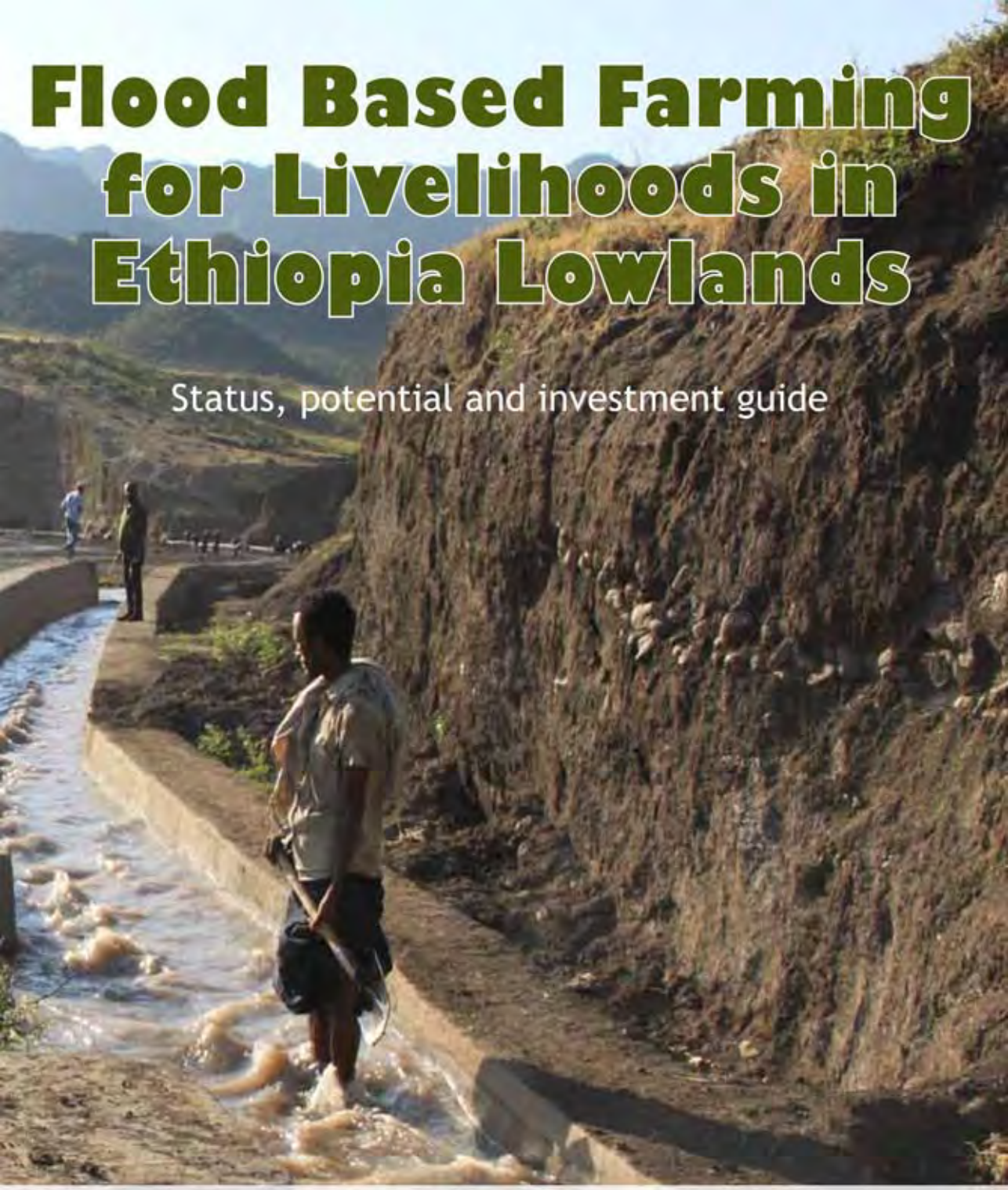
Flood Based Farming for Livelihoods in Ethiopia Lowlands

Status, potential and investment guide



Ministry of Water and Energy

Spate Irrigation Network

Spate Irrigation Network Ethiopia

Flood-Based Farming for Livelihoods in Ethiopia Lowlands:

Status, Potential and Investment Guide

Authors and contributors

The main authors of this book are:
Abraham Mehari Haile, Senior lecturer and researcher in Integrated Land and Water Development, UNESCO-IHE and Co-Chair International Spate Irrigation Network (SpN);
Abebe Demissie, Coordinator Ethiopia SpN;
Tesfa-alem G. Embaye Coordinator SpN, Tigray Region, Mekele, Ethiopia;
Abiti Getaneh, Director of Research and Development, Ministry of Water and Energy.

Significant contributions from:
Charlotte De Fraiture, Professor of Land and Water Development, UNESCO-IHE;
Kbrom Ambachew Gebrehiwot and Birhanu Kindishih Hishe, assistant lecturers in irrigation design and management, Haramaya University, Ethiopia;
Frank van Steenbergen, Co-Chair, SpN and Director MetaMeta;
Nadine Guenther, Planning Officer, project advisor, GIZ, Germany;
Dr. Johannes Schoeneberger, Program Manager, Sustainable Land Management (SLM) Program, GIZ, Ethiopia;
Dr. Elisabeth van den Akker, Senior Planning officer, agricultural production and resource use expert, GIZ, Germany;
Sophie Tentrop, Sustainable Land Management (SLM) Program, GIZ, Ethiopia.

Cover photo: Ms. Nadine Guenther, Planning Officer and Project Advisor, GIZ, Germany.

April, 2013

Addis Ababa, Ethiopia

isbn: 978-94-90792-02-2
Mehari Haile, A., Demissie, A., Embaye, T. G., Getaneh, A., 2013. Flood-Based Farming for Livelihoods in Ethiopia Lowlands. Status, Potential and Investment Guide

Endorsement

The study entitled "Flood-based Farming for Livelihoods in Ethiopia Lowlands" specify the status, potential and investment guide and presents the appropriate strategies and programs that will assist in changing the area and improve the livelihoods of pastoralists and agro-pastoralists of Ethiopia. The first part of the document provides a conceptual framework that allows a review of flood water harvesting, current experience and indigenous knowledge under different farming systems of the respective regions and the alternative development options.

As Ethiopia continues on its development trajectory, to reach middle income status in 2025, its key economic assets will be affected by climate change (CRGE 2011). There is a clear need for new resource management practices that can secure a sustainable, climate-compatible development endeavors. This is where the "Flood-based farming forlivelihoods in Ethiopia lowlands: status, potential and investment guide" comes in as one of the major strategies for alleviating water shortage and realizing food security.

The strategy provides direction for development partners and it indicates key recommendations as the basis for more detailed action plans by different stakeholder groups. The recommendations are contextualized in terms of current practices and policies, as well as understanding of the pastoral and agro-pastoral livelihoods and their challenges. The knowledge gaps and capacity building needs of the relevant institutions have been identified and accordingly suitable interventions are suggested for implementing development projects that aim at more productive use of floods and bettering the lives of the local communities.

At the same time, the Ministry appreciates the initiatives taken by the Ethiopian Spate Irrigation Network, Ministry of Water and Energy (Research and Development Directorate), GIZ, UNESCO-IHE Institute for Water Education, International Spate Irrigation Network and MetaMeta. At the same time the Ministry invites all stakeholders and responsible organization to use this document and support this endeavors.

Alemayehu Tegenu
MINISTER OF WATER AND ENERGY
Federal Democratic Republic of Ethiopia

Flood-based farming for livelihoods in Ethiopia lowlands:

Status, potential and investment guide

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Acknowledgements

First and foremost, we owe sincere and earnest thankfulness to His Excellency, Mr. Alemayehu Tegenu, Minister of Water and Energy for his full support and wonderfully written endorsement letter. His continuous personal engagement and that of his staff are invaluable for translating the findings in this book into tangible interventions on the ground for bettering the lives of the pastoral and agro-pastoral communities in Ethiopia lowlands.

We offer heartfelt and deep gratitude to the overall project supervisor, Dr. Elisabeth van den Akker, Senior Planning Officer and Agricultural Production and Resource Use expert at the Deutsche Gesellschaft fuer Technische Zusammenarbeit (GIZ), Germany. You have supported us throughout with patience and knowledge whilst allowing us the room to work in our own way. One simply could not wish for a better or friendlier supervisor.

Nadine Guenther, Planning Officer and Project advisor, GIZ, Germany; you have been a wonderful supervisor and research partner. We consider it an honour to have known you and have worked with you. Your sharp and thoughtful questions, relentless effort to go to the bottom of the issues had tremendously enriched the content of this book. We owe you the deepest gratitude.

The project is realized with the generous financial support of the German Development Cooperation through the Sector Project Rural Development of GIZ on behalf of the Federal Ministry for Economic Cooperation and Development, Germany. The International Fund for Agricultural Development (IFAD) has also provided substantial supplementary funding. We are truly indebted and thankful to both development organizations. Through this project, an in depth study of water and food security related issues within drought prone pastoral areas in the lowlands, the proposition of adaptation options and their future possible realization through development projects are brought together.

Dr. Johannes Schoeneberger, Coordinator Sustainable Land Management (SLM) Programme GIZ, Ethiopia. You have an extremely busy schedule; but you always welcomed us with a smile. The meetings we had may have been brief, but they were effective and offered us a great deal of guidance, a sense of focus and direction. Your tremendous personal effort and that of your whole staff was crucial for the success of the National Workshop that gave us ample opportunities to enrich and calibrate our field research findings. Further, the GIZ Tigray SLM office has also been of great help in organizing the field trip to Aba'ala spate irrigation scheme. We sincerely thank the whole GIZ community in Ethiopia.

To the many that set aside their busy schedules, travelled hundreds of kilometres and made it to the National Workshop; we say thank you for sharing your knowledge and experiences.

With great pleasure we would like to express our appreciation to Professor Charlotte de Fraiture, Head of the Chair Group Land and Water Development at UNESCO-IHE and Frank van Steenbergen, Director MetaMeta Research. You both have the attitude and substance of a genius. Without your guidance in the field and persistent help, this project and finalization of this book would have not been possible.

We would like to gratefully acknowledge the enthusiastic and constant help of Mr. Haile Asefha, Administrator of the Southern Zone, Tigray Region in organizing farmers, facilitating transportation and sharing his rich ideas with regard to the opportunities and challenges for developing and managing flood-based farming systems in arid lowlands of Ethiopia.

We take immense pleasure in thanking our young professionals, Mr. Kbrom Ambachew Gebrehiwot and Mr. Birhanu Kindishih Hishe. They have been a source of energy and innovation; they have worked tirelessly to ensure proper documentation of even the very minor details discussed during the field research.

Mr. Gaetano Casale, Liaison Office Manager; Mrs. Joyce Membre, Financial Officer; Mrs. Annika van Marken, Project Controller. You have shown tremendous flexibility, cut-short administrative bureaucracies and remained actively engaged throughout the project duration. Thank you very much for the smooth and exemplary handling of the contractual and financial matters.

Pilar Lopez Zamorano and Linda Navis, you have been exceptional. Thank you very much for your patience and countless hours of work that led to the artful design of the book.

Special thanks to Mr. Olaf Verheijen, Michael McClain and Professor Bart Schultz for their useful comments and valuable changes and modifications to the earlier version of this book.

We would also like to thank Mr. Getachew Mulugeta Manager Soramba Hotel, Addis Ababa, Ethiopia and the whole hotel staff for making us feel at home and providing us with excellent services consistently throughout our stay.

Keeping the best to the last - to the many pastoralists and agro-pastoralists, government officials, local and international NGOs, university staff - you have warmly welcomed us in your farms, offices, houses; shared with us your knowledge and experiences without any reservation; helped us find our way when we got lost in the field - we cannot find words to express our genuine gratitude, we dedicate this book with love and affection.

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List of abbreviations

ADA	Afar Development Association
AfDB	Africa Development Bank
AGP	Agricultural Growth Program
CSA	Central Statistical Agency
Co-SAERT	Commission for Sustainable Agriculture and Environmental Rehabilitation in Tigray
DA	Development Agent
EECMY-SWS	Ethiopian Evangelical Church Mekane Yesus South Western Synod
FAO	Food and Agricultural Organization
FTC	Farmers Training Centre
GIS	Geographical Information System
GIZ	Deutsche Gesellschaft fuer Internationale Zusammenarbeit
IFAD	International Fund for Agricultural Development
IPAS	Institute for Pastoral and Agro-pastoral Studies
IRBM	Integrated River Basin Management
JICA	Japan International Cooperation Agency
NGOs	Non Governmental Organizations
PASIDP	Participatory Small Scale Irrigation Development Program
REST	Relief Society of Tigray
RVADP	Raya Valley Agricultural Development Project
SDCU	Selale Dairy Cooperative Union
SpN	Spate Irrigation Network
SLM	Sustainable Land Management
SNNP	Southern Nations, Nationalities and Peoples
SNNPR	Southern Nations, Nationalities and Peoples Region
SORDU	Southern Rangeland Development Unit
SSIP	Small Scale Irrigation Program
TVET	Technical Vocational and Educational training
VSF Germany	Veterinary Sans Frontiers Germany
WUA	Water Users' Association

1 Executive Summary

This book is mainly based on the extensive field research conducted in a number of flood-based farming systems in the arid lowlands of Ethiopia. The field research was carried-out in the last quarter of 2012 by a multidisciplinary and multinational team of young and senior water professionals. The team members are affiliated to the Ministry of Water and Energy, Haramaya University and the Spate Irrigation Network in Ethiopia; the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany; UNESCO-IHE Institute for Water Education and MetaMeta, the Netherlands. Annex 1 has the details on the expertise and contact details of the field research team.

The field research in Ethiopia was sponsored by German Development Cooperation through the Sector Project Rural Development of GIZ on behalf of the Federal Ministry for Economic Cooperation and Development, Germany. Substantial supplementary funding was provided by the International Fund for Agricultural Development (IFAD) through the Spate Irrigation Project for Rural Economic Growth and Poverty Alleviation. This project was implemented in four countries (Ethiopia, Sudan, Pakistan and Yemen) by UNESCO-IHE in collaboration with MetaMeta and local partners. Annex 2 provides details on the field trip sites and locations.

The field research had six central objectives:

- Make an overview of the status and potential of flood-based farming systems.
- Understand the agro-pastoral and pastoral livelihoods and their challenges.
- Identify the bright spots where properly designed and managed flood-based irrigation systems are having tangible positive impacts on the livelihood of the respective rural communities.
- Investigate the main reasons behind partial successes or complete failures of some flood-based irrigation systems.
- Identify the knowledge gaps and capacity building needs of the relevant institutions responsible for implementing development programmes.
- Recommend comprehensive development interventions that include adaptive research and capacity building programmes.

The arid lowlands of Ethiopia are currently inhabited by roughly 12 million people. As many tropical diseases are being brought under control, the population is expected to grow significantly. The arid lowlands are characterized by erratic and insufficient (<350 mm) rainfall and very limited perennial water resources. The lowlands are arguably the most vulnerable to food insecurity. For instance, the drought in 2011 had severe livelihood consequences: 6 million people became dependent on food aid; pastoralists were driven to the brink of long lasting poverty as they sold a large proportion of their livestock at marginal prices. On a positive note, however, the arid lowlands are endowed with abundant land resources and numerous seasonal rivers and, if these resources would be utilized effectively through the development of sustainable flood-based farming systems, they have the potential to contribute to lasting prosperity in these regions.

Flood-based farming systems (spate irrigation, flood recession and inundation, flood-spreading weirs) account for over 30 million hectares across the world. They represent a unique option for the management of scarce water resources in support of agricultural production and livelihoods of marginalized populations in many arid regions. Further, by their nature - using flood water rather than perennial flows - they are quintessential adaptations to climate variability.

Flood-based irrigation systems are different from conventional irrigation systems in many ways. In particular, standard design approaches cannot appropriately take into account the level of uncertainty related to floods, the hydraulic challenge of guiding flood flows, the heavy sediment loads, the exceptional nature of the water rights, or the management and maintenance models that are specific to flood-based irrigation.

In the course of the field research, which covered five regions - Afar, Oromia, Amhara, Tigray and the Southern Nations, Nationalities and Peoples (SNNP)- over 30 seasonal rivers were observed, extensive discussions were held in 13 flood-based irrigation systems with relevant government officials at regional, woreda (district) and kebele (municipality) level, farmer groups and staff of Semera, Arba-Minch and Haramaya Universities. Annex 2 provides details on the field trip sites and locations and Annex 3 has the contact details of all consulted stakeholders.

A national workshop was conducted in December 2012 in Addis Ababa, Ethiopia, and the field research findings were discussed with all the stakeholders contacted as well as high ranking officials from the Ministry of Water and Energy, Ministry of Agriculture, representatives of national and international development organizations, and renowned international experts.

On the bases of the field research and the national workshop, the major findings and recommendations are summarized below.

1.1 Current status of flood-based farming and rural livelihoods

The large majority of the inhabitants in Afar region are pastoralists. They mainly depend for livelihood on livestock rearing, particularly camel, sheep and goats, whereas the Borona pastoralists in Oromia focus on cattle production. The vast majority of SNNP settlers, with the exception of Konso ethnic groups, are also cattle herders. In Tigray and Amhara the main stay of livelihood is agriculture with some integration of livestock production as is the case in the rural areas of Oromia.

There is an acute shortage of water professionals to design and supervise the development of modern flood-based farming systems at all administrative levels, particularly at woreda and kebele level. Several modernized systems, such as the Hara spate irrigation system in Tigray, have failed due to poor design. But some well-designed systems have also failed due to incompetent

construction companies. A case in point is the headwork in Golina river, Amhara Region, which was washed away with medium floods.

In many of the flood-based systems, particularly in the Afar, Amhara and Oromia Regions, the majority of the seasonal rivers are at best under utilized due mainly to inappropriate design. Most of the canals are designed on the principles of perennial irrigation and are limited to diverting the base flow. They are small in capacity (about 1 m wide), gentle in slope (0.05 to 0.1 %). They cannot handle the large flows (> 25 m^3/s) and high sediment concentration (> 4 %) of the seasonal rivers.

There are, however, some bright spots where better utilization of flood water is in place, including:

- Guguf spate irrigation system in Tigray region where wider main canals (about 5 to 10 m) and flexible improved diversion structures using gabions and the principle of flood spreading weirs are practiced. The water sharing rules, unlike in many spate irrigation systems in Ethiopia and other countries, are lottery based and do not provide absolute priority right to the upstream users, thereby safeguarding access of spate flow for downstream users. The sorghum crop yield is the highest in the country reaching up to 7 ton/ha.
- The Jarso community, which depends for its livelihood on the Konso spate irrigation system in the SNNP region, has never experienced drought and hunger. This hardworking community make use of proper land preparation practices that include pre-irrigation cultivation, land levelling and field bund (0.5 to 0.7 m height) construction. With just two irrigation turns, the farmers harvest a minimum of 4.2 ton/ha of maize crop.
- Awadi Jitu spate irrigation system in Oromia has a well organized community of water users with a smart land distribution arrangement that guarantees that each member of the community gets access to spate flow even during the driest periods. The land distribution arrangement has three pillars:
    - During a flood season with less than normal rainfall, each household is allocated a plot of land of 1/8 ha, whereas 1/4 ha is allocated to each household in a season with (more than) normal rainfall.
    - A land owner should share his/her irrigated fields in return for an equal piece of rain fed land.
    - If a landowner refuses to share a part of his/her land within the command area of the spate irrigation system, the Water Users' Association (WUA) in charge of land and water management will deprive him or her of any spate flow and he or she has to fully rely on rain fed agriculture, which is highly unreliable.
- Aba'ala Scheme, Afar region: The farmers have gained a lot of experience with building a double gabion diversion and distribution structure (2 m wide) with 2 - 3 m deep foundation that withstands spate discharge as large as 500 m^3/s and last for over 10 years with limited maintenance. They also have in place a water distribution system equipped with several intakes at different locations on the seasonal river designed to gradually dissipate the energy of the spate flow, minimize damage to structures and thereby increase the probability that the up-, mid- and downstream fields receive irrigation.

These bright spots are managed by farmers' organizations with limited support from government and non-government institutions. The wisdom with regard to land and water sharing in these bright spots is fascinating. It is guided by three simple, yet telling principles:

- Absolute "fairness" is near-impossible to achieve; sharing of resources is usually based on acceptance of "agreed degree of unfairness".
- Do not adamantly stick to "absolute land and water use right"; relinquishing these rights sometimes pays more dividends and carries less risk.
- Defining ourselves as "downstream" and "upstream" users is half of the problem - accepting each other as "neighbours" is a good half of the solution.

There are, nonetheless, several opportunities for further improvement in these bright spots. Some of the shared limitations with the flood-based systems designed and managed with the mind-set of conventional principles include the following:

- Flood water is mainly utilized for crop production; there is hardly any rangeland development, nor the use of flood water for recharging groundwater and filling reservoirs for domestic and livestock use.
- This lack of the concept of multipurpose use of flood water has particularly made the livelihood of pastoralists challenging. They have to travel for 15 to 20 km in search of either fodder or water or sometimes both. This is exhaustive for many family members, especially the young and elderly, but also to the animals themselves.
- In many woredas in the Afar region, a family could own up to 200 goats, 40 camels and more than 50 cattle. A household with less than 50 goats is considered to be poor. The lack of basic veterinary services, coupled with shortage of fodder and water, has led to frequent livestock diseases, significant reduction in milk and milk products and consequently, the pastoralists are being subject to recurrent food insecurity.

Whereas there are huge challenges for harnessing the abundant land and water resources in the arid lowlands, the foundation is there for a successful development intervention:

- There is a strong political will and commitment by the government to support any well designed development intervention in the area.
- There is a clear guiding policy: transforming the pastoralists into agro-pastoralists - maintaining a critical mass of livestock that is in-par with the carrying capacity of the grazing land and available veterinary services as a major source of livelihood along with productive agricultural sector.
- There is a supportive policy is in place: flood-based farming system is recognized as one of the major routes to bettering the lives of pastoralists and agro-pastoralists.
- There are strategic plans for development even at woreda level where development priorities are identified.
- The woreda administration heads and staff are knowledgeable about their needs, limitations and strengths and are motivated and committed to making a difference in their region. To illustrate with an example, Mr. Ibrahim Mohamed Ali, Head of the Pastoral and Agro-pastoral Rural Development Office at Awash Fantale Woreda, Afar Region made the following concluding remarks during the interview with the field visit team:
    - 'One cannot shoot without a gun.' He used this analogy to emphasize that isolated capacity building activities without continuous and long-term engagement and complementary investment programmes may not lead to a tangible impact in improving the lives of pastoral and agropastoral communities.

- 'I gave you plenty of information without reservation, because the woreda is running against time to eradicate poverty and I wanted to make sure that you also are motivated to run with us and support the woreda in its noble objective of lifting many out of poverty.'

- Development intervention has a good acceptance by farmers. Recognizing the enormous labour requirement while diverting floods with traditional earthen and brushwood means, the farmers appreciate the use of improved and modern structures, provided that these are built appropriately and in line with their rules and regulations. The farmers frequently confronted the field research team to suggest any measures that can improve their flood diversion and distribution systems.
- There are model farmers who can pioneer new technologies and systems. Three such model farmers were met during the field research: Gabir Siyum, Shekhna and Shukri Kedir from Guguf, Aba'ala and Awadi spate irrigation systems in Tigray, Afar and Oromia regions respectively.
- Haramaya University has some know-how about agro-pastoral and pastoral studies in the lowlands acquired through research conducted as part of the activities of the Institute for Pastoral and Agro-pastoral Studies (IPAS). It is interested and motivated to transform the IPAS into a national training and research centre for pastoral and agro-pastoral studies.
- Haramaya University and UNESCO-IHE Institute for Water Education have recently developed a Double Degree MSc Programme in Agricultural Water Management in Arid and Semi Arid Climates. The research works of this programme are mainly tailored at optimizing the use of (flood) water and land resources in arid areas.
- Arba-Minch University has mainstreamed flood-based farming irrigation within the module on Integrated River Basin Management (IRBM). The staff is motivated to engage in research programmes that lead to scientifically sound and practically viable outputs.
- An Ethiopian Spate Irrigation Network has been established in 2010. It has four core staff with good knowledge about flood-based (spate) irrigation. The network was fully involved and instrumental in formulating and guiding this field research.

1.2 Next steps: recommended development interventions

The recommended development interventions are as follows:

- Development and implementation of integrated packages for the development of flood-based agriculture in high potential areas of the lowlands in Afar, Tigray, Amhara, Oromia and SNNP regions, including:
  - Water balance studies for the entire watershed in order to assess minimum and maximum (base) flows, frequency and intensity of floods, actual and projected use for irrigation, domestic, industrial and environmental, impact of flood-based irrigation development on downstream users, condition of (upper) catchment, soil erosion and sediment load.
  - Formulation and implementation of effective measures to mitigate sedimentation problems due to soil erosion in catchment areas of (sub-)watersheds.

- Design and construction of appropriate, low-cost diversion/off-take structures and distribution systems for flood-based irrigation.
- Improved command area development and management including land levelling, pre- and post-irrigation tillage and construction of bunds.
- Agronomic, land fertility and marketing improvements.
- Establishment of appropriate institutional framework for the sustainable development and management of perennial and flood-based irrigation schemes within one watershed at regional, woreda, kebele/scheme levels based on a comprehensive assessment of the existing institutional framework (strengths and weaknesses).
- Establishment of appropriate institutional framework for the delivery of essential services to farmers and agro-pastoralists required for the sustainable development of profitable (flood-based) agriculture, including reliable supply of farm inputs (seeds, fertiliser, agro-chemicals), credit, extension and veterinary services, storage and marketing, based on a comprehensive assessment of existing institutional framework.

◦ Development and implementation of supportive packages, including:
  - Thematic packages (i.e. mechanization, agronomic practices, prosopis management, empowerment of women and elderly, particularly in pastoral communities).
  - Capacity building (i.e. design, construction supervision, command area development and management, operation and maintenance, agronomy, agro-forestry, rangeland management, establishment and strengthening of water users' association/cooperatives).
  - Adaptive research (i.e. impact assessment, cost-benefit analysis, comparative analysis of design assumptions, assessment of O&M practices, analysis of factors -institutional and technical- for successful development and management of flood-based agriculture.

1.3 Further reading

The main report provides further details on the key issues discussed in this executive summary. It is grouped into five chapters each focusing on Afar, Tigray, Oromia, Amhara and the SNNP regions.

Each chapter is structured as follows:

◦ Brief description of the main features of the region.

◦ Major findings of the specific field research sites: livelihood systems and challenges, key development and management problems followed by specific set of suggested solutions.

◦ Opportunities for development: priority investment, capacity building and research programmes at a regional level.

Table 1 Short overview of proposed investment programmes per region

Topic	Afar	Tigray	Anhara	Oromia	SNNP
Prosopis management	XX				
Empowerment of women and elderly	XX	X	X	XX	XX
Rangeland development	XX	X	X	XX	XX
Rain water harvesting	X	X	X	X	X
Farmer training centres/ demonstrations	X	X	X	X	X
Establishing of WUAs/ cooperatives	XX	X	X	X	XX
Strengthening of WUAs/ cooperatives	X	X	X	X	X
Livestock	XX	X	X	XX	XX
Development of flood-based farming systems for multiple benefit streams: crop production, rangeland, forage and groundwater recharge	X	X	X	X	X

2 Afar Region

The Afar region (figure 1) has a total area of 100,860 km² located in north-eastern part of Ethiopia sharing international border with Eritrea and Djibouti (Hundie, 2006). The Afars are one of the largest pastoral groups in the Horn of Africa, inhabiting the rangelands of north-eastern Ethiopia,

Figure 1: Afar Regional State: location and the boundaries of its five zones (Ministry of Water and Energy, 2012)

south-eastern Eritrea and western Djibouti. Based on the Central Statistics Agency, CSA (2008) the Afar Region in Ethiopia has a total population of about 1.5 million (2 % of the total population in the country). Of this, 78 % follows a pastoral, transhuman lifestyle keeping multispecies, multipurpose livestock to provide sufficient milk and meat for consumption, social exchange and occasional sale (Getachew, 2003 and Reda 2011). The rest are agro-pastoralists practicing both livestock keeping and cultivation. Although the government of Ethiopia has made tremendous efforts to improve the livelihoods of the Afar, they are still the most vulnerable segments of the population who increasingly struggle to keep with the dwindling rangeland as well as accessible water resources for both domestic and livestock.
During the field research, discussions were held with regional officials and experts representing the Pastoral and Agro-Pastoral Office and Afar Development Association. In addition, the field research team had extensive discussion with farmers in Aba'ala, which is the largest (10,000 ha) flood-based irrigation system, and Kebena with flood-based irrigation systems along a very wide (about 800 m) seasonal river, which has been and is still continuously eroding its bank and encroaching the agricultural areas. Further, detailed discussion was conducted with the head of the Awash Pastoral and Agropastoral Rural Development Office and staff. The main findings of each specific visit and discussions are detailed in the following sections. The investment, capacity building and research programme for the whole region are summarized in the last section "opportunities for development".

2.1 Regional level discussion: Afar Region Pastoral Agriculture Bureau

Discussions were made with Tefferi Mekonnen, Ahmed Nur Salim and other officials and experts in the Afar Region Pastoral Agriculture Bureau (ARPAB) at the regional city, Semera.

The Afar region has a number of perennial rivers, numerous seasonal rivers and lakes within the Awash and Denakil drainage basins. Most of Afar region is classified as lowland zone with an altitude ranging from 114 m below sea level to 1,300 m above sea level and an average temperature exceeding 27.5 °C for most of the year. The region is characterized by low rainfall with 53 % of the total area (zones one and two) receiving less than 300 mm per year (Ministry of Water and Energy, 2012).

In the discussions with the regional experts, the following potential development areas were identified:

- Awra, Ewa and Tera depression (zone/province four) - for groundwater development.
- Dalfagi/Borkena (zone five) - potential for rangeland and irrigation.
- Aba'ala, Kuneba, Berhale and Dalol (zone two) - for flood-based farming.
- Chifra (zone one) - for rangeland development.

The discussions also resulted in the following development priorities:

- Control and management of *Prosopis juliflora* (Mesquite tree) that has rendered 1.5 million ha out of productive use.
- Developing a guide for design and management of the large number of seasonal rivers for multiple use: rangeland development, dual purpose (food and fodder) crops, groundwater recharge.
- Capacity building of technical staff in GIS, remote sensing and other tools for proper mapping of land and water resources.

2.2 The Afar Development Association (ADA)

The Afar Development Association (ADA) was established in 2011. Like development associations in other regions of the country, ADA is mobilizing and registering members (the Afar community, interested individuals and supporting organizations). The association is operating with seed money of 4 million Birr from the Afar regional government. The ultimate objective is that the community contribution will be the main source for the association and its activities in the whole Afar region. Eyob Megersa, project coordinator of ADA, explained that the main contribution of the association is that it will be the gateway to development programs in remote locations.

At this initial state the ADA needs support as follows:

- Capacity building that can strengthen the association effort on public relation, project formulation, leadership, community mobilization, fund raising, coordinating different development programs.
- Technical trainings for the development committees at woreda level.
- Resources (vehicles, office furniture etc.).

2.3 Awash Fantale woreda: pastoral and agro-pastoral section

Discussion was held with:

- Mr. Ibrahim Mohamed Ali, Head, Pastoral and Agro-pastoral Rural Development Office.
- Alo Mohammed, Veterinarian, Pastoral and Agro-pastoral Rural Development Office.

Both interviewee were very forthcoming and answered all questions with openness and in an organized manner.

The main outputs of the discussion are as follows:

Figure 2: Interview with head of Woreda Agro-Pastoral and Pastoral Office

General Information

Awash Fantale Woreda is located 230 km east of Addis Ababa, the capital of Ethiopia. The woreda has five kebeles, four agro-pastoralists and one pure pastoralist. The woreda has vast area suitable for agriculture and grazing. It is endowed with the Awash river and two seasonal rivers, Bulga and Kebena, which ultimately join the Awash river. The government has built a dam on Bulga river with a capacity of irrigating about 20,000 ha sugarcane plantation of which only 2,000 ha has already been cultivated. The development of the irrigation scheme is still on-going. Furthermore, the government has developed about 2,500 ha for irrigation in the four agro-pastoralist kebeles:

- Doho kebele: 750 ha.
- Boleta: 600 ha.
- Kebena: 650 ha.
- Sabure: 500 ha.

Each household is allocated one ha and the common crops are onion and beans. Only 300 ha out of the 2,500 ha have actually been irrigated.

Livelihoods system and major issues to be addressed

The livelihoods of the population living in the woreda are mainly based on livestock, whereas crop production plays a supporting role. There are several major issues that need to be addressed:

- The Kebena river is difficult to control with a dam. The river passes through the agricultural areas and is continuously encroaching the irrigated fields. It has destroyed the main concrete diversion structure, which has recently been replaced with gabion and is annually costing around two million Birr (1 Euro is 23 Birr) for its regular maintenance. Further details on Kebena system is given in the following section.
- Due to extensive degradation of rangelands through massive intrusion of *Prosopis juliflora* (Mesquite tree) – this is discussed below in a separate section – but also uncontrolled deforestation and the fact that there is no rangeland development using (flood) irrigation, there is at times shortage of animal feed and the pastoralist travel for 15 to 20 km in search of fodder. This is exhaustive for the livestock and their herders. The women, very young and elderly are left behind with insufficient food – the women have little opportunities to engage in livelihoods generating activities.
- The livestock population is beyond the carrying capacity of available basic veterinary services such as vaccination. For example, a person who owns less than 50 goats is considered poor. One family could own up to 100 to 200 goats or about 30 to 40 camels and more than 50 cattle. The lack of basic veterinary services, coupled with shortage of fodder and water, has led to frequent livestock diseases, significant reduction in milk and milk products and consequently, the pastoralists are being subject to recurrent food insecurity.

- Lack of farming know-how: the communities are new to agriculture and lack basic skills such as land preparation, weeding, harvesting. As a result, the majority rent their land annually for about 3,000 to 4,000 Birr per ha. If they farm, for instance, if households would grow onion, they could get a minimum of 40,000 Birr per ha per harvest (a minimum of two harvests is possible) when they sell at 5 Birr/kg and a maximum of 80,000 ha if they sell at 10 Birr/kg.
- Lack of marketing know-how: the pastoralists do not sell their livestock to generate income and improve their livelihoods. They only sell livestock to pay for social events (i.e. wedding), health care or cultural festivities. The pastoralists have, in particular, special affection for a camel. It is considered a sign of pride and its milk is perceived to be a cure for several diseases. Their strong reluctance to sell camel has put severe strain on brushwood, as well as the available veterinary services. Another key marketing weakness is that their market domain is limited – they only sell to hotel owners and butcher in the region and private traders often at low prices. The private traders make significant revenue by reselling the livestock in bigger cities and even transporting them abroad to Saudi Arabia as life animals via Djibouti and in meat pieces through the Addis Ababa Airport.
- The woreda is understaffed as it lacks adequately skilled and competent staff in the field of agriculture, irrigation design and veterinary services.

Capacity building needs

The woreda has already a five year strategic plan (2010 to 2015) where capacity building needs at two levels are identified as crucial:

1. Woreda level staff need training on:
    - Small scale, flood-based irrigation design and development.
    - Agronomic practices.
    - Modern livestock rearing as well as suitable veterinary services.
    - Installation and repair of water pumps.

2. At community, farmers level, capacity building is required on:
    - Operation and maintenance of small scale (flood-based) irrigation systems.
    - Establishing and running cooperatives or farmers' organizations - this is crucial especially for marketing directly to the large companies that export livestock thereby avoiding the greedy middle man - the private traders.
    - Trainings on land preparation and agronomic practices that result in higher yields.
    - Basic skills for repairing water pumps – these are imperative for well-based irrigated vegetable and fruit crops.
    - Farmer to farmer knowledge sharing and exchange especially tailored at showing pastoralists and agro-pastoralists how (flood-based) small scale irrigation and proper farming practices can generate much more income than just renting their land.
    - Practical skills for enhancing livestock productivity including basic veterinary skills such as vaccination.

These and two Farmers Training Centres (FTCs) in the woreda, but both are non-functional. As both FTCs should be involved at the onset of the capacity building, support is needed to equip them with adequate training facilities.

Organizations supporting the region and their activities

CARE-Awash was active in the area in the past. But now CARE-Awash has phased out. The only organization which is currently active in the region is the Food and Agricultural Organization (FAO). FAO operates only in kebele Sabure and is mainly involved in establishing crop demonstration sites: 10 ha of rice, 5 ha maize and 5 ha onions. The major problem with FAO is that they do not properly coordinate their activities with the woreda staff.

Denmark has also indicated its interest to help the Afar Region and Awash Fantale Woreda is among the selected beneficiaries. The details of the activities are not yet known, implementation is still to start.

Mr. Ibrahim Mohamed Ali had the following message to organizations including GIZ which would like to embark on development programmes: 'one cannot shoot without a gun.' He used this analogy to emphasize that capacity building without continuous and long-term engagement and complementary investment activities may not lead to a tangible impact in bettering the lives of pastoral and agropastoral community.

2.4 Aba'ala flood-based irrigation system

The visit to Aba'ala spate irrigation system started with a general discussion about the land and water resources, irrigation practices and demographics of the area. This was held with: Tesfaye Yirga, Agricultural Extension Team Leader and Deputy Head Pastoralist and Agriculture Office.

This discussion was followed by visit to the main diversion headwork, distribution network and irrigated command area of the Burga seasonal river, one of the four rivers that supply irrigation to the Aba'ala spate irrigation system. During the field visit, extensive discussion was held with a group of six farmers. While all the farmers were very forth coming, Shekna stood as very engaging, someone with authority and ready to pioneer new ideas and interventions.

General description of Aba'ala spate irrigation system

The bowl-shaped Aba'ala sub-basin (figure 3) has a total area of 555 km^2. It is situated in two regions: the upland where the flood originates in the Tigray Region and the low-lying plain where spate irrigation is being practiced in the Afar Region. The upland area receives 800 mm average annual rainfall, while in the low-lying region, the mean annual rainfall is below 300 mm.

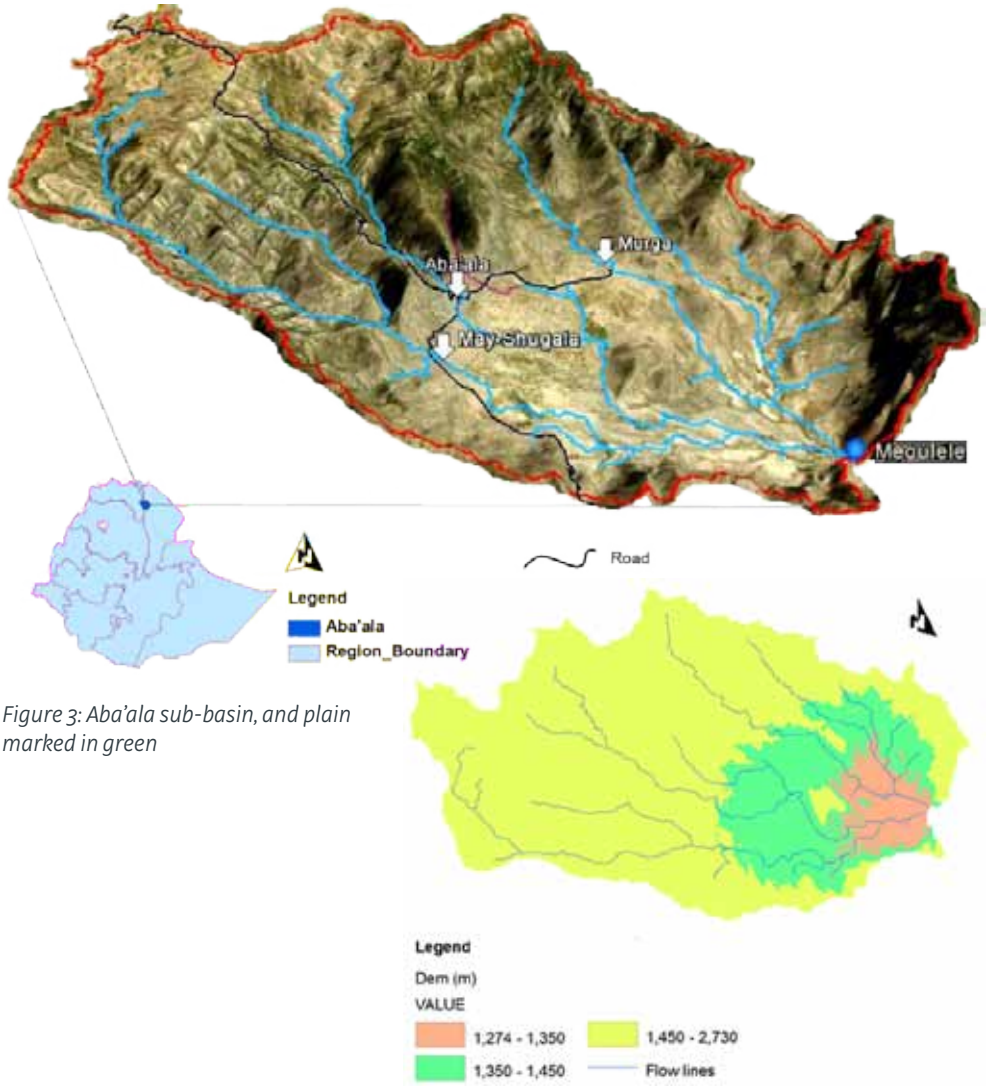

Figure 3: Aba'ala sub-basin, and plain marked in green

The Aba'ala spate irrigation system with a total irrigable area of 10,000 ha, lies in the vicinity of the Aba'ala city, which is located in Afar Region, Aba'ala Woreda, about 55 km east of Mekele, the main city of Tigray Region. Mekele is 780 km to the north of Addis Ababa. The area is characterized by flat plains and a series of elongated ridges and undulating hills. The average elevation of the area is approximately 1,300 m above sea level. The irrigated areas have fine textured silt loam soils that have good water holding and infiltration capacities.

Land and water resources

There are four main rivers currently being utilized in Aba'ala: two perennial - May-shugala and May Aba'ala - and two seasonal rivers, namely Murga and Liena. The capacity of the perennial rivers is limited and only used to irrigate about 80 ha of vegetable and fruit trees. The two seasonal rivers are

the major sources of water for the 10,000 irrigated area. Both perennial and seasonal rivers meet at the lower part of the plain and leave Aba'ala plain through one outlet at Megulele (figure 3).

Livelihoods systems and issues to be addressed

Spate irrigation is the main source of livelihoods for the 11 kebeles, six agro-pastoralists and five pastoralists. Agro-pastoralist refers to a community that is permanently settled and practice both agriculture and livestock rearing. Pastoralists also have a permanent base, but they do not practice agriculture and the youth frequently move to the highlands in Tigray along with their livestock in search of fodder and water leaving behind the elderly and the very young.

The agro-pastoralists have a well-defined cropping pattern designed to adapt to different climatic conditions and increase the probability that there will be at least one harvest at any given year:

- April 1 up to May 10: sorghum.
- May 10 to June 15: maize.
- July 10 to 30 : teff and barley
- August 30 to September 15: special beans locally called quaya or sebere.

These crops collectively provide the basic food needs of the agro-pastoralists communities. The pastoralists depend on milk and milk products from camel, goat, sheep and cattle. They only slaughter their animals for meat consumption during holidays. It is their long standing culture that a family pride is earned by having the largest stock of livestock, particularly that of camel.

The major issues that need due attention are the following:

- The rangeland, which is rain fed based with no systematic supplement from the flood water is severely insufficient, but is also located about 8 to 12 hours walking distance from the livestock water sources.
- Livestock disease is widespread - the woreda office neither has the resources, nor competent staff to provide basic veterinary services.
- The pastoralists are not organized into an association, nor do they have cooperatives. Consequently, as compared to the agro-pastoralists, they have less influence in shaping any development interventions to their benefit - the very limited development intervention in the area has been largely tailored at agricultural production.
- The agro-pastoralists, while they have a wealth of knowledge on water sharing, they have no experience in field-level soil moisture conservation as well as agronomy. They do not practice intercropping, most of the crops they use are of long duration nature and their fields do not have field bunds.
- Due to lack of infrastructure, large quantity of the rivers is leaving the Aba'ala plain unutilized, while there is a huge (about 5,000 ha) potential command area suitable for agriculture and rangeland development.
- The Aba'ala woreda have acute shortage of competent experts in the field of flood-based irrigation, rangeland management and institutional strengthening.

Capacity building and interventions needed

- The capacity building needs of the Aba'ala woreda staff and that of the pastoralists is almost identical to that outlined in the case of Awash Fantale Woreda.
- The agro-pastoralists have good knowledge about water distribution, but lack know-how on field water management, soil moisture conservation as well as agronomy. This could be addressed in two ways:
  - Exchange of experiences between the Aba'ala WUAs and Guguf WUAs in Tigray Region. As presented in the next chapter on Tigray, Guguf farmers are well ahead in field water management and soil moisture conservation.
  - Physical intervention:
    - On-site field experiment to demonstrate the combined impact of field bunds, pre-irrigation and post-irrigation tillage on soil moisture storage and crop yield.
    - On-site field experiment with different short and long duration sorghum and maize varieties.
- Other major interventions required are:
  - Introducing appropriate flood guiding bunds and canals to develop grazing areas and establish sustainable livestock water reservoirs under the command of Mogulel river. This seasonal river is currently completely untapped.
  - Large quantities of the rivers leave the Aba'ala plain through the only outlet at Megulele (figure 3). An overflow weir could be constructed at Meguele to retain a portion of the river flows sufficient to irrigate the large flat area suitable for rangeland development.

Organizations supporting the region and their activities

While there are currently no organizations supporting the Aba'ala Woreda, several organizations provided services to the region in the past:

- Water Resources Bureau of Tigray led the design and construction of the diversion structures.
- Afar Integrated Community Development Project was funded by Norway and implemented in partnership with Mekele University, Tigray. The main work was improvement of gabion structures and establishment of demonstration sites for producing fruit trees. This project stopped three years ago.
- VSF - Veterinary Sans Frontiers Germany: provided veterinary and human nutrition services for six months.

2.5 *Prosopis*: the green scourge

It has turned large hot dry plains green in the last 30 years – but still it is a major scourge that goes largely unattended: mesquite or under its official botanical name *Prosopis juliflora*.

In the last thirty years this hardy well rooted shrub made its way from Latin America to all parts of the world, covering millions of hectares in for instance India, Pakistan, Yemen, Sudan, Somalia

or Ethiopia. In many places it was first introduced in sand dune stabilization projects. However prosopis has the habit to 'overstay its welcome' and expand rapidly and not go away. The area estimated conquered by the invasive species in the last ten years in India, Pakistan, Yemen, Kenya, Sudan and Ethiopia is way above 10 million hectares.

Particularly in areas where there is livestock grazing prosopis spreads rapidly: the seedpods cling to the animals and are distributed widely. Prosopis germinates easily and once it has settled in an area it is difficult to get rid of it. It takes over the natural vegetation, does not allow undergrowth and hence greatly reduces the grazing value. It also tends to creep into waterways -including dry riverbeds- choking them in the process and causing flood rivers to run wild. The prosopis thorns are poisonous and can even cause blindness.

Prosopis is not only a scourge. It also has some benefits to its credit. Particularly when the plants are not too craggy (as happens in the more arid areas) the wood can be used for charcoal or even timber. The pods attract bees and have a high sugar content – they can serve as animal feed or be processed even into a sweetener. *Prosopis juliflora* can be used to improve the worst – saline or alkaline – soils. Particularly, when some of its charcoal is added as biochar, degraded soils get a boost. More details can be found at:

http://www.gardenorganic.org.uk/international_programme/prosopis/index.php

On balance however it is a scourge that is steadily undermining the livelihoods of large populations in some of the most vulnerable dry agricultural and pastoralist areas. By now there are several attempts to control 'the mesquite tide' with mixed results.

In Afar in Ethiopia the production of charcoal from *prosopis* was very much encouraged. The problem however is that the Prosopis charcoal is inferior to the one from acacia for instance. Instead of prosopis charcoal the acacia was widely processed – accelerating the degradation of the common land. A total ban on charcoal trading was hence re-invoked in several parts of this region.

In the Tihama in Yemen a number of entrepreneurial farmers have started to plant *Acacia ehrenbergiania* trees. Rather than using natural stands they use these stands effectively as 'charcoal plantations' and also make money with side products of the acacia charcoal making.

http://www.spate-irrigation.org/wordpress/wp-content/uploads/2011/08/PN_13_EN_setting_up_acacia_plantations_Yemen_LQ.pdf

Again in the Afar lowlands in Ethiopia, Farm Africa has worked on eradicating prosopis in a number of ways. First is to uproot the plants and then very rapidly convert the area in an agricultural area or into a well-managed grazing area – so as not to allow a comeback. Secondly, encouraging regulated production of charcoal through a number of co-operatives. Thirdly is to systematically collect the pods and crush them into animal feed - making sure they do not germinate but are turned into an economic asset. Details are available at:

http://www.farmafrica.org/downloads/resources/FARM%20Africa_Experiences%20on%20Prosopis%20Management%20Afar%20(2008).pdf

In Sudan mechanical and manual uprooting of prosopis has been promoted. The challenge is not the uprooting as such but to ensure the plant does not make a quick comeback. In one of the

irrigation systems an all-out ban on livestock was introduced after the area was cleared. This helped to keep the area 'clean'. Similarly in the Gash system in Sudan land was given to farmers on the condition that it would be taken back if they could not control the emergence of prosopis.
These are all good openings – but far more needs to be done. In the assessment of the Afar eradication programme for instance the area under prosopis expands more than 20 times faster than the area that is brought under productive use. Also menaces such as prosopis have not had much attention from research and development community – and this would need to be changed too.

2.6 Kebena seasonal river and its agricultural systems

Kebena river (figure 4) and its command area were visited based on the request from Pastoral and Agro-Pastoral Rural Development Office of Awash Fantale Woreda. The site visit was led by Ali Ahmed, Natural Resources Stream and Acting Bureau Head, and Ermias, Natural Resources Stream; both are from Awash Fantale Woreda Pastoral and Agro-pastoral Rural Development Office.

General information

Kebena river originates from the highlands of Amhara region and joins Awash river in Afar Region. A number of intakes for flow diversion for agricultural production (figure 5) were visited around the Kebena river reach (608952m E, 1022469m N, 835m).

The river passes through the agricultural areas. The river is known in both positive (agricultural and domestic uses) and negative (embankment erosion and encroaching of agricultural land as well as occasionally causing flooding of the Kebena village). Figure 6 shows the unprotected river banks that are frequently being eroded.

Livelihoods and major issues to be addressed

Figure 4: Location of Kebena river, Awash Fantale District, Afar region, Ethiopia

The Kebena communities are mainly pastoralist, but influenced by the large sugar cane plantation and the severe drought of 2011 that caused devastating losses to their livestock and rendered them to food dependency, some have adopted agriculture as a supplementary source of income. The major crops grown are onions and maize. While the current area under cultivation is less than 2,000 ha, there is a potential to expand to 10,000 ha.
An encouraging attempt has been made with


Figure 5: Earthen canal intake for traditional irrigation at Kebena river


Figure 6: Left: Bank erosion encroachment of agricultural land; Right: Onion irrigated from Kebena river

regard to embankment protection, localized bed stabilization as well as construction of intakes and canals with the objective of making better use of the hugely underutilized Kebena river flow (figures 7 and 8).

The improvement (modernization) however, had several shortcomings:

- It limited to only one intake, while there are more than 10 traditional intakes with earthen distribution structures.
- The division boxes and canals are designed with a perennial irrigation mind-set: they are small in size, the canal slope is gentle and hence cannot handle the medium to large floods and their sediment concentrations.
- The infrastructure development is not complemented with operational rules and management system: the intakes are operated in non-coordinated manner. Everyone who is capable can have intake and dig a canal. This is increasingly putting access to resources on the hands of the relatively wealthy few.

Bank protection intervention is done only on about two hundred meter section - there is large unprotected river bank where the flood is encroaching the agricultural land and washing-away the traditional earthen intakes.

Capacity building and interventions needed

The capacity development needs of the Kebena field staff and farmers are similar to those outlined in section 2.3. However, here more emphasis need to be given to embankment protection, flood


Figure 7: Modernized intake at one of the intakes at Kebena river


Figure 8: Modernized division box

damage control to agricultural area as well as establishing from scratch water users associations and flood water management system.

The major physical interventions needed include, but are not limited to:

- Rehabilitate exiting canal and intake – widening and improving slope.
- Construct intakes supported with embankment protection and localized cut-off for river bed stabilization.
- Establish demonstration sites for adaptive research on agronomy – different vegetable, fruit and food crop varieties.
- Establish flood water users' association with among other things, clear rules and regulations on sharing the flood water, operating and maintain the irrigation infrastructure.

2.7 Opportunities for development

On the basis of the extensive discussions with government officials, farmers and NGOs working in different parts of Afar and drawing on similar activities in other Regions of Ethiopia as well as other countries, the priority Investment programmes, capacity building and research packages along with their indicative investment costs are as follows.

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1.	Managing *Prosopis juliflora* (mesquite tree)	• Clearing (uprooting) mesquite tree • Converting the uprooted trees into economic assets: charcoal; animal feed (systematic crushing of pods) particularly for fattening of small ruminants (goats); constructing livestock compound (locally called zeriba) – the thorns of mesquite are poisonous and hence are good protection against some predators • Transform the mesquite cleared area into productive land: plantation of multipurpose trees such as *Acacia ehrebergiana*, dual purpose (grain and forage) crops; managed rangeland	Dense mesquite sites such as Meteka and Gewani woredas in zone 3, where there are some seasonal rivers as well as a possibility to controlled flooding from Awash river	2,000 Euros per ha	This total cost is based on experiences from Yemen. It covers: uprooting mesquite, processing pods and replacement with *Acacia ehrebergiana*. It is assumed that the labour cost is covered by the farmers and local government If properly implemented the combined benefits from mesquite and *Acacia ehrebergiana* could be twice the investment. The acacia tree matures in two to three years
2.	Empowering pastoralist women and the elderly who stay behind permanently while the youth frequently migrate in search of water and grazing land	• Fattening of small ruminants and selling them during festivity occasions. The fattening could be done by feeding on mesquite pods or dual purpose (grain and forage) maize and sorghum crop varieties • Small scale irrigation for vegetable production from shallow groundwater or small-scale diversion from seasonal rivers	Zone 4: Awra, Ewa, Teru Woredas where there is potential for groundwater. Zone 5: DelfagiBorkena where there is huge land potential and some experiences of flood diversion for vegetable production	1,000 Euros per one household or per a quarter of a ha	Cost is based on similar women empowering small scale vegetable production work done in Yemen with the World Bank food security programme

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3.	Establishment of flood-based irrigation systems for range land and forage production – trees, grasses as well as dual purpose (grain-forage) crops	Design and construction of flood diversion structures (headwork or flood spreading weirs), distribution structures (main and secondary canals)	Zone 1: Chifra: rangeland potential area. Zone 3: Gewani woreda potential diversion from seasonal rivers as well as controlled flooding from Awash. Zone 2: Aba'ala, Kuneba, Berale, where there is some potential for spate and flood-based irrigation. Zone 5: Delfagi/ Borkena where there is huge land potential and some experiences of flood diversion for vegetable production	500 to 1,000 Euros/ ha for gabion and earthen canal network; 1,000 to 2,000 Euros/ha for concrete/masonry infrastructure	These are total costs covering design and overhead. The costs assume that the farmers and the local government will contribute the labour required for construction of weirs and canal network. They are based on actual cost of structures constructed in Tigray region. The main factors that cause the difference between the higher and lower costs are the cross section of the weir and canal dimensions
		Command area development (land levelling and proper cultivation) using appropriate machinery such ass small tractors; soil moisture conservation systems including field bunds and overflow control structures		250 to 500 Euros/ha	Estimate based on similar work done in Pakistan. The highest costs refer to areas where then is large level difference between adjacent fields and hence require orifice and stilling basins
4.	Water harvesting: reservoirs/ponds as well as wells for livestock and domestic use	Construction of reservoirs/ponds	Zone 2, 5 and 4 as indicted in the above. potential in all zones and woredas need to be properly assessed	Reservoirs/ponds: 4 Euros/m^3 –earthen, 60 Euros/m^3 - Masonry with plastering	Derived from actual costs of similar works by Oromia Water Bureau, Ethiopia
		Mapping ground water potential and digging wells, constructing wells along with corridors and drinking pitches		Wells with capacity to serve up to 300 livestock per day: 4,000 Euros/well	Inferred from actual cost of similar work by Southern Rangeland Development Unit (SORDU), Borona, Oromia

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
5.	Establishment and or strengthening of existing demonstration sites along with farmer training centres	Construction of basic – one room farmer training centre with some basic training facilities including television and videos set to watch documentaries on various irrigation and farming experiences. Prepare demonstration land/site for adaptive research on improving horticultural, forage/rangeland crops; as well as fattening of livestock, particularly small ruminants	At least one farmer training site in: Zone 1: Chifra Zone 2: Aba'ala Zone 3: Gewani Woreda Zone 4: Awra, Ewa and Teru Zone 5: Delfagi	50,000 Euros per farmer training and demonstration site	Rough estimate based on discussion with staffs from Awash Woreda and other areas of Afar Region, Borona and other areas of Oromia region, Konso woreda and other woredas of SNNP region
6.	Establishment of cooperatives and farmer organizations	Prepare a tailor-made strategy and step-by-step process that addresses organizational, management and financial aspects of farmers organizations. Implement the strategy and establish farmers organizations/cooperatives	Sites should match with sites where physical intervention is made.	40,000 Euros per farmer organization/ cooperative: includes salary of one international (part time involvement) and two local guiding staff	Deducted from actual cost of carefully implemented two year WUAs establishment programme in Yemen

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Tailor-made training for all stakeholders from regional to woreda and farmer level	Prepare and conduct tailor-made trainings on: • Design, construction and construction supervision of flood-based irrigation systems. • Agronomy: cereals, oil, vegetable, and fruit crops. • Field water management and rangeland, agro-forestry and prosopis management. • Modern livestock production including fattening and basic veterinary services. • Managing farmers' organizations and cooperatives as well as ensuring their financial sustainability	• For regional professionals: Semera pastoral and agro-pastoral office. • For woreda: central woreda such as Gewani. • Farmers: respective kebele (village administration office) or farmer training centres	30,000 to 70,000 Euros per one training event of a two-week period for a total of 20 participants. Cost includes salaries of at least one international and two local experts	Based on experiences of Spate Irrigation Network in similar training programmes. The lowest cost refers to training which involves limited transportation and accommodation cost of participants
2. Strengthening the Institute of Pastoral and Agro-pastoral Studies (IPAS) at Haramaya University	Skilled staff secondment: • For developing curriculum that balances between theory and practice and incorporates real case studies and exercises on pastoralists and agro-pastoralist in Ethiopia. • Develops research and capacity building programme including MSc research work. • Mainstream the IPAS into relevant University programmes so that it can get some basic funding from the government and be sustainable	Haramaya University	36,000 Euros: • 30,000 Euros for international skilled staff, secondment for six months; • 6,000 Euros for two local senior partnering staff for six months	• Based on European average salary of 5,000 Euros per month for a senior staff. • The 500 Euros per month for local senior staff is top-up for the extra-work (on top of university duties)

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3. Farmer to farmer and expert to expert knowledge and experience sharing	Within the country, visit by selected Afar experts and farmers to gain knowledge and experiences from: • Guguf spate irrigation farmers, Tigray Region: effective flood water diversion, distribution; active farmers' organization with knowledge about fair water sharing rules and conflict management systems • Borona, Oromia: range land management including special traditional flooding and closure systems; rehabilitated traditional wells: infrastructure that includes corridors for livestock passage, cascade of reservoirs to bring water from the well to livestock drinking pitches, the traditional organization in place to ensure orderly service for up to 600 cattle per day per well • Yandefero flood-based irrigation system, SNNP region: to learn from the local successful experience on command area development: land levelling, field bund construction as well as the fruit tree (papaya, citrus) production systems and field water management Visit to Yemen: • Local practice and experience on multiple uses of acacia ehrebergiana (locally known as Selam tree): flowers for honey production, thorns and leaves for animal feed, stem for charcoal production, extraction of medicinal value liquid locally named Keteran • Centuries of experiences in traditional flood water management for production of cereals, vegetables and perennial crops Visit to Sudan: • Success and failure experience on management of prosopis, which still remains a major problem in and around the major flood-based irrigation schemes of the country	• Guguf spate irrigation system, Raya, Tigray • Yabello Woreda, Borona, Oromia • Yandefero spate irrigation system, Konso, SNNP Region • Tihama Spate Irrigation Plain, Yemen. • Gash and Toker delta flood-based farming systems, Sudan	Within the country visits: 2,000 to 2,500 Euros per visit of 4-day duration with a total of 20 participants Outside the country visit (Yemen and Sudan) 2,500 euros per person for travel, accomodation and daily subsistence allowance, for four days	Based on similar visit organized by the Spate Irrigation Network in 2010 for participants from Haramaya to Boru Dodota scheme (500 km) Cost is deducted from actual expenses of Ethiopian farmers who attended in the regional WUAs workshop in Sudan in December 2012

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
4. Strengthening the Afar Development Association – community based association, which was established about one year ago: This could potentially serve as a gateway to the rural communities	Training on: • Public relations • Project formulation and coordination • Community mobilization On-job training: involving the association in the formulation and implementation of the investment programmes, particularly the prosopis management and empowering women packages • Knowledge and experience sharing workshop with similar Tigray and Amhara Development Associations that have made significant strides in implementing community-based water , health and education activities and have become financially self sustainable • This knowledge and experience sharing workshop should involve field visit to project sites in which the association have been or is planning to be involved	• For training: Semera pastoral and agro-pastoral office • For knowledge and experience sharing workshop: site should be close to areas where the associations have development activities on the ground	30,000 to 70,000 Euros per one training event of a two-week period for a total of 20 participants. Cost includes salaries of at least one international and two local experts	Based on experiences of Spate Irrigation Network in similar training programmes The lowest cost refers to training which involves limited transportation and accommodation cost of participants

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Traditional pastoralist livelihoods system and its adaptability/ vulnerabily to climate change (drought and drown)	Three MSc students conduct in-depth field research work of three month duration: • On the basis of properly prepared proposals. • With supervision and support from the Afar Pastoral and Agro-pastoral Office, Spate Irrigation Network and selected staff of Haramaya, Semera and Mekele University	Different Afar Clans (tribes)	16,000 Euros for three MSc Research work Supervision and support: 3,000 Euros for three students.	The local budget at universities in Ethiopia for one MSc field research is 1,500 Euros. This is insufficient for extensive field work and does not motivate students to select remote research site. The experience of Spate Irrigation Network is that 4,000 Euros has provided a good incentive for in-depth analysis of complex issues in rough work environments
2. Economic analysis of traditional, improved and modern flood-based farming systems	Two MSc students develop a multi-criteria cost-benefit approach suitable for flood-based irrigation systems and accordingly analyse the economic viability of different schemes leading for recommendations on how to minimize costs and maximize benefits • On the basis of properly prepared proposals • With supervision and support from the Faculty of Business and Economics, Addis Ababa University, Spate Irrigation Network and UNESCO-IHE	As in the above.	As in the above	As in the above

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3. Agroforestry and prosopis management: in depth analysis of different experiences and practices within Ethiopia as well as Sudan, Kenya, Yemen	Three MSc students in Ethiopia, one in each Sudan, Yemen, Kenya: in-depth field research work of three month duration: • On the basis of properly prepared proposals • With supervision and support from the Afar Pastoral and Agro-pastoral office; Spate Irrigation Network and selected staff of Haramaya, Semera and Mekele University, Ethiopia as well as relevant institutions in the other countries	**Ethiopia**: Meteka and Gewani woredas, Afar region, where mesquite is a real problem and where some attempts to control it are underway. **Sudan**: Toker Delta Agricultural Scheme utilized by agro-pastoral communities where Mesquite is a major threat to livelihoods. There are some government initiatives to address the problem. **Yemen**: Tihama plain – there are a number of initiatives to harness benefits from various multiple purpose trees such as *Acacia ehrebergiana*. **Kenya**: Baringo district where some extensive prosopis management and utilization activities have been done mainly by International Development Programme, Garden Organic, UK	As in the above	Budget estimate as in the above
4. Flood water diversion and distribution: traditional, improved and modern systems	Three MSc students make in-depth analysis of existing experiences on the design of headworks, canal networks, embankment protection works, bed stabilization interventions • On the basis of properly prepared proposals; • With supervision and support from the Spate Irrigation Network, selected staff of Arba Minch and Mekele University, and UNESCO-IHE. One MSc student to do desk study on analysis of different experiences from Yemen, Pakistan and Sudan where several spate (flood-based) irrigation systems have been developed	Within Ethiopia: Aba'ala and Kebena spate irrigation systems Outside Ethiopia: • Pakistan, Balochistan and DG Khan Provinces • Yemen: Tihama and Hadramout regions • Sudan: Toker, Gash and Khor AbuHabil • Some other sites	As in the above	As in the above

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
5. Strengths and limitations of farmers and government institutions involved in management of flood-based irrigation systems	Two MSc students working together - document the characteristics of different farmers and government institutions; analyse their successes in managing flood-based farming and water harvesting structures and systems; recommend best institutional arrangements for different socio-economic setting and technologies	Active farmers and government institutions to be selected from the five zones in Afar	As in the above	As in the above
6. Field water management and soil moisture conservation.	Three MSc students make detailed assessment of different land preparation, field-level water distribution structures and systems, as well as soil moisture conservation practices including field bunds construction and maintenance • On the basis of properly prepared proposals; • With supervision and support from the Spate Irrigation Network, selected staff of Haramaya university, Mekele University, and UNESCO-IHE. One MSc student to do desk study on analysis of different field water management and soil moisture conservation experiences from Yemen, Pakistan and Sudan.	Within Ethiopia: Mainly in Afar (Aba'ala and Kebena)with complementary research in SNNP (Konso), Tigray (Guguf). Outside Ethiopia: as in programme 3.	As in the above	As in the above

3 Tigray Region

The Tigray region (figure 9) has a total area of 41,409.95 km² located in northern part of Ethiopia sharing international border with Eritrea to the north and Sudan to the west.

Tigray region is also bordered by the Afar Region to the east, and the Amhara Region to the south and southwest. Based on CSA 2008, the Tigray region has a population of 4,316,988, of whom 2,126,465 are men and 2,190,523 women. Rural inhabitants number 3,472,948 or 80.45 % of the population who majorly depend on agricultural practices for their livelihoods. This region has an estimated density of 100 people per km². As of 2004, 54 % of the total population had access to safe drinking water, of whom 42.68 % were rural inhabitants and 97.28 % were urban. In 2005 the farmers in Tigray had a total of 2,713,750 cattle (representing 7.0 % of Ethiopia's total cattle), 72,640 sheep (0.42 %), 208,970 goats (1.61 %).

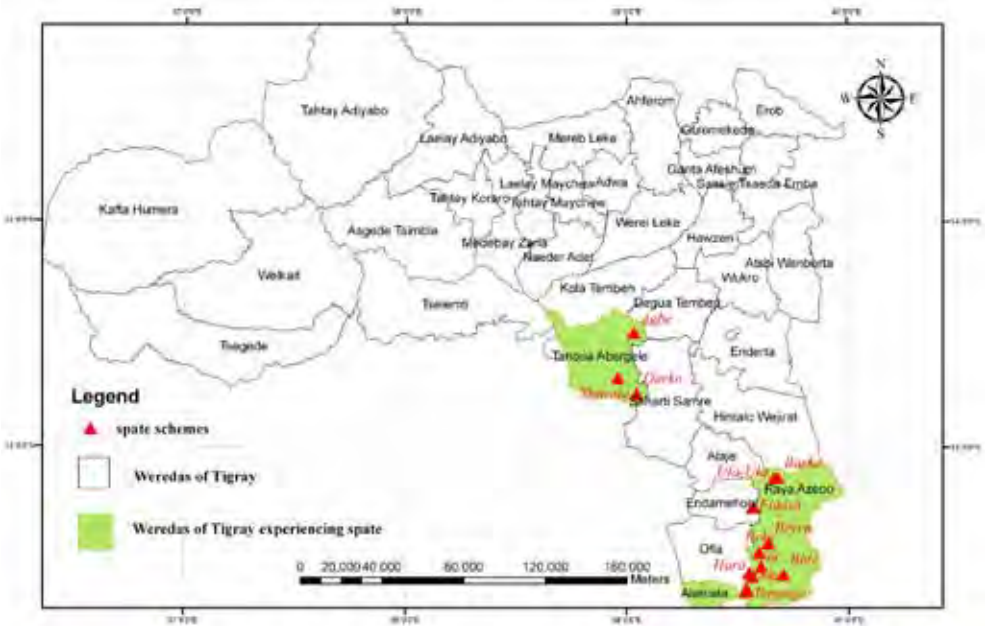

Figure 9:Tigray regional state: location and boundaries of its 34 woredas (Embaye, 2012)

Tigray has a potential of 80,000 ha of land that can be irrigated by spate irrigation. The two prominent Woredas of Tigray region, which have a very rich experience of using traditional spate irrigation systems are the Raya Azebo and Alamata of the Raya valley. Recently, spate irrigation has been introduced to another drought-prone Woreda of the region namely Tanqua-Abergele. The average annual rainfall of the highlands of the Raya valley is around 800 mm but that of the lowlands is less than 350 mm. With this amount of rainfall at the lowlands, it is difficult to get a good harvest depending only on rain fed agriculture as the rainfall is also erratic both in time and spatial distribution. As an adaptation mechanism to the shortage and erratic distribution of rainfall, the lowlanders have to supplement their fields with floods generated from the highlands using spate irrigation.

In the region there are more than 20 modernized schemes. These schemes are located in three woredas namely, Alamata, Raya Azebo and Tanqua Abergele. Most of the modernized schemes had been functioning as traditional schemes before they were modernized. The main objectives of modernization were:

- To increase the command area that could be irrigated per unit of water thereby increasing the productivity of water.
- To sustain spate irrigation usage as many years as possible.
- To reduce the cutting of trees thereby reducing the negative environmental impact that is imposed by the construction of traditional structures.

Figure 10: Dwellers of Genete kebele discussing on water use

But, the modernization is not effective as it was anticipated for so many technical and socioeconomic reasons. Therefore, schemes like Hara and Guguf have been visited. During the field visit, discussions were held with regional, zonal and woreda officials and experts; farmers in Guguf where an improved flood-based irrigation systems is located and where flood spreading is practiced by the farmers, as well as farmers belonging to Hara spate irrigation system, which was the first modern spate system constructed in Ethiopia in 1998. Furthermore, detailed discussion was conducted with the Genete kebele/Guguf spate system dwellers (figure 10) and it was learned that 800 farmers depend on the spate system and 650 ha has been irrigated from spate flow. The spate flow from Guguf supplies the command area in two kebeles: Genete and Tsega'a. The main findings of these visits and discussions are detailed in the following sections.

3.1 Hara spate irrigation scheme

The visit to Hara spate irrigation system started at the main diversion headwork, with a general discussion with Ms. Kokeb, hydro-geologist at the Alamata Woreda Water Resources Office. The discussion was focused on the land and water resources, irrigation practices, causes of the failures of the headwork structure and remedial measures. This was followed by a visit to distribution network and irrigated command area of the Hara wadi (ephemeral river) where extensive discussion was held with some farmers.

General description of Hara spate irrigation system

The Hara spate irrigation scheme is administratively located in Tigray regional state, South Tigray Zone, Alamata woreda, Laelay-Dayu kebele. Geographically, the scheme is situated 1374450 N,

Figure 11: Hara spate irrigation scheme: Hara diversion at 2 to 3 km from Alamata

0561400 E and 1540 m above sea level. The scheme can be accessed through the asphalt road after driving three km north of Alamata, which is 600 km away north of Addis Ababa, and driving about two km on a dry weather road (figure 11). The number of beneficiary farmers during designing was 1284 households of which 558 are female-headed households.

Hara spate irrigation scheme had been operated traditionally for a long period before it was modernized. Traditionally, farmers had been using locally available material: brushwood, tree branches, and stones to divert the flood into their scheme. Such traditional diversion had been labour intensive and caused degradation of the area. With objectives to improve the labour intensive work, to protect the environment from degradation and ensure optimum flood diversion and use, it was decided to modernize most of traditional spate irrigation Scheme in Tigray region piloting in Hara (figure 12).

The Hara spate system was first designed in 1998 by Concert Engineering PLC under the Raya Valley Agricultural Development Project (RVADP). But, this design was modified by the engineers at Co-SEART (Commission for Sustainable Agriculture and Environmental Rehabilitation in Tigray) and was finally constructed and handed over to the beneficiaries in 2000.

The headworks and canal systems of Hara scheme was modernized to irrigate 400 ha. The headwork was designed to be a broad crested weir as diversion structure and gated-conduit intake along with underflow sluice at both banks of the river. The canal system was designed to have two main canals one on each side having all the irrigation structures such as siphons, division boxes and drops.

Figure 12: Headwork, diversion structures of the Hara spate irrigation scheme

Livelihoods systems and issues to be addressed

The livelihoods of the Hara scheme depends mainly on agriculture. Maize and sorghum are widely grown around the area. There are two varieties of sorghum: white and red coloured. The white is used for producing Enjera and the red to produce Tela. The area is characterized by insufficient amount and erratic nature of rainfall. Hence, the scheme has to be supplemented by diverting spate flows generated by heavy rainfall in the highlands.

The Hara spate irrigation scheme failed after working for a few seasons due to the following reasons:

- Adopting conventional approach to design the spate scheme. This is due to lack of experience of the spate situation and absence of design manual/procedure.
- Under estimating the sediment concentration, and adopting closed off-takes and siphons; these structures can easily be filled with sediment and they also make dredging difficult.
- Insufficient consultation with the community in the process of the design and construction.

Figure 13: : Opening made for intake on the wing-wall of the Hara spate irrigation scheme

Following the failure of the Hara modernized headwork; the farmers tried to divert the flood as they used to with brushwood, tree branch and rocks and guiding it to the intake on the wing-wall (figure 13). However, since 2010, the Hara scheme had fully stopped functioning. Larger flood could not be diverted as the traditional diversion structures were breached before the spate flow could reach the crest level of the opening made for the intake.

When the scheme was operational, it was managed by a committee, locally known as "Asadari". Among others, the committee is responsible for setting the flood usage schedule and collecting fees which is as punishment if farmers break the agreed flood water sharing rules.

Due to failure of the Hara spate irrigation scheme, the crop production at this moment in the command area is purely rain fed and it is experiencing poor yield - one fourth of the yield compared with supplementary spate irrigation.

The followings measures are discussed to be solutions:

- Modify the intake – change it to open intake by demolishing the upstream guide walls and gated off take structures.
- Dredge the sediment from the canal.
- Widen the canal cross-section to divert larger flood size in a shorter period of time.
- The farmers need to get support to keep the system running through appropriate maintenance and operation. The governments institutions and the NGOs in particular are interested in the

construction of new systems, and often the operation and maintenance work is left to the farmers and usually these are beyond the farmers' technical and financial capacity.

Capacity building and interventions needed

The regional bureau in general and the woreda offices in particular have already five-year strategic plan (2012 to 2017) where capacity building needs at two levels are identified as crucial:

1. Woreda and regional level staff need training on:
    - Small scale, flood-based irrigation design, improvement and development- this is crucial- even though well progressing, the awareness and understanding on the guidelines and procedures of spate irrigation systems design is not to the required level.
    - Operation and maintenance of flood-based farming structures.
    - Construction procedures and supervision of flood-based farming structures.
    - Agronomic practices.
    - Formation of strong water user associations and cooperatives.

2. At community and farmer level, capacity building is required on:
    - Operation and maintenance of small scale irrigation systems.
    - Trainings on establishing and running cooperatives or water user associations.
    - Trainings on operation, designing and construction and supervision techniques of flood diversion and distribution structures.
    - Different trainings on land preparation and agronomic practices that result in higher yields.
    - Farmer to farmer knowledge sharing and exchange especially tailored at showing how flood-based small scale irrigation and proper farming practices can generate much more income .
    - Practical skills for enhancing livestock productivity including basic veterinary skills such as vaccination.

3.2 Guguf spate irrigation scheme

The visit to Guguf spate irrigation scheme started with a general discussion with the villagers who were having a monthly meeting to discuss spate irrigation and domestic water supply issues at an elementary school. The field research team introduced themselves and the purpose of their visit. The team also shared some of their experiences in spate irrigation design and management.

This general discussion was followed by a visit to the main diversion headwork, distribution network and irrigated command area of the Guguf and Wejeg improved diversion schemes. Extensive discussion was held with a group of many Abo-mays (Water Masters) who are responsible

Figure 14: Location of the intake of the Beles Maegel at Guguf Wadi

for managing the water distribution in particular and the sustainability of the system in general. It was during the discussion that the model farmers were able to explain about the idea of flood spreading weirs which has a long history in the area.

General description of the Guguf spate irrigation system

The Guguf spate irrigation scheme is administratively located in Tigray regional state, South Tigray Zone, Raya-Azebo woreda, Genete and Tsigea kebeles at 120 km from Mekele. The scheme and diversion structures (maegels) are accessible both from Alamata and Maichew towns (figure 14). The scheme can be accessed through an all weathered road after driving about 5 km through west of Mekhoni, which is 660 km away north of Addis Ababa.

The runoff generated from the Maichew watershed is the main source of water for the spate irrigated command area.

The number of beneficiary households of the scheme is around 800 of which one third are female-headed households. The command area under irrigation using traditional, improved and modern spate systems is 650 ha.

Livelihoods systems and issues to be addressed

The livelihoods of the area mainly depend on spate irrigation, with rearing livestock playing supplementary role. Sorghum and maize are widely grown in the area. In addition, papaya, guava and gesho (plant used for fermenting local drinks) are also grown by some farmers. Animals reared are cattle, sheep, goat and camel. The source of forage for feeding animals is grazing land which is kept closed. They also use maize that is not growing well as fodder.

The spate flow from Guguf supplies the command areas in many kebeles of the woreda. But the two kebeles -Genete and Tsega'a- are located at the most upstream of the wadi. The diversion system has six main canal off takes (maegels): Maegel Beles, Hantal, Desta, Mekoni, Gashe and Maegel Reta (figure 15). The intake at the third, fourth and fifth maegels are made of masonry works, and the rest are strengthened by gabion. Flood is managed by the Father of the Wadi "Abo Gereb" and each branch canal/maegel is managed by water master "Abo may". Traditionally, the Abo Gereb was a committee comprising representatives from each maegel and beneficiaries from the two kebeles. Currently, the Abo Gereb consists of a representative/delegate from the agriculture office.

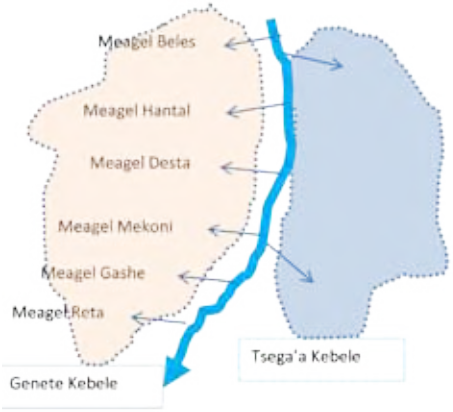

Figure 15: Layout of the Guguf spate irrigation scheme covering Genete and Tsega'a kebeles

Field visit and discussions continued with the 50 men and 10 women household beneficiaries of maegel Beles which has three branch canals (Chirto) each serving 20 households. Water sharing among the 60 beneficiary households is based on two levels of lotteries. The first is to decide which of the three branch canals has the priority. The second is to make an orderly schedule within the branch canal. Flood could occur during the day or in the night. As females should not go out in the night, the irrigation schedule for female headed household is always made during day time.

Canal maintenance including desilting is taken seriously. Failure to participate in such collective maintenance work leads to several degrees of punishment ranging from 500 to 1,000 Birr. Absence from three consecutive maintenance sessions results in the ultimate penalty - appearing before the court and immediate payment of up to 2,000 Birr or risk imprisonment.

Challenges of the scheme

- Lack of sufficient water supply for agriculture, domestic and livestock. Spate flow is the only source of water. It is unpredictable in occurrence and amount. There are no wells and reservoirs.
- The diversion structures need improvement as gabions are damaged and washed away by medium and large floods.
- The recession of the spate flow has been constantly decreasing due to irrigation activities further upstream using pumps.

Suggested solutions

- Flood spreading weir (figure 16 and 17) was discussed and this could reduce damage to diversion structures and contribute to riverbed stabilisation.
- Investment in groundwater exploration and development particularly for domestic and livestock use.

Capacity building and interventions needed

Capacity building is crucial for Raya-Azebo Woreda too. Similar to the Alamata Woreda, the Raya-Azebo Woreda has five year strategic plan (2011 to 2015) and the capacity building needs at both the woreda/ regional and farmers levels are the same except the training required by the farmers and experts on improving the use of flood spreading weirs.


Figure 16: Ms. Nadine from Germany explains flood spreading weirs; Gabir seyum, a farmer shows water distribution system

Organizations supporting the region and their activities

The organizations supporting Alamata and Raya-Azebo woreda include IFAD (PASIDP, Participatory Small Scale Irrigation Development Program), the World Bank, AGP (Agricultural Growth Program), REST (Relief Society of Tigray) and AfDB (Africa Development Bank) through its SSIP (Small Scale Irrigation Program). SSIP however has phased out as of December, 2012. All of them have been involved in developing small scale river diversion and spate irrigation development.

- The design and construction of the (flood) diversion structures is handled mainly by Tigray Bureau of Water Resources and partly by REST.
- These projects are funded by IFAD, the World Bank or AfDB.
- IFAD- PASSIDP is also involved in financing the construction of hand dug community shallow wells and pipe supported furrow irrigation system development of deep wells.

3.3 Opportunities for development

On the basis of the extensive discussions with government officials, farmers and NGOs working in different parts of Tigray and drawing on similar activities in other regions of Ethiopia as well as well as other countries, the priority investment programmes, capacity building and research packages along with their indicative investment costs are as follows.


Figure 17: Flood spreading weir on Wejeg spate system, Ethiopia

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1.	Empowering women and the elderly	Small scale irrigation for crop production from construction of ponds, shallow and deep well groundwater development Fattening of small ruminants and selling them during festivity occasions. It should be noted that, the Tigray people which accounts about 5 % of the Ethiopian population owns more than 7 % of the cattle population of the country. The fattening could be done by feeding on grain and forage (maize and sorghum crop varieties)	Humera, Raya, Alamata and Raya Azebo woredas where there is potential and experience of deep well based irrigation development for crop production and rearing animals Central, eastern and southern Zones for shallow well groundwater based irrigation	Same as in section 2.7	Same as in section 2.7
2.	Establishment of flood-based irrigation systems for range land and forage production – trees, grasses as well as dual purpose (grain-forage) crops	Design and construction of flood diversion structures (headwork or flood spreading weirs), distribution structures (main and secondary canals)	Raya Alamata and Raya Azebo woredas where there is potential and experience of spate irrigation Tanqua Abergele Woreda, where there is some potential for grain-forage development using spate and flood-based irrigation western and north-western zones where there is huge land potential and some experiences of flood diversion for vegetable production	As in the above	As in the above

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3.	Water harvesting: reservoirs/ ponds as well as wells for livestock and domestic use	Construction of reservoirs/ponds Mapping ground water potential and digging wells, constructing wells along with corridors and drinking pitches	The whole regio Deep wells in Alamata and Raya Azebo Woredas	As in section 2.7	As in section 2.7
4.	Establishment and or strengthening of existing demonstration sites along with farmer training centres	Construction of basic – one room farmer training centre with some basic training facilities including television and videos set to watch documentaries on various irrigation and farming experiences Prepare demonstration land/ site for adaptive research on improving horticultural, forage/ rangeland crops; as well as fattening of livestock, particularly small ruminants	At least one farmer training site in each zone	As in the above	As in the above
5.	Establishment of cooperatives and strengthening of farmer organizations	Prepare a tailor-made strategy and step-by-step process that addresses, organizational, management and financial aspects of farmers organizations Implement the strategy and establish cooperatives or strengthening the already established farmers organizations	Sites should match with sites where physical intervention is made	40,000 Euros per farmer organization/cooperative: includes salary of one international (part time involvement) and two local guiding staff	Deducted from actual cost of carefully implemented two year WUAs establishment programme in Yemen

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Tailor-made training for all stakeholders from regional to woreda and farmer level	Same activities as in section 2.7	For regional professionals: Mekele University. For woreda: central woreda such as Alamata. Farmers: respective kebele (village administration office) or farming training centres.	As indicated in section 2.7	As presented in section 2.7
2. Farmer to farmer and expert to expert knowledge and experience sharing	Same activities as in section 2.7	Guguf spate irrigation system, Raya, Tigray Yabello Woreda, Borona, Oromia Yandefero spate irrigation system, Konso, SNNP region Tihama spate irrigation plain	As in the above	As in the above

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3. Community/ farmer level tailor-made trainings	Prepare and conduct tailor-made trainings on: • Operation and maintenance of small scale irrigation systems • Trainings on operation, designing and construction and supervision techniques of flood diversion and distribution structures • Trainings on land preparation and agronomic practices that result in higher yields • Practical skills for enhancing livestock productivity including basic veterinary skills such as vaccination • Design, construction and construction supervision of flood-based irrigation systems • Upgrading and modernizing the existing traditional flood spreading weirs	Farmers: respective kebele(Village Administration Office) or farmer training centres	30,000 to 70,000 Euros per one training event of a two-week period for a total of 20 participants. Cost includes salaries of at least one international and two local experts	Based on experiences of Spate Irrigation Network in similar training programmes The lowest cost refers to training which involves limited transportation and accommodation cost of participants

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Traditional flood-based farming user's livelihoods and their adaptability/ vulnerability to climate change (drought and drown)	Three MSc students conduct in-depth field research work of 3 month duration: • On the basis of properly prepared proposals • With supervision and support from the Mekele University and Spate Irrigation Network	Raya Valley	16,000 Euros for three MSc Research work Supervision and support: 3,000 Euros for three students	The local budget at universities in Ethiopia for one MSc field research is 1,500 Euros. This is insufficient for extensive field work and does not motivate students to select remote research site. The experience of Spate Irrigation Network is that 4,000 Euros has provided a good incentive for in-depth analysis of complex issues in rough work environments
2. Flood water diversion, and distribution traditional, improved and modern systems	Three MSc students make in-depth analysis of existing experiences on the design of headworks, canal networks, embankment protection works, bed stabilization interventions: • On the basis of properly prepared proposals • With supervision and support from the Spate Irrigation Network, selected staff of Arba Minch and Mekele University, and UNESCO-IHE One MSc student to do desk study on analysis of different experiences from Yemen, Pakistan and Sudan where several spate (flood-based) irrigation systems have been developed	Within Ethiopia: at least one traditional, one improved and one modern scheme in Tigray, that is: • working properly and considered a bright spot • poorly functioning • completely failed system Outside Tigray region: • Pakistan, Balochistan and DG Khan Provinces • Yemen: Tihama and Hadramout regions • Sudan: Toker, Gash and Khor AbuHabil • Some other sites	As in the above	As in the above

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3. Field water management and soil moisture conservation	Three MSc students make detailed assessment of different land preparation, field-level water distribution structures and systems, as well as soil moisture conservation practices including field bunds construction and maintenance • On the basis of properly prepared proposals • With supervision and support from the Spate Irrigation Network, selected staff of Mekele University, and UNESCO-IHE One MSc student to do desk study on analysis of different field water management and soil moisture conservation experiences from Yemen, Pakistan and Sudan	As in Research programme 2	As in the above	As in the above
4. Economic analysis of traditional, improved and modern flood-based farming systems	Two MSc students develop a multi-criteria cost-benefit approach suitable for flood-based irrigation systems; accordingly analyse the economic viability of different schemes leading to recommendations on how to minimize costs and maximize benefits • On the basis of properly prepared proposals; • With supervision and support from the Faculty of Business and Economics, Addis Ababa University, Spate Irrigation Network and UNESCO-IHE	As in the above	As in the above	As in the above
5. Integration and analysis of the effect of community hand dug wells on ground water and spate irrigated fields	Three MSc students make detailed assessment of ground water level and flood level changes • On the basis of properly prepared proposals • With supervision and support from Mekele University, Spate Irrigation Network and UNESCO-IHE	Selected traditional/ improved / modern spate schemes that are integrating/using community hand dug wells	As in the above	As in the above

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
6. Analysing the effect of conservation measures at the highland on the lowland flood magnitude and duration	Three MSc students make detailed assessment of flood magnitude and frequency changes • On the basis of properly prepared proposals • With supervision and support from Mekele University, Spate Irrigation Network and UNESCO-IHE	Selected traditional/improved /modern spate schemes in which there is an activity of catchment treatment undertaken at it / from the different regions	As in the above	As in the above
7. Analysing why the operation and maintenance activities are less organized in the modern schemes than in the traditional ones	Three MSc students make detailed assessment of institution set ups of both the modern and traditional schemes • On the basis of properly prepared proposals • With supervision and support from Mekele University, Spate Irrigation Network and UNESCO-IHE	Selected a wadi having both traditional and modern spate schemes	As in the above	As in the above
8. Technical, operational and economic analysis of various water harvesting systems	Three MSc students to work jointly and analyse the current technical performance, operational approaches as well as cost-benefit aspects of the major water harvesting systems in Ethiopia; and subsequently make recommendations • On the basis of properly prepared proposals • With supervision and support from the Spate Irrigation Network, selected staff of Mekele and Arba-Minch University, and UNESCO-IHE	Raya Kobo and other regions where there is development of shallow wells	As in the above	As in the above

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
9. Strengths and limitations of farmers and government institutions involved in management of flood-based irrigation systems as well as water harvesting systems (wells, ponds and reservoirs)	Two MSc students working together - document the characteristics of different farmers and government institutions; analyse their successes in managing flood-based farming and water harvesting structures and systems; recommend best institutional arrangements for different socio-economic setting and technologies	Farmers and government institutions in major spate irrigation areas such as Alamata and Raya woredas	As in the above	As in the above

4 Oromia Region

Oromia region (figure 18) is the largest state in Ethiopia, covering about 32 % of the total land area (367,000 km$^{2)}$ and inhabits a third of the population (27, 158, 471). The region is located in the centre of the country and shares common borders with all regional states except Tigray, and international borders with Kenya and Sudan in the south and west, respectively. About 52 % of the land area of the region is categorized as lowland and lies below 1,500 m above sea level. The region experiences annual temperature ranging from 10 °C to 30 °C, with mean annual temperature of 19 °C. It has bimodal rainy season with the annual rainfall range from 400 in the lowlands to 2,400 mm in the highlands. The region is predominantly an agrarian economy, with rain fed farming, flood-based farming and small scale irrigation providing livelihoods for 85 % of the population (Hussein, 2011). Rain fed agriculture in agro-pastoral and pastoral communities, which comprise about 14.5 % of the population of the region, takes advantage of flood plains (PFE, 2010) and spate.

In Oromia region, the research team visited three flood-based farming schemes (i.e. Waltane, Awadi and Bura as well as the famous well "Ella in the Borona" in the lowland areas. Discussions were held with regional, zonal, woreda officials, experts and NGOs who are working on these pastoral

Figure 18: Oromia Regional State and the boundaries of its zones (Ministry of Water and Energy, 2012)

and agro-pastoral lowland areas. At Haramaya University, extensive consultations were made with management and academic staff focusing on the provision of training and research to support pastoral and agro-pastoral livelihoods. The main findings of these visits and discussions are detailed in the following sections.

4.1 Waltane traditional spate irrigation scheme

The visit was led by Mr. Dereje, Water and Soil Engineering expert from the Chiro Zone Water Energy and Mineral bureau.

General information

Waltane is a traditional spate irrigation scheme. It is currently being modernized -work was underway at the time of the field visit. Waltane river drains from Chiro (Asebe Teferi) and Doba district in the highlands, and flows to Awash river through lowlands of Mi'eso town in northern part of the district. The Waltane intake (705989 m E, 1023893 m N, Elevation 1,350 m) is found at 25 km off the road east of Mi'eso. The existing traditional intake (figure 19) diverts part of the flood water and the base low toward the command area for supplementary irrigation of rain fed crops during the rainy season. Local material including stone, wood and sand filled sacks are used to divert the river flow and to stabilize the river bed and river bank.

Livelihoods systems and major issues to be addressed

In addition to supplementary irrigation, the local community also use river water for domestic purposes by scooping the dry riverbed (figures 20 and 21). Whenever the river bed gets dry or if the scooping becomes difficult, a shift is made to another upstream location. Women and children spend up to two hours during wet season and three hours during dry season to scoop water from the dry wadi bed.

Figure 19: Intake made from earthen materials at Waltane river

Figure 20: Scooped water from Waltane dry wadi bed for domestic water use

Figure 21: Discussion with field research team.

There are in general two kind of flood water distribution in spate irrigation schemes: field-to-field and individual field system as is the case in Waltane spate irrigation scheme. In individual water distribution system, each field has its own inlet from a canal.

Sedimentation is both a blessing and a curse in spate irrigated practices. The finer sediment is usually welcomed by the farmers as it can build the fertility of their command area. However the course sand and boulders are better kept out of the irrigation system as they block intakes and canals, thereby reducing the diversion and distribution capacities. The Waltane scheme is managed by water committees. Though not well documented, the communities have agreed rules whereby water is shared and maintenance activities including sediment removal is collectively undertaken.

Traditional spate irrigation practices, on which the marginalized poor community mostly rely, are labour intensive and require frequent maintenance. Hence, such systems ultimately require modernization which is often welcomed by the community and perform better than the traditional system if it is implemented in consultation with the community.

Challenges in modernizing traditional spate irrigation scheme

Some of the challenges in spate irrigation systems that are reflected by the supervising engineer, Ato Dereje, who guided the visit are:

- Lack of experience by young engineers with regards to spate irrigation concepts, design and implementation. As a result, Waltane and other spate irrigation schemes in the region are designed and implemented as perennial irrigation systems. In this respect Waltane was also designed as perennial irrigation system. The modernized diversion at Waltane is planned to supplement 3,000 ha. Compared with the runoff resources in the Wadi and principle of spate irrigation system to divert manageable maximum flood within shorter period of time in to the command area, the capacity of the design canal is too small. Figure 23 displays the cross-section and the main canal.

Figure 22 : The modern diversion structure to be built across the Waltane river, explained by Ato Dereje, supervisor of Waltane irrigation project

- Construction quality: The assigned supervising engineer from the Water, Mineral and Energy Bureau along with the members of water users association at the scheme are working hard to maintain the required quantity and quality of the construction materials. However, this is often challenged due to the lack of technical capacity and maximum profit oriented ideology of the contractors.
- Missing the concept of multiple use of water in the design: the Waltane wadi not only supports crop production but also domestic water use and water supply for animals. This at least supports the community and livestock around Waltane not to travel more than three hours in the driest period of the year. The concept of multiple use was not given proper attention. One negative consequence is that the masonry diversion structure will limit the subsurface flow. This will significantly curtail the shallow groundwater for domestic supply.

Capacity and research building needs

Capacity building: There is a need for long-term comprehensive training for the young engineers and construction supervisors on how best to utilize the seasonal flow for spate irrigation, groundwater recharge, and rangeland development . In addition, the farmers and woreda water and agriculture extension staff also need to get training focusing on operation and maintenance.

Research on optimizing multiple water use and eventually use the finding for training purpose: Considering multiple water use in the development plan can sustain the whole seasonal flood water use system: The study and implementation in the seasonal flood use need to consider all sorts of water uses in a Wadi within the river basin context. In addition to the general knowledge by the experts, thorough discussion with the community helps to easily trace their important and basic water use. The visited modernization plan at Waltane spate irrigation scheme considers only the water use for crop production, hence the domestic water use and rangeland development plan need also to be considered. In the discussion it was agreed that, the domestic water supply from dry

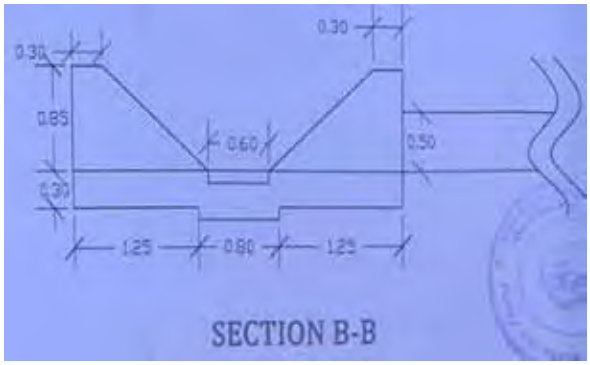

Figure 23: Cross section of a main canal for the modernized Waltane supplementary spate irrigation scheme (the intake located around 7058989.00 m E, 1023893.00 m N).

wadi through building sand-dams and water lifting mechanisms increases the water supply access in quantity and quality. Livestock is also an important sector for agro-pastoral livelihoods, hence, rangeland development needs to be also addressed so that the modernization will be complete and also sustainable.

Organizations supporting the region and their activities

The West Hararghe Water, Mineral and Energy Bureau studied the Waltane traditional spate irrigation system before three years. However, it was difficult to get the funds for implementing the project. It now looks likely that IFAD, the only organization interested in funding spate irrigation development in the region, will support the modernization of the four spate projects in Waltana.

4.2 Haramaya University: IPAS –Institute of Pastoral and Agro-Pastoral Studies

General information

The field research team made extensive visits to the laboratories, libraries, class rooms and other facilities of Haramaya University. Discussions were held with Dr. Chemeda, the Academic Vice President and Dr. Fikadu, the Administrative and Students Affairs Vice President. Haramaya University has good education facilities as well as extensive agricultural field, livestock breeding and dairy farms for research activities.

The discussions focussed on the double degree MSc programme between Haramaya University and UNESCO-IHE, and the capacity of Haramaya University on research and training related to pastoral and agro-pastoral issues. The double degree programme, in addition to graduating MSc students, it will have the added benefits such as experience sharing between the two institutions and fostering long-term partnership. The other issue discussed is IPAS (Institute of Pastoral and Agro-Pastoral Studies). It was established with funding from Nuffic in the last five years. Though it did not develop into full-fledged curriculum, several MSc research programmes and short-term trainings were conducted focusing on the pastoral and agro-pastoral issues.

Capacity building needs

Through strengthening of IPAS, including curriculum development and full integration of the programme in the university system, and establishing a close partnership with the Afar Pastoralist Institution at Semera, the Haramaya University could become a key regional player.

4.3 Awadi Jitu spate irrigation scheme

General information

Awadi spate irrigation scheme is located at (461352 m E and 814677 m N) within Ido Jigesa kebele, Arsi Negele woreda, West Arsi zone in the Oromia regional state. The Awadi Jitu seasonal river that flows for about half a year is the main source of irrigation and domestic water supply for the Ido Jigesa community (figure 24).

The scheme was pioneered by a single farmer in 1982, but soon attracted the attention of several agro-pastoralists and by 1992 there were already 30 farming individuals with about 30 ha cultivable land. The scheme continued to expand and in 2012, it was home for 68 land owners sharing flood water through three branch canals (figure 25) and another 210 beneficiaries with 310 ha rain fed area.

The branch canal that is currently serving 20 households (figure 25) crosses the seasonal river with the flume (figure 26) to irrigate the command area on the other side of the gorge. The flume was designed and constructed by the farmers. It was originally made of wood and has served for a decade before it was 2 years ago replaced by metal with funding from the Japan Agency for International Cooperation (JICA).

Land and water sharing arrangements

The land distribution system is unique and effective. Unique as the 68 land owners (12 are female) are required to share their irrigated land with the other 210 beneficiaries. Effective because it has for many years guaranteed that all the 210 beneficiaries harvested irrigated crops.

Three main rules form the pillars of the land distribution system:

Figure 24: Multiple use of Awadi Jitu spate flow

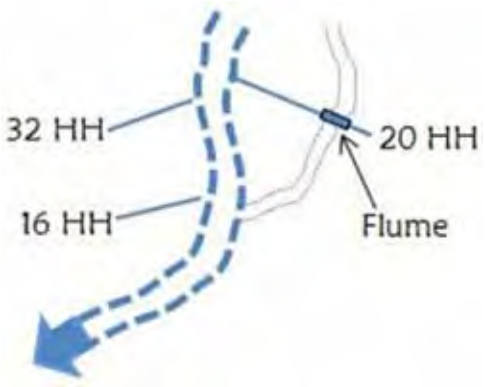

Figure 25: Layout of the Awadi Jitu river and branching canal system, HH refers to "household"

- During dry flood season (the stones on the river bed are visible, figure 24), each household is allocated one eighth of ha. In a good season when the stones are fully covered, a quarter of ha is provided to each household.
- This implies that the land owners should share their irrigated fields. In return, he or she receives an equal piece of rain fed area.
- The land owner can refuse to offer a part of his irrigated land, but the Water Users Association (WUA) in charge of water distribution will deprive him or her of any spate flow and he or she has to fully rely on rain fed agriculture.

At scheme level, a three-member WUA composed of a chairperson, a secretary and a treasury, is responsible for conflict mitigation and water distribution between the three branch canals. Each branch canal has a committee responsible for water distribution within its command area. The chairman of the WUA in consultation with the branch canal committee leaders decide on the irrigation scheduling which fluctuates between rotational in the dry period and proportional in the good flood season. The 12 female land owners are given priority to irrigate during the day time.

Livelihood systems and issues to be addressed

The Awadi community usually harvests sufficient rain fed crops (sorghum, wheat, teff), but is occasionally threatened with food insecurity due to underutilization of the large spate flow that occurs during the rainfall season when it cannot be spread over the land to produce the irrigated crops (onion, potato, pepper and cabbage).

Figure 26: : Flume on branching canal to cross a gorge

Figure 27: Chairman of the WUA and Awadi Jitu community discussing spate flow management issues

The Chairman of the WUA (shown in figure 27 in black suit making a hand-gesture) summarized their capacity building and development needs as follows: 'We have water, labour; what we need is know-how and financial resources to construct ponds so as to harvest the large spate flow during the rainfall season that is passing by and joining Lake Shala.

Organizations supporting the scheme and their activities

Apart from the limited support by the local government in the form of advice on different farming practices and organisational aspects, JICA is the only international development organization that has ever visited the scheme. Despite the various development promises including construction of ponds, however, JICA staff never paid a follow-up visit.

4.4 Bura spate irrigation scheme

Bura spate irrigation scheme has its watershed in the nearby Shashemene town and the surrounding area. It is located at 444500 m E and 803881 m N. The diversion structure (figure 28) is constructed across the Bura seasonal river. The intake is aligned at 90 degrees to the diversion structure in order to reduce sediment deposition.

Figure 28: Bura diversion headwork


Figure 29: Sediment in the canal of the Bura system

The sediment removing mechanism at the main diversion is innovative. It has three scour sluices, one is adjacent to the intake sill, the second and the third are at about 50 m and 100 m from the intake along the main canal. There is also a spillway or a rejection weir at the downstream of the intake before reaching the second sluice gate. The purpose of this rejection weir is to discharge excess flood back to the river.

The sluice gates have been successful in alleviating the sedimentation problems at the main diversion and along the main canal stretch until the location of the third sluice gate. Thereafter, however, the main and branch canals are heavily silted (figure 29).

The Bura scheme is currently being modernized. The work at the main intake and canal system is complete. But there is still construction going on in a number of branch canals. The farmers have requested that reservoirs be part of the modernization. This is because the flood season and the rainfall period coincide. Therefore the benefit from direct diversion of flood water is limited. The construction of reservoirs was not included in the original modernization plan.

There is a Farmer Training Center (FTC) with a canal network for flood water supply to the agricultural demonstration site. The FTC however is at an infant stage. It has no proper training and demonstration facilities. Currently only one farmer on his own initiative is growing spate irrigated onions (figure 30).

Capacity building and issues to be addressed

- The modernisation needs to be completed with surface water reservoirs and handed over to the farmers.
- The FTC needs to be equipped with basic training facilities and competent staff.
- Training need to be given for farmers, developmental agents, woreda water and agriculture staffs - on operation and maintenance, field water management, moisture conservation, agronomy and marketing.


Figure 30: Left: Farmer training Center at Bura; Right: A farmer initiated spate irrigated onion

4.5 The famous Borona well, "Ella"

General information

Wells, locally known as Ella, are the lifeline for the Borona pastoralist communities and their livestock. Borona is located in the southern part of Oromia region, about 200 km from the Kenyan border.

There are two types of Ellas, namely Tula and Adadi. Tula is a large well serving up to 600 animals daily and Adadi is the smaller well serving 20 to 30 animals each day. Adadi is typically located near the base of the livestock and is reserved for the weak animals that cannot join the herd to travel longer distances in search of fodder and water.

The Ella, particularly the Tula, has three main components. These are:

A. Kayena, the main body of the well.
B. Fechana, an intermediate storage.
C. Naniga, the livestock drinking pitch (figure 31).

The Borona community: the real groundwater specialists

The Borona pastoralists have long history and experience in accurately locating the potential sites for Ella. They also have centuries old traditional Ella water management system led by respected elderly member of the community. This wealth of experience has earned the Borona pastoralists the nick-name "real groundwater specialists".

Figure 31: The three main components of Ella: A-"Kayena", B-"Fechana" and C-"Naniga".

Ella Jarso is the famous well in Borona sitting at a depth of 38 m. It was constructed in a site considered unsuitable by a renowned hydrogeologist. It took one year for 100 strong men of the Jarso community to complete. Two barrels of fuel and old car tires worth 7,000 Birr were used to break the massive rock layers that were frequently encountered.

Major problems of the traditional wells:

- Collapse of livestock corridors - the passages to the well (figure 32 left).
- Lifting water is laborious and hence low well efficiency. In 30 m or deeper wells up to 16 people line-up to bring water from the Kayena to Naniga (figure 31).
- Unstable stands for people lifting water from Kayena to Naniga, occasionally people fall down and risk drowning.
- Collapse of the well itself during heavy rainfall.

Suggested remedial measures

- Embankment protection of the long gently sloping livestock corridors (figure 32 right).
- Concrete enforcement of the three main components of the well - Kayena, Fechana and Naniga. This avoids collapse of the well but also provides stable stands for lifting water.
- Alternative water lifting devices including pumps.

The South Rangeland Development Unit (SORDU) in Borona has competent staff and has rehabilitated some wells in the region as per the first two suggestions listed in the above. The very existence of the SORDU is, however, currently being threatened due to chronic underfunding. It is worthwhile providing the necessary financial resources to keep this important Unit in business and even strengthen it further with additional human resources.

Figure 32: Left: Unprotected embankment of livestock corridor and Right: Protected embankment of livestock corridor.

4.6 Opportunities for development

The following priority Investment programmes, capacity building and research packages along with their indicative investment costs are prepared based on the extensive discussions with government officials, farmers and NGOs working in different parts of Oromia as well as drawing on similar activities from other regions of Ethiopia and other countries.

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1.	Small-holder and women-friendly technologies for processing dairy products	Identify local distributors and disseminate alternative affordable milk processing technologies	Rayitu Woreda (33,169 inhabitants) and Arero Woredas (48,126 settlers) in Bale and Borona administrative zone respectively; whose livelihood purely depends on livestock rearing	20 Euros per milk churner.	The cost is based on the actual price of the technology in Pakistan
2.	Establishment of cooperatives and strengthening of farmer organizations	Prepare a tailor-made strategy and step-by-step process that addresses organizational, management and financial aspects of farmers organizations	As in the above	40,000 Euros per farmer organization/cooperative: includes salary of one international (part time Involvement) and two local guiding staff	Deducted from actual cost of carefully implemented two year WUAs stablishment programme in Yemen
3.	Establishment of multipurpose flood-based irrigation systems for crop, range land and forage production, groundwater recharge and surface water storage for domestic and livestock use	Design and construction of flood diversion and distribution structures, main and secondary canals Command area development (land levelling and proper cultivation) using appropriate machinery such as small tractors; soil moisture conservation systems including field bunds and overflow control structures	In the lowland areas of Oromia, especially those in Hararge, east Shawa, Arsi, Bale, Borona and Guji zones, where flood-based farmins is being practiced with also strong suport from the government Borona zones where there is high potential in seasonal/ intermittent flood resources, huge land potential and some experiences of flood storage, water wells and farming along river bank	500 to 1,000 Euros/ha for gabion and earthen canal network; 1,000 to 2,500 Euros/ha for concrete/ masonry infrastructure 250 to 500 Euros/ha	These are total costs covering design and overhead – they are based on actual cost of structures constructed in Tigray region. The main factors that cause the difference between the higher and lower costs are the cross section of the weir and canal dimensions Estimate based on similar work done in Pakistan. The highest costs refer to areas where is large level difference between adjacent fields and hence require orifice and stilling basins

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
4.	Water harvesting: reservoirs/ ponds and wells for livestock, domestic and agricultural use	Mapping the water resources potential (surface, groundwater) and planning for its appropriate use Construction of reservoirs/ ponds Rehabilitating the existing wells "Ella" to reduce collaps during flood and enhance accessibility Construction of hand dug wells, shallow and deep wells	Borona and other zones where seasonal rivers are the major source of water supply as well as there is experience with groundwater use Deep wells in the lowland areas where there is surface water resource. Deep well for crop production, domestic water uses and forage production have already started at Borona zone	Reservoirs/ponds: 4 Euros/ m^3 –earthen, 60 Euros/m^3 - Masonry with plastering Wells with capacity to serve up to 300 livestock per day: 4,000 Euros/well Wells with capacity to irrigate up to 3 ha of land: 4,000 Euros/well Deep wells with capacity to irrigate 30- 70 ha of land: 5,000 Euros/well	Reservoirs: derived from actual costs of similar works by Oromia Water Resource Bureau, Ethiopia Wells: inferred from actual cost of similar work by SORDU, Borona, Oromia Deep wells: inferred from actual cost of similar work done in Tigray
5.	Establishment and/or strengthening of existing demonstration sites and farmers training centres	Construction of basic – one room farmer training centre with s some basic training facilities including television and videos set to watch documentaries on various irrigation and farming experiences Prepare demonstration land/ site for adaptive research on improving horticultural, forage/rangeland crops; fattening of livestock, particularly small ruminants	At least one farmer centre in each zone	50,000 Euros per farmer training and demonstration site	Rough estimate based on discussion with staffs from Awash woreda and other areas of Afar region ,Borona and other areas of Oromia region, Konso woreda and other woredas of SNNP region

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
6.	Establishment of cooperatives and farmer organizations	Prepare a tailor-made strategy and step-by-step process that addresses organizational, management and financial aspects of farmers organizations Implement the strategy and establish farmers organizations/cooperatives	Sites should match with sites where physical intervention is made	40,000 Euros per farmer organization/cooperative: includes salary of one international (part time involvement) and two local guiding staff	Deducted from actual cost of carefully implemented two year WUAs establishment programme in Yemen

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Tailor-made training for all stakeholders from regional to woreda and farmer level	Prepare and conduct tailor-made trainings on: • Design, construction and construction supervision of flood-based irrigation systems • Agronomy: cereals, oil, vegetable, and fruit crops • Field water management • Rangeland, agro-forestry management • Modern livestock production including fattening and basic veterinary aspects • Managing farmers' organizations and cooperatives as well as ensuring their financial sustainability	For regional professionals the Oromia water works design and supervision, Oromia water works construction and Adama University For woreda professionals: Bale, Chiro, Borona, Arsi where flood-based farming has huge potential Farmers: respective kebele (village administration office) or farmer training centres	30,000 to 70,000 Euros per one training event of a two-week period for a total of 20 participants. Cost includes salaries of at least one international and two local experts	Based on experiences of Spate Irrigation Network in similar training programmes. The lowest cost refers to training which involves limited transportation and accommodation cost of participants
2. Develop irrigation design and operation and maintenance manuals.	• Make extensive review of existing design and operation and maintenance approaches and practices. • Prepare comprehensive design and operation and maintenance manual for traditional, improved and modern flood-based irrigation stystems • Translate the manual into local languages		50,000 euros	Based on the cost of the "Guidelines on Spate Irrigation" published in 2010.

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3. Farmer to farmer and expert to expert knowledge and experience sharing	Within the country, visit by selected experts from Oromia region and farmers to gain knowledge and experiences from: • Guguf spate irrigation farmers, Tigray region: effective flood water diversion, distribution; active farmers' organization with knowledge about fair water sharing rules and conflict management systems • Borona, Oromia: rangeland management including special traditional flooding and closure systems ; rehabilitated traditional Wells: infrastructure that includes corridors for livestock passage, cascade of reservoirs to bring water from the Well to livestock drinking pitches, the traditional organization in place to ensure orderly service for up to 600 cattle per day per Well • Jandefero flood-based irrigation system, SNNP region: to learn from the local successful experience on command area development: land levelling, field bund construction; as well as the fruit tree (papaya, citrus) production systems and field water management Visit to Yemen: • Local practice and experience on multiple uses of acacia ephrebergiana (locally known as Selam tree): flowers for honey production, thorns and leaves for animal feed, stem for charcoal production extraction of medicinal value liquid locally named Keteran. • Centuries of experiences in traditional flood water management for production of cereals, vegetables and perennial crops	◦ Guguf spate irrigation system, Raya, Tigray ◦ Yabello Woreda, Borona, Oromia ◦ Yandefero spate irrigation system, Konso, SNNP Region ◦ Tihama Spate Irrigation Plain, Yemen ◦ Gash and Toker delta flood-based farming systems, Sudan	Within the country visits: ◦ 2,000 to 2,500 Euros per visit of 4-day duration with a total of 20 participants Outsite the country visit (Yemen and Sudan): 2,500 Euros per person for travel accomodation adn daily subsistence allowance, for four days	Based on similar visit organized by the Spate Irrigation Network in 2010 for participants from Haramaya to Boru Dodota scheme (500 km) Cost is deducted from actual expenses of Ethiopian farmers who attended the regional WUAs workshop in Sudan in December, 2012

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Traditional pastoralists livelihoods systems and their adaptability/ vulnerability to climate change (drought and drown)	Three MSc students conduct in-depth field research work of three month duration: • On the basis of properly prepared proposals • With supervision from one local University and Spate Irrigation Network	Three case study areas: Spate scheme in Bale zone, at Awadi Jitu and in Harerge zone	16,000 Euros for three MSc Research work Supervision and support: 3,000 Euros for three students	The local budget at universities in Ethiopia for one MSc field research is 1,500 Euros. This is insufficient for extensive field work and does not motivate students to select remote research site The experience of Spate Irrigation Network is that 4,000 Euros has provided a good incentive for in-depth analysis of complex issues in rough work environments and extensive engagement with rural communities
2. Flood water diversion, and distribution: traditional, improved and modern systems	Three MSc students make in-depth analysis of existing experiences on the design of headworks, canal networks, embankment protection works, bed stabilization interventions. • On the basis of properly prepared proposals • With supervision and support from the Spate Irrigation Network, selected staff of Arba Minch and Mekele University, and UNESCO-IHE One MSc student to do desk study on analysis of different experiences from Yemen, Pakistan and Sudan where several spate (flood-based) irrigation systems have been developed	Within Ethiopia: As in the above. Outside Ethiopia: • 'Pakistan, Balochistan and DG Khan Provinces; • Yemen: Tihama and Hadamout regions; • Sudan: Toker, Gash and KhorAbuhabil; • Some other sites.	As in the above	As in the above

	Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
3.	Field water management and soil moisture conservation	Three MSc students make detailed assessment of different land preparation, field-level water distribution structures and systems, as well as soil moisture conservation practices including field bunds construction and maintenance • On the basis of properly prepared proposals; • With supervision and support from the Spate Irrigation Network, selected staff of Mekele University, and UNESCO-IHE One MSc student to do desk study on analysis of different field water management and soil moisture conservation experiences from Yemen, Pakistan and Sudan	As in the programme 2	As in the above	As in the above
4.	Economic analysis of traditional, improved and modern flood-based farming systems	Two MSc students develop a multi-criteria cost-benefit approach suitable for flood-based irrigation systems and accordingly analyse the economic viability of different schemes leading to recommendations on how to minimize costs and maximize benefits Supervision and support will be provided from the Faculty of Business and Economics, Addis Ababa University, Spate Irrigation Network and UNESCO-IHE	Selected traditional, improved and modern schemes from the different regions	As in the above	As in the above
5.	Strengths and limitations of farmers and government institutions involved in management of flood-based irrigation systems	Two MSc students working together - document the characteristics of different farmers and government institutions; analyse their successes in managing flood-based farming and water harvesting structures and systems; recommend best institutional arrangements for different socio-economic setting and technologies.	Active farmers, government and non government institutions to be selected from the major pastoralist and agro-pastoralist zones	As in the above.	As in the above.

5 Amhara Region

The Amhara region (figure 33) is located in the north-western part of Ethiopia between 9°20' and 14°20' N latitude and 36° 20' and 40° 20' E longitude. It covers an area of about 157,121.76 km^2, consists of 11 administrative zones, a total of 113 woredas and 3,216 kebeles.

The region has three major geographical zones, highlands (2,300 m above sea level), semi-highlands (1,500 to 2,300 m above sea level) and lowlands (1,500 m above sea level). The lowlands where flood-based irrigation is practiced accounts for 30 % of the total land area of the region.

Amhara's biggest rivers include inter alia, Abay (the Blue Nile), Belese, Tekezie, Anghereb, Athbara, Mile, Kessemand Jema. Tana, the biggest lake in Ethiopia and the third largest in Africa, is located at the heart of the region. It has an area of 3,620 km^2. The other lakes in the region, Ardibo and Logo cover 75 and 35 km^2 respectively.

Figure 33: Regional State of Amhara (Ministry of Water and Energy, 2012)

During the field research different flood-based irrigation systems were visited and seasonal rivers with vast potential irrigable command area were identified. To collect relevant information about the background and existing situation of the schemes and rivers, discussions were made with farmers and development agents. The outcome of the discussions and field observations are presented in the following sections.

5.1 Gobu scheme

Description of the project area

Gobu spate irrigation scheme, also referred to by the local community as "Adina Melie", which means "life saving canal", is administratively located within the Amhara region, north Wello zone, Raya Kobo Woreda along the border with Tigray region. Geographically, the scheme is situated at 1352370 N, 0559512 E and 1571 m above sea level.

The visit to the Gobu scheme started with a meeting at the Raya Kobo Woreda Agricultural and Rural Development Bureau to get an overview of the agricultural development in the area with emphasis on flood-based farming systems. The team was then accompanied by Mr. Sisay Akele for field visit where extensive discussion was conducted with several men and women farmers. Mr. Sisay is irrigation agronomist by specialization and prior to his promotion to Head the Raya Kobo Woreda, he has worked for several years as a Development Agent (DA) at kebele (village) level when he gained valuable field based experiences.

Gobu had two schemes that were traditionally used for many years by the local community as the major sources of livelihoods. The spate flow was then diverted using bunds constructed from shrubs and earth materials. While one of the traditional schemes was completely damaged by large and uncontrollable floods and became out of use, the other had a better fate and was modernized in 2011. The modernization was demand driven as it was initiated by the beneficiaries who found themselves unable to cope with the daunting task of managing the floods with their traditional structures. The feasibility study and design was conducted by experts from the Amhara Regional Bureau and the construction of the headwork was eventually completed in June 2004 (figure 34).

Figure 34: The Andina Mellie headwork structure

The headwork is an open off-take type with a three meter deep cut-off buried across the whole width of the wadi. The purpose of the cut off is to maintain levels between the river bed and the canal off-take equal, thus enabling diversion of water to the command area. The design irrigation capacity is around 60 ha and this is sufficiently irrigated in good rainfall seasons. During the field research, the pros and cons of the scheme were discussed and the farmers shared several valuable observations:

- The cut-off structure is perfectly located and built and is properly fulfilling its function of making sure that the flood water is effectively diverted to the canals.
- With regard to the scheme layout and location, it would have been nice if the retaining wall was made with smooth curve that reduces the flow velocity and hence the impact force on the retaining wall.
- The retaining walls are constructed using stone masonry; they are not reinforced with concrete and are hence susceptible to damage by medium and large floods. This is the main reason the retaining structure built to protect the right bank was severely damaged during the 2010 flood season (figure 35).
- Their involvement during the planning, design and implementation of the modernized scheme was very limited and they have not had the opportunity to make substantial inputs.

The farmers agreed that the modernized scheme is superior to the traditional system they had and that the above observations are meant to further improve the headwork and related infrastructure. They did not hide the fact that their expectation was very high as they believed that schemes constructed with the full technical and financial support from the regional government had to be perfect.

The rainfall in the area is bimodal. The main season, locally referred to as Kremt, spreads from July to August and this is the period when much of the rainfall events occur. The minor season, the Belg happens from February to April. The rain fall pattern in both seasons is very erratic and unreliable. Kremt usually stops at the crop yield formation stage and the amount of rain received during Belg is in most cases insufficient to fill the crop water demand gap. Therefore, supplementary spate flow generated by heavy rainfall in the upper catchment is vital for reducing the high risks of crop failure. The spate flow discharge estimated in the main canal during the field visit on October 17, 2012 using floating method was 350 l/s. At even a very low overall scheme efficiency of 40 %, this flow is sufficient to provide the much needed additional irrigation for the 60 ha currently cultivable land.

Livelihoods system and strategies to cope with uncertainties

The estimated 1,400 inhabitants of the area directly and indirectly depend on the scheme for their livelihoods. The average landholding per household is 0.25 ha and all inhabitants contribute in different forms of labour and cash to the maintenance of the irrigation structures.
As an adaptation to the erratic nature of rainfall and uncertainties about the duration and amount of spate flow, the farmers have in stock crop varieties with growth periods ranging from 60 to 120 days and varied degrees of tolerance to drought conditions. When early signs are good and rainfall already begins in June, they opt for the long variety of sorghum, teff and maize while they can still grow as second crop the short duration varieties along with chickpea, which is drought tolerant. In times of shortage and uncertainty triggered by failure of early rains and the subsequent shift of the planting period to September, the farmers make use of their short duration varieties. When water is plenty - good rainy season and an equally good flood period, onions and other vegetables are grown to generate some additional income.

Teff, onion, chickpea, maize and sorghum constitute the total menu, but the crops usually grown are maize, sorghum and teff. There are two local varieties of teff, namely Buni (brown) and Magna (white). Buni has a short growth cycle of 60 to 65 days, but is less marketable as compared to Magna

Figure 35: Main canal breached (left) and open off take structure showing the toppled retaining wall

that needs a total of 110-120 days. With regard to sorghum, the two common varieties are Dingata/Jebudi, this is white in colour used for preparing the local bread (enegera); and Abola/Degait, a common ingredient for local drink (tela) is red and relatively less tolerant to drought.

While crop production is the major source of livelihoods, livestock sector is a significant contributor. The community have not, however, yet developed any strategies to cope with uncertainties for the rangeland areas; the productivity is entirely dependent on the erratic rainfall.

Having in place an agreement of water sharing with their downstream neighbours who rely on one modern irrigation scheme (Gobu 2) and several traditional systems, is also on itself another effective coping strategy. It maximizes benefits from the available floodwater by avoiding vehement conflicts that could potentially lead into unfortunate deliberate destruction of infrastructure depriving all farmers of any irrigation. The water sharing agreement stipulates that in good years when there is substantial flow, the Adina Melie upstream users have the priority to irrigate their field, but in bad years, the small flow is set aside for the domestic (both human and animal) water supply for the downstream communities.

The overall Water management in Adina Melie scheme is handled by water committee with seven members, as WUA is not yet established. The responsibilities of the committee are:

- To mobilize farmers for operation and maintenance.
- To resolve conflicts and problems arising (if any).

Major problems and solutions suggested

Though the area is known for its good potential of flood-based farming, it has many problems:

- There is a very severe shortage of rainfall and spate flow for irrigation, domestic and livestock water supply.
- The open off-take site selection is not appropriately done. I. e. it exposes masonry retaining wall to direct flood impact.
- Sedimentation of off-take and canal structures and breaching of the main canal is a problem.
- The side wall of the main canal (figure 35) is not protected against flood especially around the diversion axis. If protective measures are not taken timely, the main canal would collapse very

easily.

- The scheme lacks demonstrations for capacity building of farmers such as involving and showing farmers the benefit of developing rangeland areas.

The solutions proposed are:

- The uncertainty related with insufficient rainfall and discharge can be reduced by constructing communal ponds.
- While changing the location and orientation of the open off-take may lead to a better spate flow supply, a more practical and implementable recommendation would be re-enforcing and strengthening damage susceptible sections of the retaining wall and the open off-take.
- Introduction of scour sluice and modification of canal slopes and dimensions are necessary to reduce sediment problems. Experiences from SNNP and Tigray regions; Sudan and Yemen have shown that best slopes for flood-based irrigation systems range from 0.1 % to 0.4 % (Mehari, et al., 2011).
- The illegal breaching of the main canal can be solved by providing siphons, gated turnouts and using manual pumps.
- The sidewalls of the main canal should also be protected using gabions - there is a wealth of experiences on this in Yemen that we could draw upon.
- To rehabilitate the abandoned off-take, the regional government should assist the beneficiaries in designing and constructing of the damaged structures.
- Upgrading the water committee into WUA would be beneficial in terms of:
  - Having legal entity to borrow and lend money.
  - Making bilateral relations with local development organizations.
  - Collecting money for small maintenance, buying selected seeds and fertilizers.
- The farmers should be trained on alternative rangeland management and development as well as build upon their knowledge on agronomy and crop selection and farming practices through exchange visits to other schemes such as the ones in the Raya Valley in Tigray region.

5.2 Alewuha river diversion

Description of the project area

Alewuha river is situated 15 km N of Weldia town in Amhara region. The modern diversion weir constructed of concrete in 1995 has two scour sluices. The length of main canals reaches up to 4 km.

Livelihoods systems and major issues to be addressed

The livelihoods of the area mainly depends on agriculture and rearing animals. Major crops grown are maize, sorghum, and onion. The river is used to support crop production with some kind

Figure 36: View of the Alewuha scheme

of modern and traditional irrigation systems. According to the information obtained from Mr. Mulugeta Cheru, a Development Agent (DA), around 178 farmers are benefiting from the modern irrigation diversion system from the river while 118 farmers are irrigating using the traditional diversion system. These farmers have a cultivated land that ranges from 0.0625 ha up to a little more than one ha.

Water is sufficient for the existing farms if the diversion and canal network of the scheme works properly. On the other hand, there is more potential land suitable for cultivation, which could demand more water to bring these unexploited lands under irrigation.

Based on the discussion with Mr. Mulugeta and local farmers, as well as observations of the field visit team, the following problems were identified:

- Despite the unreliable and short duration rainfall, no supplementary irrigation is being practiced during the rainy season due to near-complete blockage of the canals by huge sediment deposition and lack of operational scour sluices. Farmers spent a lot of labour and time to dredge the sediment manually (figure 37).
- Water fee is based on the size of irrigated land - farmers with the same size of land pay the same fee regardless of the crops they grow and the quantity of water they use. This does not provide any incentive for water saving practices.

Solutions suggested

- Research based intervention in order to control the serious sedimentation problem in the scheme and improve its performance. Silt trap, stilling basin or any other sediment management option at canal level is necessary.
- Water fees should be based on the amount of water used or as this may be difficult to estimate, the payments should vary depending on the type of crops grown.
- A detailed feasibility study is imperative on the suitability of the area for spate (flood-based) irrigation and the possible interventions to be made.


Figure 37: Farmers dredging sediments from the Alewuha canal

5.3 Golina river

Description of the project area

Golina river is located in a small town called Golina (between Robit and Kobo) found in Amhara Regional State, which is 4 km before Kobo on the way to Mekele. A concrete diversion structure (figure 38) is constructed with the mind-set of perennial irrigation design (small canals with no sediment control and management structures). Consequently the weir and canals only divert the base flows irrigating a maximum of 400 ha (potential is estimated at 800 ha) while the medium nondestructive floods are completely unutilized.

Livelihoods systems and major issues to be addressed

The livelihoods of the area depend on agriculture and rearing livestock. Mango, avocado and papaya are the major perennial fruit trees cultivated. In some years, when the base flow is substantial and additional irrigation is possible without affecting the productivity of the fruit trees; tomato and onion are among the major crops normally grown. The current landholding per household varies from 0.125 to 1 ha - this could be increased if the additional 400 ha of land is brought under irrigation by utilizing some of the medium floods that are currently flowing untapped.
The farmers explained that after some years of service the diversion structure had deteriorated and the maintenance made by some local construction companies has been below standard. As a result, the reinforcement made as part of the maintenance activity collapsed shortly after construction. The main reason for collapse of the structure include: inadequate reinforcement bars and poor quality of concrete and incompetent personnel.

During the discussion held with the farmers, and this was spearheaded by Moges Deje and Alemu Melese, the following major problems were outlined:

- Frequent damage of diversion structures due to the high impact of floods.
- Limited scientific support towards improving the traditional way of practicing agriculture.

Figure 38: The Golina river diversion scheme

- No communication with farmers during planning, design and construction of structures.
- Erosion of canal banks.
- Tearing and wearing of gates.
- Weak construction material and lack of transparency of the contractors.

Among the key solutions suggested by the farmers were:

- Capacity building for the local community and local contractors on operation, maintenance and (re)construction of diversion structures and canal-networks.
- Involving farmers' representatives in every aspect/activities towards improving or introducing irrigation practices.
- Remodelling the diversion structures in such a way that medium floods could be diverted and the exiting additional 400 ha could be irrigated.

Solutions suggested

- Introducing the concept of spate irrigation could help farmers irrigate more area as well as improve their productivity. Modification in the canal dimensions should also be considered in order to improve the carrying capacity of the canals.
- The farmers practice of controlling pond sedimentation (i.e. putting a zinc barrier across the direction of flow so that the silts are trapped and relatively clear water pass over the zinc crest, a kind of silt trap) should be supported by scientific knowledge.

Capacity building needed

In all the schemes and sites identified in Amhara region, capacity building on the following aspects is essential for better livelihoods of the beneficiaries.

- Trainings on engineering aspects of flood-based farming that address the pitfalls of perennial irrigation design and their subsequent negative impacts outlined in the above.
- Upgrading the skills of local contractors and construction supervisors tailored at good quality

work with regard to repairing or (re)constructing structures thereby minimizing frequent damage to weirs and canals and hence loss of precious spate flow

- Establishing viable WUAs with the capacity to develop and implement fair floodwater sharing arrangements that also mitigate conflicts

Concluding remarks

The followings are taken as concluding remarks:

- In the region, there is good potential for flood-based farming. Besides the schemes presented in the above, several other seasonal rivers such as Wuchale, Wurgesa, Mersa and Robit were observed during the field visit. Therefore, efforts should be made to make use of these water resources by putting in place appropriate infrastructure and management system.
- Capacity building on flood-based farming engineering at woreda/regional level is crucial, as many of the existing systems are designed based on the principles and approaches of perennial irrigation that only consider the small base flow neglecting the medium floods, which could be safely guided to irrigable areas.
- The region has several river systems with non-stony river beds and adjacent gently sloping cultivable areas where flood spreading weirs could be viable options. It is imperative to ensure that the wealth of experience on flood spreading weirs from West Africa is shared with the farmers and woreda and regional officials.
- Construction and supervision is not as strong as it should be. Hence, contractors and supervisors should be involved in the capacity building programs in order to ensure good quality irrigation infrastructure able to withstand the impact force of the design flow.

5.4 Opportunities for development

On the basis of the extensive discussions with government officials, development agents and farmers; drawing on similar activities in other regions of Ethiopia as well as well as other countries, the priority investment programmes, capacity building, and research packages along with their indicative investment costs are as follows.

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1.	Empowering women and the elderly	Small scale irrigation for crop production from construction of ponds, shallow and deep well groundwater development Fattening of small ruminants and selling them during festivity occasions	Kemise, Raya Kobo; there is potential and experience of deep well based irrigation development for crop production	€ 1,000 per one household or per a quarter of a ha	Cost is based on similar women empowering small scale vegetable production work done in Yemen with the World Bank food security programme.
2.	Establishment of flood-based irrigation systems for multiple use: crop production, rangeland development, groundwater recharge	Design and construction of flood diversion structures (headwork or flood spreading weirs), distribution structures (main and secondary canals) Command area development (land levelling and proper cultivation using appropriate machinery (small tractors); soil moisture conservation systems such as field bunds, overflow control structures	Raya Kobo of north Wollo	€ 500 to 1,000 /ha for gabion and earthen canal network € 1,000 to 2,000 /ha for concrete/masonry infrastructure € 250 to 500/ha	These are total costs covering design and overhead – they draw from the actual cost of structures constructed in Tigray region. It is assumed that the farmers and the local government will contribute the labour requirement. The main factors that cause the difference between the higher and lower costs are the cross section of the weir and canal dimensions Estimate based on similar work done in Pakistan. The highest costs refer to areas where there is large level difference between adjacent fields and hence require orifice and stilling basins.
3.	Establishment of cooperatives and strengthening of farmer organizations	Develop a tailor-made strategy and step-by-step process that addresses organizational, management and financial aspects of farmers organizations Implement the strategy and establish new cooperatives or strengthen the already established farmers organizations	Sites should match with sites where physical intervention is made	€ 40,000 per farmer organization/cooperative: includes salary of one international (part time involvement) and two local guiding staff	Deducted from actual cost of carefully implemented two year WUAs establishment programme in Yemen.

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
4.	Water harvesting: reservoirs/ponds/ wells for livestock and domestic use	Construction of reservoirs/ponds Mapping ground water potential and constructing wells including community hand dug wells	The whole region	• Reservoirs/ponds: earthen (€ 4 /m^3), masonry with plastering (€ 60/m^3) • Wells with capacity to serve up to 300 livestock per day: € 4,000/well • Wells with capacity to irrigate up to three ha of land: € 4,000 /well • Deep wells with capacity to irrigate 30- 70 ha of land: € 5,000/well	Derived from actual costs of similar reservoir design and construction works by Oromia Water Resource Bureau, Ethiopia. Inferred from actual cost of similar well rehabilitation work by SORDU for livestock , Borona, Oromia Inferred from actual cost of similar deep well development for irrigation work done in Tigray
5.	Establishment and or strengthening of existing demonstration sites along with farmer training centres	Construction of basic one room farmer training centre with essential training facilities including television and videos set to watch documentaries on various irrigation and farming experiences Prepare demonstration site for adaptive research on improving horticultural, forage/rangeland crops; as well as fattening of livestock, particularly small ruminants	At least one farmer training and demonstration site in each zone	€ 50,000 per farmer training and demonstration site	Rough estimate based on discussion with staff from Awash Woreda and other areas of Afar region; Borona and other areas of Oromia region, Konso woreda and other woredas of SNNP region

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Tailor-made training for all stakeholders from regional to woreda and farmer level; universities and TVETs in the region	Prepare and conduct tailor-made trainings on: • Design, construction and construction supervision of flood-based irrigation systems • Agronomy: cereals, oil, vegetable, and fruit crops • Field water management • Rangeland, agro-forestry management • Modern livestock production including fattening and basic veterinary aspects • Managing farmers' organizations and cooperatives as well as ensuring their financial sustainability • System operation and maintenances	• For regional professionals: Universities and TVETs in the region • For woreda: such as Kobo • Farmers: respective kebele (village administration office) or farmer training centres	€ 30,000 to 70,000 per one training event of a two-week period for a total of 20 participants. Cost includes salaries of at least one international and two local experts	• Based on experiences of Spate Irrigation Network in similar training programmes. • The lowest cost refers to training that involves limited transportation and accommodation cost of participants
2. Farmer to farmer and expert to expert knowledge and experience sharing	Selected experts from Amhara region visit in the country to gain knowledge and experiences from • Guguf spate irrigation fsystem: to learn a well-established fair water distribution system • Borona: 1) Range land management and 2) Rehabilitated traditional wells "Ellas" • Yandefero flood-based irrigation system, SNNP region: to learn from the local successful experience on command area development: land levelling, field bund construction as well as fruit tree (papaya, citrus) production systems Visit to Yemen: • Local practice and experience on multiple uses of acacia ephrebergiana (locally known as Selam tree): flowers for honey production, thorns and leaves for animal feed, stem for charcoal production and extraction of medicinal value liquid locally named Keteran • Centuries of experiences in traditional flood water management for production of cereals, vegetables and perennial crops	• Guguf spate irrigation system, Raya, Tigray • Yabello woreda, Borona, Oromia • Yandefero flood-based irrigation system , Konso, SNNP region • Tihama spate irrigation plain, Yemen	Within the country visits: € 2,000 to 2,500 per visit of 4-day duration with a total of 20 participant To Yemen: € 2,000 per person for a 10 day visit	• Based on similar visit organized by the Spate Irrigation Network in 2010 for participants from Haramaya to Boru Dodota scheme (500 km) • Deducted from the visit organized by Spate Irrigation Network in 2012 for Raya, Tigray Region farmers to Sudan

	Research Programme	Major activities	Pilot intervention site	Indicative Investment costs	Remarks
1.	Flood-based farming - status and potential and its role for food security and economic advancement	Three MSc students conduct in-depth field research work of three month duration: • On the basis of properly prepared proposals • With supervision and support from Spate Irrigation Network and selected staff of Adama University	Potential areas in the region such as the Gobu, Golina and Alewauha weir systems	€ 12,000 for three MSc Research work Supervision and support: € 3,000 for three students	The local budget at universities in Ethiopia for one MSc field research is € 1,500. This is insufficient for extensive field work and does not motivate students to select remote research site. The experience of Spate Irrigation Network is that € 4,000 per MSc student has provided a good incentive for in-depth analysis of complex issues in rough work environments and extensive engagement with rural communities
2.	Feasibility and economical implication of shifting from base-flow based irrigation to flood-based farming	Two MSc student in close coordination with the Amhara region irrigation agency and supervised by UNESCO-IHE, Ethiopia Spate Irrigation Network and staff from a local university assess the feasibility and economic gains of utilizing the river flows for full-fledged flood-based irrigation systems.	Gobu, Alewuha and Golina schemes - these are easily accessible - there are many other irrigation systems in Amhara region where only base flow is being utilized.	As in the above	As the above
3.	Analysing the effect of watershed management and soil conservation measures in the highland areas on the base flow and water supply for flood-based farming, perennial irrigation and downstream use	Three MSc students make detailed assessment of flood magnitude and frequency changes for alternative watershed management and soil conservation interventions in the upper catchment. • On the basis of properly prepared proposals • With supervision and support from Bahirdar University, Spate Irrigation Network and UNESCO-IHE	Gobu and other river systems that have a series of both traditional and modern flood-based farming schemes, perennial irrigation and vast human and livestock population at the downstream area	As in the above	As in the above

	Research Programme	Major activities	Pilot intervention site	Indicative Investment costs	Remarks
4.	Case-study based assessment of strengths and weaknesses of different institutional models	Three MSc students: • In selected case studies, assess in detail the effectiveness of various institutional models with regard to operation and maintenance, mitigating flood damage and conflicts, creating social coherence and improving productivity. • On the basis of properly prepared proposals • With supervision and support from Wello University, Spate Irrigation Network and UNESCO-IHE	As in the above	As in the above	As in the above

6 Southern Nations, Nationalities and Peoples' (SNNP) Region

Southern Nations, Nationalities, and Peoples' (SNNP) Region is one of the nine regions located in the southern and south-western part of Ethiopia. With about 16 million inhabitants or about 20% of the total population of the country (Central Statistical Agency of Ethiopia, CSA, 2008). The region has roughly an area of 111,000 km^2 which accounts for 10 % of the total area of Ethiopia.

Geographically, the region is situated between 4043 to 80 58 N latitude and 340 88 to 39014 E longitudes. It is bordered with Kenya in the south, the Sudan in south-west, Gambella region in north-west and surrounded by Oromia region in north-west, north and east. The region has varied climatic conditions with temperature ranging from 7.5 to 27.5 °C and mean annual rainfall that varies from less than 300 to as high as 2,000 mm.

Based on inspection records from the Ethiopian Coffee and Tea authority (2008), it is reported that for 2004-2005, the region produced 100,338 tons of coffee (44.2 % of the total production in the country). According to CSA (2007), the region had an estimated 8 million or about 20.5 % of the cattle population in Ethiopia.

Figure 39: Southern Nations and Nationality Peoples Regiom Ministry of Water and Energy, 2012

Figure 40 : Field bunds

The field research covered the seasonal rivers and flood-based irrigation systems in the vicinities of Hawasa, Dilla, Yabello, Konso, Turmi, Arbaminch, Welaita, Hosana, Welkite woreda and kebeles. To collect relevant information about the status and development potential of the schemes and seasonal river systems, discussions were held with farmers and government institutions as well as local and international NGOs. The outcome of the discussion for each scheme is briefly presented below.

6.1 Yandefero – Konso lowland spate irrigation system

This section mainly reports on the main findings of the field visit and discussions held in the lowland areas of Konso special woreda where Yandefero spate irrigation system is operational. The field visit was guided by Mr Gizachew Toraito, a Water Resources Work Infrastructure Advisor. The discussions with the farmers covered spate flow management, land sharing arrangement and agronomic practices. The issues discussed with the local experts focused on the experimental trials on papaya, citrus, groundnut, sesame, maize and other crops in the Konso Research and Demonstration Centre run by the government.

General information

Yandefero flood-based farming is situated within Konso special woreda, in the Great Rift Valley at 5020 N Latitude and 36007 E Longitude. Konso is bordered on the south by the Oromia region, on the west by the Weito river which separates it from the Debub Omo zone, on the north by the Dirashe special woreda, and on the east by Burji special woreda. Based on the CSA (2008), the Konso special woreda has a total population of 235,087 and an area of 2,274 km^2. Konso could be classified as semi-arid and arid agro-climatic zone. It is about 600 to 1450 m above sea level with annual rainfall ranging from 300 to 700 mm and mean daily temperature of about 27 °C (Befekadu, 2004).

There is no well documented history on when the Yandefero spate system came to existence. The commonly shared opinion is that three decades back the Yanda river was a shallow flood canal meandering over the alluvial plain, spreading water over a large area after the rains. The current deep river only developed over the last 30 years. The change was brought about by the degradation of the catchment. This caused floods to become flashy and silt-laden. As reported in Deribe and Wuletaw (2001), there were 29 flood intakes made of tree trunks (driven in the river bed), brush wood, mud and soil irrigating a land area close to 4,000 ha. Eleven of the flood intakes date back to more than thirty years. Most of the remaining ones were developed in the last few years under food

for work programme. Recently, the Yanda river has started to degrade dramatically; going down one to two meters in large stretches. As a result, only 11 of the 29 canals are currently operational.

The land in Yandefero spate irrigation system belongs to families of the Jarso Peasant Association. Farmers do not reside in the lowland area where the spate irrigation system lies for fear of malaria and tryposomasis, preferring to live in the mid- and highlands where there are no mesquites and tropical diseases are rare. They travel 15 - 25 kms and stay in Yandefero for few nights (they sleep in trees or on hill tops to escape mesquites) at different periods of the year to prepare and irrigate their land as well as harvest their crops.

Livelihoods systems and major issues to be addressed

The livelihoods of the Konso people are based on agriculture and thus, crop production, animal husbandry and trading are dominant economic activities. The main crops planted in Konso are sorghum, maize, millet, teff and cotton. Low rainfall amounts and the distance of the settlements from the irrigable land have limited the variety of crops cultivated.

Most population of the Konso people has settled on the midlands and highlands. At the lowlands of Konso the general land slope is less than 1 % and the soils of the area are well developed (Befekadu, 2004). At present, due to high population pressure and low land productivity, the people have started to cultivate the low land area using the seasonal flood from the upper catchments i.e. spate irrigation. They had previously avoided these zones, largely because of the incidence of malaria. The terrain of these lowland zones is very different from their highland home, but with typical Konso initiative and hard work, they have attempted to harness the water flowing from the hills in seasonal rivers for use in the fertile alluvial plains adjacent to the river courses. Further details on the spate irrigation system and agronomy are presented in the next section.

Irrigation and agronomy of Yandefero

Spate flow is distributed through a well-laid network of primary, secondary and tertiary canalss. The traditional techniques used include building stone and brushwood spurs into the riverbeds to divert a proportion of the stream flow and then guide it along long narrow hand-dug canals and into the fields surrounded by soil bund. The shape of the primary canals is remarkable: rectangular, narrow and deep. The preference of Konso farmers for this shape of the canals relates to the objective of creating high velocities and hence reducing deposition of fine sediments. There is no legally recognized WUA. A traditionally established farmers' association is responsible for timely operation and maintenance, and equitable distribution of flood water.

Flood water is usually released into the fields surrounded by soil bunds through the tertiary canals for around three hours and retained in the field for three to four days to allow proper infiltration. Field bunds are typically 50 to 70 cm high (figure 40). The height of the bunds is fixed traditionally by farmers with the available labour input. This height is considered to be sufficient (with two irrigation gifts) to harvest maize yield of about 4 ton/ha from the seeded crop and 1.5 to 2 ton/ha from the ratoon.


Figure 41: Left: Maize field in Jarso kebele; Right: Solo Papaya

Maize, sorghum, and cotton are the main crops in Yandefero. There are three local varieties of sorghum that mature within four to five months. According to the information obtained from experts of the agronomy division in the Yandefero Segen Sawate Food Security Project, seven maize varieties were introduced by the project aimed at boosting the productivity of the area. However, only BH-140 variety, which, besides providing higher yields, also withstands very windy conditions, received farmers' acceptance. The other varieties, despite being high yielding, were considered inferior to the local variety (figure 41 left) because they were less tasty.

Best example of the modern varieties introduced by the Ethiopian Evangelical Church Mekane Yesus-South Western Senod (EECMY-SWS) is the solo papaya (figure 41 right). This papaya received wide acceptance among the farmers because:

- It starts yielding fruit at 50 cm height and stays productive for five years. The local variety on the other hand only provides yield for one year.
- It has thick flesh and can stay up to four days before ripening - the local variety ripens overnight and hence it is less marketable.
- It has higher sugar content - almost twice that of the local variety.

Modernization of traditional intakes

According to Befekadu (2004), Farm Africa (FA), an international nongovernmental organization based in UK with a country office in Ethiopia, has been carrying out a number of integrated development activities. These include improving intakes and constructing a gully crossing at some spate sites in Konso special woreda for the last seven years.

Figure 42: Potota diversion

The EECMY-SWS is a very recent project funding the construction of ten modern intakes in Konso woreda out of which eight are in the Jarso kebele and two in Segen kebele. These intakes are designed to irrigate a total of 5,400

ha of land. One of these intakes, the potota diversion, is already in place, whereas the rest are in different design and implementation phases.

Potota diversion

Potota diversion (figure 42) was constructed in 2004 in order to divert flood water from the Yanda river. The diversion is located at 0344373 E and 0591325 N and 912 m above sea level. The diversion weir is 1.15 m in height and 32 m in length with a downstream apron of 11 m. The intake is one sided and gated (undershot) with 80 cm depth and 100 cm length opening. According to the explanation from the irrigation expert (Mr.Gizachew Toria) the gated intake is selected for the scheme with the assumption that it could be more efficient in controlling floods of different magnitudes. The main canal is earthen with an average slope of 0.1 %.

The beneficiaries of the diversion are the communities in Jarso kebele and it is designed to irrigate 500 ha. Like most spate irrigation systems in Ethiopia, there was no discharge data on Yanda river where the Potota diversion is constructed. However, the design discharge was estimated by studying the historical background of the river and using flood marks at known locations. The diversion headwork is constructed with a combination of concrete and gabion to minimize cost and around 1.9 million birr (€ 83,000) has been invested for the masonry headwork (excluding the canals) which is roughly € 166/ha.

Concluding remarks

The farmers at Yandefero spate irrigation scheme are by far performing better in constructing field bunds and managing the flood at field level – this is bright spot where other spate irrigation systems in the country can learn from. However, the high labour requirement for bund maintenance is tedious and hindering the farmers to go for higher bund height, which could help to harvest large flood volume with one irrigation turn. Hence, to ensure more timely maintenance activity and reduce labour for field preparation, introducing small farm machinery deserves a worthy consideration.

Field based experiments involving farmers and awareness creation works are required to change farmers' perception on the new crop varieties. As a means to further improve productivity and increase household income and hence enhance livelihoods, it is recommended to diversify the existing crop menu, which is basically dominated by maize and introduce crops such as water melon and pearl millet, which are less water demanding. There is already a successful trial of short duration pearl millet in the Konso Research and Demonstration Centre. Leguminous crops such as green beans and ground nuts that have the added value of improving soil fertility are also useful. The rust on the maize stem observed during the field visit is an early indicator of degrading soil fertility.

There are dedicated hard working farmers in Konso. With some technical and financial support from government and nongovernment organizations, the farmers have the potential to produce surplus. Establishing viable farmers' cooperatives could contribute to better market accessibility and help them improve their living standards.

6.2 Kaske and Luka- Skalla-Ruri flood plains

Kaske seasonal river - in Hamer Woreda

Hamer is one of the woreda under South Omo zone. Flood recession farming is widely practiced using Woito and Omo rivers, but there are vast arid areas with limited and erratic rainfall. The use of wadis such as the Kaske could enable development of large pasture and rangeland areas and significantly improve the already fragile livelihoods of the pastoralist communities.

Kaske river (translated to English from Hamer language meaning the Sand river) is a seasonal river with typical lowland flow characteristics - flash flood with short duration (two to three hours) and high sediment concentration. The only exploitation of the Kaske river is currently in the form of hand scooping shallow wells in river bed for small-scale household domestic supply (figure 43).

The Kaske river can significantly improve the livelihood of the communities. They are currently travelling long distance in search of pasture, and this is contributing to poor health of the animals as well as the quality of the meat and dairy products. There is already a plan to develop the flat 10,000 ha Wale Kula plains adjacent to the Kaske river with appropriate intakes and distribution networks. The plan currently only envisions agricultural development. Given that the Kaske spate flow is huge (figure 44), the plan should be re-formulated to include development of the extensive flood area suitable for rangeland. In the Hamer woreda, livestock is the main source of livelihood. There is acute shortage of forage and water supply.

Luka-Skalla-Ruri flood plain

Achi Kumbulti or Buska, Ole, Befo and Gonne are sub-basins that drain to Ansoda seasonal river. The flood from Ansoda seasonal river supports the traditional spate irrigation systems at Luka (figure 45), Shalla and Ruri flood plains. These schemes are performing well partly because they receive relatively better extension support due to their proximity to the highway and the farmers have a more settled life and hence can invest time and labour into land preparation and other important farming and agronomic practices.

Figure 43: Kaske river: Scooped water use from the sand bed of the river

Maize, sorghum, and selit (sesame variety introduced by government extension services) are the main crops in the area. The planting period is in January and February, following the rainfall period and the crops complete their growth season with floodwater.


Figure 44: "Kaske river" Sand river, about 60 m wide, and trunk transported with the flow Luka- Skalla-Ruri flood plain

Like most of the spate irrigation systems, sediment is both a blessing and a curse. The fine sediment brings fertility and builds up well-structured soils with high water holding capacity. On the other hand, the coarse sediment blocks the diversion structures and reduces the amount of flood water supplied through the intakes. It also alters the agreed equity of water sharing if varied degrees of deposition occur at the site of spate flow splitting structures (figure 46). In the field, sediment deposition can cause rapid rise of the command area eventually rendering it impossible to irrigate.

Concluding remarks

- Spate irrigation yields in Shalla, Luka, and Ruri kebeles are poor compared with that in Raya, Tigray and Aba'ala, Afar regions. The reasons are lack of effective farmers organizations, poor spate flow management and lack of soil moisture conservation practices. Hence experience sharing visits and workshops are important capacity building programmes.
- Use of the flood for producing pasture and recharging the groundwater through flood spreading and other techniques enhance the living standards of the agro-pastoral and pastoral communities. In both Bena-Tsemay and Hamer woredas, livestock rearing is an important source of livelihoods.


Figure 45: Multiple diversion of road side flood for maize cultivation, Luka kebele

Figure 46: Imbalance in water distribution due to sedimentation at the spate flow splitting structure of Luka kebele scheme

- Investing in surface and sub-surface sand dams in Kaske and other sandy river beds is among the top priorities because domestic water is in short supply.

6.3 Opportunities for development

On the basis of the extensive discussions with government officials, development agents and farmers; drawing from relevant activities in other regions of Ethiopia as well as other countries, such as Yemen, Pakistan and Sudan (Mehari et al., 2011; van Steenbergen et al., 2011 and Nawaz, 2012), the priority investment programmes, capacity building, and research packages along with their indicative costs are as presented in the table below.

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1.	Empowering women and the elderly	• Small scale irrigation for crop production from construction of ponds, shallow and deep well groundwater development • Fattening of small ruminants and selling them during festivity occasions	• Konso woreda where there is some experience of flood-based farming as well as deep and shallow well based irrigation development for crop production • Hamer and Bena-Tsemaye woreda pastoralist communities	€ 1,000 per one household or per a quarter of a ha	Cost is based on similar women empowering small scale vegetable production work done in Yemen with the World Bank food security programme
2.	Support with appropriate technology and vibrant pastoralist unions for profitable marketing of livestock and livestock products	• Assess the feasibility of some small-scale affordable technologies for processing livestock products • Initiate effective unions of pastoralists - lessons are to be drawn from the Selale Dairy Cooperative Union (SDCU) that was established in June 2001 with 512 household members and 39,000.00 birr (€ 1,700)	Hamer and Bena-Tsemay woredas. Market access is generally poor due to remoteness of the area and lack of cooperatives or unions. The middle men buy the products at very low price from the pastoralists and make unjustifiably big profit margins	• € 20 per household for butter making technology • € 10,000 seed money for establishing livestock and dairy cooperative unions	• The cost is based on actual costs of similar household level milk processing technologies used in Pakistan • The seed money assumes a total of 1,500 household beneficiaries and is inferred from the experiences of SDCU
3.	Establishment of flood-based irrigation systems for multiple use: Crop production, rangeland development, groundwater recharge	As in the Amhara region	Kaske and other seasonal rivers in Bena-Tsemay (Shalla, Argo-meda, Ruri)	As in the Amhara region	As in the Amhara region

	Investment Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
4.	Water harvesting: reservoirs, ponds and wells for livestock and domestic use	As in the above	Hamer and Bena-Tsemay woredas	As in the above	As in the above
5.	Establishment and/ or strengthening of existing demonstration sites along with agro-pastoralist training centres	As in the above	At least one farmer training site in each zone and one agro-pastoralist training centre in each woreda of South Omo zone	As in the above	As in the above
6.	Establishment and/ or strengthening of cooperatives and farmer organizations	As in the above	Should match with sites where fysical intervention is made	As in the above	Às in the above

Capacity building Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Tailor-made training for all stakeholders from regional to woreda and farmer/ agro-pastoral level	In addition to the themes and topics in chapter 5 on Amhara region: • Acquainting rural women and local artisans with how to use, repair and maintain milk churners and other small-scale technologies for processing dairy products • Design and rehabilitation of wells such that they are easily and safely accessible for livestock and humans	Besides beneficiaries outlined in chapter 5: • Rural pastoralist and agropastoralist women • Regional professionals: Universities and TVETs in the region; woreda: primarily Kobo; local non-governmental development organizations	Same amount as in the Amhara region	Same source as that indicated in the Amhara region
2. Farmer to farmer and expert to expert knowledge and experience sharing	• Selected farmers and experts from SNNPR region visit to other regions within the country (such as Guguf spate irrigation, Tigray region, Borona, Oromia region) as well as to Yemen spate irrigation systems to acquire experiences and knowledge as detailed earlier in chapter 5 • Selected rural women to visit Pakistan to gain first hand information on importance of electric milk churners and other technologies that significant reduce their workload	• Guguf spate irrigation system, Raya, Tigray • Yabello woreda, Borona, Oromia • Yandefero spate irrigation system, Konso, SNNP Region • Tihama spate irrigation plain, Yemen • Balochistan, Pakistan where electric milk churners are commonly used	As in the above	As in the above

In addition to the research programmes discussed in chapter 5 for the Amhara region, the following are specifically relevant to the SNNP region:

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
1. Pastoralists and agro-pastoralists livelihoods and their adaptability/ vulnerability to climate change (drought and drown)	Three MSc students conduct research with the objective of identifying practical measures that address the limitations and build upon the strengths of the pastoralists' strategies to cope with climate variability induced drought and drown: • On the basis of properly prepared proposals • With supervision from one local university; and the Spate Irrigation Network	Three case study areas: South Omo zone	The same amount as in chapter 5	Same as in chapter 5
2. Social and economic analyses of small-scale technologies for processing dairy products	Two MSc students assess the social acceptability and economic viability of electric milk churners and dairy product processing technologies that are widely used in rural areas in Pakistan where they have been technically effective and have resulted in significantly reducing the workload of women. • On the basis of properly prepared proposals • With supervision from the Spate Irrigation Network and selected staff of Arbaminch University	Two case study areas in South Omo zone	As in the above	As in the above
3. Field water management and soil moisture conservation	3 MSc students make detailed assessment of different land preparation, field-level water distribution structures and systems as well as soil moisture conservation practices including field bund construction and maintenance. • On the basis of properly prepared proposals • With supervision and support from the Spate Irrigation Network, selected staff of Arbaminch University, and UNESCO-IHE	As in the above	As in the above	As in the above

Research Programme	Major activities	Pilot intervention site	Indicative costs	Remarks
4. Comparative analyses of traditional versatile watershed managing institutions and the flood-based farming organizations in the lowlands	Two MSc students will make in-depth comparative analyses of the organizational set-ups, mandates and operational practices including guiding rules and regulations, main strengths and weaknesses of the various institutions functioning at different sub-basins within a watershed or catchment. The ultimate objective is to identify any useful lessons the different institutions could learn from each other and to prepare a framework for a representative watershed/catchment users' association/committee. • On the basis of properly prepared proposals • With supervision from the Spate Irrigation Network and selected staff of Arbaminch University	Yandefero flood-based farming water shed in the Konso special woreda.	As in the above	As in the above

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Annex I: Field visit team contact details

Field visit team member	Position and organization	Expertise	Email address
Kbrom Ambachew	Assitant lecturer and researcher in soil and water engenineering. Haramaya Univerity	Irrigation engineering. Conducting MSc research on spate irrigation	kibeo611@gmail.com
Birhanu Kindishih	Assistant lecturer and researcher in soil and water management, Haramaya University	Irrigation water management: Conducting MSc research on spate irrigation	b.kindishih@gmail.com
Tesfa-alem G/ egziabher	Lecturer and researcher in Spate Irrigation in wMekele University, representative and IFAD-PASIDP Tigray project Office	Spate irrigation design and management	tesfa_alemge@yahoo.com
Abebe Demissie	Senior Expert in Water Resources Management, SpN-Ethiopia	Spate irrigation design and management	abedeme@hotmail.com
Nadine, Guenther	Planning Officer, project advisor, GIZ, Germany	Agriculture/Rural Development	Nadine.guenther@giz.de
Charlotte de Frature	Professor in Land and Water Development, UNESCO-IHE, the Netherlands	Socio-economic aspects of small scale irrigation systems	c.defrature@unesco-ihe.org
Abiti Getaneh	Director of Research and Development, Ministry of Water and Energy	Agronomist	abitigetaneh@yahoo.com
Abraham Mehari Haile	Senior Lecture and Researcher in Land and water development, UNESCO-IHE, the Netherlands Cp-chair: International Spate Irrigation Network	Integrated planning, design and development of flood-based farming systems and rural livelihoods	a.meharihaile@unesco-ihe.org

Annex II: Field visit routes and locations of sites

A. *Field visit to northern and eastern lowlands of Ethiopia*

Days	Journey, km	Visit/Schemes	Night
1st day, Oct 16	Addis Ababa to Dese , 400 Km	Journey, visiting the topography and plain field on the way • There will be a stop for coffee	Desse
2nd day, Oct 17	Dese to Alamata, 200 km	Visiting Mersa (traditional spate schemes with open Off-take) - 8 Km off the road and Glance visit to Harusha(that has stable intake at the Bridge) along the road • Discussion with water offices at Kobo	Alamata
3rd day, Oct 18	Alamata to Mekele, 180 Km	Visiting Hara(completely failed spate scheme, it is the first and eye opening modernized spate irrigation scheme), • Short discussion with local gov't official at Maichew (southern Tigray Zone): • To arrange discussion with WUA on our return leg • Brief our mission	Mekele
4th day, Oct 19 Friday	Mekele to Aba'ala, 50 Km Gravel road, the route traverses from Tigray highland(2200 m a.m.s.l) to 1500m at Aba'ala plain	• One hour meeting (at 9 hrs) at GIZ regional office in Mekele • Visit Aba'ala Plain(Traditional, modern spate irrigation schemes at Zone-two of Afar region)	Mekele
5th day, Oct 20	Mekele to Weldia, 300 km	Visit and discussion with WUA at Guguf	Weldia
6th day, Oct 21	Weldia to Awash through Mile(Afar); 450 Km	Journey through Afar Crosses Awash river	Awash
7th day, Oct 22	Awash to Dire Dawa; 300 km	Discussion with the Afar's local gov't at Awash On our way to Dire Dawa either of the following two will be visited: • Me'eso Somali spate scheme, at Hardime village on the asphalt road or • Water Scoping from Wadi bed	Dire Dawa
8th day, Oct 23	Dire Dawa, Shinile, DireDawa, Haramaya U, Dire Dawa; 200 km; Gravel road between Dire Dawa and Shinile	Discussion with coordinator of shinile areas from HCS Visit Range land development in Shine woreda around Dire Dawa Visit Haramaya University	Dire Dawa
9th day, Oct 24	Dire Dawa to Adama; 400 Km	Visit Spate around Chiro (Mechawa)	AA
10th to 13th day, Oct 25 to 28	Adama and Addis Ababa	Report writing and power-point preparation	Adama and Addis
14th day, Oct 28	To GIZ office	Debriefing meeting at GIZ office, Addis Ababa	Addis

B. Field visit to southern lowlands of Ethiopia

Days	Journey, km	Visit/Schemes	Night
13 & 14	Addis Ababa to Hawasa, 270 Km	• Visit Awadi traditional spate scheme, 500 ha • Shashemene modernized spate scheme • On the way, visiting farms around lake Ziway	Hawasa
15 & 16	Hawasa to Yabelo, 300 km	Short stop along the wayand visit water uses, pasture lands etc	Y abelo
17 & 18	Yabelo to Konso, 90 km; Gravel road (good standard)	• Short stop along the way at Segenand other seasonal wadis • Visit Yandafaro spate irrigation scheme • Discussion with woreda official and farmers group at Yadafaro	Konso
19, 20 & 21	Konso to Jinka, 200 km	• Visit Kaske seasonal river (Spate potential but unutilized resources) – discussion with Dimekaworeda officials • Visit at glance to Luka, Shalla, Asonda traditional flood uses from seasonal stream – Bena Tsemay agro-pastoralist community	Turmi
22	Turmi to Arba Minch	• Visit Segen and other seasonal wadis along the way • Visiting Abaya and Chamo lakes	Araba Minch
23	Arba Minch to Hosaena, through Welaita	• Visit Arba Minch areas, • Discussion at Arba Minch University with Water Research centre	Hosaena
24	Hosainato Addis Ababa through Welkite; 150 km is Gravel road between Welkite and Addis Ababa	Visit Becho plain (Flood recession farming from Awash river)	Addis Ababa
25 to 28	Prepararion of workshop		
29	Workshop		
30	Follow-up discussion with GiZ and Newcastel University	Research and investment programmes	

Annex III: Contact details and consulted stakeholders

Name	Position	Contact	
		Mobile	Email
Mr Shukri Kedir	Chairman of the Water Users Association at Awadi Spate Irrigation Scheme, Oromia Region	0926047732	
Ms Mulunesh Balcha	Irrrigation and Drainage Expert at Shashemene woreda, Oromia Region	0913411306	
Mr Ahmed Hussien	Oromiya Regional Environmental Protection and Land Agency, Advisor on Environmental issues related to Small Scale Irrigation, Oromia Region	0911842155	
Dr Fikadu Beyene	Administrative and students Affair Vice President of Haramaya University, former director of IPAS, Oromia Region	0930074540	fbk@yahoo.com
Dr. Getachew	Seniore lecturer and researcher at Haramaya university	0930074540	
Yohannes Geleta	Irrigation Water Supply and Drainage Process Owner, Oromia Region	0911981665	yohketi@gmail.com
Mr. Dereje	Water and Soil Engineering expert, water - energy and mineral bureau, Chiro zone, Oromia Region	0913920377	
Mr Solomon Abera	Department Head and Senior Lecturer at Mekele University, Tigray Region	0914709664	bariagabre@yahoo.co.uk
Mr Haile Asfah	Adminstration of southern Tigray Zone, Tigray Region	0914785558	
Mr Gabir Siyum Hagos	Water Master, WUA leader, Guguf spate Irrigation system, Raya Valley, Tigray Region	0914168202	
Ms Kokebe Mengesha	Hydrogeologist at Alamata Woreda, Tigray Region	0914043083	koki.mengesha@yahoo.com
Mr Deresa Ali	Deputy Head of Bureau of Pastoral Agricultural Development (BoPAD), Afar Region	920547035	
Mr Ahmed Nur Salim	Irrigatuion expert in the Afar irrigation and draianage office	910160510	

Name	Position	Contact	
		Mobile	Email
Mr Teferi Mokonnen	Watershed expert of the Afar Pastoral Agriculture Development Bureau in Semera	0913911761	
Mr Eyob Megerssa	Afar Development association, Project Programme Coordinator, Afar Region	0911921187	iyobobsse@gmail.com ebirattu@yahoo.com
Mr Shikna Derso	Progressive Farmer from Aba'ala Spate Irrigation Scheme, Afar Region	0914143982	
Mr Mohammed Shumbari Guluf	Progressive Farmer from Aba'ala Spate Irrigation Scheme, Afar Region	0921972975	
Mr Ali Ahmed	Expert and acting bureau head in natural resources stream, Pastoral and Agro-pastoral Rural Development Office. Awash Fantale Woreda, Afar Region	0913918567	
Mr Ermias	Expert in natural resources stream, Pastoral and Agro-pastoral Rural Development Office. Awash Fantale Woreda, Afar Region	0911445066	
Mr Tesfaye Yirga	Team leader of the Aba'ala Woreda extension services, Afar Region	0910564482	
Mr Kebeno Feyiso	Dean of Dry Land Agriculture, Semera University, Afar Region	0912134765	
Mr Sisay Akele	Raya Kobo Woreda Irrigation Agronomy Specialist, Mersa Scheme, Amhara Region	0920595899	
Itegu Yimer	Raya Kobo Woreda Irrigation Agronomy Specialist, Mersa Scheme, Amhara Region		
Mr Mulugeta Cheru	Irrigation Development Agent at Alewuha scheme, Amhara Region	0913930596	

Name	Position	Contact	
		Mobile	Email
Mr Moges Deje	Farmer at Golina Scheme, Amhara Region	0920492965	
Mr Alemu Melese	Farmer at Golina Scheme, Amhara Region	0921959355	
Mr Dawit Bekele	Pastoralist Affair Office, Irrigation and water supply Coordinator, SNNP Region	0916130717	gobarodawitbekele@yahoo.com
Mr Gizachew Toraito	Irrigation Engineer at SWS Yandafaro Spate Project, Konso, SNNP Region	0916702788 0467730371	
Mr Mengistu	Agropastoralist, Luka kebele, Keyafer, South Omo, SNNPR Region	91673464	
Mr Gebeyehu	Early warning expert, Hamer woreda, South Omo, SNNPR	0920982561	
Dr Mekonen Ayana	Director of Water Research Center, Arba Minch University, SNNP Region	0916831052	meko_amu@yahoo.com
Ms. Hiwot Hailu Teshome	Head of Hydraulic and water resources engineering department, Arba Minch University, SNNP Region	0913166833	hhailu96@yahoo.com
Mr. Ibrahim Mohamed Ali	Head, Pastoral and Agro-pastoral Rural Development Office, Awash Fewntale	0911381953	

BMZ Federal Ministry for Economic Cooperation and Development

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IFAD Enabling the rural poor to overcome poverty

UNESCO-IHE Institute for Water Education

META META