: 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**

Figure 80: Regional Irrigation Potential for all water sources under 50% HVC / 50% HPC scenario

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 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	1	2	6	2	4	12	3	4	13
Amhara	87	122	363	145	202	649	163	226	744
Benishangul	1	2	6	2	4	10	3	5	14
Gambella	1	1	4	2	2	7	2	3	10
Harrari	0.1	0.2	1	0.3	0.4	1	0.3	0.4	1
Oromia	150	208	516	274	374	1,056	318	433	1,277
SNNP	50	70	209	106	149	476	128	179	579
Somali	6	9	31	11	17	60	13	21	73
Tigray	12	18	47	29	45	116	38	58	154
National	***309***	***433***	***1,181***	***572***	***797***	***2,388***	***668***	***930***	***2,865***

Figure 81: Regional Annual Net revenue assuming full cultivation of Economic Irrigation Potential

APPENDIX A3

DETAILS OF MAJOR PROGRAMS

A AGRICULTURAL
G GROWTH
P 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 (revised down from initial targets after limited completion of schemes in first 2-3 years):
  - ***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

Figure 82: AGP I/II Small-scale Irrigation Component 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

Figure 83: MoA-PASIDP program profile

PROJECT OBJECTIVES

- **Main focus:**
  - Improved planning, design and construction of gender equitable and sustainable irrigation schemes
  - Improved management of gender equitable and sustainable small-scale and micro irrigation schemes by water users' organizations (WUOs) and individual users respectively
  - Improved water, soil and crop management practices for irrigated crops
- **Duration:** 2015-2019
- **Geography:** Tigray, Amhara, Oromia, SNNPR
- **Beneficiaries:** n/a
- **Donor:** Government of Canada (DFATD) & Government of Netherlands (EKN)
- **Funds:** ~ Euros 20 M
- **Implementing Partners:** MoA-(SSID, NRMD), ATA, Regional bureaus of water, agriculture, marketing & cooperative, OIDA ,AGP, PASIDP, REST, SLM, LIVES, Agriteam, other partners

ACHIEVEMENTS

- Participatory irrigation and design management (PIDM) approach successfully piloted in 4 schemes
- Amhara BoWR adopted PIDM as a guiding principle for scheme planning and design
- Community was involved from the design of the scheme up to joint evaluation and approval of design, lading to increased interest to scale up this approach in other non-pilot schemes
- Training of trainers conducted for 300 regional experts on different topics including project management

MAIN CHALLENGES

- Information management system is weak with limited availability of data, fragmented data and limited analysis
- Lack of coordination between government agencies
- Limited implementation of government policies due to most not being supported by clear strategies and action plans

KEY LEARNINGS

- Planning, design and construction of irrigation scheme should be gender equitable and sustainable
- Full participation of the community is critical to ensure the sustainably of irrigation schemes
- Community should be involved in decision making in every stage and process of irrigation scheme development
- Comprehensive approach involving all relevant stakeholders is required to bring about changes in irrigated agriculture

Figure 84: MoA-SMIS program profile

ATA

PROJECT OBJECTIVES

- **Main focus:** Promote household irrigation technologies and high value crop production and marketing to: increase incomes for smallholder farmers, improve food security throughout the year, and catalyse farming communities
- **Duration:** 2014-2106 (On going)
- **Geography:** 21 pilot woredas across Tigray, Amhara, Oromia & SNNPR
- **Beneficiaries:** 200,000 Households in 21 pilot woredas of the 4 Regions
- **Donor:** World bank (Under AGP) & DANIDA
- **Fund:** USD 2M from AGP, CIDA and Danida over the last 3 years
- **Implementing Partners:** MoANR, AGO, Regional Bureau of agriculture, EIAR, RARIs, Regional Agricultural Mechanization Centers, Agricultural Technical and Vocational Education training Centers (ATVET), Federal Cooperative Agency, MoWIE, Ethiopian Geological Survey, National Metrological Agency, IDE Ethiopia, JICA, ILRI, IWMI

ACHIEVEMENTS

- Developed High Value Crop assessment tool & 281 experts were trained. More than 100,000 SHFs used the tool
- Developed localized cropping calendar and trained 135 experts. About 70,000 SHFs used the calendar in 21 woredas
- A total of 2,179 woreda experts and DA's were trained on irrigation water management , irrigation agronomy and post harvest. Reference materials were distributed and the training was cascaded to 251,249 SHF(2006-2008)
- Some 37 pump maintainers and 36 manual pump manufacturers were trained; 2,299 SHFs purchased manual pumps & 1,179 engine pumps were maintained
- 52 persons were trained on manual well drilling in 13 woredas to form well driller enterprises in Oromia & SNNPR
- 21 FTC's are capacitated –manual pumps, engine pumps, improved seed and blended fertilizer were provided and 11 Field Days were organized to demonstrate best practices
- 60 cooperatives , 7 WUAs and 10,661 farmers were linked with different buyers and a total of 376,291.2 MT of vegetables were sourced(Traded).
- 149.735.92 ha was cultivated under HHI and nearly 2,383,404.2 MT of veg. produced (2006-2008 EC)
- SHF were linked to input providers to buy 461 qt. veg. seeds
- As of Dec 2014, 216,849 unique and 895487 total callers received extension support through the 8028 toll free IVR service

MAIN CHALLENGES

- WWGs less commitment to own and lead the project
- Inadequate support and follow up from zonal and regional working groups to pilot woredas
- Failure to collect demand on manual pumps and link with manufacturers
- Brokers influence on market linkage

KEY LEARNINGS

- Interventions are required on all bottlenecks across the crop & Irrigation value chain
- House hold irrigation is feasible when high value crops are produced
- Trainings given on irrigation agronomy, irrigation water management and post harvest handling for DA's and woreda experts helps reach lot's of small holder famers

Figure 85: ATA-HHI Value Chain program profile

PROJECT OBJECTIVES

- **Main focus:**
  - Identification and filed testing of appropriate SSI technologies, data assembly and modelling
  - Assesses the impacts of access to SSI on women and men, labour, and nutrition
  - Provide capacity development through various trainings and workshops for stakeholders
- **Duration**: Nov 2013- Jan 2018
- **Geography:** Amhara, Oromia, SNNP, Tigray
- **Beneficiaries**: TBD
- **Donor**: USAID- Feed the future initiative
- **Fund**: USD 2 M
- **Implementing Partners:** IWMI, Borlaug Institute for International Agriculture/ Texas A&M University, IFPRI, ILRI, Bahirdar University, Arbaminch University, Send A Cow and Sustainable Environment and Development Action (SEDA)

ACHIEVEMENTS

- Farmers have taken micro-credit loans for various water lifting technologies through the **revolving fund** set up in this project
- Crop coefficient for irrigated fodder have been estimated
- Capacity building training conducted for PhD and MSc
- Capacity development program implemented on irrigation scheduling, agronomic practices for irrigated crop production and on integrated decision support system (IDSS)
- Credit and saving training workshops have been completed

MAIN CHALLENGES

- At initial stage of the project the main challenge was lack of coordination among implementing partners
- The technologies promoted through this project were not adopted by some farmers
- Acquisition of input data for IDSS was a major challenge

KEY LEARNINGS

- Irrigation technology adoption should fit the context of the farm, the biophysical environment and the market
- Market and environmental boundaries need to be considered in up-scaling irrigation
- Capacity development of institutions at all levels critical to effectively promote the adoption of SSI

Source: ILSSI website (http://ilssi.tamu.edu/), Interview with IWMI representatives, IWMI projects brief (2015)

PROJECT OBJECTIVES

- **Main focus:**
  - Supporting HVC diversification through introduction of SSI technologies
  - Understanding major drivers of key sustainable intensification technologies
  - Introduction and up-scaling of targeted water management technologies
- **Duration**: Jan 2015- Sep 2016
- **Geography:** Amhara, Oromia, SNNP, Tigray and In Ghana and Tanzania
- **Beneficiaries**: TBD
- **Donor**: USAID- Feed the future initiative
- **Fund**: 250K USD (for irrigation component)
- **Implementing Partners**: ILRI, IITA, ICRAF, Practica Foundation, CIMMYT, MoANRD, EIAR, Universities, Oromia Microfinance Association (OMFI)

ACHIEVEMENTS

- Providing farmers with detailed irrigation scheduling advice increased fodder productivity by 2 t per ha
- Farmers welcomed the saving literacy training and improved their saving skills to pay back the technology
- The irrigation of fodder and young avocado seedlings were expanded with vegetables in the second year using the same water lifting technologies
- IWMI is conducting the credit evaluation together with OMFI after both parties signed the memorandum of understanding

MAIN CHALLENGES

KEY LEARNINGS

PROJECT OBJECTIVES

- **Main focus:**
  - Capacity development of post-graduate students and regional implementers on farmer training, irrigation agronomy and WUAs
  - Providing technical support to regional implementers and farmers, sharing IWMI's research with LIVES knowledge centres in target districts
  - Undertaking research on the economic, environmental and social sustainability of various irrigation technologies
- **Duration**: Apr 2013- Dec 2018
- **Geography:** Amhara, Oromia, SNNP, Tigray
- **Beneficiaries:** TBD
- **Donor**: DFATD of Canada
- **Fund**: ~ USD 15 M
- **Implementing Partners:** ILRI, IWMI, MoANRD, RBoANRD, regional livestock health and development agencies

ACHIEVEMENTS

- Training was provided to input/service providers on improved forage development and management practices
- Business were provided with coaching services on topics such as proper silage making, proper harvesting, sorting etc…
- A farmer based seedling (grafted and non-grafted) production and supply system has been established in all the regions
- Irrigation Water Users Associations (IWUA's) manual and guideline was developed

MAIN CHALLENGES

- Shortage of improved forage seeds and planting materials is a limiting factor for fodder development
- Lack planting materials for improved fruit varieties and cultivars

KEY LEARNINGS

- Efforts to promote irrigation should go hand in hand with solving crop value chain bottlenecks from input provision up to market linkages
- Providing capacity building programs to small business such as basic training and coaching services will have huge impact on the value chain development

Figure 86: IWMI program profiles (multiple programs)

REFERENCES

1. Agricultural and Rural Development Policies, MoA, 2003
2. Agricultural Credit in India – Innovations in Design and Delivery of Products and Service; R. Thejeswinia, V.R. Kiresura , N.S. Preetia , M.Y. Teggia and G.A. Trilokanathab, Agricultural Economics Research Review, 2013
3. Agricultural Use of Ground Water in Ethiopia: Assessment of Potential and Analysis of Economics, Policies, Constraints and Opportunities, Semu Moges, IWMI, 2012
4. Agricultural water management and poverty in Ethiopia, Fitsum Hagos et. al. IWMI, 2012
5. Bangladesh: Irrigation Management Improvement Project: Country Gender Assessment Bangladesh, ADB, July 2016
6. Climate Green Resilient Economy Strategy, FDRE, 2011
7. Directives No. FXD/45/2016, Transparency in Foreign Currency Allocation and FOREX Management, National Bank of Ethiopia
8. Ethiopia: Irrigation market brief, FAO Investment Center, 2015
9. Ethiopia: Strategic Framework for Managed Groundwater Development, MoWIE and GW-MATE, 2011
10. Ethiopia: Water Security and Drought, M MacDonald / British Geological survey, 2001
11. Ethiopia's Agriculture Sector Policy and Investment Framework, MoA, 2010
12. Ethiopian Water Resources Management Policy, MoWIE, 2001
13. Ethiopian Water Resources Management Proclamation No. 197/2000, Council of Ministers, FDRE,
14. Ethiopian Water Resources Management Regulations No. 115/2005, Council of Ministers, FDRE
15. Ethiopian Water Sector Strategy, 2001, MoWIE, 2001
16. First Growth and Transformation Plan (GTP I), MoFED, 2010
17. Four case studies on credit guarantee funds for agriculture, FAO, 2013
18. Gender and Irrigation in India; Barbara van Koppen, Rashmi K. Nagar, Shilpa Vasavada, Aga Khan Rural Support Programme and IWMI, 2001
19. Gender in Lift Irrigation Schemes in East Gujarat, India, Harmeet Sainin and Barbara van Koppen, N. M. Sadguru Water and Development Foundation, Gujarat, India and IWMI, 2001
20. Grameen bank tube well irrigation program: a case of management transfer in Bangladesh, M. A. Hakim and D. E. Parker, 1994

21. Impact Assessment Of The Asi Sunhara India Project – Cultural practices LLC

22. Irrigation Policies, Strategies and Institutional Support Conditions in Ethiopia, from MoWR/ MoARD/USAID/IWMI Workshop (date unknown), MoWIE

23. Irrigation potential in Ethiopia, IWMI, 2010

24. Irrigation technology transfer in support of food security, Economics of irrigation; FAO Land and Water Division, 1997

25. National Extension Manual – SSID / Irrigation, 2015, MoA

26. National Extension Manual – Various Crops, 2015, MoA

27. Overview of mainstreaming gender inclusion into water resources management in Egypt, National Water Research Center of Egypt, 2010

28. Participatory Irrigation management Experiences in Rajasthan, Dr. C.M. Tejawa: National Convention of Presidents of Water User Associations organized by MoWR RD and GR., India NPIM at Delhi, 2004

29. Plan for Accelerated and Sustained Development to End Poverty, MoFED, 2005

30. Pre-Shipment Product Conformity Assessment Program for Irrigation Pumps and Accessory Products in Ethiopia; Guidelines for imports for the trade, SGS

31. Realizing the Potential of HHI in Ethiopia, MoA, ATA, 2012

32. Rural Financial Services in Kenya: What is Working and Why? And Why?, Betty Kibaara, Tegemeo Institute of Agricultural Policy and Development, Egerton University, 2006

33. Second Growth and Transformation Plan (GTP II), MoFED, 2015

34. Shifting towards market-oriented irrigated crops development as an approach to improve the income of farmers: Evidence from northern Ethiopia, IMPS (ILRI), 2011

35. Situation Analysis of Agricultural Water Management Solutions in Ethiopia: A Synthesis Report Beyene Tadesse, 2010

36. Small scale irrigation capacity building strategy for Ethiopia, MoA NRM Directorate, 2011

37. Small scale irrigation situation analysis and capacity needs assessment, MoA NRM Directorate, 2011

38. Small Scale Irrigation Water Management Guideline, 2014, MoA SSID

39. The Status and Challenges of Irrigation and Drainage Development and Research in Ethiopia, MoWIE, 2013

40. Trend Assessment and Technical Estimation of Investment cost of irrigation in Ethiopia, MoA, 2012

41. Water Lifting Irrigation Technology Adoption in Ethiopia: Challenges and Opportunities, IWMI, 2012

42. Water Resources and Irrigation Development in Ethiopia, IWMI. 2007

43. Water Resources Development in India: Critical Issues and Strategic Options; Indian Environmental portal (http://www.indiaenvironmentportal.org.in/)

44. Water Smart Agriculture in East Africa, 2015, IWMI

45. **የተሳትፎአዊ ጥቃቅን የመስኖ ልማት ሥራዎች የአሠራርና አጠቃቀም የቴክኒክ መመሪያ** / Technical Manual