Recent Achievements and Priorities in Irrigation Water Management Research in Ethiopia with Particular Reference to Amhara Region

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Introduction

Amhara National Regional State, with a population of more than 18 million faces both chronic and transitory food security due to a combination of factors. About 20% of the population, who are chronically food insecure women and female-headed households, suffer more from poverty than men and male-headed households. Agriculture is the mainstay of the economy of Amhara Region as the sector contributes about 62% to the Region's GDP. More than 90% of the labor force is engaged in Agriculture. Performance of agricultural sector basically dictates the growth rate of the economy. Despite relatively abundant surface and ground water resources and presence of the four major river basins of the country and Lake Tana, more than 95% of Amhara Region's agriculture, both crop and livestock sector is dependent on erratic and uncertain rainfall.

Poor performance of agricultural sector, mainly due to such erratic and uncertain rainfall, and drought erodes the capacity of rural households to withstand the declines in their income. Dependence on traditional production system, as well political and institutional neglect, has brought agriculture to a virtual stagnation. Even attempts during the recent past have not produced satisfactory results. Consequently, farmers are continuing to spiral down economically and their resilience to withstand the vagaries of nature is dwindling. Even the traditional livelihood coping strategies are continuing to dwindle. Continued poverty is leading to degradation of natural resources on which future of development depends. Degradation of the natural resources is also a root cause of the low farm productivity, directly contributing to poverty and food insecurity. A vicious cycle has set in.

Continued poor performance of agriculture is also contributing to out-migration from rural areas to urban areas. More people are being attracted to live and work in the urban areas, thus a significant potion of the economically active population is being siphoned out of the rural areas. This has direct negative effect in the agriculture sector and create burden on the socio- economic development efforts of the urban centers where labor absorptive capacity is insignificant. There is an urgent need to improve the performance of the agriculture sector so that more and more jobs are created in the rural areas. However, these jobs should be economically attractive, which calls for making agriculture more profitable. There is a need to turn agriculture from subsistence to commercial agriculture. There is also need to emphasize on value addition to farm products to that poor farm families can generate additional income from agricultural products. These, however, will require creating environment so that producers have adequate access to both input and output markets.

Roads, easy access to market information, policy framework for market support, enabling private entrepreneurs to play fair roles, extension and development support to enable farmers to produce marketable surplus, organizing farmers to have control over output prices, etc. are very important in alleviating rural poverty and improving the livelihood of the farm families. Agro-based rural

industrialization should go hand in hand with agricultural development. The recently formulated Rural Development Policy is expected to assist the farmers to not only produce more but also gain economically.

Developing the irrigation potential is an essential requirement to overcome the problem of chronic food security and poverty. There is a need to improve the efficiency of the existing traditional and modern irrigation schemes. Though Amhara region is endowed with relatively higher amount of rainfall, there is a need to explore fully the ground water potential. However, much of the rain water flows across the borders. In addition, uneven spatial and temporal occurrence and distribution of rainfall compounds the problem farming under rainfed condition. With effective planning, policy and technologies, it should be able to deal with this uneven occurrence and distribution in space and time. Harvesting of rainwater, whether through household water harvesting structures, community based ponds, small-scale irrigation projects, improving performance of traditional irrigation schemes will greatly contribute to deal with these issues. Of equal importance is the developing and using the knowledge of how efficiently the use the water could be managed so that more people can benefit from water resources.

The water resources and irrigation potential in Amhara Region

The region has four major river basins with small tributaries, which are part of Abay, Tekeze, and Awash River systems, Danakil depression with a total estimated annual renewable potential of 35Bm^3 fresh water (CoSAERAR, 2002); Lakes act also as sub-basins of these major river basins. The catchment area of the region that contributes for the renewable potential surface water is more than 134,056 Km^2 (MoWR, 2003).

An indicative point of the wealth of the region's undeveloped water resources are, first it is thought that most of the renewable water resources constitute surface water rather than groundwater, although the understanding and quantification of the latter is rather limited (Table1). As stated in the MoWR 15 years water sector development program, availability of groundwater in Ethiopia in hard rock formations shows great variability from location to location, depending on recharge, degree of fracture, permeability, obstacles to water movement, concentration and nature of chemical in the water, depth of groundwater level; the case is true for the region as well (Muluken, 2005).

The recharge, in Abbay basin for example, expressed as an average continuous flow ranges between 250 and 300m^3/s (BCEOM, 1999). However, the present boreholes are yielding an average of 5 litres/s, which indicates that there is a gap between the recharge and the estimation of the total abstraction through boreholes. On the other hand the Kobo-Girana valley feasibility study indicates that the estimated groundwater potential with in the valley is about 179 Mm^3, in addition observations show that the presence of considerable potential of shallow groundwater in the region's alluvial deposits of flood plains; such as Fogera, Kobo-Girana, Borkena and Chefa plains, although no comprehensive survey of this resource has been undertaken.

Second, estimated potential land for large and medium scale irrigation of the region is about 650,000 - 700,000 ha and for small-scale irrigation is about 200,000 - 250,000 ha (of which less than 10% has been developed), indicates the magnitude of water resources available for development (BCEOM,1999).

The potential of water resource to be used for different purposes is available either in the form of surface or subsurface water. Even though the region's rainfall is known by its erratic nature, the average annual rainfall amount ranges from 600mm to 1600mm (MoWR, 1999).

This being changed into surface water and enriching the groundwater, depending on the nature of geological formation of the catchments, is assumed to supply water for domestic purpose, the indicated potential irrigable land and other economic needs by constructing diversions, dams, pumping the water after storage and/or boreholes (shallow or deep). The rainfall amount in most of the region

is changed into flood due to most of the catchments are almost bare; hence no drop of water get access to recharge the groundwater. However this is the case for the upland areas, some part of the flood at lowland is enriching the groundwater. Therefore, the groundwater in the alluvial deposits of flood plains should not be ignored especially for local and small-scale abstractions as well.

The hydropower potential of the region is quite large; estimated generating capacity is about 6000 MW. However, high dams and large reservoirs may require to produce sufficient firm power, because of three main reasons; no steep drops, the rivers flow is high for a short period, and variability over the years is very high. Many studies reveal that the country in general is known as it stands second next to Congo by the hydropower potential.

Table1. The water resources of basins that the region has major shares (ESP, 2003)

River basin	Catchment area (Km^2)	Annual Runoff (Bm^3)	Ground water (Bm^3)
Abbay	199,812	52.6	1.23
Tekeze	89,000	7.63	0.18
Awash	112,700	4.6	0.13
Danakil	74,000	0.86	-
Total	475,512	65.69	1.54

In view of the water resources available, the estimated irrigation potential of the Region is about 900,000 ha. The estimated potential with large-scale irrigation schemes is about 650,000 – 700,000 ha and with small-scale irrigation schemes it is about 223,600 ha.

Issues beyond irrigation

In developing the water resources, it is important to keep in mind that there is not only need for water for irrigation to support crop and livestock production, there is need for manage water resources in an integrated manner which will also support overall social and economic development in an environmentally sustainable manner. Improving access to safe drinking water for the rural people, use of water for generating power; to support industrial growth, mining and construction and harnessing the potential for fisheries development are some of the important areas, which should be dealt with in an integrated way while developing and managing water resources. In other words, there is need for a comprehensive and integrated water resources management plan. Towards this goal, the Federal Government has recently formulated the Ethiopian Water Resources Management Policy.

Another important issue that is affecting both irrigated and rainfed agriculture in Amhara is widespread prevalence of HIV/AIDS. Though the relative prevalence is low in the rural areas as compared to the urban areas, this is posing a serious threat to sustainable development of agriculture as HIV affected families suffer from shortage of farm labor. In all development programs, there is need to integrate issues related to HIV/AIDS so that the issue can deal with it effectively.

Obviously, there is a need to generate technologies for irrigation water management, which will be appropriate to our predominantly small-scale and resource-poor farmers and which will help conserve our natural resources for our future generations. There is need to use appropriate approaches through which development and adoption of such technologies and knowledge at an accelerated speed is ensured. However, this cannot be done by an individual institution alone; it requires collaborative efforts of all stakeholders.

Bringing stakeholders together

Sustainable Water Harvesting and Institutional Strengthening in Amhara Region (SWHISA) is a six-year project to be implemented by the Amhara National Regional State of Ethiopia with support from the Canadian International Development Agency (CIDA). SWHISA's purpose is to strengthen the capacity of institutions involved in water harvesting to work together effectively to strengthen farmers' associations, communities and families in planning, designing, implementing and managing sustainable water harvesting and use of water for irrigation. SWHISA will contribute to the ultimate goal of increasing food security of poor farmers through improved water

management. Strengthening research and extension capabilities of partner institutions to develop and transfer appropriate and sustainable irrigation water management technologies is an integral part of SWHISA. As the project has started to implement its work plan for the first year, it is necessary to document and synthesize the state-of-the-art knowledge of irrigation water management in Ethiopia, with particular reference to Amhara in order to avoid duplication, infuse synergy to on-going initiatives and to build up on existing knowledge base. Under these circumstances, a workshop was organized on 5 -7 December 2005 at Alma Building in Bahir Dar to discuss the recent achievements with the following specific objectives:

- To document the recent achievements in research on irrigation water management with a view to identify technologies available for transfer and scaling up in Amhara region;
- To identify priorities for applied and adaptive research in irrigation for the Amhara region with particular reference to SWHISA and Amhara Regional Agricultural Research Institute (ARARI) objectives and activities;
- To discuss recent successes in transferring irrigation water management technologies in the Amhara Region and analyze innovative approaches used in successfully transferring such technologies; and
- To explore possibilities of establishing partnership with IARCs and universities to conduct applied and adaptive research on irrigation and water management in Amhara Region;

The workshop was jointly organized by ARARI and SWHISA in collaboration with of BoARD and BoWRD. The workshop was inaugurated by Dr. Tewodros Bekafa, Rural development Advisor to the President of Amhara Region. The inaugural ceremony was covered by electronic and print media, including Ethiopian TV.

The program, workshop format and participants

A total of 24 papers were submitted covering research and development and 23 were presented. The workshop was organized into five technical sessions. On the first day, experiences from transferring irrigation water management technologies and on the second day, research achievements and research priorities for irrigation development were discussed. In the first session, 11 papers and in the second and third sessions, 12 papers were presented. Usually, each presentation was followed by an active discussion. Technical and policy issues were also raised and discussed in the general and summing up discussions after every session. Based on their experiences, knowledge and the papers presented, two multidisciplinary working groups were formed on the third day - one group for successful approaches and methodologies in generation and transfer of irrigation water management technologies and the second group for priority areas for applied and adaptive research on irrigation water management. In the afternoon, working groups presented their outputs and recommendations. The presentations and issues arising were discussed in details.

About 54 invited policy makers, senior managers, senior researchers and development officials from Ministry of Agriculture and Rural Development, Ministry of Water Resources Development, Ethiopian Agricultural Research Institute (EARI), International Water Management Institute (IWMI), Universities, USAID, Mekele Agricultural Research Center (Tigray), Private consultants, Worer, Debre Zeit and Melkassa Agricultural Research Centers of EARI, SARDP, BoARD, ARARI and its research centers, BoWRD, CARE, AMAREW project, ORDA and other NGOs and development projects had participated (Please see Appendix II for list of participants). The participants were drawn from various disciplines of research and development, which included irrigation agronomists, irrigation engineers, soil scientists, irrigation extension experts, economists, horticulturists, and social scientists. About 50% of the participants presented a paper. Unfortunately, there were no woman participants except the lone SWHISA

consultant. It was discussed and emphasized that in future such activities, the organizers should proactively ensure participation of women research and development workers.

Issues and recommendations

The following were the main issues raised and recommended during the technical and the final summing up sessions included the following:

Recent research achievements and priority themes of research:

- Recognizing that research experiences in Ethiopia in general are recent, and in Amhara Region in particular are in the nascent stage, there were five technologies (Table 1) identified as ready for validation, adaptation and/or demonstration in Amhara region, which include Irrigation scheduling for wheat, developed by Debre Birhan agricultural research center., for transfer in similar agro-ecological conditions in Amhara

- Further analysis will be needed to decide whether the research results presented in several papers are ready for transfer or validation and to decide on their agro-ecological niche.

  Additional information on possible technologies suitable for Amhara Region will be provided by EARI. Synthesis of this information may be done by SWHISA research group or a working group.

- The following priority thematic areas for research and extension on irrigation water management were identified:

Table 2. List of technologies available for validation and/or demonstration in Amhara region

Crop/ area	Technology Practice	Brief description	Agro-ecological suitability	Potential benefit	Center
Wheat	Irrigation Schedule, Nutrient mgt	Apply water at Early tillering, booting and milk stages	Highland (Vertisols)	435 % MRR	DB
Various	Water abstraction	Rope and washer & other pumps	Current WHS Small streams	100 lit/min Less costs Uniform application	Sirinka And other centers
Horticultural & Oil seed crops	Alternative crops	Horticultural and Oil seed crops	Low lands Moisture stress		NRS
Alternative crops	improved varieties	Improved varieties of alternative crops	Low lands Moisture stress		NRS/ HLI
	Nutrient Mgt	Fertigation technologies			HLI/ NRS

DB = Debre Birhan agricultural research center

- Irrigation water management:

i. Irrigation agronomy practice such as determination of crop water requirement, agronomic practices on irrigation, and water-yield production functions and decreasing post-harvest losses to increase yield as the most priority areas;
ii. Development and evaluation of design parameters;
iii. Irrigation method/system evaluation;

iv. Monitoring and evaluation of water quality for agriculture water requirements and
v. Documentation and understanding of indigenous successful practices, farmer innovations and successful adoption of modern technologies in both small-scale irrigation schemes and Household water harvesting schemes;

-Water harvesting and efficient utilization:
Include performance evaluation and design and development

- Scaling-up of technologies
- Impact assessment
- Drainage and salt affected soils
- Integrated water resource management
- Integrated water resource development
- Small-scale and household level water harvesting technologies for supplemental irrigation:
Include selection of water lifting and application technologies, optimal use of the stored water to supplement the terminal dry-spell in the rainy season and irrigation at sensitive stage of crop growth at full irrigation in the dry season.

Details of the researchable topics by crop type and agro-ecology be worked out by the working group.

Priority Themes for Extension

- Irrigation Water Management to include (i) development of appropriate extension approach; (ii) community participation; (iii) capacity building; (iii) improving the mechanisms of linkage with partners; (iii) emphasis on readily available technology package.
- Improve efficiency of Irrigation schemes through ensuring timely operation & maintenance; linking farmers to marketing outlets; selection of appropriate profitable crops; organizing farmers/beneficiaries in extension activities; considering land tenure as an important factor in adoption; community empowerment; improving partnerships among stakeholder; and ensuring timely availability of agricultural Inputs

Research and Extension Approaches

An analysis of the current stakeholders with respect to their objectives, organizational strengths and weaknesses were done. It was noted that the work on irrigation extension and development is fragmented and there are confusions with respect to roles and responsibilities of these organizations. It was also noted that the newly introduced Agriculture Extension Advisory Training Services might lack adequate emphasis on participation but it emphasizes on irrigation development. It was recommended that:

- Community participatory approach to agricultural research and extension be used with a holistic perspective.
- An integrated, scheme-based, holistic approach should be used for sustainable development and to improve the efficiency of the whole scheme and enhance productivity and income of the farmers. A scheme includes catchments area, headwork, the conveyance and distribution network, the command area, and the water users. It has also impact on the farmers and their use of water down stream. Level of adoption of improved water management technologies and improved farming systems is directly influenced by the level of access to input and output markets.
- Indigenous technical knowledge, traditional practices, and successes in irrigation water management and household water harvesting should be analytically documented so that research and development can build upon such knowledge and successes.
- Research and extension activities should contribute to improving market access for farm products as well as to inputs.
- Mainstreaming of gender and environmental issues, including involvement of female-headed household in irrigation research and development are very important for equitable distribution of benefits.

Capacity development

- There is a strong need for capacity building for research and extension, and improving the research facilities at the research centers. It was stressed that capacity building shall be in

line with the priority research themes. It was also felt that on-farm research and demonstration be undertaken in the six SWHISA project Woredas and in a few other non-project Woredas as well. The training needs and the requirements for facilities and equipments may be reviewed and improved by the group.

- Strengthen the capacity of farmers' organizations in using modern and improved technologies, irrigation and management practices for irrigation water management, including their capacity to resolve conflicts and to ensure efficient operation and maintenance of irrigation schemes.

Policy

- Formulation of appropriate policies is needed for irrigation research and development. Constraints that need policy intervention include promoting community participation for scheme utilization (upstream and down stream users); payment for water used; Land tenure in reference to irrigation management and water equity; input and credit supply specific to irrigation; simplification of credit norms; improving access to credit and markets; redistribution of irrigated land to improve performance of irrigation schemes; size of irrigated land holding for cultivation; setting up of clear duties and responsibilities in technology development and dissemination process (BOWRD, BOARD, BOCP, ARARI).

Networking and partnership

- Bureaus, public and private sector organizations, NGOs, universities, International Agricultural Research Centers, donor supported projects and entrepreneurs involved in irrigation development should work together as active partners. Such partnership should clearly delineate roles and responsibilities of each partner.
- A database for irrigation water management be created in the Region.
- The value of such workshop in establishing a network of professionals in irrigation water management was recognized and in future, such workshops be organized as and when needed to facilitate working and learning together.

Conclusions

The workshop brought together professionals from different parts of the country and from different institutions which helped identifying priority areas of research and development irrigation water management. This has definitely facilitated initiation of networking to learn from each other. It was recognized that well guided research and extension, with appropriate policy support, in irrigation water management for both small-scale irrigation schemes and household water harvesting schemes can contribute to:

- Reduction of expansion of agriculture to marginal areas;
- Generation of employment opportunities in the rural areas;
- Reduce migration or rural people to urban areas;
- Improving food security and reduce malnutrition; and
- Having positive impact on other sectors of the economy.

All these positive effects can eventually improve the rural livelihoods, and thereby, lead to equitable distribution of benefits of development. Institutionalization of networking process would be an important need.

The workshop also recognized that there is a need for the researchers and extension workers to change their attitudes towards their tasks, partnerships and towards the farmers. They need to expand the horizon of their thinking so that they see their individual roles and responsibilities and their organizations roles are integral parts of a larger socio-economic system that affects the livelihoods and economy. This would require that they think outside of their boxes.

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