WORKING PAPER 98

Experiences and Opportunities for Promoting Small-Scale/Micro Irrigation and Rainwater Harvesting for Food Security in Ethiopia

S. B. Awulachew, D. J. Merrey, A. B. Kamara, B. Van Koppen, F. Penning de Vries and E. Boelee with editorial assistance from G. Makombe

International Water Management Institute

FUTURE HARVEST
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Acronyms and Abbreviations

AfDB	African Development Bank
ADF	African Development Fund
ADLI	Agriculture Development Led Industrialization
AFD	French Agency for Development (Agence Française de Développement)
AMIT	Affordable Micro Irrigation Technology
AMU	Arba Minch University
ARARI	Amhara Regional Agricultural Research Institute
BCEOM	French Engineering Consultants (Société Française d'Ingénierie, bureau d'études en ingénierie)
BOA	Bureau of Agriculture
BoARD	Bureau of Agriculture and Rural Development
BONARD	Bureau of Natural Resources Development
CARE	CARE Ethiopia
CBO	Community Based Organisation
CIDA	Canadian International Development Agency
Co-SAERAR	Commission for Sustainable Agriculture and Environmental Rehabilitation for Amhara Region
CRDA	Christian Relief and Development Association
CRS	Catholic Relief Service
CSA	Central Statistical Authority
Cu. M	Cubic Meter
DA	Development Agent
DPPC	Disaster Prevention & Preparedness Commission
EARO	Ethiopian Agricultural Research Organisation
EEC	European Economic Commission
EPA	Environmental Protection Authority
ERHA	Ethiopian Rainwater Harvesting Association
ESRDF	Ethiopian Social Rehabilitation and Development Fund
ETB	Ethiopian Birr
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
FTC	Farmer Training Centre
GDP	Gross Domestic Product
GO	Government Organisation
GTZ	German Technical Cooperation
ICRAF	World Agroforestry Centre
IDE	International Development Enterprises
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute

IPTRID	International Programme for Technology and Research in Irrigation and Development
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
LMSID	Large- or Medium-Scale Irrigation Developments
LU&NRAA	Land Use and Natural Resources Administration Authority
LWF	Lutheran World Federation
MDG	Millennium Development Goal
MI	Micro Irrigation
MoA	Ministry of Agriculture
MoARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resources
MUS	Multiple Use Water Supply Systems
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
OIDA	Oromia Irrigation Development Authority.
PA	Peasant Association (Kebele)
RELMA	Regional Land Management Unit funded by SIDA.
REST	Relief Society for Tigray
RWH	Rainwater Harvesting
SARI	Southern Agricultural Research Institute
SCF/UK	Save the Children Fund/United Kingdom
SDPRP	Sustainable Development and Poverty Reduction Project
SIDA	Southern Irrigation Development Authority
Swedish-SIDA	Swedish International Development Cooperation Agency
SNNPR	Southern Nations Nationalities and Peoples Region
SSI	Small-Scale Irrigation
SWHISA	Sustainable Water Harvesting and Institutional Strengthening in Amhara
TVET	Technical, Vocational, Educational and Training Program
UNDP	United Nation Development Project
USAID	United States Agency for International Development
WFP	World Food Programme
WHIST	Water Harvesting & Institutional Strengthening, Tigray
WOCAT	World Overview of Conservation Approaches and Technologies
WSDP	Water Sector Development Programme
WUA	Water Users Associations

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IWMI is also grateful to officials of the Ethiopian Ministry of Water Resources and the Ministry of Agriculture and Rural Development for providing information and feedback. A number of officials from regional governments, NGOs and donors also took a lot of time to provide information and we are grateful to all of them. Finally, we thank Dr. G Makombe, Postdoctoral Fellow at IWMI, for his critical and constructive editorial assistance.

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Executive Summary

Covering a land area of 1.13 million km^2, Ethiopia is one of the largest countries in Africa. With a population of over 70 million people, it is the second most populous country in sub-Saharan Africa, and the third on the continent. According to the World Bank, per capita income in 2003 was only USD 90 per year. The population has been increasing by about 3.0 percent annually in the 1990s. Infant mortality is at 116 deaths per 1000 live births and child mortality rate is at 184 deaths per 1000 live births. Persons of 0-14 years made up 43.8 percent of the population in 2000. This and other economic conditions make the dependency rate higher than in other African countries. It is estimated that about 100 persons in the productive ages, 15-59 years, have to support 124 dependents in terms of food, clothing, health and education. This situation exacerbates food insecurity and poverty. Population density, and hence pressure on resources, varies from region to region. Eighty-five percent of Ethiopia's population is rural. The incidence of poverty in the rural areas is higher than in urban areas, and 49 percent of the total population is considered under-nourished. This situation requires a concerted development effort between government, donor agencies, NGOs and farmer institutions in order to reverse the poverty downward spiral currently experienced. Since agriculture is the most important sector, contributing 50 percent to GDP, and since less than 40 percent of the arable area is cultivated, it makes sense for a significant part of the development effort to focus on agriculture. Irrigation can play a major role in this development effort.

Ethiopia covers 12 river basins with an annual runoff volume of 122 billion m^3 of water and an estimated 2.6 billion m^3 of ground water potential. This amounts to 1707 m^3 of water per person per year, a relatively large volume. However, due to lack of water storage capacity and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year. Frequent dry spells and droughts exacerbate the incidence of crop failure and hence food insecurity and poverty. Given the water available, the promotion of water related technologies, especially irrigation, at both small- and large-scales, makes sense.

Large-scale irrigation schemes and related technologies are relatively well known and the government already has plans to actively promote these systems. Some types of small-scale irrigation technologies, especially micro irrigation, are still relatively new in Ethiopia. Yet they have the potential to enable supplementary irrigation for millions of people and to achieve household food security through home garden micro irrigation, and modest wealth for emerging commercial farmers. The relatively simple equipment needed can be produced locally, hence promoting off-farm employment, while post harvest processes can also stimulate similar indirect benefits. Since small-scale technologies are also particularly effective in expanding the source of water for domestic use and home gardens, they are, therefore, key to empowering women. There are examples of successful financing mechanisms for poor farmers to adopt small-scale technologies, including self-financing and micro-loans.

To carry out such a program, activities must build on the ongoing projects and experiences by government organizations, NGOs, community-based organizations and farmer organizations. This includes learning from other countries, building research and extension capacity, participatory implementation of household and communal water use systems for domestic and productive uses, and refining the methods for implementation through evaluation, demonstration and learning sites. It must also include development of the legal framework for land and water and related service providers. Research needs to accompany the implementation process to allow acceleration of up- and out-scaling, and to continually adjust recommendations to local conditions and to development in materials and knowledge. To prepare for such an expansion, capacity building and awareness

promotion must be addressed from the beginning. If the implementation program is successful, significant local demand for small-scale equipment will develop. The creation of local supply chains of these equipments and other agricultural inputs, including fertilizers, is crucial.

If the implementation of water resources development projects is really successful, significantly larger volumes of cereals will be produced to ensure food security, vegetables and other cash crops will be produced to increase incomes and improve nutrition, and the burden of women in collecting water will be reduced. This can enable women to participate in other economic activities, young girls will be freed from carrying water to attend school, and adult women can engage in more productive work on the farm. A virtuous cycle is then possible to increase food security, enhance incomes and reduce poverty.

CHAPTER 1

INTRODUCTION

GENERAL

Ethiopia is the third most populous country in Africa and is rated the poorest in the world, ranked last out of 208 countries, with a per capita gross national income of USD 90 in 2003 (World Bank, 2004). The incidence of poverty, standing at 44 percent nationally, in the rural areas is higher than in urban areas, at 47 percent and 33 percent respectively, with about 49 percent of the total population 'under-nourished' (UNDP, 2003). The infant mortality rate is among the world's highest, at 116 deaths per 1000 live births and child mortality is 184 deaths per 1000 (UNDP, 2003; Heins, et al., 2001). Fifteen to 20 percent of poor rural households are female-headed (AfDB, 2003). A recent poverty assessment indicates that female-headed households are more vulnerable to poverty, as they traditionally have less direct access to land and productive resources (AfDB, 2003).

With regard to food insecurity, it is estimated that the country must double its cereal production by 2025 to meet the food needs of its rapidly growing population. Contributing 50 percent of GDP and employing 85 percent of the population, agriculture is by far the largest part of the economy. It is mostly based on rainfed small-holder systems and livestock. Agriculture is heavily dependent on rainfall, which is highly variable spatially and temporally. The farming system too is largely based on plough and draught power, which has created complementarities between crop and livestock production for centuries. With the advent of high population growth in recent years, deforestation and frequent land distribution has begun threatening the farming system. This effect is felt in ever-decreasing household production, decreasing grazing land, forage scarcity and weakened draught animals, scarcity of manure and destruction of forests by the growing populations in their search for livelihoods. As a consequence, food insecurity often turns into famine with the slightest adverse climatic incident. The challenge, therefore, is how to meet this increasing demand with the existing but dwindling natural resources under worsening climatic conditioning by using improved technologies of agricultural production, both modern and traditional, and enhance the economic, social and institutional conditions necessary for increased agricultural production and productivity.

To address the above challenges, the international community and the country have joined together in the New Coalition on Food Security in Ethiopia (NCFSE), with the goal of achieving a drastic reduction in the food insecurity threatening vulnerable households. The coalition has put forward three main objectives: increased food availability; increased access to food; and improved health, nutrition, water supply and sanitation. To achieve these objectives, the Coalition intends to undertake interventions over five years, with a total program cost requirement of US$ 3.02 billion.

In response to this situation, as well as based on previous development objectives, the country has developed a rural development policy and a comprehensive food security strategy that targets the chronically food insecure segments of the population especially in highly vulnerable areas. Implementation of these objectives has been reflected in the unreserved support for water harvesting and small-scale irrigation nationwide (WSDP, 2002; McCornick et al., 2003), capacity building through establishing a number of Technical, Vocational, Educational and Training (TVET) colleges and universities, and the establishment of regional agencies, such as rural development, agriculture, water resources development, irrigation authorities/bureaus, cooperative promotion bureaus, etc.

The international community is also playing its role in contributing significantly towards this initiative. The World Bank, for instance, intends to invest US$100 million over the next five years on water supply. Canada intends to commit an additional C$150-200 million to agriculture, water and food security. Similarly, the AfDB, European Union, US Government, Japan, UNDP and UNICEF are committed to the implementation of the objectives of NCFS. Among others, the introduction of high value crops, livestock and agro-forestry development to enhance intensification, provide the thrust of the agricultural development strategy of the country.

AGRICULTURE AND WATER IN ETHIOPIA

Ethiopia's topography can be broadly grouped into uplifted central highlands, tapering into peripheral lowlands that also include the Rift Valley. Most of the country consists of high plateaus and mountain ranges with precipitous edges dissected by numerous streams in the center, and rolling plains all along the periphery (Mati, 2004). The lowlands are relatively hot, with annual rainfall varying between less than 200 to 800 mm and average temperatures of 25^{o} C. The climate in the highlands above 1800 m is mild and annual rainfall ranges from 800 to 2200 mm, with a mean annual temperature of 15^{o} C. The highlands above 1500 m altitude constitute 43 percent of the country and accommodate 88 percent of the human population, over 65 percent of the livestock, comprise 90 percent of the cultivated land and nearly 100 percent of the industrial forest cover (Bekele-Tesemma, 2001). The dry lands occupy about 70 percent of the total landmass and 45 percent of the arable land. They are characterized by a highly fragile natural resource base; soils are often coarse-textured, sandy, and inherently low in organic matter and water-holding capacity, making them easily susceptible to both wind and water erosion. Crops can suffer from moisture stress and drought even during normal rainfall seasons. Farm productivity has declined substantially and farmers find themselves sliding into poverty (Georgis, 1999).

The different altitudes and ranges of precipitation give Ethiopia six major agro-climates having distinctly different agricultural potential:

i. Arid - 42.3 million hectares, used for pastoral grazing

ii. Semi-arid - 2.9 million ha, used for grazing and cultivation

iii. Dry sub-humid - 19 million ha, used for cultivation of annual crops

iv. Moist - 24.5 million ha, used for annual crops

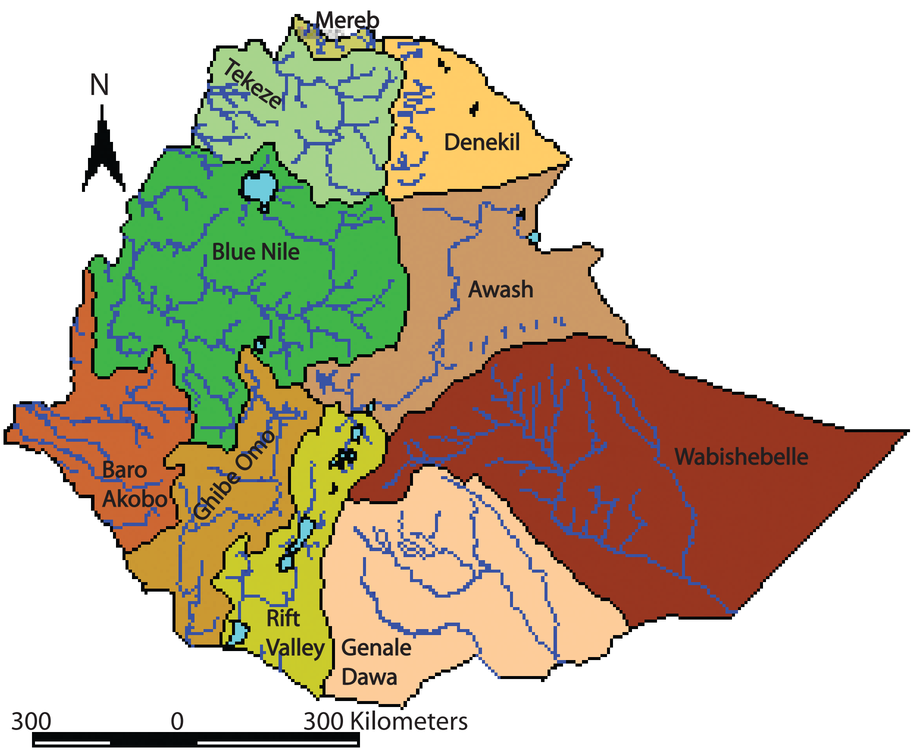
v. Semi-humid - 16.5 million ha, annual/perennial crops

vi. Per-humid - 0.7 million ha, used for perennial crops.

The agricultural potential of Ethiopia is largely unexploited; with less than 40 percent of the arable land currently under cultivation. Under the prevalent rainfed agricultural production regime, the progressive degradation of the natural resource base, especially in highly vulnerable areas of the highlands, aggravates the incidence of poverty and food insecurity in these areas. Rural dwellers in the country are among the most vulnerable to poverty, with limited access to agricultural technology, limited possibility to diversify agricultural production, underdeveloped rural infrastructure, and weak or sometimes lack of access to agricultural markets and to technological innovations. These issues combine with increasing degradation of the natural resource base, especially in highlands, to aggravate the incidence of poverty and food insecurity in rural areas.

The 12 river basins covered by Ethiopia have an annual runoff volume of 122 billion m^3 of water. These river basins are shown in Figure 1.1. There is also an estimated 2.6 billion m^3 of ground water potential (MoWR, 2002). This amounts to an estimated 2,620 m^3 of water per person per year in 1990 for a population of 47 million. By 2005, this has reduced to 1707m^3 due to population growth to about 73 million and the per capita availability continues to fall. Figure 1.2 shows the per capita water availability of Ethiopia based on population data of the past and projection into the future. Ethiopia will become a physically water scarce country by the year 2020. Furthermore, due to lack of water storage capacity and large spatial and temporal variations in rainfall, there is not enough water for most farmers to produce more than one crop per year. Crop failures due to dry spells and droughts are frequent. Moreover, there is significant erosion, reducing the productivity of farmland.

Figure 1.1: Water resources basins of Ethiopia (Source: Awulachew, 2001).[1]

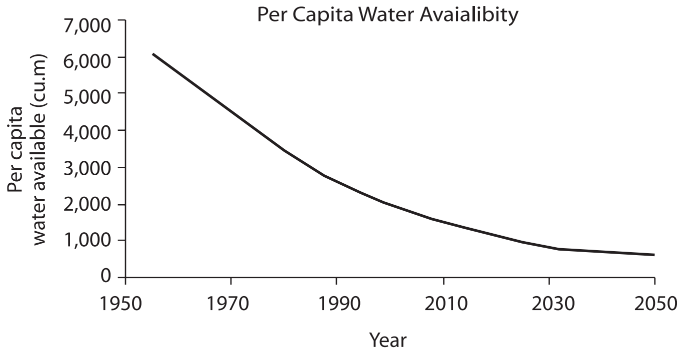


Water resources management for agriculture includes both support for sustainable production in rainfed agriculture and irrigation. These two categories of usage—actually two ends of a continuum—are respectively referred to as "green water," i.e., water that is available directly as rain falls and returns to the hydrological cycle in the form of vapor, and "blue water," which is diverted water from streams and aquifers (Rockström, 2000).

[1]Note that the basins of Ogaden and Aysha, both no flow basins, are integrated to Wabishebelle and Awash basins to their east.

“Green water”, i.e., rainfall, is the major source of agricultural water in Ethiopia. The major problem associated with the rainfall-dependent agriculture in the country is the high degree of variability and unreliability. As a result, production capacity varies from region to region each year. Due to climate-induced rainfall variability, dry spells and drought, agricultural production often fails and is doing so more frequently over time. The key issue, therefore, is how to guarantee production during these severe unfavorable situations.

Figure 1.2: Per capita water availability of Ethiopia.



The “blue water” resources of the country are found in lakes, rivers, streams and ground water, which is obviously dependent on the rainfall. The rivers take water to low rainfall areas and offset the spatial variability of rainfall distribution to a certain degree. The “abundance” of water resources in some regions has led to the country being called the “water tower of Eastern Africa.” This water resource from the excess runoff basins could, in principle, provide supplementary irrigation to overcome the effects of rainfall variability and drought during the major rain and secondary production seasons, as well as full irrigation during the dry season to intensify production and maximize the return on available land and water resources.

There are many challenges that must be confronted before water resources can be better utilized and productivity enhanced. Some of the most relevant ones with respect to agricultural water and availability of water are to overcome rainfall variability, dry spells and drought; increase availability of per capita storage for productive and consumptive purposes and even out the availability of water in space and time; overcome soil degradation; and overcome water holding capacity and productivity problems.

New in this analysis is the emphasis on ‘investments in water.’ Although it will become clear quickly that there is no such thing as investing in ‘water only’, articulating it this way does help to focus upon the issue. Physical and economic scarcity of water is very common, and growing, problem in Ethiopia. Although not a magical single-factor solution, investments in water combined with complementary policies (for example, to encourage private enterprise) and infrastructure (for example, roads and communications) can bring the rural and peri-urban poor a significant improvement in household food security, poverty relief and economic growth. The impact of investments in water will also be far greater, if accompanied by investments in other sectors, (such as roads, communications and health and by appropriate policies effectively implemented).

In brief, the study recognizes the opportunities for the private sector, smallholder farmers and various entrepreneurs, to be both a source of investments and to contribute to an environment where investments yield higher returns. The role of the government is particularly in facilitation at different levels (legal frameworks, infrastructure, standards, etc.). Investments in these capacities are likely to provide rapid returns. While designing and adopting regulations is a matter for government, execution and monitoring can be done better, many argue, by non-governmental organizations and in public-private partnerships.

The Agricultural Investment Source Book (World Bank, 2003), a rich source of valuable insights and practical recommendations for investments at the country level, is particularly aimed at public sector investments for agricultural development. These are complementary to the private sector investments that are also discussed here.[2] The Source Book confirms that 'more efficient outcomes can generally be achieved if the private sector is involved in the provision of public services.'

Water can help to reduce poverty and increase food security and economic growth. Starting at the lowest level of availability of water, the top priority, after domestic water supply, should be water for food security, such as for home food gardens. The next step is water for commercial production, such as through irrigation. This yields the farmer-entrepreneurs an (extra) income and can turn poverty into modest wealth. Where this process occurs at a large-scale, economic growth is attained. It is important to note that alternative development strategies that involve developing large-scale commercial enterprises, even though they can contribute significantly to economic growth, may not alleviate poverty for small farmers because the trickle down effects that are assumed by this strategy often do not occur. It is, however, possible and effective to develop both small-scale and large-scale commercial farms concurrently, in a two pronged approach, in order to ensure that the poor are not left out in the development process.

METHODOLOGY AND OVERVIEW

The focus of this report is broader than just examining the traditional implications of the term "irrigation." It examines not only the opportunities for small-scale formal "irrigation" but also other types of water management technologies including supplementary irrigation, rain water harvesting for crops and livestock, and micro-irrigation–all covered by the term 'agricultural water.'

This paper reports on government institutions involved in the development and promotion of smallholder water and land management interventions, especially small-scale irrigation, micro-irrigation and water harvesting, for improving the livelihoods and food security of millions of poor rural people. The assessment also covers the activities of regional bureaus and key NGOs involved in promoting agricultural water use (small-scale irrigation, micro-irrigation and water harvesting) in various regions, as well as empirical data from key communities in selected regions. The review is comprehensive and up-to-date as of 2004, and covers a wide range of issues to highlight previous trends, current developments and state-of-the-art on smallholder agricultural water use in Ethiopia. This includes social, technical, institutional and management issues, as well as current investment opportunities and challenges. In addition, relevant experiences and lessons from projects elsewhere in the world are highlighted.

[2]Penning de Vries, et al. (2005) provides an argument and overview of evidence on the critical importance of investments by small- and medium-sized enterprises including farmers

Four sets of open-ended questionnaires were developed for data collection at four levels. These levels correspond to Federal Institutions, Regional Bureaus, Non-Governmental Organizations (NGOs), and selected local communities engaged in small-scale or micro irrigation and water harvesting. The detailed results are contained in the Appendices. The questionnaires are available from IWMI's Addis Ababa office on request.

The results of the study are presented in the following sections and organized as follows: section 2 provides a general background review of irrigation in Ethiopia; section 3 deals with specific experiences of Small-scale Irrigation (SSI), Micro-Irrigation (MI) and Rainwater Harvesting (RWH) in Ethiopia; section 4 provides a summary of international experience with regard to SSI, MI & RWH; section 5 focuses on assessing the existing experiences in Ethiopia and in the world to identify opportunities for promoting successful SSI, MI and RWH to overcome food insecurity in Ethiopia, and suggest needs in terms of pilot scale studies and ideas for action. The research and training needs are covered in a separate section 6. Finally, section 7 provides a synthesis, conclusions and recommendations based on the assessment and investigated opportunities.

CHAPTER 2

IRRIGATION IN ETHIOPIA

OVERVIEW

Irrigation is one means by which agricultural production can be increased to meet the growing food demands in Ethiopia. Increasing food demand can be met in one or a combination of three ways: increasing agricultural yield, increasing the area of arable land, and increasing cropping intensity (number of crops per year). Expansion of the area under cultivation is a finite option, especially in view of the marginal and vulnerable characteristic of large parts of the country's land. Increasing yields in both rainfed and irrigated agriculture and cropping intensity in irrigated areas through various methods and technologies are the most viable options for achieving food security in Ethiopia. If the problem is failure of production as a result of natural causes, such as dry-spells and droughts, agricultural production can be stabilized and increased by providing irrigation and retaining more rainwater for *in situ* utilization by plants.

The challenge that Ethiopia faces in terms of food insecurity is associated with both inadequate food production even during good rain years (a problem related to inability to cope with growth of population) and natural failures due to erratic rainfall. Therefore, increasing arable land or attempting to increase agricultural yield by, for instance, growing higher yielding varieties of crops offers limited scope to provide food security in Ethiopia. The solution for food security will be provided by a combination of these factors, enhancing water availability for production and expansion of irrigation that can lead to security by reducing variation in harvest, as well as intensification of cropping by producing more than one crop per year. This should be combined with improved partitioning, storage and soil water-retention capacity to increase plant water availability, and use of rainwater to overcome erratic rainfall especially in the relatively higher rainfall areas of highland Ethiopia. There are also important other ways to reduce risk for farmers (social, economic, spatial diversity) and for the government (trade, buffer, pricing).

The estimates of the irrigation potential of Ethiopia vary from one source to the other, due to lack of standard or agreed criteria for estimating irrigation potential in the country. The earlier reports, for example the World Bank (1973) as cited in Rahmato (1999), show the irrigation potential at a lowest of 1.0 and 1.5 million hectares, and a highest of 4.3 million hectares, according to Tilahun and Paulos (2004). Table 2.1 provides the distribution according to the latter. Thus, the above variation in estimates calls for an accurate review of the irrigation potential of the country.

Similarly, there is no consistent inventory with regard to the developed irrigation of the country. In 1990, BCEOM (1998) estimated a total of 161,000 ha of irrigated agriculture for the country as a whole, of which 64,000 ha was in small-scale schemes, 97,000 ha in medium- and large-scale schemes, and approximately 38,000 ha was under implementation. Tilahun and Paulos (2004) report that the traditional irrigation schemes alone cover 138,339 ha, and that 48,074 ha are under modern small-scale irrigation, 61,057 ha under modern large- and medium- scale schemes, with the aggregated sum of irrigated agriculture at 247,470. From the latter, it can be seen that small-scale irrigation contributes 75 percent of the irrigation–56 percent from traditional and 19 percent from modern small-scale irrigation. Given the current household level irrigation expansion through traditional schemes and water harvesting, it is assumed that the total sum of actual irrigation development could be over 250,000 ha.[3]. One of the limiting factors of irrigation potential is water abstraction. The Ethiopian hydrographical network often shows deep and narrow gorges that make water abstraction costs extremely high. However, construction of multipurpose dams for irrigation, hydropower and flood control may help reduce the per hectare cost of development.

Ethiopia indeed has significant irrigation potential assessed both from available land and water resources potential, irrespective of the lack of accurate estimates of potentially irrigable land and developed area under irrigation. Despite efforts of the government to expand irrigation, the country has not achieved sufficient irrigated agriculture to overcome the problems of food insecurity and extreme rural poverty, as well as to create economic dynamism in the country.

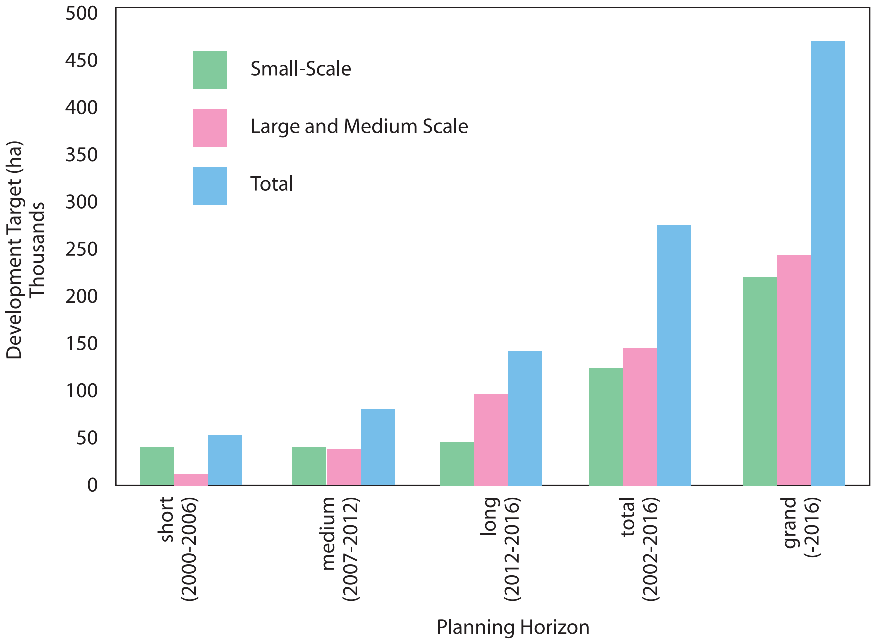
LARGE- AND MEDIUM-SCALE IRRIGATION

Irrigation projects in Ethiopia are identified as large-scale irrigation if the command area is greater than 3,000 ha, medium-scale if it falls in the range of 200 to 3,000 ha, and small-scale if it covers less than 200 ha. The categorization in this document is based on the size of land area irrigated. In addition to the above classification according to MOWR (2002), the new classification developed by Lempérière also includes the dimensions of time and management. This system distinguishes between four different types of irrigation schemes in Ethiopia: traditional, modern communal, modern private and public. More details on the different types can be found in Werfring et al. (2004**)**. The existing irrigation scheme development based on Regions is shown in Table 2.1.

Table 2.1: Existing Irrigation Schemes by Region (Source: Tilahun and Paulos, 2004).

			Current Irrigation Activities		
S. No.	Region	Irrigable Potential	Traditional	Modern Irrigation	
				Small	Medium & large
1	Oromia	1,350,000	56,807	17,690	31,981
2	Amhara	500,000	64,035	5,752	-
3	SNNP	700,000	2,000	11,577	6,076
4	Tigray	300,000	2,607	10,000	-
5	Afar	163,554	2,440	-	21,000
6	Ben Shangul Gumz	121,177	400	200	-
7	Gambella	600,000	46	70	-
8	Somali	500,000	8,200	1,800	2,000
9	Hareri	19,200	812	125	-
10	Dire Dawa	2,000	640	860	-
11	Addis Ababa	526	352	-	-
	TOTAL	4,256,457	138,339	48,074	61,057

Figure 2.1: Irrigation Development Targets (data based on MoWR, 2002). (Note: grand is the existing and planned total to be achieved by 2016).



Although the number of large- and medium-scale irrigation projects has remained stagnant in the last decade, in the new water sector development program, these types of irrigation schemes are considered important. Figure 2.1 provides information on the targeted development of irrigation schemes in Ethiopia. The development of large-scale schemes is considered important as they are associated with useful infrastructure development, create job opportunities, and contribute to agricultural growth and the macro economy.

Parallel to the water sector development program, there are considerable efforts to develop master plans for the various river basins, such as Abay, Tekeze, and Wabishebelle. In fact, comprehensive master plans for five basins have already been developed. Through these master plan studies, a number of medium- and large-scale irrigation projects have been identified. The challenge is to transform these master plans into practice through undertaking feasibility studies, design and construction, operation and maintenance in a sustainable and profitable way.

Even with its limited capital for investment, Ethiopia needs to consider the opportunities that large- and medium-scale schemes provide as mechanisms for promoting economic development. Many countries have developed irrigation schemes as public investment, for instance India, China, Egypt and USA, while some are still developing irrigation through the allocation of public and government resources, for instance Turkey, India and Brazil. Although not always designed as pro-poor interventions, large-scale irrigation schemes in Asia have been shown to have positive poverty impacts (Hussain, 2005). The Government could also consider other models found for example in China and build large public schemes at its expense, and then contract out the operation and maintenance (O&M) and even agricultural services to private firms. The promotion of farmer-based WUAs or cooperatives at secondary canal levels to do the O&M is also a viable option but takes a long-term effort.

SMALL-SCALE IRRIGATION SCHEMES

The small-scale irrigation schemes in Ethiopia are understood to include traditional small-scale schemes up to 100 ha and modern communal schemes up to 200 ha (MoWR 2002). However, we also see a 'traditional' *spate* irrigation scheme in, for instance Tigray, of up to 400 ha. Traditionally, farmers have built small-scale schemes on their own initiative, sometimes with government technical and material support. They manage them through their own water users association or committees (MoWR 2002). The farm size varies between 0.25 ha and 0.5 ha. Water users associations have long existed to manage traditional schemes. They are generally well organized and effectively operated by farmers who know each other and are committed to cooperating closely to achieve common goals. Typical associations comprise up to 200 users who share a main canal or a branch canal. They may be grouped into several teams of 20 to 30 farmers each. Such associations handle construction, water allocation, operation and maintenance functions.

The Federal or Regional Government normally constructs small-scale modern schemes. Such schemes were expanded after the catastrophic drought in 1973 to achieve food security and better peasants' livelihoods by producing cash crops. Such schemes involve dams and the diversion of streams and rivers. The constructed and completed schemes of such types are usually "handed over" to WUAs for management, operation and maintenance with the support of personnel from Regional Bureaus. See section 3 for further discussion.

MICRO IRRIGATION

Micro irrigation is not understood in the same sense in all regions of Ethiopia. Sometimes the term is used for small-sized schemes of less than 1 hectare developed at household level, such as rainwater harvesting schemes, while others consider micro irrigation in relation to the technology and refer to drip irrigation schemes. *In this report, we use "micro-irrigation" to refer to individualized small-scale technologies for lifting, conveying and applying irrigation water*. It therefore includes treadle and small power pumps to lift water, and a variety of irrigation application technologies, such as small bucket and drip systems, and small sprinkler systems. In general, the advantages of this category of technologies are: 1) they can be adopted and used by individual farmers because they do not depend on collective action by groups; 2) they are of relatively low cost in terms of their capital and operating costs per farm (but not necessarily per hectare); and therefore are potentially affordable by small farmers; 3) they are often highly efficient in use of water with high water productivity, while also improving crop quality and reducing labor costs and; 4) they can be distributed by private firms through markets that are not dependent on being provided for by government institutions. This category is sometimes referred to as "Affordable Micro Irrigation Technology, AMIT" (ITC et al., 2003) to distinguish it from commercially available 'high-tech' irrigation application technologies, such as pressurized drip systems.

In Ethiopia, some private entrepreneurs producing high value crops use the latter types of conventional 'high-tech' micro irrigation systems. The mushrooming flower farms around Sebeta Hollota areas in the Oromia Region, and to some extent others, such as vegetable farms like Genesis Farm in Debre Zeit, Oromia Region, are using conventional imported irrigation technologies on relatively large holdings.

The use of micro irrigation, for example under current efforts of water harvesting in Ethiopia where the harvested volume of water is small, is appropriate from the point of view of conserving water. The use of micro irrigation by poor farmers has hardly begun in Ethiopia. Its introduction is a recent phenomenon, with some attempts to utilize this concept by NGOs, (such as World Vision in the South, SNV in Wello Area) and universities, such as Arba Minch University (AMU), Mekelle University (MU) and Alemaya University (AU).

It is appropriate and timely to consider introducing the wide range of technologies developed elsewhere, such as in India and Kenya, so farmers can make their own selection. For example, farmers in India in 2002 could buy four types of kits: bucket kit, drum kit, customized kit and micro sprinkler. According to ITC et al. (2003), the prices of different types of kits ranged from Rs 225 (US $5) for bucket kits to Rs 3,000 (US $63) for tank kits. Individual farmers directly purchase these kits.

In Ethiopia, there are also local manufacturers, such as Selam and Wolita Rural Development Center, who are trying to manufacture and promote treadle pumps. Treadle pumps and small power pumps could provide an opportunity to lift water stored from harvested rain in underground tanks or shallow ground water wells. This type of technology could be also imported and adapted for up scaling.

It is important to note that a plant nutrient replacement strategy must be an integral part of any irrigation strategy. Market-driven profitable agriculture provides farmers incentives to invest in soil fertility.

RAINWATER HARVESTING

The term rainwater harvesting (RWH) is used in different ways and, thus, no universal classification has been adopted (Ngigi, 2003). According to Critchley and Siegert (1991), water harvesting in its broadest sense is defined as the "collection of runoff for its productive use". Runoff may be harvested from roofs and ground surfaces, as well as from intermittent or ephemeral watercourses. A wide variety of water harvesting techniques for many different applications is known. Productive uses include the provision of domestic and livestock water; concentration of runoff for crops, fodder and tree production and, less frequently, water supply for fish and duck ponds.

An excellent overview on land and water conservation technologies and small- to medium-scale irrigation in Ethiopia is presented by WOCAT (http://www.fao.org/ ag/agl/agll/wocat/wocatqt.asp). It lists seven technologies specific for Ethiopia, while many others from other countries apply in some areas. Oweis et al. (1999) reviewed water harvesting methods used in winter rainfall areas (>100 mm per year) and in summer rainfall areas (>250 mm). They give an excellent overview of the theory of catching, concentrating and storing water, and how this relates to rainfall characteristics, landscape and crop demands. The principles have been known and applied for millennia. Practical designs are given, yet the authors note that recent attempts to encourage more farmers in semi-arid zones are often disappointing. They give the following reasons for lack of adoption: (i) people often do not understand the principles and get inadequate training, (ii) transaction costs are high, (iii) outside institutions are often needed to get started, (iv) too little focus on 'risk' and how to handle it, and (v) cooperation with other people is difficult. The fact that many farmers in semi-arid regions do not own the land they farm is another reason why investments in water harvesting are low. Not mentioned in the review, but likely also to be a cause of slow uptake, is that many of the farmers in semi-arid regions have more experience of being herdsmen than being cultivators. Kunze (2000) showed that, although profitability of water harvesting can be significant at the field level, it might still be negligible if only applied to a small part of the farm.

RWH systems are generally categorized into two; *in-situ* water conservation practices, small basins, pits, bunds/ridges; and runoff-based systems (catchment and/or storage). The storage system is usually used in supplemental irrigation. The *in-situ* systems, which enhance soil infiltration and water holding capacity, have dominated over storage schemes in Ethiopia until recently. Despite the additional costs involved in storage schemes, the recent trend shows there is a relatively high degree of adoption. Surface runoff from small catchments and roadside ditches is collected and stored in farm ponds holding an average of about $60m^3$ of water. This storage is not significant in volume but sufficient for supplementary irrigation of vegetables. The use of these systems can be extended to crop fields and larger plot sizes can be warranted through larger sizes of storage combined with efficient water application methods, such as low-pressure drip irrigation methods. Hence, rainwater harvesting is a useful means to overcome the recurrent erratic rainfall and dry spell conditions, which often result in crop failures in Ethiopia.

There is a huge scope for irrigation in terms of land and water resources, and there is a strong argument for targeted irrigation investments as a means to promote highly productive commercial agriculture. However, given the relatively high costs of development of irrigation and low global prices of staple grains, combined with the relatively modest performance of irrigated agriculture in Ethiopia, development of irrigation alone may not be the most appropriate investment to achieve household and national food self-sufficiency. An integrated approach to improving the productivity of rainfed agriculture, through a combination of RWH, better management of land, especially fertility, supplementary irrigation using low cost micro irrigation technologies, and improved varieties can lead to a doubling of rainfed yields over the next 10-15 years for a relatively lower per ha and per capita investment than is required for formal irrigation investments. SSI can be an important part of the overall investment package as it enables farmers to engage more effectively in commercial high-value agriculture.

CHAPTER 3

53 EXPERIENCE OF MAJOR REGIONS IN INSTITUTIONAL SET-UP AND SMALL-SCALE, MICRO IRRIGATION AD WATER HARVESTING

In the following sections, the results of our assessment are analyzed with respect to the institutional set-up and the extent of development in each category (SSI, MI and RWH, as well as large- and medium-scale irrigation) in the four selected regions. Geographical distribution of the schemes based on Zones and *Woredas*, the stakeholders involved in the various regions, socioeconomic profiles of farmers, the potential for further development, constraints and limitations observed, and opportunities for private sector development and further investment are also addressed.

INSTITUTIONAL SET-UP IN VARIOUS REGIONS

The manner of project implementation is such that most of the federal level institutions and international organizations act as donors and the regional bureaus, local government institutions and NGOs as implementing agencies. Under this sub-section, therefore, institutional accountability, mandate issues and stakeholders involved are discussed.

Institutional Mandate and Accountability

Based on the recent restructuring, federal level responsibilities with respect to development, planning and development of large- and medium-scale irrigation projects fall within the mandate of the MoWR. The small-scale irrigation and water harvesting schemes are planned, implemented and governed under the MoARD at the federal level. The institutional set-up and accountability issues vary from region to region, and are not stable. As a result, there is confusion on mandate, resulting in some cases of scheme failure due to lack of accountability. Some of the regional bureaus' mandates involve planning, design and construction of small-scale irrigation schemes and hand-over to another bureau for management, operation and maintenance. In the regions of Amhara[3], SNNP[4] and Tigray, the planning, design and construction of small-scale irrigation is carried out by the regional Irrigation or Water Bureaus and the schemes are then handed over to the Agricultural Bureaus for further implementation, operation and maintenance. This institutional form has led to unsustainable development in many instances. In some other regions, such as Oromia, irrigation schemes are fully implemented by the Oromia Irrigation Development Authority (OIDA). The Authority has its own extension wing and Development Agents (DAs).

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[3]The Bureau for small-scale irrigation development has been under Co-SAERAR (Commission for Sustainable Agriculture and Environmental Rehabilitation for Amhara Region).

[4]The Bureau used to be under the Commission for Sustainable Agriculture and Environmental Rehabilitation for Southern Region.

Organizations for Development of SSI, MI and RWH

Amhara Region

The government organs currently involved with SSI, MI and RWH in Amhara Region include: the Commission for Sustainable Agriculture and Environmental Rehabilitation in the Amhara Region (Co-SAERAR), Bureau of Agriculture (BoA), Amhara Regional Agricultural Research Institute (ARARI), and the Bureau of Co-operatives. NGOs and donors are many, but some of the major ones are: Organization for Rehabilitation and Development in Amhara (ORDA), Amhara Micro-enterprise Development, Agricultural Research, Extension, and Water Management (AMAREW), Swedish International Development Agency (Swedish-SIDA), Ethiopian Social Rehabilitation and Development Fund (ESRDF), United States Agency for International Development (USAID), German Development Cooperation (GTZ), Canadian International Development Agency (CIDA), International Fund for Agricultural Development (IFAD), and CARE Ethiopia. The diffuse institutional arrangement is not optimal and may create institutional separation and difficulties of operation, which makes the implementation of Integrated Water Resources Management (IWRM) and MUS much more complex.

Oromia Region

The government organs currently involved with SSI, MI and RWH in Oromia Region include: OIDA, Bureau of Agriculture (BoA), Bureau of Water, and the Bureau of Cooperatives. The many NGOs and donors include**:** ADF, ESRDF, IFAD, JICA, USAID, CARE, and Oromo Self Help. The Oromia Irrigation Development Authority (OIDA) is well organized according to our understanding. It executes the various activities in relation to irrigation as discussed above.

Tigray Region

The government organs currently involved with SSI, MI and RWH in Tigray Region are: Commission for Sustainable Agriculture and Environmental Rehabilitation for Tigray (Co-SAERT), which has recently been merged under the Bureau of Water Resources Development (BoWRD), Bureau of Agriculture, and the Bureau of Co-operatives. The NGOs and donors are again numerous but some of them are**:** Relief Society for Tigray (REST), ESRDF, USAID, CIDA, CRS, Irish Aid, and FAO.

The new mandate of the BoWRD includes all issues of water, including also domestic water supply. The new Bureau deals mainly with diversion schemes. Previously, SAERT exerted substantial effort and achieved appreciable results in terms of small-scale irrigation development, especially in construction of micro dams. Rainwater harvesting and related activities are also associated with the BoA.

SNNP Region

The government organs currently involved with SSI, MI and RWH in SNNP Region include: Southern Irrigation Development Authority (SIDA), Bureau of Agriculture (BoA), Bureau of Co-operatives, Southern Agricultural Research Institute (SARI), Rural Development Coordination Office (RDCO), and the Cooperative Promotion Bureau (CPB). The numerous NGOs and donors include**:** Irish Aid, Farm Africa, World Vision, Lutheran World Federation, Action Aid, and ESRDF.

The institutional arrangement in SNNPR—i.e. SIDA—with respect to irrigation, now almost resembles that of OIDA, except that it does not have an extension wing. The water harvesting projects, such as small ponds and wells are carried out as a joint activity by SIDA, Water Bureau and Bureau of Rural Development. In the joint activities, SIDA designs and constructs ponds and structures; the Water Bureau deals with wells.

The Southern Irrigation Development Authority (SIDA), by mandate, is the overall responsible body for study, design, construction and maintenance of irrigation schemes in the region. The Bureau of Agriculture's (BoA) responsibility starts after the schemes are completed and handed over to the community. This Bureau is mainly responsible for ongoing agricultural activities after project construction. On the other hand, the Cooperative Promotion Bureau (CPB) is responsible for organizing the community through Water Users Associations (WUA).

All three Bureaus are accountable to the Rural Development Coordination Office (RDCO). During our discussion with these different bureaus, the lack of coordination among them with regard to the development and management of irrigation schemes was strongly emphasized. Due to this lack of coordination, there are some overlapping responsibilities, while other activities are overlooked, as indicated by the officials of the bureaus. The same is more or less true in all regions.

FEDERAL/NATIONAL SMALL-SCALE IRRIGATION, MI AND AND RWH PROGRAMS

The federal ministries, authorities and bureaus provide funding to the regional implementing bureaus for SSI, MI and RWH. Therefore, not much information is available at the federal level regarding which particular projects are implemented, at what cost. However, sometimes federal agencies directly implement irrigation projects in a region. For example, MoWR uses International Fund for Agricultural Development (IFAD) and French Development Agency (AFD) funding to implement irrigation projects in various regions. Previously, beneficiary communities were selected based on their suitability in terms of resources potential for irrigation development. Several irrigation schemes have been constructed in various regions on this basis. Nowadays, after obtaining the funds, the regions themselves make the selection using their own criteria, but the major driving force remains food insecurity. It is planned that SSI and RWH will continue to be implemented through government allocated budget, bilateral agreements, donors and NGO sources. As stated above, implementation of most development projects on SSI, MI and RWH is at regional level and, thus, we focus on the regions in the following section. For additional information on investment plans, see section entitled *Plans for SSI and MI and RWH Development.*

EXPERIENCES WITH REGIONAL SSI, MI AND RWH SCHEMES

Data relevant for this topic are not readily available. It was, therefore, necessary to collect information from stakeholders in all regions with regard to irrigation and water harvesting schemes. The collected data and information is based on a pre-designed questionnaire and interviews. The questionnaires were used for Federal Government (Bureaus), Regional Government Bureaus, NGOs/Donors, and communities. The classification of small-scale traditional and modern is not uniform throughout the regions. As an example, Table 3.1 provides the classification used in Amhara by the Co-SAERAR and BoA (both informal classifications), by Oromia, by SNNP Regions and MoWR

(2002). The result shows how the lack of standards leads to variable understanding within the regions, across the regions and at federal level. As stated earlier, for reasons of simplification we adopt the MoWR classification.

Table 3.1: Various classification criteria for small-scale irrigation

Organization	Parameter	Small-scale	Medium-scale	Large-scale
Co-SAERAR	Command Area	≤250ha	250-700ha	>700ha
	Dam Height	<9m		
	Catchment Area	Co-SAERA works for catchment area of <25km^2 and for diversion no limit for catchment area		
BoA (Amhara)	Command Area	≤300ha	>300ha	No bottom limit set
Oromia	Command Area	<300ha	300-3000ha	>300ha
SNNPR	Command Area	50-200ha	200-1000ha	>1000ha
MoWR	Command Area	<200ha	200-3000ha	>3000ha

Data Sources in Regions

Several organizations are currently involved in planning, designing and constructing small-scale, micro irrigation and rainwater harvesting in all regions. In addition to the questionnaires, interviews and discussions with relevant persons have been used as a database for this analysis. The organizations who were contacted for data in the various regions is summarized in Table 3.2.

In addition to the organizations listed in Table 3.2, there are many others that have been involved in planning, studying, constructing, designing, and funding medium, small and micro irrigation schemes, and rainwater harvesting in the Regional States; for instance, others like CIDA, World Vision International, Plan International, Menschen für Menschen, Ethiopian Orthodox Church, Ethiopian Evangelical Church, CARE Ethiopia, Concern Ethiopia, Water Action, Oxfam, Lutheran World Federation, FHI, and IFAD are also actors in the agricultural sector. The table thus shows only those available in the regions during the data collection interview. On the other hand, almost all the SSI and RWH projects are known to the Bureaus of Irrigation or Agriculture; the information from these Bureaus is therefore crucially important.

Small-Scale, Micro Irrigation and Rainwater Harvesting in Amhara Region

Table 3.3 provides a summary of irrigation and water harvesting schemes in Amhara Region. There could still be some traditional irrigation schemes, as well as water harvesting schemes that have not yet been reported to BoA at the time of this data collection. This may cause marginal errors.

Table 3.4 provides the distribution of the schemes based on the implementing agencies in Amhara Region. This is provided as an example for all regions. According to the database provided in Appendix 1, most of the schemes completed in Amhara Region are "operational". Only two schemes failed as a result of sedimentation problems; namely Gobeya in South Wello Zone, planned to irrigate 106 ha and benefit 540 people, and Adrako South Gonder Zone, intended for 75 ha and 300 beneficiaries. In addition, there are two more schemes reported with subsurface seepage problems. All diversion schemes and the remaining micro dams are reported to be functional. However, during our visit to Kobo Girana Valley in Amhara Region, we observed that old schemes constructed

Table 3.2: Data collected at Regional level for this study (NB. Data has been also collected at federal level)

Region	GOs	NGOs/Donors	Communities/Institutions
Amhara	Co-SAERAR, BoA, ARARI, Cooperative promotion bureau	ORDA, Swedish-SIDA, ESRDF, AMAREW-USAID bilateral	Lomi Dure Irrigation Cooperative Timkete Bahir & Brinto Irrigation Cooperative Birgina Mariam Irrigation Cooperative Timbel Irrigation Cooperative
Oromia	OIDA, BoA	IFAD, ADF	Batu Degaga, Golgota
Tigray	TWRDB, TARI, BoANR	REST, IFAD, CIDA-WHIST	Miela irrigation scheme, Genefel irrigation scheme
SNNPR	South Irrigation Development Authority (SIDA), BoA, SARI RDCO, CPB	World Vision Ethiopia Lutheran World Federation (LWF) SOS- Sahel, ESRDF	Eballa irrigation scheme

more than a decade ago are not fully operational, and even the new schemes are operating below capacity. In the valley, out of a developed command area of about 3,400 ha under about 13 schemes, only about 970 ha of command area is operational. This shows less than one third of the schemes' capacity is effectively utilized.

Small-Scale, Micro Irrigation and Rainwater Harvesting in Oromia Region

Smallholder irrigation activities in Oromia include some 161 small-scale irrigation schemes under the implementation and management of the Oromia Irrigation Development Authority (OIDA). Apart from those implemented by OIDA, donors and NGOs, such as IFAD, ADF, JICA, ESRDF, etc. are also involved in irrigation development. There are also irrigation initiatives by private investors, as well as state farms. Table 3.6 provides the zonal distribution. The number of schemes varies significantly across zones, but most are concentrated in the Zones of Arsi,East Hararge, East Shewa and East Wollega, and average around twelve schemes per zone.

Productivity and sustainability of SSI are low. According to the OIDA Annual Report (1999), 15 SSI (= 2100 ha) have been completely abandoned and 40 percent of recently-built SSI were partly abandoned; yields in some schemes are low as low as less than 2 t/ha for maize.

Schemes implemented in the region are diverse, especially in terms of water sources. Some schemes procure water through river diversions, while others are either pump schemes, drip irrigation schemes, or schemes relying on various forms of water harvesting. Surface ponds, traditional irrigation structures, flood diversions, as well as hand-dug wells, are the major water harvesting technologies in use. The choice of beneficiaries for these interventions largely depends on the resource potential of the beneficiary communities, and is usually demand-driven. That is, projects are usually initiated as a response to some form of need, interest or demand expressed by the beneficiary communities, either explicitly or implicitly. The existence of indigenous knowledge, especially in traditional schemes, sometimes creates a demand for the intervention, as well as a higher level of food security observed in these communities.

Table 3.3: Irrigation and Water Harvesting Scheme in Amhara Region (as of 2004)

Type of scheme	Completed Schemes			Schemes Under Construction			Planned Schemes		
	Number	Area (ha)	Beneficiary	Number	Area (ha)	Beneficiary	Number	Area (ha)	Beneficiary
Large/Medium Scale[5]	6	2,388	4,636	KOGA irrigation project (planned) 6,000 ha					
Small-scale Modern	71	5224	20,580	11	1,033	4,002	19	1,446	6,257
Small-scale Traditional	1,095	80,844	323,376	No strategic approach from GO and NGOs is obtainable					
Micro Irrigation	2	19	113	Micro irrigation combined with RWH would probably be given high importance					
Water Harvesting[6]	9,589	HH[3]	9589	No indicative plan available, but it is believed that the effort continues in a strong manner as the most preferred food security measure.					

[5]Note that, although in Table 2.1, it was reported that there is no medium/large scale irrigation, as can be seen in the detail of Appendix 1, there are 6 schemes with command areas of 310 to 618 hectares.

[6]Note that water harvesting schemes require less long term planning for implementation, and data on plans is therefore not available.

[7]HH = Household.

Table 3.4: Irrigation and Water Harvesting Scheme in Amhara Region (classified based on implementing agency)

Scheme	Implementing	Completed Schemes			Scheme Construction on-going			Planned Schemes		
Type	Agency	Number	Area (ha)	Beneficiary	Number	Area (ha)	Beneficiary	Number	Area (ha)	Beneficiary
Medium	ORDA[1]	-	-	-	-	-	-	-	-	-
Scale	Co-SAERAR[2]	6	2,388	4,636	-	-	-	-	-	-
	NGOs[3]	-	-	-	-	-	-	-	-	-
	BoA (Tradi.)[4]	-	-	-	-	-	-	-	-	-
	Total	6	2,388	4,636	-	-	-	-	-	-
Small-scale	ORDA[1]	30	1,056	5,151	4	347	1,290	12	1446	5,784
Irrigation	Co-SAERAR[2]	34	3,910	13,518	7	686	2,712	7	*	473
Schemes	NGOs[3]	7	258	1911	-	-	-	-	-	-
	BoA (Tradi.)[4]	1,095	80,844	323,376	-	-	-	-	-	-
	Total	1,166	86,068	343,956	11	1,033	4,002	19	1,446*	6,257
Micro	ORDA[1]	-	-	-	-	-	-	-	-	-
Irrigation	Co-SAERAR[2]	-	-	-	-	-	-	-	-	-
	NGOs[3]	2	19	113	-	-	-	-	-	-
	BoA (Tradi.)[4]	-	-	-	-	-	-	-	-	-
	Total	2	19	113	-	-	-	-	-	-
Water	ORDA[1]	-	-	-	-	-	-	-	-	-
Harvesting	Co-SAERAR[2]	-	-	-	-	-	-	-	-	-
	NGOs[3]	-	-	-	-	-	-	-	-	-
	BoA (Tradi.)[4]	9,589	*	9,589	-	-	-	-	-	-
	Total	9,589	*	9,589	-	-	-	-	-	-
Grand Total	10,763	88,475*	358,284	11	1,033	4,002	19	1,446*	6,257	

Notes = [1] Organization for Rehabilitation and Development in Amhara;
[2] Commission for Sustainable Environmental Rehabilitation in Amhara;
[3] Only ESRDF supported schemes (Ethiopian Social Rehabilitation Development Fund).
[4] Traditional Small-scale Schemes Amhara Regional Bureau of Agriculture (not exhaustive), *for abbreviations see the list of abbreviations.*
*Data are missing

According to OIDA's plan, for the period 2004-2007, there is a plan to bring about 7,856 ha of land under irrigation, mainly small-scale modern, and about of 8,500ha land under traditional irrigation, which are expected to benefit about 31,400 and 34,000 households respectively. The planned small-scale modern scheme is nearly 60 percent of currently existing schemes of the same category, and if properly planned, there may be good potential for achieving significant food security and poverty reduction impacts. This initiative will include the construction of about 90,000 hand dug wells and 638,500 ponds to cover 21,855 hectares of irrigation land, benefiting 728,500 households. Furthermore, a water-harvesting scheme of about 185,000 hectares is planned, to benefit about 370,000 households. These construction and development plans are summarized in Table 3.5. The impacts and outcomes of these planned investments will depend crucially on the capacity of OIDA to achieve a better performance than in the past.

Table 3.5: Oromia: Scheme Construction Plan for the Years 2004-2007 (Source: Strategic Planning Document, OIDA)

Schemes Type	Capacity(ha)	Beneficiaries (hh)	Water Source
SS I	7,856	31,400	Diversion and small dams
Micro Irrigation	21,000	728,500	90 hand dug wells; 638500 ponds
Traditional SSI	8,500	34,000	Diversion
RWH	185,000	370,000	Rain and flood water

It is claimed that virtually no feasibility studies were done by most of the agencies constructing the schemes except those of OIDA, because most of the NGOs were not skilled in this. There is recent evidence that NGOs are planning to start coordinating their activities, especially during project implementation. According to our surveys of the Regional Bureau staff, NGO projects are generally more expensive than OIDA projects, due to longer periods of construction and higher budgets than OIDA projects. In general, it is claimed that projects implemented based on the will and expectations of the beneficiary communities are the ones that succeed. On the other hand, those that are not in line with the peoples' expectation failed. Pump projects are not very successful, as the farmers cannot immediately handle the technology or afford the electricity fees for the pumps. Pump maintenance has also proved to be critical and poses major challenges to farmers, as spare parts are difficult to find.

There is a need for a clear policy on the rights of traditional irrigators and those of modern schemes. Our evaluation suggests that there are disputes between traditional irrigators and those using the improved irrigation schemes along the same river or stream. There is a need to clearly define the entitlements and property rights with regards to water, particularly irrigation water in such situations. Such rights should be supported by a policy document and a legal framework. Some of these issues are known in OIDA and there is a plan to redefine the objectives of the small-scale irrigation projects to cover many of the problems (environmental, social and engineering, etc.) that arise on these schemes.

Table 3.6: Summary of Small-scale Irrigation Scheme Development in the Oromia Region

Zone	No of schemes	Area (ha)	Benefi-ciaries	Total costs[a]	Development costs[b] per ha	Development costs[a] per beneficiary hh	Period of construction (year)	Donor (s)
Arsi	26	2291	6850	12204716	5327	1782	1980 – 1997	Gov, IFAD*, ADF
Bale	14	1761	4129	12705601	7215	3077	1986 – 1994	Gov, IFAD
Borena	4	180	281	2491120	13840	8865	1987 – 1994	Gov*, IFAD
East Hararge	26	1636	6796	12037170	7358	1771	1986 – 1994	Gov, IFAD*, AFD
East Shewa	25	1591	3554	7660111	4815	2155	1985 – 1995	JICA*, ESRDF, EEC*, Gov
East Wollega	18	1041	3080	7799371	7492	2532	1984 – 1994	Gov*, ESRDF
Illubabor	2	132	540	2550430	19321	4723	1986 – 1996	Gov
Jimma	8	785	2669	6045074	7701	2265	1986 – 1992	Gov*, ESRDF
North Shoa	5	399	1559	1286043	3223	825	1988 – 1992	Gov*, ESRDF
West Hararge	10	895	2905	6829310	7631	2351	1982 – 1994	Gov, IFAD
West Shoa	10	968	2555	7132576	7368	2792	1989 – 1990	Gov, ESRDF, EEC
West Wollega	10	602	1908	6379260	10597	3343	1990 – 1997	Gov, ESRDF
Baalee	2	820	2701	NA	NA	NA	1996	AFD
I/A/Bora	1	60	84	1246720	20779	14842	1997	NA
AVERAGE	12	940	2829	6169107	8762	3666	NA	NA
TOTAL	161	13161	39611	86367502	6562	2180	NA	NA

* funded a majority of the schemes; [a] development costs in Ethiopian Birr, excluding cost of community labor,
NA = Not available or Not applicable; hh = household; Gov = Government. For other acronyms, see list at beginning of report. Note that the planned schemes to be completed in 2004/2005 are also included in the Table.

Small-Scale, Micro Irrigation and Rainwater Harvesting in Tigray Region

The Tigray farmers have a long history of practicing irrigation to supplement rainfed agriculture. Local people's initiatives include surface irrigation through river diversions, spring development, and pond systems, all widely used in the region to irrigate plots. In the highlands of Tigray, farmers construct *dorra* (ponds) for the storage of spring water to irrigate their farms. In Tigray, over 15,000 hectares are irrigated using traditional methods, making up five percent of the estimated irrigable land. Diversion structures are made simply of stones and wood and the floods frequently wash them away. The canals are not lined and water loss through seepage is significant, but they do not incur significant capital costs, except the labor (Teshome 2003:44ff).

The regional government believes irrigation intervention to be a drought-proofing strategy. To this end, Co-SAERT had been constructing micro dams until 2002. Co-SAERT planned to construct 500 micro-dams over ten years. However, the Commission had constructed only 44 micro-dams up until 2002, and has stopped further construction. Other institutions and organizations have also supported these initiatives. REST, for example, had built 11 micro dams and 17 diversion schemes by the end of 2003. The reservoir capacity of earthen dams is a maximum of 3 million cubic meters. In total, what has been achieved is just 10 percent of what was planned and now there is a shift towards RWH and diversion schemes.

Table 3.7 provides a summary of irrigation and water harvesting schemes in Tigray Region.

Type of Scheme	Completed Schemes		
	Number	Area (ha)	Beneficiaries
Small-scale Modern	86[8]	4989	NA
Small-scale Traditional[9]	NA	15,000	NA
Water Harvesting[10]	41,097	4,109.7	41,097

Water harvesting and micro-dam construction have been largely promoted to capture run-off water for multiple uses, including domestic, irrigation and livestock, especially in the northern part of the Region. This widespread dam construction and promotion of micro-dams is, however, slowly becoming questionable, as many negative impacts—such as erosion, sedimentation, increased transmission of malaria (Ghebreyesus *et al.* 1999) and schistosomiasis, and salinization and pollution with fertilizers and pesticides—have been reported. In some cases, the negative impacts outweigh the benefits, leading to abandonment of the dams and associated land in some cases (Behailu and Haile, 2002). This situation is largely due to insufficient technical, socioeconomic and agronomic baseline studies at the inception of these dams, and the consequent lack of adequate scientific knowledge on the long-term impacts of the water harvesting systems, in terms of hydrology as well as for socioeconomic and environmental outcomes. While many are convinced that water harvesting can indeed make a difference in terms of responding to the nation's food security needs,

[8]The number of micro dams is 53 and the remaining are diversion schemes.

[9]The traditional schemes are known to be significant, but detailed data are not available with the relevant authority.

[10]Note that water harvesting schemes do not require as much long term planning for implementation, and therefore data on plans are not available. Note that the figure is achievement in 2003. Each RWH is set at 0.1ha, according to the data obtained.

there is a consensus among experts on the need for scientific information on both indigenous and introduced water harvesting technologies to understand their particular characteristics and constraints, and appreciate the needs for adaptation for successful water harvesting in the country.

In the construction of micro dams in Tigray, numerous problems were identified including lack of skilled manpower, negligence or lack of awareness on the part of experts, technical problems in the fields of irrigation engineering and geology, and severe environmental and health impacts. These problems have led to cases of failure that resulted in abandonment/non-functionality of the schemes. Out of the 44 micro dams constructed by Co-SAERT, 18 are reported as non-functional and an additional 9 schemes are reported to have problems, such as high seepage. Similarly, 7 of the 11 micro dams constructed by REST are also reported as having problems of catchment degradation and seepage.

Teshome's (2003) in-depth study of two SSI in Tigray brings out numerous problems at this level. In the two schemes studied, a majority of the plot holders rent their plots out to others. Numerous socio-technical problems resulting from inappropriate technology and poor irrigation management leading to crop failure are identified; and the "uncomfortable" relationship between the local bureaucracy doing irrigation management and the weak water users association is analyzed. The lack of clear water rights is said to de-motivate farmers from participating in irrigation management. The alleged use of coercion to get farmers to adopt modern agricultural technologies is also counter-productive.

Small-Scale, Micro Irrigation and Rainwater Harvesting in SNNPR

Table 3.8 provides a summary of irrigation and water harvesting schemes in SNNP Region based on the information collected from the organizations shown in Table 3.2.

In addition to the summary in Table 3.8, detailed information on the status of all irrigation schemes in SNNPR is provided in Appendix 3. In SNNPR, irrigation is developed by individual farmers, private and public commercial entities, NGOs and SIDA. Beneficiary communities for irrigation development are basically selected by SIDA and some NGOs on the basis of: prevalence of drought and food insecurity, high population pressure, water resource potential, land suitability, equity in resource distribution among various zones or *weredas*, interest of the communities to practice irrigation, and willingness to contribute to the project.

Table 3.8: Irrigation and Water Harvesting Schemes in SNNP Region (as of 2004)

Scheme	Completed Schemes (Functioning)			Scheme Construction on-going			Planned Schemes		
Type of Scheme	Number	Area ha	Beneficiary	Number	Area ha	Beneficiary	Number	Area ha	Beneficiary
Large/Medium Scale	10	5,638	13,035				1	300	600
Small-scale Modern	49	6,509	23,349				25	2,542	8,878
Small-scale Traditional	No specific data are available for traditional small-scale irrigation and micro irrigation.								
Water Harvesting[11]	106,323	HH	106,323						
Total	106,333	12,147	142,707				26	2,841.5	9,478

[11]Note that all water harvesting schemes have been constructed in 2003/2004. HH is households.

According to the information in Appendix 3, twelve of the 59 schemes in SNNPR are not functional or fully functional. According to informants from the regional Bureau, the sites where the schemes have completely failed have created negative perceptions in the beneficiary communities. The causes of failures need further detailed investigations on an individual scheme basis. The failed schemes need rehabilitation, with a strong focus on community mobilization, formation of WUAs, creation of appropriate support links to input supply and marketing, and adequacy on technical design, as these are reported as causes for failures. These also imply that future planning and design procedures need to be revisited and revised to address all technical and non technical components adequately.

The rainwater harvesting schemes have been initiated recently, i.e., as of 2003, in most regions except Tigray. Therefore, not much could be deduced for all the regions. Landell Mills (2004) evaluated the water harvesting structures among others, for Tigray Regional State. They concluded that RWH ponds can contribute significantly to household incomes and enable farmers to purchase between 30 percent and 80 percent of their food needs by the end of year five. This assumes that complementary essential extension support is provided.

Other Regions

The remaining regions of Ethiopia, not included in the above analysis, are Afar, Somali, Gambella, Benshangul Gumuz, Addis Ababa, Dire Dawa and Harrar. These regions are relatively less dependent on irrigation and were, therefore, not selected for this study. Some are heavily dependent on livestock, such as Somali and Afar; some are mainly cities (Addis Ababa, Dire Dawa and Harar) and have little potential for agriculture in general and irrigation in particular, although there is evidence of urban farming. The Gambella and Benshangul Gumuz are less dependent on irrigation and rainwater harvesting despite significant potential. However, there are certain interesting public irrigation schemes, such as in the lower Awash Basin or Afar Region, which constitute one third of the total of the public schemes (see Table 2.1).

Although the analysis and database do not include these regions, the positive lessons learnt from the other regions and the future development strategies could be applicable to these regions as well.

CONTRIBUTION OF DONORS AND NGOS TO SSI, MI, RWH DEVELOPMENT

As previously indicated, there are several local and international NGOs and donor agencies actively engaged in supporting and promoting SSI, MI and RWH in Ethiopia. The NGOs and donor agencies, the types of support and their areas of intervention are quite diverse and their activities vary from region to region. Some agencies are directly involved in field interventions through field staff or working with local NGOs and government agencies.

Most donor agencies provide their financial support through implementing agencies at the regional level, as well as some support to local and international NGOs and research institutions, including institutes of the Consultative Group on International Agricultural Research (CGIAR). The objectives of most of these interventions are generally complementary to the food security and poverty alleviation objectives of the Ethiopian Government, and in most cases, are also linked to environmental protection and conservation objectives. For most donor agencies and NGOs, the criteria for selecting beneficiary communities for irrigation interventions include:

- *Food security*–food insecure communities;
- *Existence of resource potential*–e.g., communities with suitable land and water resources for irrigation development;
- *Expressed interest*–communities and beneficiaries that have expressed interest in particular types of interventions, in line with their mission oriented targets.

The kind of support provided may vary from community to community and often includes technical expertise or technical support; technology provision, including adaptation, testing, adoption and up-scaling, facilitating access to input and output markets, capacity building in various areas of production and environmental rehabilitation and conservation, and financial support for construction and management of SSI, MI and RWH. Table3.9 highlights examples of various donors and NGOs and their priority regions.

The relative contributions of selected donors and NGOs to the development and management SSI, MI and RHW in various regions are significant in many cases.

PLANS FOR SSI AND MI AND RWH DEVELOPMENT

There are a number of implementation plans for SSI, MI and RWH by the federal government, regional governments, donors, NGOs and private sectors in meeting the NCFS and the nation's development programs. While capturing all these plans is beyond the scope of this study, the following provide examples.

MoARD/MoWR

One of the main implementation plans for SSI emerges from the Water Sector Development Plan (WSDP) of the MoWR. The SSI component plan of the MoWR, which has now become the mandate of MoARD, to be implemented through the regions, has an ambitious target: it aspires to develop 127,138 ha, of which 40,319 is to be implemented in the period 2002-2006. With regard to water harvesting and usage of micro irrigation technologies, a significant implementation plan is described and the government effort is also supported by various donors, such as AfDB, CIDA, the World Bank, and Irish Aid.

Regions

The indicative regional development plans provided in Tables, 3.4, 3.5, and 3.8 show the planned schemes in the various regions based on information that could be obtained. These plans, with respect to SSI, are mainly components of the MoWR's WSDP plan.

Table 3.9: Areas of Water Management Intervention of Selected NGOs/Donors in Ethiopia.

NGOs, Donor or Agency	Small-scale *Irrigation* (SSI)	*Micro* Irrigation *(MI)*	Rainwater Harvesting (RWH)	Region(s) of Activity
Action Aid	✔			SNNPR
SG 2000	✔		✔	Amhara, Oromia, SNNPR
CIDA	✔		✔	Tigray, Amhara
CRS	✔	✔	✔	Amhara, Oromia, Tigray, SNNPR
AFD	✔			Amhara, Oromia, SNNPR
CARE	✔	✔	✔	Amhara, Oromia, Afar
USAID	✔			Amhara, Tigray
ESRDF	✔	✔		Amhara, Oromia, SNNPR
IFAD	✔	✔		Amhara, Oromia, Tigray, SNNPR
GTZ			✔	Oromia, Amhara
JICA	✔			Oromia
ORDA	✔			Amhara
ADF	✔			Amhara, Oromia, SNNPR
AfDB	✔			SNNPR
FAO	✔			Amhara, SNNPR
Greek Aid	✔			SNNPR
LWF	✔		✔	SNNPR
REST	✔			Tigray
World Vision- South Branch	✔			SNNPR
SOS-Sahel	✔			SNNPR
EEC	✔			Amhara, Oromia

See list of acronyms at front of report.

AfDB

According to the interview with MoARD, a nation-wide project, entitled “Agriculture Sector Support Project,” was being launched at the end of 2004, financed through the African Development Bank (AfDB) and coordinated by the MoARD. The project is intended to develop 7,500 ha of SSI at 59 sites to benefit 28,300 households; RWH projects will provide 590 micro catchment soil conservation benefiting 23,600 households; 590 potable and livestock water sites benefiting 23,600 households; 2,940 individual backyard water harvesting facilities; and other activities related to ecosystem management, capacity building and training.

CIDA

The Canadian International Development Agency intends to invest significantly in interventions for the safety net program, rural capacity building, SSI plus soil fertility, and management and technical engagement. This is in addition to the existing CIDA-WHIST program operating in Tigray Region and SWISA program to be implemented in Amhara Region.

CHAPTER 4

SUMMARY OF RELEVANT INTERNATIONAL EXPERIENCES

INTRODUCTION

The foregoing analysis of current irrigation practices in Ethiopia highlights some successes, but also remaining problems and untapped potential. Internationally, various solutions have been found for some of these problems. Testing and adapting these solutions for the Ethiopian context avoids the huge costs of unnecessarily reinventing the wheel. Similarly, expertise developed in Ethiopia—for example, on micro dams—would benefit other Southern African countries. South-south exchange by researchers and also by policy makers, practitioners and farm leaders is a key to fast-tracking learning for better performance.[12] This section identifies fields, in which lessons and solutions emerging elsewhere in the world, if adapted to the national context, have considerable potential to contribute to enhancing productivity, reducing food insecurity, poverty reduction, and balancing gender equity in Ethiopia. New approaches have emerged, particularly in response to the disappointing returns on the huge public investments in large-, medium-, and small-scale irrigation up until the 1980s worldwide. The new approaches perform better in terms of scheme operation and maintenance, cost-recovery, agricultural productivity, environmental impacts, poverty reduction impact and certainly gender equity.

An overarching cause for the disappointing impacts of conventional irrigation investments has been the supply-driven nature of many investment projects in irrigation, which as in Ethiopia, were largely seen as primarily technical projects. External agencies took most of the decisions for scheme lay-out and supervised the construction. In a number of cases, they also bore primary responsibility for operation and maintenance, except perhaps at the lowest scheme levels. Otherwise, immediately after construction, they handed scheme management over to an uninformed, untrained group of irrigators. Hardly any attention was paid to farm households' own priority water needs not only for irrigation but also for domestic needs and other water needs and for the role that water played in both women's and men's livelihoods, especially among the poor. Also, farmers' capabilities and motivation to collectively self-manage irrigation schemes have been underestimated. Further, the supply-driven, technical approach tended to ignore the many other factors required to render irrigated farming sufficiently rewarding to justify the costs of investments in water, such as seed and input supply, training, and outlet markets. Last but not least, public investments in irrigation schemes tended to reach only a small proportion of farmers, who became 'islands of wealth in oceans of poverty', leaving the rural majority continuing low-productive rainfed agriculture without public assistance.

With the growing understanding of poor rural women's and men's water needs, capabilities, and aspirations, profoundly different approaches have been developed in the last decades, including:

[12]The World Bank is supporting a project for the Nile Basin countries, "Efficient Water Use for Agricultural Production," intended to promote such exchanges among Nile Basin countries.

- Multiple use water supply services (MUS) that take poor women's and men's water needs and livelihoods as the starting point, which in most cases implies priority for satisfying domestic needs and for alleviating women's and children's burdens of water fetching, while also considering productive uses of water. Alleviating women's burdens is a key condition to unleash their productive potential. A MUS approach is Integrated Water Resources Management (IWRM) at the lowest tiers, and constitutes the basis for bottom-up IWRM and basin-level water management, thus complementing the approaches developed in a more top-down manner.

- Development and promotion of a wide range of affordable water technologies not only for irrigation, but also for rainfed farming and other purposes. These technologies, such as rainwater harvesting, small household and village storage tanks, manual water lifting pumps, groundwater recharge methods, and low pressure drip kits, are within the reach of much higher numbers of farm households, including the poor and even the very poor. Individual technologies avoid the high transaction costs intrinsic to collective schemes, while their low price, adaptation to small-scale use and generally high (manual) labor productivity fit the features of small-scale farming. They also lend themselves to being provided by private firms through the market.

- Participatory management in new small-scale collective water schemes, and transfer of government management to users in existing schemes.

PRO-POOR AND GENDER-SENSITIVE MULTIPLE WATER USES SUPPLY SERVICES

There is ample evidence that investments in rural water development to meet the array of unmet basic needs for drinking, hygiene and income in cash and kind among poor women and men are often the entry point to significantly reduce poverty among women and men, especially if water development interventions are accompanied by measures to promote hygiene and sanitation on the one hand and on the other hand by measures to render productive uses of water more profitable, for example by agricultural training, input provision and forging market linkages (Africa Water Task Force, 2002; Rijsberman, 2003). The consensus on the role of water for poverty eradication is also reflected in the Millennium Development Goals, which underline the critical contribution of improving access to safe and near drinking water to improve health, a key dimension of multifaceted human deprivation, poverty. Improved domestic water supply also makes it possible for girls to attend primary school, as they will not have to fetch water from long distances. Moreover, the HIV/AIDS pandemic, which seriously affects labor availability, compounds the need to reduce women's and children's hours of fetching water. If women are victim themselves, they will be too weak to perform this heavy workload.

The Millennium Development Goals entail the commitment to halve the population living on less than one US dollar a day by 2015. For Ethiopia, this means significantly improving the income of 25-30 million people in the next 11 years (based on UNCTAD, 2002). In Asia, where irrigation development was massive, poverty reduction impacts of both public and private irrigation were found in many studies (Mellor and Desai, 1985; Hussain, 2005). Generally, after roads, investments in irrigation emerge as the key factor triggering rural upliftment (Bhattarai, 2004). An important contributor to these poverty reduction impacts is the multiplier effect of investments in agricultural intensification, for example for irrigation, which are considerable. Studies reveal that for each dollar invested in agriculture, the value of economic activity in forward and backward linkages including input supply, trade, export, and processing adds another 1.5-2.0 dollars return. Even stronger, throughout history and worldwide, agricultural growth has been identified as the engine of overall economic growth and poverty eradication. Systematic analysis of the historical development paths of today's developed countries and of the Asian Tigers invariably shows that non-agricultural economic growth was based on agricultural expansion, except in countries where abundant mineral resources allowed wealth creation (Timmer, 1988; Koning, 2002).

A major weakness of conventional schemes is that targeting to reach the poor and ultra-poor has been weak. New forms of individual irrigation with cost-effective appropriate technologies have the potential to perform significantly better in terms of poverty reduction. Neglect of gender issues and the potential of irrigation support to raise incomes for both men and women are common. Gender-sensitive domestic water development is critical for alleviating the burdens of water fetching and for better sharing of this contribution to family welfare between the genders. Among the poor, men's income alone is not sufficient, and water could create additional income for both. Women's incomes are also vital for their dependents and even more so, because, worldwide, women tend to spend a higher proportion of their incomes on family welfare than men (Quisumbing, 1996).

An important conclusion from many gender projects and studies in irrigation is that the gendered organization of irrigated farming, which varies considerably worldwide, is a key determinant for the type of gender activities that can be undertaken successfully (Van Koppen, 2002). In areas where 'female or dual farming systems' prevail, in the sense that half or more of the farm decision-makers are women, many studies show that women farmers are as productive as men farmers, provided women have similar access to land, technologies, training, and markets and control over the output as men (Quisumbing, 1996). Irrigation projects in these areas that started targeting women farm decision-makers have been very successful (Zwarteveen, 1997; Hulsebosch and van Koppen, 1993; Merrey and Baviskar, 1998). If given the chance, women's participation in irrigation projects is massive. Including women is often a prerequisite to even reach project goals. In projects in which women's irrigation activities were taken away, and reallocated to men, this even led to scheme collapse or women leaving settlement schemes, returning to their original villages (Hanger and Morris, 1973; Van Koppen, 2000).

In contrast, in areas where a 'male farming system' prevails, the majority of women are primarily unpaid family laborers on their husbands' fields. Women tend to be responsible for the labor-intensive tasks, such as weeding and harvesting, and sometimes also field irrigation, but they have very little say over the farming process and over the produce harvested, which are in the male domain. Men often also hold the primary land rights and carry out critical tasks, such as plowing and harvesting and attending the meetings of the Water Users Associations. They also take virtually all decisions about crop choice, cropping pattern, applying fertilizers and chemicals, use for family consumption or marketing, and use of the income gained, whether or not after consulting their wives.

Nevertheless, also in male farming systems, there are often small niches of cultivation by women, where they already have relatively more control over the production and sometimes even marketing, such as homestead gardening, for example in Gujarat (Van Koppen et al. 2001). Interventions targeting women in these niche activities are also particularly successful. Moreover, in areas where a male farming systems prevails, there is always a minority of women who do have land rights, and/or whose male relatives passed away, are absent or are not interested in farming. Specific support for this minority to become more productive is critical. These women farmers face serious taboos in farming and irrigating, which supporting irrigation agencies can help mitigate. For some tasks, like plowing and sometimes also irrigation, as reported in Kenya (Adams et al., 1997), women are often forced to hire men at high costs. While there is often a norm that women should not go for night irrigation, the reality can also be that it is precisely the women, who get the night turns, because the more favorable time periods are already taken by men (Von Benda-Beckmann et al., 2000).

Canal maintenance work, typically a primary obligation for all irrigators and the single most important condition to gain the right to access water, may be surrounded by local taboos against women doing maintenance work. If so, women are, again, forced to seek a more costly male replacement. Further, women are often significantly less mobile, both physically and socially, than men in interacting with input suppliers and traders. They also face cultural constraints in attending male-dominated meetings, such as Water Users Associations, and typically are not supposed to enter the places, such as bars or bus-stands, where men discuss many issues about water allocation in reality. Not surprisingly, therefore, in the face of these bottlenecks, women may decide just to lease their land out or hand over to their sons, even though they typically gain much less than what they could have gained if they had farmed themselves (Agarwal, 1994).

Nevertheless, in such male farming systems, government and NGOs have taken important initiatives to challenge taboos and practices that curtail women's potential to gain an income. For example, farm leaders in West Gandak Irrigation Scheme, Nepal, and intervening agencies, such as the PATA project in Pakistan, effectively stimulated women to become members of the Water Users Associations, which not only give a forum to discuss the domestic uses of irrigation water, but also challenge many of the social norms and taboos that prevent women from becoming farmers (Zigterman, 1996; Van Koppen et al., 2001). Perceptions that women would not be able to carry out maintenance work have drastically changed in Bangladesh, after projects targeted women's groups for maintenance work (Jordans, 1991). Also in many cases, women's organizations and allocation of some land also led to new opportunities for women to gain an income in a field that till then tended to be considered as exclusively male.

These lessons on how to ensure locally specific, successful interventions by building adequately on the prevailing gendered farming system (ranging from male to dual to female farming systems), will be highly relevant in Ethiopia, where the gendered organization of farming may fit the characteristics of a male farming system in many localities, but also significantly varies regionally. In sum, by meeting not only poor women's domestic but also their varying productive water needs, pro-poor and gender-sensitive water development interventions can significantly contribute to reaching the Millennium Development Goals.

MUS: PRO-POOR AND GENDER-SENSITIVE IWRM

It is increasingly recognized that one of the bottlenecks in water services provision to meet the range of water needs of both poor women and men lies in the artificial division between the domestic water sector and irrigation sector, despite the reality that schemes are used invariably to satisfy a range of people's water needs. For example, domestic water is often used for homestead gardening or livestock, where it significantly adds to people's well being (Moriarty et al., 2004). On the other hand, irrigation schemes are always used for domestic purposes, including drinking, and often also for livestock, fisheries, and small-scale businesses such as brick-making (Bakker et al., 1999; Van der Hoek et al., 2002). A 'multiple use water supply' (MUS) approach seeks to overcome these counterproductive barriers among water service providers. This approach takes the community's own needs and priorities on how to develop and use their multiple water sources as the starting point (Moriarty et al., 2004). Moreover, stimulating productive uses of water in multipurpose schemes also enables users to pay more for cost-recovery. Recognizing that 'the community' is no homogenous entity, a MUS approach especially targets women, the poor, ultra-poor, HIV/AIDS affected households, and other marginalized groups within the community in order to ensure that their water needs receive at least equal attention as those of others.

Basically, the MUS approach is a form of Integrated Water Resources Management (IWRM), as advocated globally since the declaration of Dublin in 1992. It finally integrates the domestic and productive water departments within the water sector itself, and starts bottom-up with the reality of IWRM at household and community level in poor rural areas. Communities themselves develop and use their multiple water resources in an integrated way to first meet their domestic and, if water resources are available, their productive needs for minimum health and income needs. The integration between the domestic and productive water sectors allows providers and service deliverers to coordinate and render their service delivery more efficiently, while recognizing domestic water provision and labor-saving for women and children as priorities. The ability to pay for domestic water, a key condition for better cost-recovery and financial sustainability within a scheme, also improves. Cost reduction for more sustainable schemes allows the providing agencies to reach many more communities. These key poverty and gender strategies are then reflected in water governance at each higher level, up to transboundary agreements. A MUS approach is an effective way of mainstreaming both poverty reduction and gender equity in IWRM and basin level management.

APPROPRIATE INDIVIDUAL TECHNOLOGIES AND MODES OF IMPLEMENTATION

As already mentioned, the potential merits of affordable micro-irrigation technologies, like low-pressure drip kits, treadle pumps, small diesel pumps, RWH technologies, including *in-situ* water conservation practices, small basins, pits, bunds/ridges and runoff based systems (catchment and/or storage), are increasingly recognized by the government and many NGOs in Ethiopia. However, there is little experience in the country as yet with a) methods for widespread manufacturing and dissemination, and b) integrated approaches that cover the whole range of production factors and that need to be in place in order to derive full potential benefits. International lessons on these related aspects will contribute to accelerated uptake and augmented incomes among thousands of farm households, benefiting from net income increases such as those reported elsewhere; for example, increases of US$ 100 per household per year are reported for treadle pump adopters in the Gangetic Plain (Shah et al., 2002), or increases of even US$ 1,000 per pump sold in Kenya, though lower in Tanzania (Van Koppen, 2004; Regassa 2005).

Farmers themselves, governments, NGOs and the donor community have long played an important role in the research-based development of water technologies and the upscaling of these technical innovations via agricultural extension networks and, especially for domestic water supply, via local government. On-farm trials and building upon farmers' own innovations generally improve the match between demand and invention. A more recent trend is making the market work for poor farmers' own purchases or loan taking (Aeschliman, 2002). For treadle pumps, for example, different modes of market-dependent implementation have emerged, followed by different NGOs. ApproTEC, which has sold over 38,000 pumps in Kenya and Tanzania, and is now expanding to other African countries, established self-financed supply chains with central manufacturers and wholesalers, and a diverse network of retailers. Investments in supportive research and development of new appropriate technologies, marketing, and evaluation and monitoring are financed by the donor community (Van Koppen, 2004; Van Koppen and Safilios-Rothschild, 2005; Regassa 2005). Enterprise Works stimulates local manufacturers to both make and sell pumps within a smaller radius of activity and lower pump sales (Beaujault and Dodson, 2002). An NGO, International Development Enterprises (IDE), which operates in Zambia and recently opened an office in Ethiopia, has shifted from its earlier approach focused on pump manufacturing, to a 'prism' approach that covers all aspects of profitable small-scale farming, in which the identification of the most profitable market product precedes input provision, including pumps, and linking with the market (IDE and WI, 2002). Higher income becomes the 'pull' factor creating a market for treadle pumps. Whatever the mode of implementation, though, the costs of pumps in Africa remain considerably higher than in Asia (US$ 20 in Bangladesh compared to US$ 40 in Kenya); so importation from China and India remains an important alternative.

Some of the main generic success factors behind the uptake of new small-scale technologies for food security or profitable enterprises are generally known: demand-driven, rapid return on farmer investments (and common knowledge thereof), technology matching water resources, the existence of factors enabling higher water productivity, such as output markets, input provision, enabling policy and legal environment, and importation facilities (Sally and Abernethy, 2002). However, comparative action-research that takes the local specifics sufficiently into account is still largely lacking.

PARTICIPATORY IRRIGATION MANAGEMENT IN SMALL, MEDIUM- AND LARGE-SCALE SCHEMES

Since the early 1990s, many efforts have been made worldwide to explore the potential benefits of a more participatory mode of irrigation management in existing large- and medium-scale irrigation schemes. It was assumed that devolving management responsibility, with or without some form of scheme ownership to the irrigating farmers, improves scheme performance, water distribution, and productivity, while saving public resources for agencies to carry out such tasks.

A major driver of this global endeavor was the growing recognition of farmers' own initiatives and capacity to take up irrigation, without public assistance. Studies on Farmer Managed Irrigation Systems (FMIS), for example, highlighted how farmers constructed and maintained their own river diversions, intakes, canals and other infrastructure and developed highly effective and quite equitable ways of water sharing, for many centuries (Merrey, 1997; van den Dries, 2002). Farmers' own rule setting, fully tailored to local constraints and opportunities, and peer-control in enforcing these rules, appear generally more effective than rules imposed by outsiders (Ostrom, 1990; 1992). Well-intended efforts of governments and NGOs to 'improve' farmer-managed irrigation are often counter-productive, distorting rather than strengthening the irrigation arrangements that already exist (Yoder, 1994).

Another example of farmers' own massive initiative, in favorable market conditions, is the booming purchase and use of small-mechanized water lifting equipment and groundwater development in countries like Bangladesh, India, Vietnam, and Sri Lanka. Thus, farmer managed irrigation tends to be effective, resilient, and highly cost-effective for government.

Influenced by these experiences, it was assumed that the devolution of management responsibilities to farmers in already existing large-scale and medium-scale public irrigation schemes would also tap this potential. However, available evidence on the impacts of widespread Irrigation Management Transfer (IMT), or also called Participatory Irrigation Management, is mixed. First of all, there is hardly any evidence of increased productivity, at least in the initial years, so IMT remains primarily a matter of cost-saving for government, devolving tasks to farmers that they can also perform at less cost (Vermillion, 1997). For such IMT, two major conclusions have emerged: first, the process of IMT should be right, and, second, even if the process is right, more factors need to be taken into consideration to render IMT effective in the context of smallholder irrigation schemes in low-income countries.

Vermillion and Sagardoy (1999), based on experiences worldwide, propose an overall process of IMT that is most likely to lead to successful transfer of management responsibility to farmers. Important features are a gradual phased approach of IMT, starting by organizing farmers into multi-tiered Water User Associations, by clearly defining their rights and responsibilities, and by capacity building for the new functions farmers have to perform. IMT usually starts at the lowest tiers, with a gradual devolvement of government tasks to farmers at higher and apex tiers of the WUAs. A first activity of the new WUA is often farmer-indicated urgent repairs in infrastructure and, depending on available resources and the state of the infrastructure, further rehabilitation of the scheme. Water fee setting and cost-recovery by the new WUA are also important tasks from the outset. Last, but not least, new incentive structures are to be crafted for government water officers to become more accountable to farmers and remove negative incentives that lead to fostering dependence, not independence.

A study by Shah et al. (2002) emphasizes that getting the process right does not guarantee success. IMT has worked in middle and high-income countries and among the better-off farmers in developing countries, where irrigation is central to farmers' incomes, where water payments only constitute a small portion of total input costs, where incremental transaction costs after IMT are limited, and where farming is business oriented. However, many irrigation schemes in Africa typically provide supplementary irrigation to increase only part of the household income; they have large numbers of small farmers, which translates into very high transaction costs for any organization; holdings are often too small to be the major source of household income; the infrastructure is often relatively expensive and designed for centralized management; land and water rights are often unclear; and these schemes are often already weak in input provision and market outlets. In the past decade, governments withdrew their support, often suddenly, from these schemes. Such IMT has led to significant reduction in scheme productivity, and in many cases, even to complete scheme collapse. Therefore, for such schemes, IMT should not only follow the right process, but also address all other factors that are critical for farming that is profitable enough to raise the income required to pay for operation and maintenance. Contract farming with agri-business often fulfills these conditions quite well.

While irrigation management transfer in existing schemes appears more complicated than the early assumptions suggested, it is now realized that it pays to involve the future irrigators at an early stage of planning, site selection, technical design and institutional set-up for operation and maintenance and cost-recovery in any new scheme construction. More input by the farmers in technology choice, in the organization and financing for operation and maintenance through Water User Associations, and clear agreements and contracts on farmers' and agency's roles in the process, enhance farmers' responsibility and to help to solve problems arising in the operation, maintenance and productivity of the scheme.

CHAPTER 5

OPPORTUNITIES FOR PROMOTING SMALL-SCALE/MICRO IRRIGATION AND RAINWATER HARVESTING IN SELECTED REGIONS

OVERVIEW

In the preceding discussion, especially in Chapters 3 and 4, it is clear that even in countries where water resources potential is relatively well known and known to be substantial, other conditions may not be conducive for sustainable irrigation development to achieve food security, improve livelihoods and reduce poverty. Such conditions may vary from attributes such as topography, soils conditions and rainfall characteristics, to technical and socioeconomic issues such as lack of physical infrastructure, access to innovations and information, markets, credits, extension, and other institutional support services needed to enhance viable irrigation farming. There is ample evidence that most of these conditions have not been sufficiently met in the expansion of small-scale irrigation (SSI), micro irrigation (MI) and rainwater harvesting (RWH) in Ethiopia. Thus, the impacts of these initiatives in most regions of the country have been limited, especially in addressing the country's chronic food insecurity problems.

There is evidence that most modern irrigation development in Ethiopia, (including SSI, MI and RWH), has largely been a supply driven, technically focused approach, which has tended to ignore various factors that are relevant for making smallholder irrigation farming sufficiently rewarding to justify investment costs, and to achieve significant food security and poverty reduction impacts. Besides ignoring other important production-enhancing factors, irrigation water development in the country has not been conceived in ways that reflect the reality of multiple water uses in rural settings, taking domestic needs and diversified livelihood strategies into account. Although hardly incorporated into planning, the actual use of small-scale irrigation water use for crop production in Ethiopia is usually in tandem with livestock farming, vegetable gardening, backyard production, along with various kinds of domestic water uses. Although experience in the country differs from region to region, the current review has found little evidence that SSI, MI and RWH investment initiatives have been done in the context of this broader view of multiple uses, which is among the many reasons for their very limited impact.

The synthesis in this section focuses on specific impacts, major constraints and limitations, knowledge gaps, future opportunities for investments and lessons learned with regard to SSI, MI and RWH, from the perspectives of various regions of Ethiopia. The discussion is focused on the main regions under review (Amhara, Oromia, Tigray and SNNPR), but extrapolates discussions of the findings to experiences in other regions of Ethiopia in a national development context.

EXPERIENCES, OPPORTUNITIES AND IMPACTS OF SSI, MI AND RWH

The actual and perceived impacts of irrigation (SSI, MI, RWH) were assessed through interviews with various government bureaus, officials, key informants and communities in the selected regions. The assessment was done for successful, moderately successful and unsuccessful schemes at regional levels so as to capture a broad perspective. Follow-up rapid assessment studies were conducted in successful schemes in selected communities so as to understand the reasons for the positive experiences from a local perspective. The criteria used for this evaluation include:

- Farmers' general satisfaction, in terms of perceived impacts on income and food security;
- Improvement in production structure (cropping intensity, crop productivity, etc.) and conditions;
- Improvement of income, through the introduction of high value crops, or through the second point above;
- Expansion of the scheme through farm size increase or through increase in land area that can be cropped all the year round, or the arrival of new farmers on the scheme;
- Negative experiences, such as flood, salinity and other agronomic problems that may lead to abandonment of schemes;
- Out growers or multiplier effects that enhance diversification into other income generating activities;
- Sustainability of scheme (reduction/increase in conflicts; reduction/increase in hydrological or agronomic problems, etc.).

Opportunities and Lessons on SSI

In the Amhara Region, irrigation infrastructure has been increasing year after year, which may suggest experiences with SSI in the region have been positive. Indeed, the current survey reveals evidence of success on some schemes, where farmers admitted satisfaction in terms of improvement in incomes, as well as expansion of command area due to increased accessibility to water. However, these positive experiences were largely evident on traditional small-scale schemes. Farmers, who have used traditional small-scale irrigation, which are mainly diversion schemes, for a long time seem to have good experiences. Their local know-how and indigenous knowledge perhaps enables them to take good advantage of emerging opportunities associated with interventions. This draws attention to the relevance of including local knowledge and know-how in small-scale irrigation development and planning. There is a general consensus that irrigation investments will achieve broader food security and poverty reduction impacts, if efforts are geared towards revitalizing and up-grading existing traditional small-scale irrigation schemes, with support to enhance access to input supply, output marketing and extension to facilitate access to information and innovations.

Some success was also reported on modern schemes, especially in the Amhara Region. There are instances where farmers earn up to about Birr 15,000.00 (about $1,800.00) from farm products, mainly horticultural crops from modern small-scale irrigation schemes. This evidence, however, remains mixed, as there are also several cases of failures in both technical and social terms. Technical evidence is largely reflected in negative outcomes, such as secondary soil salinization, flooding, and the outbreak of diseases, such as malaria. From the perspective of local respondents, these failures are, among others, attributed a to lack of adequate community consultation and participation during planning and, hence, a lack of 'sense of ownership'; inadequate operation and maintenance skills due to lack of participatory processes that facilitate training or the incorporation of indigenous knowledge into planning; lack of maintenance or spare parts of scheme machinery; and lack of access to input and output markets. From the perspective of the recipient communities, the main reasons for failures are summarized below:

a. Limited or lack of community consultation, which precludes the inclusion of indigenous knowledge or local know-how in scheme planning and construction. In most cases, low cost design and construction with little guidance from local knowledge make the schemes vulnerable to floods, or creates high maintenance and other technical requirements that can hardly be met by the communities, with increasing problems of water reticulation and distribution, often with water shortage, low yields and, sometimes, abandonment of the scheme.

b. Some horticultural crops are highly vulnerable to pests and diseases; often these crops are introduced without accompanying programs of pest and disease management, which drastically reduces yields and the profitability of farming.

c. Organized input supply, through government or government-supported channels are often available only for the major rain-fed season. Farm inputs, especially fertilizer, are scarce and relatively expensive during the irrigation season, i.e., the dry season, which leads to sub-optimal application of inputs, low yields and low profitability. In some instances, farmers attempt to substitute mineral fertilizers with farmyard manure, but this is often not available in desired quantities.

d. Poor access to markets for both inputs and outputs creates problems for production on a market-oriented basis, whereby lack of markets for certain crops after harvest leads to huge losses.

Impacts of SSI

Impact assessment at the community level is based on key informant interviews, which categorize schemes into successful, moderately successful and failed schemes. On one particular successful scheme—*Miela Scheme* in Tigray—average earnings of farmers ranged between Birr 1000 to 2000 per season from the sale of a harvest. Irrigation income was said to be sufficient to cover basic household needs. Children were also reported to be attending schools. These are the primary success indicators used by local NGOs.

The *Genfel* river diversion irrigation scheme, located in Wukero Woreda in Tigray, was also cited as another example of a successful irrigation scheme. On this scheme, there is evidence of success with smallholder farmers obtaining relatively good tomato, maize and pepper harvests, along with oranges, bananas, avocados, and fodder for cattle.[13] For about half of the irrigators, this income is supplemented by additional income from the soil and water conservation projects of food for

[13]Realized yields are around 4 quintals tomato and 2 quintals maize on 0.25 ha, and 1.5 quintals of pepper on 0.0625 ha, etc. i.e., yields are 1.6t/ha for tomato, 0.8t/ha for maize, and 2.4 tons/ha for pepper.

work. This income improvement has also increased the number of school-going children, as well as access to food. The scheme has a relatively high level of food security, and irrigators have not received relief food, since the scheme started operation in 1996, except during the severe droughts of 2003.

A couple of irrigation schemes were also suggested as moderately successful, while several were referred to as failed schemes, with various kinds of problems associated with micro-dams and small-scale irrigation infrastructure, seepage, sedimentation, cracks in dams, silting up of reservoir, high input costs—especially cost of fertilizer, pests and diseases especially for onions and tomatoes, high interest rate on loans and marketing problems. Where these types of failures occurred, they have generated negative attitudes toward irrigation development among farmers. Non-acceptance of irrigation schemes by farmers is the main social failure that results in cultivation of only a small part of the available potential area. This is largely a function of the top-down implementation process often followed. It also suggests some of the interventions are often not appropriate, given the circumstances of the recipient populations. Table 5.1 provides impact evaluations of six schemes in the SNNPR categorized as successful, moderate and failed schemes, as additional examples.

Key Lessons from SSI

The general lessons gathered from experiences with SSI in all regions relate to the need to improve communication, community consultation and involvement in project planning and implementation, proper design with adequate timing and reference to local information and indigenous knowledge, technology choice and market related issues, as well as adequate baseline studies prior to implementation (also see Table 5.2). At the macro level, the lack of *clear policies*, especially in relation to water use and irrigation development, is at the top of the list as responsible for failures, along with lack of co-operation and coordination among organizations involved in SSI funding, development and management. *Ambitious irrigation planning,* without securing sufficient skilled manpower, and insufficient local capacity to run the schemes—management, financial, and technical capacity, have also been alluded to in nearly all regions as a source of failure. *Scheme design* or design of irrigation structures should fully incorporate farmer's indigenous knowledge and traditional experience, and take local level capacity into consideration.

Another key area of concern emerging as a key lesson relates to *communication* and *community consultation* during planning and implementation. Communities emphasized that if given the opportunity to identify and decide the types of project in line with their expectations, they will mobilize and their participation will be high at all stages of the project. There is ample evidence from all regions that most of the failed projects are those implemented without sufficient and effective beneficiary consultation and participation. The establishment of *water users organizations* (WUAs) based on local irrigation experience to take the responsibility for operation and maintenance of irrigation infrastructure is also essential and needs to be strengthened. Experience from other IWMI projects in Ethiopia, for example APPIA, shows that WUAs successfully achieve effective water distribution mechanisms, often completely different from the original design; WUAs are undertaking successful scheme maintenance activities organized by themselves without external incentives or motivation; and some have succeeded in expanding scheme command area, as well as digging new secondary/tertiary canals to correct design errors.

Table 5.1: Impact Evaluation of Irrigation Schemes, Example from SNNPR

Name and location		Evaluation criteria about impact (sample schemes from SNNPR)					
Name of the Scheme	Location Zone/ Woreda	satisfaction	Farmer's Improvement	Production Improvement	Income abandonment	Expansion Multiplier effect	Sustainability
Successful							
Ella	Wolaita/ Humbo	High, as the scheme has changed their lives	Able to produce 2 to 3 times per year	Better, as they can now buy oxen for agriculture and upgrade their houses	Expanded from 80 ha to 120ha	Yes	Sustainable (less conflicts, water problems, etc.)
Eballa	K.T. K/ Gemila	Increasing, as they realize they can produce more	Able to produce at least 2 times per year	- do -	- do -	Yes	- do -
Moderate							
Bissare	Wolaita/ D.Woide	Moderate	Better and food aid is not required now	Better as they buy something from the market and send children to school	Full capacity irrigation	Yes	Too early to evaluate sustainability
Bedessa	Wolaita/ D.Woide	- do -	- do -	- do -	- do -	Yes	- do -
Failed							
Segengate	Konso	Very low, because the scheme is not functional	No production by irrigation	No	No expansion	No	No
Erbore	S. Omo H/Bena	Very low, because of technical problem	- do -	No No	No expansion No	No No	No

Another important lesson relates to the technology choice. The choice of technology should consider the capacity of the beneficiaries to operate equipment on their own (e.g., mechanized pumps) and to maintain the pumps and obtain spare parts. There is a classical example of the *Meki-Ziway* Scheme in Oromia, which failed largely because farmers could not get spares for the imported pumps, could not carry out maintenance, and could not afford the electricity fees to run the pumps. The need to introduce irrigation technology that is commensurate with the capacity of the final users of irrigation infrastructure needs to be considered properly. There is a need to provide *periodic training* in the field of irrigation technology, water management, operation and maintenance, agricultural input supplies and marketing to irrigators and employees of government and non-governmental organizations.

Furthermore, it is important to assign well-trained manpower in the field of *irrigation and agronomy*. Initial investments, including credit facilities and irrigation water management training, were found to be critical in many SSI projects that succeeded. Access to input and output markets and institutional support services remain critical. Solving the problem of soil nutrient mining will also be very challenging, but an integrated approach that combines improved crop varieties and management practices, availability of knowledge of fertilizer options, availability of appropriately packaged fertilizers, conservation tillage, and access to markets where crops can be sold profitably will help[14].

To date, most efforts to promote SSI in Ethiopia have paid at best lip service to *gender* issues. This is a missed opportunity from a development perspective, since women play such key roles in the production process, and also because the number of female-headed households is increasing. .That said the cultural rules militating against gender equity are rather powerful, and the strategies that would change this are not clear. However, there are two possible avenues: 1) individualized micro-irrigation technologies do lend themselves to being used by women, as they are relatively inexpensive, do not require much in the way of male cooperation, and can dramatically increase labor productivity; and 2) designing and implementing multiple use water supply systems may enable water supply systems to meet the different needs of various customers, both males and females.

This introduces another important avenue for innovation: *multiple use water supply systems (MUS)*. We believe there is now sufficient evidence that such an approach implementing IWRM at the local level—where it is most meaningful—can lead to more sustainable water supply schemes, which meet a wider range of needs in communities, and thus make greater contributions to improving livelihoods and food security than is possible with single-purpose water supply schemes.

It is also important to match the right technologies to the right circumstances—something now made possible with the wide range of low-cost water management technologies available in the world. Rural Ethiopia exhibits a huge variation along a number of social and economic dimensions: ethnic group, religion, and economic status are just three. For the purposes of this report, we suggest three broad groups that could be considered 'target groups' for future investments:

> Group A: The large group of rural poor, who are chronically food-insecure and have minimal market opportunities and minimal alternative employment opportunities. These are a major target of the New Coalition on Food Security in Ethiopia, but are also relatively difficult to reach.

[14] A recent evaluation of SSI by IFAD emphasizes all the points discussed here, but especially the soil conservation issue (IFAD 2005).

Group B: Farm households, on the margin between subsistence and commercial agriculture, and food secure at least most of the year, which are classified as low vulnerability in the classification of the World Food Program, and usually able to produce small surpluses for market but are constrained particularly by access to markets, diversification and opportunities.

Group C: Similar people as in Group B, but with the advantage of having potential access to irrigation water, either through diversions from streams or small dams to capture water, or through shallow groundwater.

Many farmers consider water used for drinking by cattle and small livestock to be so important that it is seen as part of 'domestic water'. Per animal, cattle need more water than people, but demand less in term of quality. A peculiarity is that cattle often pollute water also used by humans because of inadequate design of the drinking and walking areas. A neglected area on which IWMI and ILRI are currently launching research is the amount of water 'consumed' by livestock through the food they eat and how the productivity of this livestock water can be optimized. Meeting the needs of livestock is, therefore, another very important dimension of MUS. Peden et al. (2005) review experiences and opportunities for integrating water and livestock projects in Africa including Ethiopia.

Finally, we note that there continues to be a serious under-investment in research and capacity building. In this context, we welcome the new Research and Development Department in the MoWR. Research is an important mechanism to innovate by finding and applying better solutions to problems. Ethiopian agriculture has been relatively less innovative than agriculture in other developing countries. Furthermore, IWMI has had experiences in Asia, where applied research was an important component of irrigation water management investment projects; in many cases, these projects have proven more sustainable and had higher returns than those that did not support research and capacity building (for example, Uphoff, 1992).

Opportunities and lessons from MI

Despite confusion in Ethiopia as to what micro irrigation (MI) actually is, the potential is huge for micro irrigation technologies, such as low cost drip irrigation, small bucket and drip systems, pitcher irrigation, treadle pumps, and hand and pully pumps, to make a difference in chronically food insecure areas. This is because such systems are individual or household-based and do not depend on group efforts or collective action for success. MI is also attractive to achieve greater gender equity. Women, like men, can use such technology for horticulture production in the backyard to supplement and diversify the production for household use, as well as for limited sale of products to supplement household needs. Evidence of micro irrigation especially in the flower farming areas of Oromia (for example, Sebata and Hollota areas) and to some extent vegetable farming (for example around Debre Zeit) show some indication of success. However, these are imported 'high-tech' technologies used on large land holdings, which preclude poor smallholders' participation. Thus, even though these initiatives may be making a real contribution to farmers' incomes and welfare, their actual poverty and food security impacts on poor farmers remain questionable.

Recently, efforts by NGOs such as World Vision, SNV, and institutions (such as Arba Minch University) have targeted poor farmers. However, these efforts have so far focused on drip kits which, offered at about US $174 per kit, remain expensive for poor smallholders, compared to alternative bucket or drum and drip kits of between US $1 to US $65 in India. Therefore, there is a need for alternative MI kits that are cheaper and can be produced locally, an initiative that is currently being looked at by AMU, experimenting with buckets, pots, modified filters, flexible pipes and drippers.

The real opportunity for MI in Ethiopia is the existence of a wide variety of small, cheap, adaptable MI technologies worldwide, which can be easily adapted or produced using local materials. MI technologies are well suited to the production conditions and natural resource endowments of Ethiopia. The commitment of various NGOs and institutions, such as AMU and MoARD, to promote MI for food security fits very well within the framework of the food security objectives of the New Coalition for Food Security in Ethiopia. These should be seen as emerging opportunities for enhancing the opportunities of poor smallholders to acquire a share of the benefits emerging from these interventions.

As with the other irrigation intervention technologies, there are real constraints that have to be addressed. These include training, start-up capital, access to adequate land resources to produce, say vegetables, and diversify into other high value crops for increased income, and access to input and output markets. Evidence from elsewhere in Asia and Africa show that MI has a potential to considerably increase incomes of poor households through intensification or modest increases in irrigated areas, enhancing the adoption of higher value crops and the realization of higher yields.

Opportunities and Lessons from RWH

With the various shocks associated with rainfed agricultural production in Ethiopia, for example dry spells, droughts and floods, the potential contribution of rainwater harvesting to stabilizing agricultural production is obvious. Despite the global consensus that rainfed agriculture will in the foreseeable future continue to be the major source of food security in the world (Rockström 2001), there is accruing evidence that this potential can only be fully realized if yield-enhancing measures are taken to reduce the negative impact of rainfall shocks, and to increase yields through supplementary irrigation and rainwater harvesting combined with better fertility management. Besides its contribution to improved food production and food security, the impacts of rainwater harvesting are also recognized in improved water availability for multiple uses, including domestic, with potentially positive, but sometimes negative, health impacts, improved environmental conservation, and often social integration of a community around the common pool resource that binds them together.

Evidence from elsewhere in Eastern Africa suggests current estimates of potential yield increase are too modest. Rockström (2001), citing other research as well, notes that 70-85 percent of the rain falling on fields is "lost" through evaporation and runoff and therefore, is not used by plants (see also Rockström et al., 2003; Falkenmark and Rockström 2004). Appropriate rainwater harvesting combined with conservation tillage to make water available to plants can maximize infiltration, mitigate short dry spells, and reduce soil erosion and loss of soil fertility, leading to average yield increases of up to four times current levels. Further, technologies that make better use of such "green" water tend to be far lower in cost than "blue" water technologies like irrigation. This has two advantages: in the right environment, far more people can be assisted to achieve food security per dollar invested; and low-cost RWH technologies can be used to enhance the productivity of staple food grains; the high costs of irrigation can often be justified only if farmers grow high-value crops for the market.

Even though several assessments and studies show that yields in irrigation systems in Ethiopia are generally low, there is some evidence that rainwater harvesting practices, including *in-situ* water conservation and tillage practices, have led to cereal yield increases in Ethiopia. Desta (2003), for instance, reported a potential for yield increases of up to 15 percent in High Potential Cereal (HPC) zones and of about 7.5 percent in Low Potential Cereal zones. Water conservation measures and rainwater harvesting techniques (such as soil/stone bunds, bench terraces, retention ditches, runoff diversion, and micro-basins) were also shown to be suitable in the drier areas of the country, primarily due to improved moisture retention capacity of the soil. Thus, integrated rainwater harvesting, ensuring the integration of a wider range of approaches, is strongly recognized as an important step towards improving production at both the household and community levels. The Ministry of Agriculture and Rural Development (MoARD) is currently collaborating with regional governments and bureaus in promoting runoff agriculture, in addition to structural storage systems.

The impacts of rainwater harvesting can be seen at the local level in many parts of Ethiopia today. Runoff irrigation in parts of Eastern and Western Hararghe, in Tigray, is reported to have made a considerable difference in increasing crop yields (Habtamu, 1999). The use of ridge ties to retain moisture around plants is recognized as a yield-increasing practice especially by the *Konso* tribe in SNNPR. These practices have been recognized as production-oriented water harvesting techniques that have created positive impacts on food security through yield increases, particularly in drier areas of Ethiopia (Asrat et al., 1996). Storage-based rainwater harvesting activities, especially in Tigray and Amhara, have also achieved modest food security impacts, though environmental and health impacts associated with these activities have recently resulted in suspension of construction of such structures as ponds, micro dams and terraces, especially in the drought prone region of Tigray. Despite the unreserved commitment of government (and some donors and NGOs, like Sasakawa Global 2000 or SG2000), to continue supporting these activities, the need for adequate feasibility studies to minimize negative health impacts and enhance environmental sustainability is currently being emphasized.

The specific impacts of rainwater harvesting, as experienced by farmers, NGOs and beneficiary communities, are assessed on the basis of farmers' satisfaction, improvement of production as observed in increased cropping intensity and productivity, actual improvements in income, scheme expansion, or abandonment, observed or perceived multipliers effects and sustainability issues. Overall responses were mixed. In the SNNPR, for example, farmers reported modest yield increases as a result of rainwater harvesting, and a potential to diversify income if trained in basic skills of rainwater harvesting.

In order to help the training of farmers, 603 specialists and development agents from 53 districts in the SNNPR region have been trained in rainwater harvesting techniques (Desta, 2003). These trained personnel have become trainers of the farmers. This, however, is said to be far less than half the number of the trainers in need of training. Farmers' training is expected to grow significantly in the coming years throughout Ethiopia, as thousands of FTCs are under establishment, and thousands of DAs are graduating from various TVETs.

In the Oromia Region, the work of SG2000, for example, in promoting rainwater harvesting and drip irrigation was noted to have started achieving impacts, such as food security and income increases. Farmers expressed satisfaction with the intervention, which they claim is accompanied by modest credit facilities, technical support and some training. These activities are also extended to SNNPR, and there are efforts underway to emphasize drip irrigation for higher value crops and vegetables to attain a higher level of food security.

Impacts of water harvesting in Tigray, especially with large ponds and micro dams, remain controversial. NGOs, such as Water Action and Water Aid, in collaboration with CRS, are active on the water harvesting front. While modest yield increases are reported in some parts of the region, others narrate huge problems of secondary soil salinization and outbreak of diseases, such as malaria, associated with micro dams. Yield increases are reported to be marginal, while the use of material inputs, like fertilizers, in some schemes remains absent or small. This is quite consistent with other assessments, such as Teshome (2003), who also asserts that fertilizer use in most schemes in the region is far below recommended levels. According to the information we obtained from Water Harvesting & Institutional Strengthening Tigray (WHIST), sponsored by CIDA, positive impacts, such as farmers' satisfaction, improvement of production through higher cropping intensity and/or productivity, improvement of income, sustainability of schemes, food security, better design and construction capabilities by local government staff, and more efficient use of irrigation water, are occurring due to the interventions of the regional government in the project. However, there are a number of challenges and lessons learned as well, which include: the importance of participatory planning and training, significant bureaucratic hurdles, lack of coordination among NGOs, women under-represented in training, decision making and farming due to cultural barriers, too many religious days, and changing of priorities of government.

182 Key lessons and opportunities for RWH

As discussed in the earlier sections, the country has substantial water resources potential. What is constraining production is access to appropriate water and land management technologies, infrastructure and institutional support services (including roads, markets, financial institutions), and an enabling environment for effective private sector involvement. The lessons from rainwater harvesting vary from one part of the country to the other, while huge opportunities exist for supporting RWH on a sustainable basis. Some of these opportunities and lessons are highlighted below:

- Several NGOs and regional bureaus have assessed the water potential in their areas of operation to be huge. If this is exploited efficiently, it would contribute significantly towards poverty reduction and to solving the country's food security problems, especially if irrigation of food crops, along with high value crops, is emphasized.

- All the communities covered in the surveys indicated willingness to participate in any form of water harvesting intervention that will improve their current livelihoods. This is a good opportunity that reflects a potential for local level participation and cooperation. This willingness should be taken advantage of, especially during the planning and implementation of water harvesting projects, thorough community consultations, which is critical for sustainability once the active support phase has ended.

- Large numbers of donors and NGOs and the Ethiopian government are willing to support rainwater harvesting initiatives in Ethiopia. Perhaps the most direct impact of water harvesting on food security is through livestock, the main use of many ponds, which could be supported along with conventional use for irrigation. Research institutions, (including IWMI) are also interested in collaboration through research and professional guidance to facilitate successful implementation and to achieve positive food security impacts.

- A wide range of rainwater harvesting technologies now exist worldwide; for example, in Asia, Southern Africa and Western Africa. The issue is mainly that of access, adaptation and adoption, and also the creation of local community level institutions for successful implementation.[15]

- Most regions in Ethiopia receive rainfall amounting to over 600 mm, albeit with spatial distribution and unreliable temporal availability. If this rainfall could be better used through rainwater harvesting to overcome dry spells, it could provide reliable food production at least once, or possibly twice, a year. Areas with more rainfall could also be made productive through soil moisture maximization and shallow well development, to achieve a higher cropping intensity.

[15]Mati et al. (forthcoming, 2005) provides an overview of RWH technologies used in eastern and southern Africa, while Barry et al. (forthcoming, 2005) offers similar information on West African experiences.

Table 5.2: Main Constraints of SSI, MI and RWH in Ethiopia.

No	CONSTRAINT	SSI	MI	RWH
1	Baseline studies/data–*lack or inadequacy of baseline studies, data and information on potentials of different areas for the development of water resources*	+++	o	+++
2	*Technology choice*–inappropriate technology that is difficult to manage by farmers at the end of the project support phase; lack of appropriate irrigation technologies for smallholder farmers.	+++	+	++
3	*Low yields*–yields are extremely low, due to soil degradation and other agronomic problems	++	+	+
4	*Property rights*–land use rights and land ownership are major constraints; lack of clear water rights and hence lack of access to land	+++	+++	+++
5	*Too small landholdings*–land holdings remain small; increasing evidence of continued land fragmentation; insufficient land resources for diversification into high value crops	++	o	+++
6	*Conflicts*–increasing conflicts between traditional irrigators and those using modern systems	+++	o	++
7	*Marketing* and market access–limited knowledge of marketing to produce target commodities using irrigation; need for market assessment, market information	+++	+++	+++
8	*Dependency syndrome*–aid or donation has become a part of rural life, farmers strategically anticipate aid as one of the various livelihood options; they hesitate to accept any development including irrigation, because of the fear that they will lose out on donations; on the other hand, the "dependency syndrome" has become the syndrome of aid organizations that cannot imagine local initiatives without them.	+++	o	+
9	*Institutional arrangements*–gaps, overlaps and conflicts of mandates and responsibilities of regional/ federal institutions; implementing agencies do not adequately involve beneficiaries (farmers) in a formal and institutionalized way	+++	+++	+++
10	*Training*–lack of training to handle technologies; lack of extension services	++	+++	+++
11	*Capital*–lack of start-up capital or access to credit to initiate venture	o	+++	o
12	*Research*–poor linkage between research and extension in the area of irrigation water management	+++	o	+++

Notes*: + = potential constraint; ++ = constraint; +++ = serious constraint; o = not reported as a constraint.

*Table 5.3: Major knowledge gaps and future opportunities with SSI, MI and RWH in Ethiopia**

No	MAIN AREAS OF KNOWLEDGE GAPS	SSI	MI	RWH
1	*Location, design, construction of infrastructure*–faulty design outcomes; insufficient or reversed canal bed gradient; inappropriate positioning of outlets/spillways, absence of foot path across canals	+++	o	+
2	*Use of modern irrigation technology*–knowledge on micro-dams, drip irrigation and motor pump irrigation (all new technologies in the region) required; knowledge on maintenance of infrastructure, seepage, siltation and negative environmental outcomes required	+++	+++	+++
3	*Water management*–experience in basic irrigation water management, how to improve the efficiency of irrigation water use; knowledge on improved and diversified irrigation agronomic practices	+++	+	++
4	*Land management*–knowledge of land management, especially erosion, infiltration, *in-situ* water conservation, soil fertility management	++	+	+++
5	*Input utilization*–knowledge on optimum utilization of inputs; knowledge on crop diversification, market opportunities and market situation	+++	+++	+++
6	*Management capacity*–knowledge and capacity to initiate maintenance practices for sustainable running of the schemes by farmers themselves; organizational capacity; financial management; institutional capacity to resolve conflicts in relation to upstream/downstream water management and uses	+++	+	+++
7	*Information and database*–knowledge and capacity for data base generation and management: climatic, rainfall, runoff and sedimentation data; adequate hydrological information for micro-dams construction	+++	+++	+++
8	*Post-harvest technology, management*–knowledge on post harvest technologies, farmers' knowledge on post-harvest management of high value and perishable crops	+++	+++	+++
FUTURE OPPORTUNITIES				
9	*High water potential* to be tapped for irrigation water in almost every region. Specific areas earmarked in some regions by NGOs and regional authorities for irrigation development	++	++	+++
10	At the moment, high *commitment of the Ethiopia government*, *donors* and *NGOs* to support irrigation management and development activity	+++	+	+++
11	Opportunity for implementing *multiple use water systems (MUS)*, with regions coordinating sub-activities. Effective utilization of scheme infrastructure through diversification of uses to meet various needs for water, such as domestic, irrigation, livestock and hygiene is the most important.	+++	++	+++
12	Opportunities for improving *knowledge* of policy makers, planners, designers, contractors and development agencies through education, training, dialogues and participation	+++	+++	+++
13	Opportunities for more *gender-equitable investments*, targeting poor women, through for example MUS and micro irrigation	+++	+++	o

Notes:+ = potential knowledge gap/opportunity; ++ = knowledge gap/opportunity; +++ = major knowledge gap/opportunity; o = not reported as a knowledge gap/opportunity.

CHAPTER 6

RESEARCH AND TRAINING NEEDS

The causes of poverty and food insecurity in a highly populous and poor country like Ethiopia are diverse but are largely related to changes in climate; increasing population pressures on a limited natural resource base; poor access to agricultural technologies; soil and environmental degradation; and lack of institutional support services, appropriate policies, and economic incentives for sustainable small holder agricultural production. Although food insecurity in Ethiopia has persisted over several decades, often it is aggravated by unpredictable climatic events, mainly dry spells and droughts, which create the need for food relief programs. The need for research to help define sustainable pathways out of this situation through appropriate development and policy interventions is obvious.

RESEARCH NEEDS

The areas of research identified by this assessment relate primarily to the issue of low yields of conventional crops compared to yields obtained elsewhere in the world. This is also directly related to the observed low level of input utilization, found to be far below recommended levels, less than 10 percent in five schemes in Amhara and less than 20 percent in others in Oromia and Tigray. Several questions were also raised about the lack of adequate feasibility studies prior to the initiation and implementation of irrigation programs, which in most cases become the primary reason for limited success and sometimes failures. The choice and adoption of irrigation technologies is another area where research is required, particularly to give farmers adequate opportunities to learn about the range of available technology options, field-testing, and adaptation to suit local conditions. Finally, research needs were also recognized in the areas of output marketing, including crop choices and targeted production that will enhance market-oriented production; how to achieve more gender equity by providing women with opportunities to enhance their access to and productive use of water; and policies to enhance sustainable agricultural production as a mechanism for poverty reduction.

The research needs specific to this study can be grouped into the following broad categories:

- *Policy research*: strategic policy research to help improve national level policies and processes, and to achieve broader and more positive impacts of smallholder irrigation interventions at national, regional and local, community and household levels.

- *Institutional research*: research to establish clear and effective policies to minimize conflicts between upstream and downstream water users. This was raised as an issue in Amhara. Problems of institutional arrangements in regional structures were acknowledged as relevant in all regions except Oromia. Research on property rights regarding access to land and water was emphasized, particularly clear definition of rights to water to minimize conflicts between traditional irrigator and those on modern small-scale scales. Finally, identifying appropriate WUA models and strategies to assist farmers to form and strengthen them is important.

- *Socioeconomic and market research*: research on marketing and market information so that farmers can produce targeted crops using irrigation was a general issue in all regions; market surveys and analysis so that farmers can produce according to market requirements; input supply arrangements during irrigation period; research on how to successfully upgrade traditional schemes into modern ones, including organizational issues related to WUA formation; benefit-cost analysis for alternative irrigation technologies taking into account affordability, accessibility, maintenance and sustainability.

- *Research to enhance yields in irrigation schemes*: the need to generate research-based knowledge that will enable farmers to make appropriate use of improved seeds was emphasized, and also to acquire basic knowledge of product diversification possibilities, particularly in the Amhara Region. Research should also focus on on-farm seed production both for cash crops, such as vegetables and rain-fed food crops. Research on how to make the role of extension effective to enhance high yield realization by farmers. Agronomic research on best crop varieties under different irrigation conditions was emphasized particularly in Oromia. Finally, research is needed to find ways to enhance optimal utilization of farm inputs, enhance crop diversification, and integrate crops, livestock including fish in some places, and agroforestry into a more productive irrigated agriculture.

- *Water technologies*: research to enhance proper and efficient utilization of water potential was emphasized in Amhara but is relevant to all regions. In Amhara, there is also a need for research on the appropriateness of irrigation technologies for small holders. This was particularly emphasized by AMAREW. Assessment of smallholder irrigation performance in terms of water use efficiency under different crop water requirements for particular crops was raised as an issue in Oromia; on drip irrigation and how best it can be made known to farmers. Applied research to promote local design and manufacture of low cost water management technologies is also needed. The issue of whether to import or produce such technologies locally is an important one, and if the latter, how to promote sustainable businesses for designing, producing and marketing such technologies.

- *Hydrological research*: topics identified include thorough water situation assessment prior to scheme construction; databases on the potential of different areas for the development of water resources so that scheme development can be based on sound scientific knowledge; adaptation of irrigation technologies based on hydrological information, raised as an issue in Oromia; and runoff estimation for different agro-ecologies and soil types, raised as an issue in Amhara.

- *Environment and health*: critical issues include how to reduce negative health impacts of some water interventions, for example malaria and schistosomiasis, while enhancing the positive impacts[16]; how sanitation aspects could be integrated with irrigation intervention; how to minimize negative environmental impacts, for example secondary soil salinization and sedimentation through erosion in upper catchments; and in some areas, how to balance the agricultural uses of wetlands with preserving their vital environmental services.

[16] McCartney et al. (2005) provides an overview of this issue.

- *Gender research:* Gender/cultural issues remain an obstacle for development of agriculture. Women are under-represented in professional positions and are frequently left out of training. Women are also frequently left out of decision-making at the field level for example, water user associations, and are culturally prohibited from taking part in certain farming activities. It is necessary to empower women to get opportunities to share benefits, have equal access to land, attend school and get involved in decision making. Research is needed to identify investment strategies and policies to overcome the cultural barriers and enhance gender equity, including targeting specific investments to poor women.

TRAINING NEEDS

Currently, there are plans and on-going implementation by government to build national and regional capacity in terms of water technology and agriculture. Some of the universities, like Alemaya, Arba Minch, Mekelle, and Jimma, have included programs like cooperatives, agricultural education, irrigation engineering, hydrology and water resources and soil and water conservation in the curriculum up to the postgraduate level. These are supposed to contribute quite significantly to the manpower needs of the country and have started producing graduates. The issue is, thus, to streamline their focus areas and curriculum to meet the manpower needs in key development areas. While training at this level is useful, it is more important that the trained professionals and technicians be able to train producers on how to use improved production techniques, use inputs efficiently, and improve institutional efficiency. In addition, 25 Agricultural TVET and 6 water TVET colleges, as well as the envisaged thousands of Farmers Training Centers (FTCs), are expected to train and add tens of thousands of field level technicians.

In the context of the above initiatives, the training needs of the beneficiary communities were identified in all areas related to technology, water management, operation and maintenance, input supply, and output marketing. These are:

- *Technology related*: training on how to use newly introduced technologies such as drip, small ponds, and shallow wells, was seen as critical. Training, in the use of fertilizers in irrigation fields and in field leveling, is also needed.

- *Water management related:* training and guidance in irrigation scheduling, water allocation and distribution on the basis of crop-water requirements. Furthermore, MUS is currently not addressed in training programs.

- *Operations and maintenance related*: maintenance of the head works and canals, seepage control and lining of canals was perceived as relevant especially in traditional schemes.

- *Input supply related:* training needs were reiterated on how and when to apply various farm inputs and associated water requirements.[17]

- *Post-harvest technology related:* Training is needed in post harvest technologies, especially in handling and storage of various farm products.

[17]Based on the APPIA project experience, irrigation schemes especially in the Amhara Region suffer from lack of input supply during the irrigation season, and as a result, crop intensification is hardly achieved.

- *Marketing*: Training should also be given to Development Agents (DAs), who are already in the field, since they are in frequent contact with farmers. Besides, other employees of governmental and non-governmental organizations, who have direct or indirect contact with farmers, should also be considered for such training opportunities.

- *Gender*: new curricula on gender and water issues with a special focus on various aspects of gender, and equity, perspectives of water resource management and implementation in university and the training system is needed.

- *University level education*: especially in agricultural and water technology universities, the curricula should be reviewed, research and practical sessions should receive adequate emphasis, as well as support for innovative education and technologies helping promotion of water and land development.

- *Technicians and DAs training* should provide more time and proportions of the training to practical skills than theoretical education. The training centers should provide adequate focus on the trainings needs identified in above.

CHAPTER 7

SYNTHESIS, CONCLUSIONS AND RECOMMENDATIONS

SYNTHESIS

This study has reviewed experiences with SSI, MI and RWH in Ethiopia, with a special focus on the Amhara, Tigray, Oromia and SNNP regions, where the bulk of the irrigation development in the country has occurred. The country is heavily dependent on rainfed agricultural production, which in turn depends on highly variable rainfall. The potentially crucial role that improved water and land management could play in contributing positively to Ethiopia's food security needs is well recognized. The government has, thus, embarked on a comprehensive food security strategy that targets food insecure and highly vulnerable areas of the country. There is evidence of government involvement in interventions, along with NGOs and donors, in all the regions covered in the study. The focus has been on the introduction of high value crops, livestock and agro-forestry development to enhance intensification, along with improved water and land management technologies in the small-scale irrigation sub-sector, (including MI and RWH).

This review reveals that irrigation development in Ethiopia is currently low, at about 250,000 hectares, which is barely 6 percent of the total estimated irrigation potential of over 4 million hectares. About 75 percent of this developed irrigation is small-scale, about three-quarters of which is traditional, and is mostly based on local practices and indigenous knowledge. Given that the overwhelming majority of farming activities in Ethiopia is small-scale, there could be a unique opportunity for positive interventions to stimulate agricultural production, especially if certain fundamental conditions are met. Experience in many parts of SSA has shown that with adequate community involvement in planning, design and management, SSIs can be more viable and sustainable than conventional large-scale schemes from a number of perspectives (Merrey et al., 2002).

The often-assumed high costs associated with smallholder irrigation development remains controversial, at least in the Ethiopian context. The current review reveals cost estimates for small-scale schemes in the range of US $3,000 and US $3,500 per hectare with diversion structures, and US $900 to US $1,500 without such diversion structure. Estimated costs presented in the current report on 161 small-scale irrigation schemes in Oromia average at about US $1,000 per hectare, excluding family labor (Table 3.6). Thus, the above higher cost assertion with regards to SSI is not supported by this study. A recent study based on over 300 irrigation projects has also shown that small-scale irrigation can be cost-effective and give high returns in Sub-Saharan Africa (Inocencio et al., 2005). Therefore, from many perspectives, the current focus on small-scale irrigation (SSI), micro irrigation (MI) and rainwater harvesting (RWH) in Ethiopia is a step in the right direction, even though performance still has a huge room for improvement.

The review shows that current irrigation development, on a regional basis, is largely concentrated in the two Regions of Oromia and Amhara, which account for about 43 percent and 28 percent of the total irrigation in Ethiopia respectively, or together 71 percent of total irrigation. That is, together they account for about 176,000 hectares of the 250,000 hectares of irrigation in Ethiopia (see Table 2.1). Over 60 percent of irrigation in each of these regions is traditional. About 13 percent of the remaining irrigated area is in the SNNPR and Tigray, with about 19,600 hectares and 12,600 hectares of irrigated land respectively. For Tigray in particular, most of the irrigated area is served by reservoirs and micro dams constructed in the last eight years. The government of Ethiopia has plans to increase the current irrigated area to about 472,000 hectares by 2016[18], most of which will be small-scale, targeting poor and food insecure communities.

While these plans by the government are supported by various donors, NGOs and development partners, there is an acute need to foster cooperation and coordination of efforts, resources and activities so as to achieve greater food security impacts. It is also crucially important that the private sector get involved in order to accelerate irrigation and agricultural development. A review of international experience and linkages to Ethiopia's agro-ecological and climatic conditions calls attention to the need to combine rainfed agriculture with micro irrigation technologies, as well as with irrigation expansion to improve productivity. Thus, *we hypothesize that efforts to achieve food security and reduce poverty through irrigation will achieve greater impacts, if complemented by simultaneous efforts to increase productivity in the rainfed sub-sector, which contributes the overwhelming proportion of agricultural production and nearly all the staple grain in the country.* In fact, this may have a much more direct impact on food security than irrigation alone, because most of the food crops are rain-fed.[19] Some of these improved water and land management interventions are already practiced in Ethiopia, especially in traditional production. However, the efficiency and productivity impacts of these traditional practices can be greatly improved by better understanding these practices in various agro-ecology, land and soil condition, so that they can be up-scaled to achieve much broader impacts especially on poor people.

In all regions, perceptions about the impact of irrigation in general and SSI, in particular, are mixed. There is evidence in several regions that irrigation has created better opportunities, optimism and hope, and generated benefits for many poor rural communities. These are prioritized, in terms of positive impacts, in the following order: modern diversion schemes, traditional diversion and the micro dams. When viewed from the perspective of resilience and ability to provide water for multiple cropping, micro dams are in most cases regarded by communities as having created the greatest impacts. This is largely related to the high water storage capacity of most of the micro dams, which reduces risk of crop failure, facilitates livestock watering and other uses, and enhances a holistic impact of irrigation. However, there are many cases, where micro dams are reported to have created health problems, and others that led to failure due to inadequate design and sedimentation. The causes of these failures need to be correctly addressed to avoid reoccurrence.

There is also evidence of some schemes, especially in the Arsi Zone in Oromia, where the choice of technology was not appropriate. This is a critical issue, since the choice of technology should also consider the capacity of the beneficiaries to operate equipment on their own (e.g., mechanized pumps) and to maintain it and obtain spare parts. Some schemes failed in this zone, particularly because farmers could not get spares for the imported pumps, could not carry out maintenance, and could not afford the electricity fees to run the pumps. The need to introduce irrigation technology that matches the capacity of the final users of irrigation infrastructure must be seriously considered in Ethiopia. International experiences show that small farmers may be

[18] This shows an increase of 274,612 on the top of 196,000 the Ministry noted in its water sector development policy document (MOWR (2002)) as already developed schemes. The overall investment cost of irrigation is estimated at US$1,683.1 million, from which the region-based SSI development is at US$ 599.4 million to develop 127,138 ha.

[19] De Fraiture (2005), based on the use of a new model to examine African conditions, comes to a similar conclusion for Sub-Saharan Africa.

innovative and could make modest investments with limited external support provided the technology suits their production circumstances. A typical example of farmers' massive own initiative, without much public assistance, is the booming purchase and use of small mechanized water lifting equipment and groundwater development in countries like Bangladesh, India, Vietnam, Sri Lanka and Kenya. The uptake of treadle pumps and other small-scale individual technologies is another example. Such farmer managed irrigation tends to be effective, resilient, and highly cost-effective for government.

This review also reveals that scheme development is sometimes ambitious with limited resources, supply-driven, and in most cases crop focused, rather than facilitating multiple uses to include livestock and other income generating activities. It is also clear that most of the interventions are not based on scientific research, nor are the schemes provided with adequate institutional support services, including extension services and markets. There is evidence of female-headed households being included in irrigation schemes, especially in Tigray. However, due to cultural barriers, mostly they lease out their plots to male farmers. There is hardly any female representation in WUAs, and hardly any women members in decision making committees and bodies, hence they remain voiceless. Therefore, interventions should have a strong gender focus to enhance access of poor women to intervention benefits.

There is evidence of conflicts between traditional irrigators and those on modern schemes, where communities claim that property rights to water are not clearly defined. This creates a need for policy support and the development of appropriate policies that can lay the basic framework for clear definition of rights. This issue of rights was also extended to land rights and frequent fragmentation, which create conflicts especially in areas of limited suitable land for irrigation, and reduce production-enhancing economies of scale.

CONCLUSIONS

This review reveals mixed perceptions about the impacts of small-scale irrigation in Ethiopia. In some regions, there is evidence that irrigation has created some positive impacts: better opportunity for production, better income, reduction of risks and, hence, more optimism and hope to generate benefits for poor rural communities. Despite these perception-based assessments, this study concludes that the impact of SSI, MI and RWH still needs critical fieldwork-based assessment, based on production and productivity enhancing criteria, equity, and health criteria, as well as sustainability criteria including environmental indicators. Micro dams are particularly noted for negative health and environmental impacts in all the regions covered in the study.

There is a general perception in all regions that the current trend of low performance of small-scale irrigation schemes is related to flawed project design and lack of adequate community consultation during project planning. This assertion was affirmed by key informant surveys in several communities. This lack of beneficiary consultation and neglect during scheme design is a critical issue, as it is a primary determinant of successful implementation. Since most of the SSI, MI and RWH programs are currently in the planning stages, and are yet to be implemented, these conclusions should be seen as providing a unique opportunity to learn from these seemingly flawed projects designs and implementation processes. If ignored, well-intended efforts of governments and NGOs are likely to continue falling short of their intended impacts.

The impacts of well-intended projects can be better enhanced if accompanied by baseline studies, as well as action research during project implementation. In particular, lack of social and economic research on costs and benefits of interventions in a multiple livelihoods perspective, returns on particular investments and how they compare to alternative options of livelihood generation, impacts on poverty, incomes, and equity, are critical issues that need attention. In most cases, critical issues constraining viable production and poverty impacts on existing schemes—including property rights and access of the poor to land and water for the realization of production-enhancing economies of scope and scale, as well as access to input and output markets to enhance food security and modest market orientation to realize market-generated efficiency gains—are not clearly understood.

The evidence of conflict between traditional irrigators and those on modern schemes, regarding property rights to water, creates a need for clearer water and irrigation management policies, and a basic framework for clear definition of water rights. Clearly defined rights to land and water are very crucial and must be taken into account in project design and implementation, if modest investments from farmers are to be expected in land improvement and other production enhancing activities.

RECOMMENDATIONS

The search for solutions to the country's poverty and food insecurity requires efforts to reverse negative trends that have hitherto limited the impact of well meaning interventions. In doing this, we emphasize the importance of recognizing the heterogeneity of the rural society of Ethiopia, which consists of groups of poor people with different levels of assets and endowments, and often different cultural traditions. With this recognition, a possible approach that could be recommended is to:

- Classify and identify target groups based on the scope of their assets and livelihoods and provide development assistance that enables them to protect and improve these assets and livelihoods through various combinations of interventions.

- Provide selected technologies based on experiences elsewhere to overcome natural calamities, such as dry spells and droughts.

- Put in place land use classification and delineation, based on suitability, that reduces risk of degradation (rainfed agriculture, irrigated agriculture, forest land, grazing land).

- Increase the volume of production and enhance productivity through proper land and water management, which may require strategic and applied research.

- Improve degraded land through conservation-based interventions, catchment treatment and afforestation.

- Invest in rural water development as multiple use water systems to reduce poverty and improve livelihood through providing water for agriculture, livestock, domestic and sanitation.

- Enhance access to institutional support services, such as credit and extension. Accessing market information on input and output marketing will only achieve the desired impacts, if an effective extension system is in place to guide farmers to understand the issues related to the optimal application inputs, targeted planting dates and product quality, to enable them to respond well to market incentives.

- Capacity building in various aspects of irrigation management as discussed in Chapter 6.

- Provide the necessary policy framework at all levels to give more attention to poor people, especially women, to enable them to be a major beneficiary of investments.

- Improve policies for enhancing private sector investments in irrigated agriculture development, especially the manufacture and sale of micro irrigation technologies, as well as other input and output market functions.

- Project planning should be a step-wise exercise that avoids 'too ambitious' projects, with limited resources for adequate baseline studies, stakeholder consultations and effective implementation.

We conclude with a plea for more innovation, programs and projects designed as "learning experiments," more emphasis on capacity building, selectively from past experiences in other countries, and adaptation of successful approaches to the conditions in Ethiopia where appropriate.

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Appendices

APPENDIX 1: AMHARA REGION IRRIGATION SCHEMES

Small-scale Irrigation Schemes by ORDA (Organization for Rehabilitation & Development in Amhara (ORDA))–completed schemes

Zone	Woreda	Scheme	Coord-inates	Coord-inates	Size (ha)	Benefici-ary (hhs)	Main contribution	Cons-tructed	Irrigation start (yr)	Water source	Status
North Gonder	Belessa	Sheha	NA	NA	11	44	Study, Cons, Training	1998	1998	Spring	operational
North Gonder	Belessa	Guargua	NA	NA	7	28	Study, Cons, Training	1998	1998	River	operational
North Gonder	Belessa	Dedeha	$12^0$26'29"N	37d43'14''E	34	136	Study, Cons, Training	2001	2001	River	operational
North Gonder	Gonder Zuria	Arno	$12^0$43'20"N	37d26'40"E	24.4	98	Study, Cons, Training	NA	NA	River	operational
North Gonder	Debark	Asera	$13^0$07'00"N	$37^0$54'00"E	80	320	Study, Cons, Training	2002	2002	River	operational
North Gonder	Gonder Zuria	Garno	$37^0$37'26"N	$12^0$13'26"E	37	148	Study, Cons, Training	2001	2001	River	operational
North Gonder	East Belessa	Nillie	$12^0$30'59"N	$38^0$03'41"E	71	284	Study, Cons, Training	NA	NA	River	operational
Total	7	7	NA	NA	264.4	1058	NA	NA	NA	NA	NA
South Gonder	West Belessa	Genet Bahir	$12^0$03'17"N	$38^0$11'44"E	35	140	Study, Cons, Training	NA	NA	River	operational
South Gonder	Fogera	Lomidure	$11^0$50'05"N	$37^0$40'02"E	34	136	Study, Cons, Training	2000-2001	2001	River	operational
South Gonder	Ibnat	Zeha	NA		42	168	Study, Cons, Training	1998	1998	River	operational
South Gonder	Ibnat	Gunaguna	$09^0$22'48"N	$39^0$18'00"E	18	72	Study, Cons, Training	1998	1998	River	operational
South Gonder	Ibnat	Mehon	$12^0$04'15"N	$38^0$02'36"E	42	168	Study, Cons, Training	2001	2001	River	operational
South Gonder	Tach Gaynt	Nebelbal	NA	NA	7	28	Study, Cons, Training	2000	2000	Spring	operational
Total	6	6	NA	NA	178	712	NA	NA	NA	NA	NA
Wag Himera	Sekota	Ziqua	NA	NA	24	96	Study, Cons, Training	1998	1998	River	operational
Wag Himera	Sekota	Gudguda	NA	NA	12.5	50	Study, Cons, Training	1998	1998	River	operational
Wag Himera	Sekota	Lamua	NA	NA	17.9	72	Study, Cons, Training	1998	1998	River	operational
Wag Himera	Sekota	Tsatsique	NA	NA	8.5	34	Study, Cons, Training	1998	1998	River	operational
Wag Himera	Sekota	Bela	NA	NA	12	48	Study, Cons, Training	1998	1998	River	operational
Total	5	5	NA	NA	74.9	300	NA	NA	NA	NA	NA

Amahara: Small-scale Irrigation Schemes by ORDA (Organization for Rehabilitation & Development in Amhara (ORDA)–completed schemes (continued)

Zone	Woreda	Scheme	Coord-inates	Coord-inates	Size (ha)	Benefici-ary (hhs)	Main contribution	Cons-tructed	Irrigation start (yr)	Water source	Status
North Showa	Basona-worena	Gunagunit	NA	NA	127	508	Study, Cons, Training	1999	1999	River	Operational
North Showa	Basona-worena	Lege Yida	09⁰44'37"N	39⁰38'25"E	24	96	Study, Cons, Training	2000	2000	River	Operational
Total	2	2	NA	NA	151	604	NA	NA	NA	NA	NA
West Gojjam	Burie Wonberma	Cillala	10⁰47'40"N	36⁰50'26"E	50	200	Study, Cons, Training	1999-2000	2000	River	Operational
Total	1	1	NA	NA	50	200	NA	NA	NA	NA	NA
Awi	Fagta Lekuma	Timble	11⁰03'20"N	36⁰41'40"E	86	344	Study, Cons, Training	1999-2001	2001	River	Operational
Awi	Ankessa	Kulanti	10⁰47'39"N	36⁰50'26"E	65	460	Study, Cons, Training	1999-2000	2000	River	Operational
Total	2	2	NA	NA	151	804	NA	NA	NA	NA	NA
North Wollo	Gedan	Eyela	11⁰58'40"N	39⁰22'36"E	45	180	Study, Cons, Training	2000	2000	Spring	Operational
North Wollo	Wadla	Inchikie	11⁰39'06"N	38⁰55'05"E	36	144	Study, Cons, Training	2000	2000	River	Operational
North Wollo	Gubalaftu	Lideta-kere	11⁰48'21"N	39⁰29'30"E	20	80	Study, Cons, Training	2001	2001	Spring	Operational
North Wollo	Gubalafto	Wanzaye			50	200	Study, Cons, Training			River	Operational
North Wollo	Wadla	Gazo			18	725	Study, Cons, Training	2002	2002	River	Operational
Total	5	5	NA	NA	169	1329	NA	NA	NA	NA	NA
Wag Humra	Sekota	Akem-Yoh.	12⁰40'10"N	39⁰04'53"E	6	96	Study, Cons, Training	2001	2001	Spring	Operational
Wag Humra	Sekota	Terkena	12⁰32'47"N	38⁰57'55"E	12	48	Study, Cons, Training	2002	2002	River	Operational
Total	2	2	NA	NA	18	144	NA	NA	NA	NA	NA
GRAND	TOTAL	30	NA	NA	1056.3	5151	NA	NA	NA	NA	NA

Amhara: Small-scale Schemes under On-Going Construction by ORDA

Zone	Woreda	Scheme	Coordinates		Size (ha)	Benefici-ary (hhs)	Main contribution	Cons-tructed	Irrigation start (yr)	Water source	Status
North Gonder	West Belessa	Hota	NA	NA	282	1,128	Study, Cons, Training	NA	NA	River	being constructed
North Gonder	Ibinet	Akayna	NA	NA	-	-	Study, Cons, Training	NA	NA	-	
North Gonder	East Belessa	Amba	NA	NA	13	52	Study, Cons, Training	NA	NA	Stream	-
North Wollo	Wadla	Kendebe-Er.	NA	NA	52	110	Study, Cons, Training	NA	NA	Storage	-
Grand Total	4	NA	NA	347	1,290	NA	NA	NA	NA	NA	

Amharan: Small-scale Schemes Planned for Construction by ORDA

Zone	Woreda	Scheme	Coordinates		Size (ha)	Benefici-ary (hhs)	Main contribution	Cons-tructed	Irrigation start (yr)	Water source	Status
West Gojjam	Mecha	Chury Abay	10°12'12"N	37°00'37"E	244	976	Study, Cons, Training	NA	NA	River	planned
West Gojjam	Bahirdar Zuria	Andasa	11°30'33"N	37°21'55"E	210	840	Study, Cons, Training	NA	NA	River	planned
Total	2	2	NA	NA	454	1,816	NA	NA	NA	NA	planned
East Gojjam	Machakel	Ted	NA	NA	90	360	Study, Cons, Training	NA	NA	River	planned
East Gojjam	Huletju Enese	Tijan	10°54'07"N	38°47'48"E	170	680	Study, Cons, Training	NA	NA	River	planned
Total	2	2	NA	NA	260	1,040	NA	NA	NA	NA	planned
South Wollo	Worebabu	Wokelo	11°10'00"N	39°40'00"E	24	96	Study, Cons, Training	NA	NA	River	planned
South Wollo	Kallu	Felan	10°55'53"N	39°43'34"E	120	480	Study, Cons, Training	NA	NA	River	planned
South Wollo	Kallu	Harbu	10°55'08"N	39°47'16"E	63	252	Study, Cons, Training	NA	NA	River	planned
South Wollo	Kallu	Beshilo	11°03'53"N	39°49'18"E	17	68	Study, Cons, Training	NA	NA	River	planned
Total	4	4	NA	NA	224	896	NA	NA	NA	NA	planned
Oromia	Bati	Bone	11°12'26"N	39°59'32"E	10	40	Study, Cons, Training	NA	NA	River	planned
Oromia	Artuma Jille	Agemti	NA	NA	63	252	Study, Cons, Training	NA	NA	River	planned
Oromia	Dewa chefe	Dewe	10°42'32"N	40°30'00"E	75	300	Study, Cons, Training	NA	NA	River	planned
Oromia	Bati	Mi-a	NA	NA	200	800	Study, Cons, Training	NA	NA	River	planned
Total	4	4	NA	NA	348	1,392	NA	NA	NA	NA	planned
North Shewa	Basona-worena	Feleko	09°48'16"N	39°40'50"E	160	640	Study, Cons, Training	NA	NA	Spring	planned
Total	1	1	NA	NA	160	640	NA	NA	NA	NA	planned
Grand	Total	13	NA	NA	1,446	5,784	NA	NA	NA	NA	

Amhara: MEDIUM-SCALE SCHEMES: Constructed by the Commission for Sustainable Agricultural and Environmental Rehabilitation in Amhara (Co-SAERAR)

Zone	Woreda	Scheme	Size (ha)	Beneficiary house holds	Const-ructed	Irrigation started (yr)	Water source	Supported by	Current status
North Wollo	Gubalafto	Alawha	360	610	1994	1999	River diversion	Gov.	operational
North Wollo	Kobo	Gulina	400	1,600	1994	1999	River diversion	Gov.	operational
North Wollo	Gubalafto	Gimbora	310	1,024	1995	1999	River diversion	ESRDF	operational
North Shewa	Kewet	Sawer	300	488	1992	1996	River diversion	EEC	operational
Awi	Banjashirodad	Fetam	400	434	1980	1996	River diversion	ESRDF	operational
West Gojjam	Jabitenan	Geray	618	480	1980	1998	River diversion	ESRDF	operational
Grand Total	6	6	2,388	4,636	NA	NA	NA	NA	NA

Amhara: CO-SAERAR: Small-scale Irrigation Schemes-Completed

Zone	Woreda	Scheme	Size (ha)	Beneficiary HH	Constructed	Irrigation started (yr)	Water source	Supported by	Status
North Wollo	Habru	Mersa	65	315	1986	1996	River diversion	Gov.	operational
North Wollo	Habru	Gota	200	452	1994	1997	River diversion	Gov.	operational
North Wollo	Mekete	Tilkit	50	200	2000	2002	River diversion	FAO	operational
Total	3	3	315	967	—	—	—	—	—
South Wollo	Tehuledere	Hardibo	150	436	1989	1996	Lake-intake (unlined)	Gov.	operational
South Wollo	Tehuledere	Gobeya	106	540	1994	1996	Lake, pump (unlined)	Gov.	operational
South Wollo	Dessie Zuria	Gerado	80	200	1994	1997	River diversion	Gov.	operational
South Wollo	Mekedela	Tuliti	42	140	2000	2001	River diversion	ESRDF	operational
South Wollo	Wereilu	Seigi	70	440	2000	2001	River diversion	ESRDF	operational
Total	5	5	448	1,756	—	—	—	—	—
East Gojjam	Machakel	Gedeb	250	472	1994	1997	River diversion	Gov.	operational
East Gojjam	D.Telatge	Muga	200	800	1994	1998	River diversion	Gov.	operational
East Gojjam	Goncha	Azuari	150	688	1994	1998	River diversion	Gov.	operational
Total	3	3	600	1,960	—	—	—	—	—
West Gojjam	Bahir Dar Zuria	Mendel	100	390	1990	1996	River diversion	Gov.	operational
West Gojjam	Achefer	Kility	290	760	1979	1997	River diversion	ADF	operational
West Gojjam	Jabitenan	Tikurwuha	117	408	1980	1996	River diversion	ADF	operational
Total	3	3	507	1,558	—	—	—	—	—
North Gonder	Belessa	Lower-Zona	75	300	1998	2000	River diversion	Gov.	operational
North Gonder	Belessa	Sewak	80	400	1997	1998	River diversion	ESRDF	operational
North Gonder	Belessa	Gelgelmena	65	150	1999	2000	River diversion	ESRDF	operational
North Gonder	Belessa	Tebtebta	75	240	1998	2000	River diversion	ESRDF	operational
North Gonder	Belessa	Gurumbaba	70	280	1998	2000	River diversion	ESRDF	operational
North Gonder	Belessa	Zana (1)	65	200	1996	1998	Micro-earth Dam	ESRDF	
North Gonder	Belessa	Atelkayna	65	203	1996	1998	Micro-earth Dam	ESRDF	operational
North Gonder	Ebinat	Adrako	75	300	1998	2000	Micro-earth Dam	ESRDF	Failed
Total	8	8	570	2,073	—	—	—	—	—
North Shewa	Asagrit	Chacha	160	640	2002	2003	River diversion	IFAD	operational
North Shewa	Kewet	Tikur-Wuha	175	700	2002	2003	Spring, lake, lined	IFAD	operational
North Shewa	Kewet	Kobo	25	100	2001	2002	River diversion	IFAD	operational
Total	3	3	360	1,440					

Amhara: CO-SAERAR: Small-scale Irrigation Schemes-Completed (continued from above)

Zone	Woreda	Scheme	Size (ha)	Beneficiary house holds	Const-ructed	Irrigation started (yr)	Water source	Supported by	Current status
Awi	Ankasha	Zingini	270	720	1989	1997	River diversion	Gov.	operational
Awi	Guangua	Buchiksi	90	200	1989	1996	River diversion	Gov.	operational
Total	2	2	360	920	—	—	—	—	—
Sekota	Waghimra	Woleh	40	208	1997	1998	River diversion	ESRDF	operational
Oromia	D. cheffi	Beteho	250	900	1997	1998	River diversion	ESRDF	operational
South Gonder	Ebnat	Tikin	60	220	1997	1999	River diversion	ESRDF	operational
North Wollo	Habru	Dana	70	280	1997	1998	Micro-earth Dam	ESRDF	operational
South Wollo	Mekdela	Tebi	200	720	1998	2001	Micro-earth Dam	ESRDF	operational
Total	5	5	1,340	4,168	—	—	—	—	—
Waq	Sekota	M/Genet	70	280	1996	1998	Micro-earth Dam	ESRDF	operational
Waq	Sekota	May Lomy	60	236	1996	1998	Micro-earth Dam	Gov.	operational
Total	2	2	130	516	—	—	—	—	—
GRAND	TOTAL	34	4,630	15,358	—	—	—	—	—

Notes: * Lined and unlined canal; ** unlined canal and non-perenial river

Amhara: Small-scale Irrigation Schemes (Co-SAERAR) On-going

Zone	Woreda	Scheme	Size (ha)	Beneficiary households	Const-ructed	Irrigation started (yr)	Water source	Supported by	Current status
South Wollo	Legambo	Busso	60	340	2001	—	River diversion	IFAD	Under construction
South Wollo	Legambo	Barneb	60	252	2001	—	River diversion	IFAD	Under construction
South Wollo	Kalu	Dirma	180	576	2001	—	River diversion	IFAD	Under construction
Total	3	3	300	1,168		—			
North Shewa	Asagirt	Sewer (2)	191	764	2002	—	River diversion	IFAD	Under construction
North Shewa	Kewet	Dodoti	73	292	2002	—	River diversion	IFAD	Under construction
Total	2	2	264	1,056		—			
South Gonder	Este	Gumara	64	256	2002	—	River diversion	IFAD	Under construction
South Gonder	Este	Gota	58	232	2002	—	River diversion	IFAD	Under construction
Total	2	2	122	488		—	—	—	—
GRAND	TOTAL	7	686	2,712		—	—	—	—

Amhara: Small-scale Irrigation Schemes (Co-SAERAR) Planned

Zone	Woreda	Scheme	Size (ha)	Beneficiary households	Const-ructed	Irrigation started (yr)	Water source	Supported by	Current status
South Gonder	Fogera	Guanta	60	—	—	—	Micro-earth Dam	—	—
South Gonder	Dera	Shina	60	—	—	—	Micro-earth Dam	—	—
South Gonder	Farta	Selamko	63	—	—	—	Micro-earth Dam	—	—
Total	3	3	183	—	—	—		—	—
West Gojjam	Enargi Enawga	Enatche	70	—	—	—	River diversion	—	—
West Gojjam	Enargi Enawga	Abrajit	70	—	—	—	Micro-earth Dam	—	—
Total	2	2	140	—	—	—		—	—
North Gonder	Basonawerana	Burale	80	—	—	—	Micro-earth Dam	—	—
North Gonder	Gonder Zuria	Megech	70	—	—	—	River diversion	—	—
Total	2	2	150	—	—	—		—	—
GRAND	TOTAL	7	473	NA	NA	NA		NA	NA

Notes: *Lined and unlined canal; ** unlined canal and non-perennial river

APPENDIX 2: TIGRAY REGION IRRIGATION SCHEMES

Tigray Region: Small-scale Irrigation Schemes

No	Zone	Woreda	Scheme	Coordinates UTM zone 37N (m)	Size	Constructed (ha)	Irrigation start (yr)	Water source	Status
1		Enderta	Mai-Serakit	544866	149 54 38	31	1989	Dam	NF
2		Enderta	Adi-Akur	565680	148 50 68	30	1989	Dam	NF
3		Enderta	Embo-Gaedo	564814	148 13 67	80	N/A	Dam	F
4		Enderta	Gereb-Baeti	551413	148 66 98	88	1994	Dam	F
5		Enderta	Gereb-Shegal	549115	150 24 76	50	1988	Dam	F
6		Wikro	Laelay-Wikro	566279	152 64 18	36	1990	Dam	F
7		Wikro	Korrir	566212	151 98 76	84	1988	Dam	F
8		Wikro	Gindae	536582	152 26 01	28	1990	Dam	F
9		ATabi	Era	N/A	N/A	100	1987	Dam	NF
10		ATabi	Tegahre	578801	153 56 11	60	1990	Dam	F
11		ATabi	Adi-Shihu	575061	150 87 11	40	1989	Dam	NF
12		ATabi	Ruba-Feleg	578704	154 21 32	80	1987	Dam	NF
13		ATabi	Filaga	580773	1546642	75	N/A	Dam	F
14		Enderta	H.W. Cheber	558675	1477430	80	N/A	Dam	F
15		Enderta	Era-Guihila	564770	1486761	87	N/A	Dam	F
16		Laelay-Adyabo	Mai-Nigude	N/A	N/A	150	1987	Dam	F
17		S-Samre	Mai-Gundi	N/A	N/A	46	N/A	Dam	F
18		Weri-Leke	Meskebet	N/A	N/A	70	1987	Dam	F
19		Weri-Leke	Haiba	530337	1469066	218	1989	Dam	F
20		Weri-Leke	Rubagered	N/A	N/A	50	N/A	Dam	F

Note: NF =not functional, F=functional, N/A=not available, UTM=Universal Transverse Mercator

Tigray Region: Small-scale Irrigation Schemes, continued

No	Zone	Woreda	Scheme	Coordinates UTM zone 37N (m)	Size	Constructed (ha)	Irrigation start (yr)	Water source	Status
21		Weri –leke	Hena		20	N/A		Dam	F
22		Weri –leke	Adihedon		5	N/A		Dam	F
23		Weri –leke	Maiselasia		70	N/A		Dam	F
24		Ahferom	Belesat		32	N/A		Dam	F
25		Ahferom	Maishum		70	N/A		Dam	F
26		Adwa	Maimungola		20	N/A		Dam	F
27		Kola- Tembien	Adi-Asmean		2	N/A		Dam	NF
28		Dega- Tembein	Mai-leba		50	N/A		Dam	NF
29		L/ Maichew	Mai-siyu		80	N/A		Dam	F
30		T. Abergele	Agushala		50	N/A		Dam	F
31		Hintalo- Wajirat	Kaston		26	N/A		Diversion	F
32		Enda- Mekoni	Serenga		16	N/A		Diversion	F
33		T/ Abergele	Selle		7	N/A		Diversion	F
34		Tahtay- Koraro	Mai-timket		8	N/A		Diversion	F
35		Hawzren	Senefti		10	N/A		Diversion	F
36		Endo- Mekori	Shimta		6	N/A		Diversion	F
37		Wikro	Genfel		50	N/A		Diversion	F
38		Kola- Tembien	Adi-Ha		100	N/A		Diversion	F
39		T/ Abergele	Agbe		30	N/A		Diversion	F
40		Weri-Leke	Seguh		25	N/A		Diversion	F

Tigray Region: Small-scale Irrigation Schemes, continued

No	Zone	Woreda	Scheme	Coordinates UTM zone 37N (m)	Size	Constructed (ha)	Irrigation start (yr)	Water source	Status
41		Wirko	Birki		70	N/A		Diversion	F
42		M/ Zana	Debrekerbe		5	N/A		Diversion	F
43		Adwa	Seisa		35	N/A		Diversion	F
44		Enderta	Semha		60	N/A		Diversion	F
45		Alage	Tek-a		80	N/A		Diversion	F
46		S/ Samre	Fetse		50	N/A		Diversion	F
47		Enderta	Maimbaradom		30	N/A		Diversion	F
48		Ahferom	Maisuru		40	N/A		Diversion	F
49		M/ Leke	Nefah		50	N/A		Diversion	F
50		A/ Arge	Atsela		34	N/A		Diversion	F
51		R/ Azebo	Munera		45	N/A		Diversion	F
52		R/ Azebo	Haza		66	N/A		Diversion	F
53		Alamata	Hara		400	N/A		Diversion	F
54		H/ Wajirat	Nazere		43	N/A		Diversion	F
55		H/ Wajirat	Higacti-Afras		54	N/A		Diversion	F
56		H/ Wajirat	Baheri-Weyra		43	N/A		Diversion	F
57		H/ Wajirat	Gereb-Didik		36	N/A		Diversion	F
58		Enderta	Gereb-kokhi		48	N/A		Diversion	F
59		Wukro	Laelay-Agula		33	N/A		Diversion	F
60		Ofla	Fala 1		22	N/A		Diversion	F

Tigray Region: Small-scale Irrigation Schemes, continued

No	Zone	Woreda	Scheme	Coordinates UTM zone 37N (m)	Coordinates UTM zone 37N (m)	Size (ha)	Beneficiary start (yr)	Main contribution	Construction source	Irrigation start	Water source
61		Ofla	Zaha	N/A	N/A	15		N/A		Diversion	F
62		Ofla	Shayna	N/A	N/A	50		N/A		Diversion	F
63		Enderta	Adibasur	N/A	N/A	20		N/A		Diversion	F
64		Hintalo-WajiratMejae	555100	1458732	14			1989		Dam	NF
65		Hintalo-Wajirat	Gereb-Mihiz	550908	1469715	80		1988		Dam	F
66		Hintalo-Wajirat	Mai-Gassa (I)	553270	1468823	100		1988		Dam	F
67		Hintalo-Wajirat	Mai-Delle	556727	1461652	90		1988		Dam	F
68		Hintalo-Wajirat	Gum-Selasa	558774	1463392	110		1987		Dam	F
69		Hintalo-Wajirat	Adi-Kenafiz	544296	1465527	60		1989		Dam	F
70		Hintalo-Wajirat	Mai-Haidi	559073	1458213	9		1989		Dam	F
71		Hintalo-Wajirat	Gra-Shitu	554847	1480489	16		1989		Dam	F
72		Hintalo-Wajirat	Filglg	545484	1464371	20		1989		Dam	NF
73		Hintalo-Wajirat	Dur-Anbessa	547768	1467671	61		1993		Dam	NF
74		Hintalo-Wajirat	Shillanat (I,II,III,IV)	552530	1449712	282		1993		Dam	F
75		Hintalo-Wajirat	Mai-Ella	537459	1470020	100		1988		Dam	F
76		Hintalo-Wajirat	Adi-Gela	555402	1451594	100		1988		Dam	F
77		Hintalo-Wajirat	Botgua	536383	1473244	70		1988		Dam	NF
78		Hintalo-Wajirat	Gereb-Jegen	553404	1465567	24		1993		Dam	NF
79		Hintalo-Wajirat	Mai-Egam	544750	1466337	10		1989		Dam	F
80		Enderta	Adi-Amharay	562231	148228	60		1988		Dam	NF
81		Enderta	Sewhi-Meda	544964	1496550	23		1989		Dam	NF
82		Enderta	Gereb-Aweso	560089	148026	9		1989		Dam	NF
83		Enderta	Adi-Hino	561405	1486352	9		N/A		Dam	NF
84		Enderta	Enda-Zoey	570876	1489334	13		N/A		Dam	NF
85		Enderta	Hashenge	573105	1490150	120		1988		Dam	NF
86		Enderta	Arato	570198	1494180	120		1988		Dam	NF

Zone	S/ Weredas	No. of completed schemes/ wereda	Total size, ha	Start date for such technology	No. of people benefited	Crops	Water harvest technology	Supported by	Remarks
1.Hadya		5265		2003			hand well		
		7078		2003			Tuff		
		1455		2003			spring		
		554		2003			pond		
2.K.T		1722		2003			hand well		
		4143		2003			Tuff		
		1231		2003			spring		
		406		2003			pond		
3.Sidama		3173		2003			hand well		
		278		2003			tuff		
		407		2003			spring		
		21		2003			pond		
4.Gedeo		17		2003			hand well		
		71		2003			Tuff		
		7		2003			spring		
5.Welaita		12577		2003			hand well		
		11965		2003			Tuff		
		366		2003			spring		
		366		2003			pond		
6.G/Gofa		4727		2003			hand well		
		447		2003			tuff		
		2496		2003			spring		
		515		2003			pond		
7.Silte		1871		2003			hand well		
		6837		2003			tuff		
		3230		2003			spring		
		4350		2003			pond		
8.S/Omo		53		2003			tuff		
		183		2003			spring		
		9		2003			pond		
9.Guraghe		5053		2003			hand well		
		4174		2003			tuff		
		370		2003			spring		
		171		2003			pond		
10.Bench Maji		259		2003			hand well		
		773		2003			spring		
11.Sheka		259		2003			hand well		
		773		2003			spring		
12.Burji		20		2003			hand well		
		118		2003			tuff		
13.Derashe		9		2003			hand well		
		47		2003			tuff		
		23		2003			pond		
14.Konso		24		2003			hand well		
		159		2003			tuff		
15.Alaba		2425		2003			tuff		
		262		2003			pond		

APPENDIX 3: SNNPR IRRIGATION SCHEMES

Medium- and Large-Scale Schemes

Name of the Scheme	Location (zone, wereda, kebele)	Coordinates (Lat. Long.)	Size, ha	No. of Benefi ciaries	Yr of construction begin	Yr of irrigation begin	Crops [see below for key]	Water source control and delivery	Supported by	Status (operational, etc)	Remark
1. KodoBoga	Sidama, Awassa,AbelaWendo		230	460	1978	1980	C,Ch,V, AV,S/C	River	ENI&SIDA	operational	
2. Harre	G/Gofa,A/Min.Zuria	N.A	1000	2000	1985	1987	M,MA,B,LE,P,PA,S/P,CA	„	GOV.	„	
3. Sille	„	N.A	310	570	1992	1994	„	„	LWF	„	
4. Masta	G/Gofa,Daramalo	N.A	450	1800	N.A	1984	M,B,MA,LE,S/P,OR,P	„	LWF	„	
5. Zagae	„	N.A	450	1600	N.A	1982	M,MA,B,PA,S/P,V	„	UNICEF	Abandoned	
6. Wajifo	G/Gofa,Satusa	N.A	300	1200	N.A	1989	M,B,PA,CA,C	„	WORLD VISION	Operational	
7. Woyto	Konso	N.A	250	650	1982	1987	M,SO,B,CO,TE,H/BTO,	„	FAO	N.A	
8. Lowerbillate	Wolaita,D/Woyde	N.A	648	1955	N.A	1964	M,TOB,,P,S/CCO,MA,B	„	LWF	Operational	
9. Upperbillate	„	N.A	1200	2200	N.A	1964	„	„	GOV.	„	
10. Arbaminch	Gamo Goffa/Arbaminch	N.A.	800	600	N.A.	1968		River	Gov.	„	

M-maize; MA-mango; P-pepper; O-onion; TO-tomato; S/P-sweat potato; CA-cassava; B-banana; V-vegetables; C-cotton; CO-coffee; S/C-sugar cane; TE-teff; G-ginger; CAB-cabbage; I/P-Irish potato; CIT-citrus; G/N-groundnuts; SO-sorghum; AV- avocado; CH-chat; LE-lemon; OR-orange; BE- beans; PE-peas; S/B-soybean; C/P-chickpea; S/P-sweet potato; GA- garlic.

Medium- and Large-Scale Schemes continued.

Name of the Scheme	Location (zone, wereda, kebele)	Coordinates (Lat. Long.)	Size, ha	No. of Beneficiaries	Yr of construction begin	Yr of irrigation begin	Crops [see below for key]	Water source control and delivery	Supported by	Status (operational, etc)	Remark
1. Ella	Wolaita, Humbo	N.A.	80	320	1986	1987	M,P,B,O,T,S/P,CA	River	IFAD	Operational	
2. Lasho	Wolaita,Humbo	N.A	120	320	N.A	1977	‘’	River	ESRDF	„	Rehabilitated by SIDA IN 1994
3. Bissare	Wolaita, D/Woide	N.A	164	600	1991	1990	TO,M,P,S/C,CO,MA,B	River	„	„	
4. Bedessa	Wolaita D/Woide	N.A	100	400	1993	1993	‘’	„	„	„	
5. Balle	Wolaita K/Koisha	$6^0$54‘$37^0$32‘	100	400	1993	1994	M,B,VCA,CO,P	„	„	„	
6. Soke	Wolaita, Bolosore	N.A	100	400	1990	1990	M,MA, CO, CA, S?P, S?C, PO, G	„	GOV.	„	
7. Woybo	Wolaita Bolosore	N.A	150	600	1986	1987	„	„	IFAD	„	
8. Menisa	Wolaita,Offa	$6^0$48‘55“N, 37035‘30“	200	800	1993	1995	M,CO,S/P, S/C,T,H/B,TA,P, CAB,O	River	ESRDF	Operational	
9. Tekecha	Wolaita, Offa	N.A.	200	800	1994	1995	„	„	IFAD	„	
10. Megera	Wolaita, Bolososore	$31^0$31‘48“E$71^0$3‘53“N	110	440	1993	1996	M,CO,CA S/P,MA, S/C,PO,G	„	AFD	„	
11. Eballa	KT, K/Gemila	37^0-$37^0$35‘$67^0$15‘-$7^0$20‘N	120	200	1989	1989	O,M,P, CAB	„		„	Rehabilitation by SIDA in 1992

M-maize; MA-mango; P-pepper; O-onion; TO-tomato; S/P-sweat potato; CA-cassava; B-banana; V-vegetables; C-cotton; CO-coffee; S/C-sugar cane; TE-teff; G-ginger; CAB-cabbage; I/P-Irish potato; CIT-citrus; G/N-groundnuts; SO-sorghum; AV- avocado; CH-chat; LE-lemon; OR-orange; BE- beans; PE-peas; S/B-soybean; C/P-chickpea; S/P-sweet potato; GA- garlic.

Medium- and Large-Scale Schemes continued.

Name of the Scheme	Location (zone, wereda, kebele)	Coordinates (Lat. Long.)	Size, ha	No. of Beneficiaries	Yr of construction begin	Yr of irrigation begin	Crops [see below for key]	Water source control and delivery	Supported by	Status (operational, etc)	Remark
12 Lamo	KT,O/Sheleko		120	400	1990	1991	M,S/C,P,MA,B,S/P,T,H/B,O,CAB,G/N	„	GOV.	„	
13 Lentalla	Hadiya,Gimbicho	N.A.	60	240	N.A	1978	M,S/C,T,H/B,S/P,O CAB,PO,TO,P,CIT	„	ADF	„	
14. Hom, bancho	Hadya,Soro	$7^0$19“-721‘N $37^0$29‘-$37^0$35E	80	320	1991	1992	„	River	ESRDF	Operational	
15. Wondowosha	Sidama,A/Zuria	N.A	200	400	N.A	1989	„	„	LWF	„	
16. Wamole	Sidama,Shebedino	N.A.	120	480	N.A	1978	P,CO,B,M,CH,AV	„	ENI AND GOV.	„	
17. Gelana	Sidama,Argoba	N.A	100	162	N.A	N.A	CO,B,M,AV,SO, S/C	„	N.A	It needs minor rehabilitation	Rehabilitated by SIDA in 1994
18. Gidabo	Sidama,dale	N.A	150	600	1986	1987	M,S/P, H/B,S/C	„	LWF	Due to technical problems it is not operational	Rehabilitation is completed and ready for operation
19. Shafite	G/Gofa,G/Zuria	N.A	150	600	N.A	1986	CA,B,G/N, M,S/C,S/P, T	„	FAO	N.A	
20. Sesga	„	N.A	60	120	1987	1988	„	„	IFAD and GOV.	Not fully operational	
		N.A			N.A	1990	„	„	ADB	Not operational	It has social constraint
21. Meshkere	„		80 120	160 480	1993	1996	„	„	ESRDF	Completed	Ready for operation
22. Zenti	„	N.A									
23. Wore	„		100	400	1994	1995	„	„	IFAD	Operational	

M-maize; MA-mango; P-pepper; O-onion; TO-tomato; S/P-sweat potato; CA-cassava; B-banana; V-vegetables; C-cotton; CO-coffee; S/C-sugar cane; TE-teff; G-ginger; CAB-cabbage; I/P-Irish potato; CIT-citrus; G/N-groundnuts; SO-sorghum; AV- avocado; CH-chat; LE-lemon; OR-orange; BE- beans; PE-peas; S/B-soybean; C/P-chickpea; S/P-sweet potato; GA- garlic.

Medium- and Large-Scale Schemes continued.

Name of the Scheme	Location (zone, wereda, kebele)	Coordinates (Lat. Long.)	Size, ha	No. of Beneficiaries	Yr of construction begin	Yr of irrigation begin	Crops [see below for key]	Water source control and delivery	Supported by	Status (operational, etc)	Remark
24. Mendelke	„	N.A	150	600	N.A	N.A	N.A	„	Action for Development(AFD)	N.A	
19. Shafite	G/Gofa,G/Zuria	N.A	150	600	N.A	1986	CA,B,G/N, M,S/C,S/P,T	„	FAO	N.A	
20. Sesga	„	N.A	60	120	1987	1988	„	„	IFAD and GOV.	Not fully operational	
		N.A			N.A	1990	„	„	ADB	Not operational	It has social constraint
21. Meshkere	„		80	160							
			120	480	1993	1996	„	„	ESRDF	Completed	Ready for operation
22. Zenti	„	N.A									
23. Wore	„		100	400	1994	1995	„	„	IFAD	Operational	
24. Mendelke	„	N.A	150	600	N.A	N.A	N.A	„	Action for Development (AFD)	N.A	
25. Osone	G/Gofa, Deramalo	$6^0$10‘-$6^0$15‘N $37^0$15‘-$37^0$20‘E	100	200	1991	1993	B,MA,M,S/P,OR,P,LE	„	ESRDF	Operational	
26. Goha	„	N.A	200	595	1992	1994	M,MA,B,PA,S/P,V	„	LWF	Not fully operational	
27. Kankara	G/Gofa	N.A	112	180	1988	1989		„	ESRDF		
28. Betto	G/Gofa,D/Tsemay	N.A	100	400	1989	1989	„	„	FAO	Operational	Rehabilitated in 1996 by SIDA
29. Goymo	G/Gofa,Kemba	$5^0$57‘30“-$6^0$02‘00 “-N, $37^0$05‘30 “E-$37^0$11‘16“E	55	220	1992	1992	M,PA,B,OR,MA	„	ESRDF	„	
30. Maze	G/Gofa,Kemba	544‘30“-615‘45 “N, $37^0$0‘00 “-$37^0$22‘30“	200	800	1993	-	M,PA,B,OR,MA	River	IFAD	It is not completed	Not yet completed

M-maize; MA-mango; P-pepper; O-onion; TO-tomato; S/P-sweat potato; CA-cassava; B-banana; V-vegetables; C-cotton; CO-coffee; S/C-sugar cane; TE-teff; G-ginger; CAB-cabbage; I/P-Irish potato; CIT-citrus; G/N-groundnuts; SO-sorghum; AV- avocado; CH-chat; LE-lemon; OR-orange; BE- beans; PE-peas; S/B-soybean; C/P-chickpea; S/P-sweet potato; GA- garlic.

Medium- and Large-Scale Schemes continued.

Name of the Scheme	Location (zone, wereda, kebele)	Coordinates (Lat. Long.)	Size, ha	No. of Beneficiaries	Yr of construction begin	Yr of irrigation begin	Crops [see below for key]	Water source control and delivery	Supported by	Status (operational, etc)	Remark
31. Lebu	Guraghe,Sodo	N.a	100	160	1989	1989	TE,M,TO,CAB,BE,PE,	„	ESRDF	Operational	
32. Woldiya	„	8^{0}20‘N, 38^{0}30‘58“E	80	320	1992	1992	„	„	„	„	
33. Dobi	Guraghe,Meskan		40	160	1989	1989	„	„	GOV	„	
34. Dobena	„	08^{0}06‘N, 38^{0}25‘E	150	600	1993	1994	„	„	IFAD	It is not completed	Additional amendment work will be done by 1997
35. Kako	S/Omo,B/Gazer	5^{0}40‘5^{0}45‘N, 36^{0}35‘and36^{0}40‘	120	480	1993	1995	M,SO,H/B,O,G/N	„	ESRDF	Functional	
36. Erbore	S/Omo,Hammer	N.A.	100	400	1991	1992	M,S/B,S/P,B, SO,O,P,TO	River and deliver is by pump	GOV	It is not operational	There is technical problem
37. Shoshuma	Konta		45	180	1995	1996	M,SO,H/B,S/P,I/P,TA,,O,,P,G/N	River	IFAD	Operational	
38. Duano	Amaro	5^{0}40‘5^{0}45‘N 37^{0}50‘-37^{0}54‘E	100	400	1991	1992	M,TE,CO,B,CA,S/C,C/P	„	ESRDF	„	
39. Gewada	Konso		100	400	1982	1985	SO,M,B,CO,H/B,TO,P	„	ADB	„	Rehabilitation done by SIDA in 1996
40. Segengete	„		200	800	1991	-	„	„	ESRDF	It is not completed	There is technical problem
			150	600	1982	1987	M,SO,B,MA,BE,LE,CO,CA,	Not functional	ADB	Not operational	Further study is required for rehabilitation

M-maize; MA-mango; P-pepper; O-onion; TO-tomato; S/P-sweat potato; CA-cassava; B-banana; V-vegetables; C-cotton; CO-coffee; S/C-sugar cane; TE-teff; G-ginger; CAB-cabbage; I/P-Irish potato; CIT-citrus; G/N-groundnuts; SO-sorghum; AV- avocado; CH-chat; LE-lemon; OR-orange; BE- beans; PE-peas; S/B-soybean; C/P-chickpea; S/P-sweet potato; GA- garlic.

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