Household Water Harvesting and Small Scale Irrigation Schemes in Amhara Region

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Abstract

Many schemes, both Household Water Harvesting (HHWH) and Small Scale Irrigation (SSI) Schemes, have been developed in Amhara Region. In the year 2004, Regional Irrigation Land and Water Resource Inventory was undertaken by Amhara National Regional State (ANRS) to collect basic information for future planning and management of the schemes.

A total of 14,976 HHWHS were counted, 13,028 (87%) of which were based on run-off harvesting and 1,948 (13%) hand dug wells. 82% of the schemes were constructed in 2003 while only 1.2% before this period. 22 % of the structures were found to be functional, 70% not functional and the rest were destroyed. Harvested water has been used for different purposes: 35.6 % for irrigation only, 31.4 % for other purposes (water supply, cleaning and construction) and 33 % for both purposes. The total area irrigated using the functional structures in the dry and wet season was found to be only 51.4 and 25.9 ha, respectively. Water from these functional structures were used to provide supplementary irrigation to an average area of only 216 m^2 in the dry season and/or 290m^2 in the wet season.

A total number 6,219 SSIs were counted, of which 311 (5%) were modern and 5908 (95%) were traditional. A total of 8063 ha was irrigated by the modern schemes during the dry season, which put the modern irrigation at a rate of 80% of the planned area. This was only about 1.4 % of the potential irrigable area of Amhara Region. Irrigated area of most of the beneficiaries ranged between 0.125- 0.25ha, benefiting more than 330,000 households and 1.9 million people. Use of modern inputs was seldom and minimal, with fertilizer rate of not more than 0.013 q/ha. Flooding and furrow were the most common methods of irrigation used. Irrigation intervals were dangerously too long and hardly met.

Lessons learnt from HHWHS and SSI schemes in the region includes that these schemes have problems encompassing technical, social and environmental issues. The major problems with HHWH schemes were design, construction and operation related where as with SSI schemes operation was the most important problem. As a result, crop yield and income were low. It is important that the whole process of planning and management of these schemes are based on full participation of the communities so that the schemes are eventually owned and sustainably managed by the farmers and operated at their full potential providing maximum benefits to the farmers.

1. Introduction

Amhara national regional state is one of the largest regions in Ethiopia. It occupies a territory extended within a geographical coordinate between $9^0\ 29'$- $14^0\ 0'$ N latitude and $36^0\ 20'$ – $40^0\ 20'$ E longitude. The total area of the region is estimated to be 170152 km^2 with ten administrative zones, 106 rural *woredas*, 12 urban administrations and 3231 *kebeles*.

The region is endowed with four river basins with net potential area of 0.57 million hectares. Modern small-scale irrigation development in the country as well in the region began after the establishment of the irrigation development department within the MoA at the end of 1984. Since 1995, CO-SAERAR was mandated to undertake the same; however, in both cases the progress was slow. Moreover; most of the modern schemes were poorly operated, managed and under-capacity. At tradition

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schemes peasant farmers were utilizing irrigation schemes date back to the last century.

Lately in 2003, in the national/regional food security program, one of the strategies envisaged was the introduction of small-scale water harvesting systems. As a result there was big attempt to introduce small-scale irrigation and HHWHS in all parts of the region. A number of different structures were built all over the region. The number of structures built in the same year outstripped those built before.

To identify/ know the size and distribution of the structures in the year 2005, the Bureaue of Water Resources Development (BoWRD) undertook regional irrigation land and water resource inventory study. The result of this inventory study is adapted to evaluate the current operational status of both irrigation and HHWH schemes. It also helped to develop water resource data base of the region for future planning.

1.1 Household Water Harvesting Structures

In the region a total of 14976 HHWH structures were counted, about 87% (13, 028) and 13% (1948) were found to be Runoff Harvesting Structures (RHS) and Hand Dug Wells (HDW) respectively. The highest proportion of the structures was found in Weyna dega agro climatic zone. 13192 structures were in moisture deficit and 1784 structures were in moisture sufficient woredas of the region.

The geometric shape of the structures were found to be Hemispherical, Dome shaped, Trapezoidal, Cylindrical, Rectangular and others; Hemispherical and Cylindrical were the dominant geometric shapes of the structures. The materials used to construct the structures include cement, plastic and earth. The dominant material used was earth

Different organizations have participated directly/indirectly in the construction of RHS. Organizations participated were summarized in groups; government, community, government

Table 1.Water harvesting structures by agro-ecology zones

Area / struc.	Dega	WD	Kolla	Total
Runoff Struc.	**2643**	**6465**	**3920**	**13028**
Hand dug well	**663**	**1042**	**243**	**1948**
Regional total	**3306**	**7507**	**4163**	**14976**

WD= Weyna Dega

+community, non-governmental organizations and private. Government and private agencies constructed the highest 62% and the least 5.2% of the structures respectively. Among the government-constructed structures, most of the structures were found to be earthen, followed by cement and plastic membrane.

The status of the structures showed that those constructed before 2003 were found to be more functional compared to those constructed in succeeding years (2003 and 2004). The highest number of structures was constructed in 2004 (82%). Of the total RHS 2794 (22%) were found to be functioning, 8783 (70%) not functioning and the rest 964 (8%) were destroyed. WH structures used to supplement crop production in the dry and wet season were found to be 2382 and 896, supplementary irrigated 51.3 and 26 ha of land, respectively

The crops cultivated include root crops (48%) followed by vegetables and cereals. The use of modern inputs was minimal with 6.8%, 0.5% and 0.2% of the HHs utilized animal manure, Urea and DAP fertilizers, respectively. HHs utilized one or more of the different methods of water application to supplement crop growth and save it from total failure. Drip application accounted the highest (43%), followed by furrow method (26%). The harvested water has been used for different purposes: crop development only, other purposes (cleaning, construction, and livestock drinking) and both purposes with 36%, 31% and 33%, respectively.

Table 2. Geometric shape of RHS & Construction material used

Geometric shape	Construction Materials		
	Cement	Plastic Sheet	Earth
Hemispherical	2753	177	5778
Dome	360	12	165
Trapezoidal	163	933	603
Cylinder	173	5	894
Rectangular	49	24	442
Others	43	1	116
Total	3541	1152	7998

Major problems observed in HHWH structures include the following:

- **Design and construction related:** poor awareness of the technology, poor implementation procedures (use of standard design, site selection problems and poor construction management)
- **Operation related :** shortage of water, water lifting problems, shallow depth of irrigation water application, poor crop selection and cropping pattern problems with time and method of irrigation and limited experience in irrigation extension
- **Maintenance related:** tearing of plastic sheets, silt up of structures, etc.
- **Environmental related:** malaria, hazard to human & animals, stinging water, etc.

In general, yield level of crops supplementary irrigated through harvested water was found to be low compared to irrigated and rain fed crop yield levels. Yield level of these crops was established and found that cereals, vegetables and root crops averaged 15, 101 and 89 qt/ha, respectively.

Table 3. WH structures and irrigated area by season

Area/ Season	Water harvesting Structures						
	Type/Number			Used for irrigation			Irrigated area (ha)
	HDW	RHS	Total	HDW	RHS	Total	
Moisture Deficit	1434	11758	13192				55.5
• DS				331	1682	2013	40.8
• WS				73	689	762	14.7
Moisture surplus	514	1270	1784				21.8
• DS				170	199	369	10.6
• WS				33	101	134	11.2
Region Total	1948	13028	14976				77.3
• DS				501	1881	2382	51.4
• WS				106	790	896	25.9

HDW = Hand dug well; RHS = Runoff harvesting structures; DS = Dry season; WS = Wet season

2. Small Scale Irrigation

2.1 Irrigation Schemes by Type and Irrigated Area

Irrigation schemes are classified in two as modern and traditional. A total of 6219 schemes were counted, 5% (311) and 95% (5908) were found to be modern and traditional schemes, respectively. Of the total irrigated land area (76,131 ha) at dry season, the share of modern and traditional schemes was found to be 10.6% (8063 ha) and 89.4% (68068 ha), and at the wet season out of supplementary irrigated (14178.5 ha) it was 8.1% (1154.5 ha) and 91.9% (13024 ha), respectively. Thus there was large difference in size of the total irrigated land area between modern and traditional schemes at both seasons. The share of moisture deficit and moisture sufficient *woredas* in both schemes at dry and wet season was found to be 38.8% (29555.8 ha) & 61. 2% (46574.6 ha) and 18% (2494 ha) & 82% (11684 ha), respectively. A total of 334,824 HHs and 1,930,249 families have been benefiting from irrigation.

Modern schemes were found operating under capacity from the planned 10036.8 ha to be irrigated in both seasons only 80% (8063 ha) was covered under crops at dry season the rest was kept fallow, at the wet season 14.3 % (1154.6 ha) supplemented and 73.4 % (5920.86 ha) was under rain-fed crops. The area left uncultivated (987.5ha) was kept fallow by virtue of some reasons. In the same case the cropping intensity was estimated to be 150.5%. At traditional schemes, a cropping intensity of 179% was observed the balance left uncultivated in the wet season due to water logging problems. Ample possibilities exist to expand irrigation in the region. A total of 223597.33 ha of potential land was estimated which 55.6% (124367.5 ha) at moisture deficit and 44.4% (99229.8 ha) at moisture sufficient areas.

At modern schemes, during dry season, the root crops took up the highest coverage of the cropped land at 33.7% (2720.8 ha) followed by vegetables 27.7 % (2237 ha). Similarly, at traditional schemes root crops took up the highest 37.6% (25598 ha) followed by vegetables 27% (18351 ha). At the wet season at modern and traditional schemes vegetables took up the higher 21% (241 ha) and 30.7% (3993.6 ha), respectively.

Table 4. Irrigation Schemes by type of structure

	Type of structure / No. of structure					
Area	**diver.**	**dam**	**pump**	**pond**	**h/dug**	**total**
MD	2334	8	26	26	25	2419 (40%)
Modern	105	8	26	9	12	160
Tradition.	2229	-	-	17	13	2259
MS	3520	2	98	16	164	3800 (60%)
Modern	49	2	98	1	1	151
Tradition.	3471	-	-	15	163	3649
Region	5854	10	124	42	189	6219
Modern	154	10	124	1	13	311
Tradition.	5700	-	-	30	176	5908

MD = Moisture Deficiet; MS = Moisture Sufficient

Table 5. Land use pattern at irrigation schemes

Area	Planned (ha)	Season / irrigated area (ha)					Expansion Potential (ha)
		Dry season		Wet season			
		Irrigated (ha)	Fallow (ha)	Irrigated (ha)	Fallow (ha)	Rainfed (ha)	
Region Total	78104	76131	1974	14178	15106	46846	223597
Modern Scheme	10037	8063	1974	1154	987	5921	19669
Traditional Scheme	68067	68067	-	13024	14118	40925	208928

Table 6. Fertilizer application rate

Season/ Region Total			Amount Applied (qt/ha)				
			Cereals	Vegetables	Root	Pulses	Fruits
Dry Season	Inorganic Fertilizer	DAP	0.013	0.013	0.015	-	-
		Urea	0.005	0.023	0.012	-	0.167
	Organic Fertilizer	Compost	0.015	0.010	0.598	-	0.927
		Manure	1.181	1.058	1.169	0.015	0.931
Wet Season	Inorganic Fertilizer	DAP	0.014	-	0.004	-	-
		Urea	0,012	-	0.002	-	-
	Organic Fertilizer	Compost	0.019	-	0.002	-	-
		Manure	1.023	-	0.120	-	0.060

2.2 Fertilized Irrigated Cropland Areas

In irrigation schemes data on rate of application of natural and chemical fertilizers were collected. As shown in Table 5, chemical fertilizers DAP and Urea were applied at dry & wet season at modern schemes for cereals at the rate of 0.013 & 0.005 qt/ha for dry and 0.014 & 0.012 qt/ha for wet seasons respectively. At traditional schemes 0.29 & 0.17 qt/ha and 0.175 & 0.25 qt/ha in the order mentioned. At modern schemes for the same crop organic fertilizer, compost and manure were applied at the rate of 0.015 & 1.2 qt/ha for dry and 0.02 & 1.02 qt/ha for wet season. Where as, at traditional schemes at dry & wet season the rate applied was found to be 0.64 & 4.6 and 0.6 & 3.23 qt/ha, respectively.

2.3 Irrigation Schemes and Oxen Possession Pattern

The significant contribution of cattle to crop farming is draught power. In modern schemes, HHs possessing two oxen was found to be the highest (42.56%) and those with no ox were (17.26%), where as at traditional schemes 45.49% of the HHs possesses two oxen and those with no ox were found to be 13.34%. In the region one can infer that oxen possession is uneven and is found to be problem to accomplish farming activities on time. HHs with no and one ox employed other means to plough their farm. Of the various means the most commonly employed by modern scheme HHs with no ox was use of hand tools 38 % and

crop sharing 32%, at traditional schemes use of crop sharing was 32.7% and hand tools 29.1%. Those with one ox at modern scheme used mekanajo[1] 90% and hand tools 3.9%, where as at traditional schemes mekenajo accounted 82.9% and hand tools 5.4%.

2.4 Extension Services under Irrigation Schemes

The extension support services provided to modern and traditional scheme HHs was found to be not satisfactory to relay upon. Irrigation packages were not properly provided and the support was not found to be complete to enhance the yield of growing crops. In both schemes HHs to DA ratio was not narrow.

In the region the frequency of DA's visit of irrigation HHs was assessed once in a week, once in two weeks, once in a month and once in more than a month. At modern schemes it was found to be 49.4 %, 22 %, 15.4% and 13 % where as, at traditional scheme it was found to be 32.2%, 33.3 %, 20.5% and 14 %, respectively.

2.5 Water Management Related Problems

Poor water management and inadequate drainage invariably increase water logging and salinity accompanied by health hazards like malaria. The most serious environmental hazard caused by irrigation schemes with water management problems were salinazion and the loss of valuable land because of it. In the region, at modern schemes water logging, mild salinity and malaria were found to be problems accounting 29.7%, 12.5% and 40.6% of the participating HHs, where as, at traditional schemes it was found to be 23.9%, 8.2% and 44.6%, respectively.

2.6 Major Constraints of Irrigation Schemes

The performance of irrigated schemes is far below expectation. Attempt has been made to rank the major constraints of irrigated schemes from the most sever problems to the least (1 to 8). Insufficient water supply and availability was found to be the 1st constraint in both schemes. Input supply & marketing problems were the 2nd at modern and the 3rd at traditional schemes. Maintenance was the 3rd at modern schemes and the 2nd at traditional schemes

Table 7. Frequency of development agents visit of HH

Frequency of Visit	HHs, %	Total HHs responded
Once in a week	15.4	1755
Once in Two Weeks	22.1	1755
Once in a Month	49.4	1755
Once in more than a Month	13.1	1755

2.7 Crop Yield under Irrigation

Crop production under irrigation is characterized by low yield level. Attributed to the traditional water management practices, limited use of modern inputs and the depletion of soil fertility. Regional yield level of irrigated crops is low; at the dry and wet season average yield level of crops was found to be 68 and 37 qt, respectively.

3. Current Trends and Lessons Learnt

Improvement in planning process
Shift to ground water abstraction
Change of geometry of HH water harvesting structures
Improvement in volume of structures

Lessons Learnt

Leesons learnt include

- The need to improve, study, design and construction
- Lack of adequate design skills

[1] Pairing of oxen with other HH having single ox or extra ox

- Formal Trainings should incorporate solution to local needs
- Improve knowledge and skill of practitioners
- Implementation should follow scheme based approach

Organization of O & M Activities

Organization of operation and maintenance activities includes:

- Organization of irrigation agency: refers to the organization of agencies working on irrigation; like BoWRD, BoARD, etc.
- Organization of the farmers: refers to the organization of farmers in WUA's and irrigation cooperatives.

Operation: irrigation operation at scheme includes the following activities: planning of cropping pattern & irrigation demand, daily operation, monitoring, evaluation, timely supply of inputs and necessary materials, use of on farm research and demonstration, provision of strong & appropriate extension system, credit & marketing services and Training

Maintenance

Maintenance is required to keep the schemes at top operation at all time; obtain the longest life and greatest use of the system through adequate maintenance; achieve the above two at lowest possible cost

Major maintenance activities:

- Identification of needs
- Costing of needs
- Categorization and prioritization of requirements
- Implementation of maintenance
- Supervision and inspection of works done

Marketing

- Irrigation season versus rainfed season
- Inadequate input and credit supply
- Poor marketing infrastructure
- Poor marketing institutions (weak Water User's Association (WUA)) and lack of Irrigation Cooperatives

Irrigation institutions

The major bottlenecks related to institutions include:

- Institutional mandates and linkages
- Stability of institutions
- Irrigation fees and related costs
- The necessity to establish regional water data base

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