Vol. 13(1), pp. 49-56, January-March, 2021
DOI: 10.5897/IJWREE2020.0958
Article Number: D0AB3C865957
ISSN 2141-6613

http://www.academicjournals.org/IJWREE

International Journal of Water Resources and Environmental Engineering

Full Length Research Paper

Indigenous knowledge assessment on irrigation water management practices at Western Showa Zone, Ethiopia

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Received 23 September, 2020; Accepted 19 November, 2020

Farmers practices in irrigation water management mostly from indigenous knowledge but the potential of such knowledge is not much understood in terms of irrigation water management in West Showa. Therefore, this study was carried out based on the objective to identify the indigenous knowledge on irrigation water management of the West Showa. The survey was conducted at West Shoa Zone, Dandi, Ambo, Toke Kutaye, Liban Jawi, Ilu Galan and Bako Wored. The survey was made on 117HHs. The collected qualitative and quantitative data both from primary and secondary sources was analyzed using appropriated statistical methods SPSS. The survey result showed that farmers have developed several indigenous in knowledge of irrigation water management practices. Among these knowledge, frequent maintenance of river side diversion weir, main line, sub main and in field furrow to avoid flow obstruction, cutting back water flow in the furrow when water reached at furrow end to decide amounts of irrigation water to be applied, giving priority for drought sensitive crop type and crop growth stage that cause significant yield when there is shortage of water, irrigate their crops after 5:00 pm to reduce evaporation water loss during irrigation, applying the next irrigation when the soil is dry (soil crack) and/or crop start wiling, application of farm yard manure and frequent weeding to increase soil water holding capacity and to avoid soil moisture competition among the crop and weed are the best one.

Key words: Farmers practices, irrigation water management, small scale irrigation.

INTRODUCTION

Ethiopia's economy is dependent on agriculture, which contributes 43% of the GDP and 90% of exports (USAID, 2017). It also employs 83% of the active population (MoA, 2011). The agriculture is primarily rain-fed and thus highly dependent on rainfall. But the uneven temporal and spatial distribution of rainfall has significantly affected the agriculture. The challenge of food insecurity due to its dependency on rain–fed and inability to develop the irrigation potential in Ethiopia is a concern and it is also a bottleneck problem in Ethiopia

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(Mihret et al., 2013).

Modern irrigation scheme construction in Ethiopia was started in the Middle Awash Valley by private investors at the beginning of 1960s. There are several large (>300 ha) and medium (200-300 ha) irrigation schemes constructed in the country mainly found in Oromia, Afar, SNNPR, Amhara, and Somali regions (Tilahun and Paulos, 2004). They were constructed aiming to maintain food security, sustainable supply of agricultural raw materials for the domestic industries and factories, and create increased foreign incomes through optimal use of water resources (MoA, 2011). Although there are some functional schemes by cultivating cotton and sugarcane, most of the schemes are performing under design and others remained without function (Awulachew et al., 2007). The project performances of functional large and medium irrigation schemes even are not yet identified. The government of Ethiopia has given a due emphasis for irrigated agriculture through expansion of small, medium and large-scale irrigation. The evaluation of existing functional and non-functional irrigation schemes is relevant for better water management and generation of information to support for newly planned scheme construction.

Investment in small-scale irrigation has been identified as a key poverty reduction strategy (Ostrom, 1992; Ostrom et al., 1994; Tang, 1992; Pradhan, 1989a, b; Lee, 1994). In addition, given the water resources potential, promoting groundwater use and adoption of household level water lifting irrigation technologies is crucial. It has been discussed and planned in making use of groundwater by supporting farming households in the adoption and use of private hand-dug wells and suitable water lifting technologies (WLTs). How exactly this can be achieved remains unanswered.

In Ethiopia small scale and traditional irrigation accounts for more than 55% of the total irrigated land (Agricultural Water Solutions, 2010). In such conditions, farmers practice irrigation water management mostly from indigenous knowledge. Moreover, farmers easily understood and accept indigenous knowledge than other technical recommendations from extension point of view. However, the potential of such knowledge is not much understood in terms of irrigation water management in West Showa. Therefore, this study was carried out based on the objective to identify the indigenous knowledge on irrigation water management of the West Showa and recommend the best indigenous knowledge which could be recommended for other areas and different farmers.
The objectives of the study are:

(1) To identify the current irrigation water management practice under small scale farmers condition.
(2) To assess the technical performance.
(3) To assess the farmers perception and subjective assessment towards irrigation water management practice in their area.
(4) To identify the best indigenous irrigation water management of different area.

MATERIALS AND METHODS

Description of the study area

The survey was conducted at Dandi, Ambo, Toke kutaye, liban Jawi, Ilu Galan and Bako Wored of West Shoa Zone where smallholder farmers practice traditional irrigation activities. The survey was conducted from March 2019 to April 2019. The geographical location of the site is 037° E longitude and 08° N latitude and at altitude of 2144 m a.s.l. The area is about 115 km from Addis Ababa and experienced a bimodal rainfall within a mean annual precipitation of 1029 mm. The mean maximum and minimum temperatures of the area range from 26.4 and 10.3°C, respectively. The soil textures of the study area are clay loam to clayey.

Data collection

A reconnaissance survey and observation was carried out with Woreda Bureau of Agriculture to obtain overview of different irrigation schemes and irrigation practice conditions. Secondary data was collected from documents and literatures and Bureau of Agriculture.

Based on the reconnaissance survey and observation survey area was selected and appropriate semi-structured survey questionnaire was prepared for different schemes and community. Experts of Woreda Bureau of Agriculture were included for the survey work especially on the fields of irrigation and extension. The assessment was to include survey questionnaire interview for different users including all level of community and with gender inclusion using stratified random sampling technique. Moreover, it also included focus group discussion, key informant interview and transect walk for observation of indigenous knowledge on the current irrigation water management practices.

Total number of household to be interviewed and number of areas (schemes) was set based on the local condition. Key informant including Woreda irrigation experts, development agents and water use association committee was interviewed with semi-structured interview on information regarding institutional functioning of the scheme, water management condition, irrigation scheduling, input use, conflict resolution mechanisms and market linkage.

Data analysis

Based on these questioner and discussions, primary data was collected for the study. The collected qualitative and quantitative data both from primary and secondary sources was analyzed using appropriated statistical methods SPSS.

RESULTS AND DISCUSSION

To identify the current and the best indigenous irrigation water management practices under small scale farmer’s condition of West Showa, both primary and secondary data were used for the analysis. Multistage sampling technique was employed to select the respondents.

Table 1. Socio-demographic characteristics by respondents per Woreda.

Variable	Categories	Woreda						Pooled (%)
		Dandi (n=20)	Ambo (n=13)	Toke Kutaye (n=22)	Liban Jawi (n=10)	Ilu Galan (n=9)	Bako (n=43)	
Gender (%)	Male	15	10	16	9	7	36	93
	Female	2	1	3	-	1	1	7
Household age (%)	18-64	17	9	17	8	7	37	95
	>64	-	2	1	1	1	-	5
Household education (%)	Non-education	1	1	2	1	2	-	7
	Read and write only	5	2	2	1	-	-	10
	Primary	-	-	-	-	-	9	9
	Secondary	9	8	12	6	4	21	60
	College	2	1	3		2	6	14
Family size (%)		6.2	5.8	5.4	6.6	6.7	4.7	

Table 2. Total farming experience of household.

Farming experience of household (year)	Dandi	Ambo	Toke kutaye	Liban Jawi	Ilu Gelan	Bako
5	5	7.7	13.6	-	-	18.6
12	5	7.7	18.2	10	33.33	25.58
16	5	7.6	9.1	20	33.33	14
21	10	-	27.27	10	11.11	25.52
26	25	30.8	4.6	-	-	2.3
>26	50	46.2	27.23	60	22.23	14
Total (%)	100	100	100	100	100	100

Woreda and PAs were purposively picked. HHs were randomly chosen from the sampling frame which exists at PAs level. The survey was conducted on 117 HHs of 6 West Showa Woreda.

The results of descriptive statistics indicated that the respondents had an average age range of 18-64 years old and 60% had secondary school education level (Table 1). 37% of the respondent had farming experience of >26 years and about 8% of them had 5 years farming experience (Table 2). 30% of the respondents had irrigation experience of >16 year and 23% of them had 4 years of irrigation experience (Table 3).

Irrigation method used in the Woreda

Survey result showed that irrigation method used by Toke Kutaye, Liban Jawi, Ilu Gelan and Bako Tibe wase furrow irrigation method and in case of Dandi and Ambo woreda both furrow and flood irrigation method was used (Table 4). No drip and sprinkler irrigation methods were used in all woreda (Table 4). The farmers responded that, even though drip and sprinkler irrigation systems are the best irrigation method in terms of water saving, the systems were not used due to lack of facilities, knowledge and capital.

Source of irrigation

Traditionally, water is managed for two major purposes, namely agriculture and domestic consumption. These distinctions are unclear sometimes. Sources of such waters vary from direct rainfall to waters from runoffs, rivers, streams, creek flows and seepage. Underground water resources are also included. The water so collected has been used to meet domestic needs in addition to requirements for watering livestock and runoff farming and irrigation. The survey result showed that almost all sources of irrigation water in case of West Showa Woreda

Table 3. Irrigation experience of respondent.

Farming experience in irrigation (year)	Dendi	Ambo	Toke Kutaye	Liban Jawi	Ilu Gelan	Bako
6	10	-	10	10	-	35
8	0	16	5	20	34	19
12	10	5	19	0	12	11
16	5	5	4	30	23	0
> 16	50	50	25	30	20	2
Pooled (%)	100	100	100	100	100	100

Table 4. Irrigation method used.

Irrigation method	Woreda					
	Dendi	Ambo	Toke Kutaye	Liban Jawi	Ilu Gelan	Bako Tibe
Basin (%)	0	0	0	0	0	0
Flooding (%)	75	85	0	0	0	0
Furrow (%)	25	15	100	100	100	100
Sprinkler (%)	0	0	0	0	0	0
Drip (%)	0	0	0	0	0	0
Pooled (%)	100	100	100	100	100	100

Table 5. Sources of irrigation water all woreda uses.

Source	Dendi	Ambo	Toke Kutaye	Liban Jawi	Ilu Gelan	Bako
River	√	√	√	√	√	√
Well	-	-	-	-	-	-
Lake	-	-	-	-	-	-
Water harvest	-	-	-	-	-	-

are rivers (Table 5). The respondents answered that there is no yet rain water and runoff water harvesting practices practiced in the woreda to solve irrigation water shortage to increase crop production and land productivity.

Available literatures reveal that more innovative indigenous water management techniques have been developed in the climatically dry areas and in mountainous regions of Africa (ATPS, 2006). For agricultural purposes, traditional African farmers have devised techniques such as terrace, building, pitting systems, drainage ditches and small earth dams in valley floors to conserve soil and water.

Farmers in the study area apply their indigenous knowledge of irrigation water management practices to manage irrigation water starting at the water source site (river diversion site) and ends at crop site. The respondents perceive that beyond these areas water management practices is not their mandate.

Large amount of water is lost during its route up to the farms level, especially the conveyance losses are pronounced at tertiary (watercourses) level of the irrigation system. The main reasons for conveyance losses in watercourses are leakages from turnouts, high density of vegetation in the unlined watercourses, turns in the watercourse, uncompacted and weak banks, deposition of sediments, siltation, holes made by rodents, and lack of maintenance (Zeb et al., 20000). The survey result indicated that at Dandi, Toke Kutaye, Ilu Gelan, and Bako Woreda earthen canal, lined canal, and delivery hose is used to convey water from the source to the farm fields. In the case of Liban Jawi means of water conveyance is an earthen canal. Irrigators of Ambo Woreda convey their irrigation water by Lined and Earthen canal (Table 6). The irrigators respond that they maintain frequently river side diversion weir, main line, sub main and in field furrow to avoid leakages and evaporation losses caused due to flow obstruction. In order to find the perception of farmers about their indigenous knowledge in irrigation water management

Table 6. Types of conveyance structure used.

Conveyance Structure	Woreda					
	Dandi	Ambo	Toke Kutaye	Liban Jawi	Ilu Gelan	Bako
Lined canal (%)	15	23.1	13.6	-	33.33	-
Earthen canal (%)	10	7.7	45.5	100	22.22	46.51
Lined and Earthen (%)	5	53.9	40.9	-	11.11	-
Delivery hose (%)	70	15.3	-	-	33.34	53.49
Pooled (%)	100	100	100	100	100	100

Table 7. Indigenous knowledge of farmers on when to irrigate.

When to irrigate	Woreda					
	Dandi	Ambo	Toke Kutaye	Liban Jawi	Ilu Gelan	Bako
Crop wilting (%)	30	30.8	27.3	0	11.1	53.5
Soil crack (%)	0	0	9.1	10	11.1	9.3
Crop wilt and soil crack (%)	65	61.5	22.7	30	22.2	6.9
When water available (%)	5	7.7	40.9	60	55.6	30.3
Pooled (%)	100	100	100	100	100	100

Table 8. Indigenous knowledge of farmers on depth of irrigation water to be applied.

Cut off time	Dandi	Ambo	Toke Kutaye	Liban Jawi	Ilu Galan	Bako
When water start to pond (%)	0	0	0	0	0	0
When water reached at furrow end (%)	100	100	100	100	100	100
By experience (%)	0	0	0	0	0	0
Pooled (%)	100	100	100	100	100	100

practices in irrigated agriculture sector, respondents were asked to express their indigenous knowledge that are practiced to manage irrigation water. The practices were classified into three variables displayed in Tables 7 to 9. The variables were classified as irrigation system maintenance, irrigation scheduling and agronomic practices.

Virtually all the on-farm water management techniques are typical examples of low external inputs combined with the use of locally available resources. While water is being retained, some of the techniques also provide effective check against soil erosion and loss of water and soil fertility. Such techniques conserve both soil and water resources for agricultural production and to prevent soil degradation (2006, ATPS). In wetter regions, these techniques are usually combined with other techniques such as crop rotation, shifting cultivation, crop mixture, manure application and the protection of nitrogen-fixing plants.

Observations during the survey showed that all irrigation water sources (rivers), diversion weirs and diversion canals were not protected from animals and wild life that cause damage to them. As a result the system was subjected to damage and blockage. To avoid water flow obstructions, irrigators in the study area have traditionally been cleaned and maintain periodically diversion weir, main and sub main canal to minimize water loss through deep percolation and canal over flow in all irrigated agriculture of West Showa Woreda. The cleaning practices were scheduled through irrigators association of that PAs. The group committee set the cleaning time and did follow up of absents. In field water way cleaning and furrow correction were also done before each irrigation.

In the study areas, there is no scientific irrigation scheduling practices practiced. But farmers schedule their irrigation simply by observing soil moisture conditions and crop conditions. These means, the next irrigation was applied when soil starts cracking and plants start to wilting during sunny day condition (Table 7). At

Table 9. Farmer's perception against critical stage of crop growth to irrigate when there is shortage of irrigation water.

Which development stage is critical to irrigate	Dendi	Ambo	Toke Kutaye	Liban Jawi	Ilu Gelan	Bako
Initial stage (%)	15	0	4.55	10	33.333	6.98
Mid stage (%)	40	30.77	13.64	10	33.333	0
Development stage (%)	40	61.54	36.36	0	0	20.93
Maturity stage (%)	0	0	0	10	0	0
Initial and development (%)	5	7.69	18.18	0	33.33	46.51
Initial and mid (%)	0	0	27.27	70	0	25.58
Pooled (%)	100	100	100	100	100	100

scheme where there is shortage of irrigation water irrigators irrigate their field when water is available (Table 7).

Among main questions in the irrigation water managements is to decide the amount of irrigation water to be applied (How much to irrigate?). According to the respondent, farmers in the study areas decide on the amount of irrigation water to be applied per irrigation per each furrow by simply observing water flowing in the furrow. Their practice is that, when water in furrow reaches the furrow end they cut back the water and then irrigate the next furrow (Table 8).

Water stress during critical crop growth periods reduces the yield and quality of crops. Crop water use (ETa) at critical growth stages can be used in irrigation scheduling to avoid stressing crops. So, in water shortage areas identifying the critical crop growth stage at which there is no significant yield loses is the main issue. The respondents of Dendi, Ambo, Toke Kutaye, and Bako perceive that mid and development crop growth stages are the critical stages. Deficit irrigation at this stage causes significant yield losses. The case of Liban Jawi Initial and mid-crop growth stages is the critical stage (Table 9). As a result, they didn't stress their crop at these critical crop growth stages to overcome the problems of irrigation water shortage.

Effective agronomic practices are essential components of irrigated water management (FAO, 1989). Management of the soil fertility, cropping selection and rotation, manure application, mulching and weed control are among effective agronomic practices.

Different agronomic adaptation practices are applicable to different farming systems and agro-climatic zones to enhance moisture utilization. These include the use of drought tolerance crops for adaptation to climate change, crops that have deep and prolific root systems and varieties that have short development stage (Mati, 2011).

Farmers in the study area respond that they plant crops that consumes relatively less amounts of water (have short development stage and narrow leave) and crops that are tolerant to shortage of water to utilize properly scarce water resources. For farm yard manure application, frequent weeding is among practices that are practiced by the farmers to overcome yield loss caused due to shortage of water.

Conclusions

The survey result showed that farmers have developed several indigenous knowledge of irrigation water management practices, which are:

(1) Frequent maintenance of river side diversion weir, main line, sub main and in field furrow to avoid flow obstruction
(2) The respondents decide to cut back water flow in the furrow when water reached furrow end to decide the amounts of irrigation water to be applied
(3) The respondents give priority for draught sensitive crop type and crop growth sage that cause significant yield reduction when there is shortage of water
(4) The respondents prefer to irrigate their crops after 5:00pm to reduce evaporation water loss which occur during sunny day irrigation.
(5) The irrigators apply the next irrigation when the soil is dry (soil crack) and/or crop start wiling.
(6) Farm yard manure application and frequent weeding to increase soil water holding capacity and to avoid soil moisture competition among the crop and weed are the best one.

From the discussion, we can draw the following conclusions.

Strengthen local irrigation water management of smallholder irrigation

Community management of irrigation systems is more efficient, cost effective, and sustainable. Still, poor irrigation water management is a contributing cause of many unsuccessful irrigation interventions including support to smallholder schemes by both government and development assistance agencies. Irrigation management problems are consistently underestimated by governments and donors and, as a result, not adequately addressed. The government can improve irrigation by helping strengthen indigenous irrigation water management practices. The focus should be on helping communities establish effective local water-management practices within viable existing village-based. Farmers who are practicing irrigated agriculture often establish a water-users' association to manage system development and maintenance and water usage and distribution. Most effective associations are characterized by sound leadership and a high degree of active involvement of water users in all aspects of the system's operation and management. Pluralistic management structures promote communication, conflict resolution, and consensus-building. Community-wide participation helps enable all water users to express their individual opinions and ensures that they contribute their particular knowledge and skills. In so doing, it often fosters a sense of ownership, commitment and involvement. And successful participatory experiences encourage further involvement in new decisions and actions.

Government technical support to the establishment and improvement of smallholder irrigation systems should be complimented by assistance to system management and organization. Assistance to local water-management can take the form of political support to help legitimize local water-users' associations, training local leaders in negotiating, consensus building, and accounting advice on critical water management issues, such as water acquisition, allocation, distribution and drainage; and information on "externalities" such as weather and market dynamics.

Improve information exchange between irrigators

Irrigation can be promoted and improved by farmer-to-farmer exchanges of experiences and information on smallholder irrigated agriculture. Farmers are more likely to adopt irrigated agriculture or upgrade their traditional systems when they know and understand new or improved practices and techniques.

Government can facilitate the sharing of such information by promoting and supporting farmer-to-farmer exchanges and other "informal" communication channels.

Networking between irrigators is as old as farming itself, yet relatively few efforts have been made by the government to better understand and capitalize on traditional and informal "horizontal" communication links. The little information collected by government on traditional practices and experiences has more often been assessed through formal communication channels, such as publications and national workshops. Farmer-to-farmer exchanges, farm visits, and farmer networks are particularly useful and cost-effective in sharing information and encouraging the adoption of new practices and techniques. Such exchanges allow information sharing among experienced and inexperienced farmers, help build confidence, reduce risks, and avoid the mistakes associated with adopting new techniques and practices. Farmer-to-farmer exchanges across communities are particularly important for irrigation development because of the up and down-stream implications of any project and the opportunities that exist for multiple-village systems.

Focus on improving traditional smallholder irrigation system

To meet national goals in irrigation and food security, existing schemes will need to be rehabilitated, and new irrigation systems will need to be established. The government priority should be to rehabilitate and improve existing smallholder schemes, especially traditional systems. Most irrigated land is under traditional smallholder schemes, many of which are under stress and operate below capacity and some are near collapse. Improving such schemes would be cost effective.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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