Challenges of Irrigation Water Management on Smallholder Schemes: Case Study in Dembecha Woreda, Northwest Ethiopia

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Abstract

Smallholder irrigation has enormous potential to improve the incomes of poor rural households in developing countries like Ethiopia. However, numerous problems constrain irrigated crop production and irrigation water management efforts in many areas. In light of this, a survey was conducted with the objective of assessing the challenges of irrigation water management over smallholder schemes, in Dembecha Woreda (District), in the northwestern highlands of Ethiopia. Data were gathered through key informant interviews, group discussions, field observations and a questionnaire survey of 118 households. The data gathered were then analyzed using descriptive statistics; independent sample T-test and the Chi-square test. The results showed that irrigation water in the study area was distributed using rotation turns and the process was managed by an elected body of water users called irrigation water use committees. Over 63% of the respondents faced water shortages on their farms. Loss of water through seepage, poor coordination of water distribution by water use committees, water theft problems, water shortage at tail-end irrigators, absence of enforcing rules, water use conflicts, and rotation turn abuses were identified as major challenges of irrigation water management in the study areas. Hence, it is suggested that farmers be encouraged to harvest rain and underground water to stabilize water shortages and be provided with water management trainings.

Keywords: Smallholder irrigation, Water management challenges, Water use conflicts, Ethiopia

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1. Introduction

Agriculture plays decisive role in the economy of developing countries. The sector makes great contribution by providing food for human population, raw materials for domestic industries and export items to generate foreign exchange earnings. But, recently, climate change is impacting agricultural production through droughts and famines. Inconsistencies in temperature and rainfall trends cause droughts, pest infestations and crop damages in many areas. This necessitates proper and sustainable irrigation water management in affected areas. As a component of sustainable water management, irrigation has the potential to mitigate the negative impacts of variable rainfall and to stabilize agricultural production in such areas. Moreover, irrigation contributes to livelihood improvements through generating increased income, employment opportunity and poverty reduction (Asayehegn, et al., 2011). Proper irrigation water use and management is thus essential to minimize the impacts of agricultural water stress and to ensure sustainable social development (Dungumaro and Madulu, 2003).

Agriculture is the leading sector in the national economy of Ethiopia. It accounts for 48% of the Gross Domestic Product (GDP), 85% of the foreign exchange earnings and employs over 80% of the country's population (MoA, 2014). However, agricultural production in Ethiopia is primarily rainfed. It depends on unpredictable and often insufficient rainfall which results in frequent crop failure. Conversely, Ethiopia has enormous water resource potential that can be developed into irrigation (Makombe, et al., 2007) to complement the variable rainfall. Traditional irrigation has also been practiced in the country since ancient times. The small-scale traditional irrigation schemes that have been developed in the different regions of the country were also helpful in enhancing household food security and reducing the chronic poverty. Irrigation has thus the potential to stabilize agricultural production and mitigate the negative impacts of the variable rainfall in Ethiopia. Nevertheless, the existing irrigation schemes are not yet operating efficiently and the country continues to receive food aid from international donors.

Modern irrigation development in Ethiopia was started in the 1950s with the introduction of large-scale irrigation and hydroelectric power projects (Gebermedhin & Peden, 2002). However, most of the modern irrigation schemes are at micro level in size, serving households usually not exceeding 200 to 300 in number. Many of the schemes are based on stream and river diversions, whilst some are dependent on small dams and springs. Moreover, the existing smallholder irrigation schemes (both the traditional and modern ones) encounter problems related to inefficient water use, seepage from canals, rotation turn abuses, siltation of dams, canal destructions, poor coordination of water distribution by water use committees (WUCs) and water conflicts. Besides, the irrigation development planning in the country puts huge emphasis on the agronomic, engineering and technical aspects of the water projects with little consideration to the issues of management and sustainable use. Most of the traditional and modern small-scale irrigation schemes managed by smallholder farmers are not well supported by expert knowledge and skills. Beneficiary participation, institutional support, input supply and marketing services are low and inadequate (Gebremedhin & Peden, 2002). Upstream developments and excess abstraction of water supplies negatively affect the welfare of downstream users (Hussain and Hanjira, 2004). Shortage of water for agriculture and other uses thus often push people into vicious competitions and disagreements over most of the smallholder irrigation schemes (Sultana, 2011; Belay & Bewket, 2013).

Smallholder irrigation has recently received significant focus from local governments in Ethiopia so as to enable farmers to cultivate crops at least twice a year (Makombe, et al., 2007). There are now few improved irrigation schemes sparsely distributed in the different parts of the country with the prime aim of ensuring household food security and improving the living standards of the community. The performances and challenges of smallholder irrigation schemes should be studied and provided with appropriate institutional support to improve their overall performance and capacity (Belay and Bewket, 2013). Different studies were conducted in the past (e.g. Ayaleneh, 2004; Asayehegn, et al, 2011; Bacha, et al., 2011; Kebede, 2011; Belay & Bewket, 2013), but most were not specifically focused on examining the challenges of irrigation water management in the smallholders' schemes. More research is thus required to fill the gap so as to enhance the performance of the smallholder traditional irrigation schemes.

In the study woreda (district), smallholder traditional irrigation has been practiced since early times. However, no detailed study related to the challenges of irrigation water management on smallholder schemes was conducted as is known to the authors, and hence, a knowledge gap to fill. This study intends to address the challenges of irrigation water management on the smallholder schemes in Dembecha woreda, in the north-western highlands of Ethiopia. It specifically aims to: assess the existing methods of irrigation water allocation practices in Dembecha woreda; identify the challenges faced by irrigators in managing irrigation water; and examine the conflict resolution mechanisms used by irrigation water users in the study woreda.

2. Description of the Study Area

Dembecha woreda is found in northwest Ethiopia, 350 kms northwest of Addis Ababa. It has an elevation ranging from 1,500-2,999 above mean sea levels (amsl). The total area of the woreda is 97,926 ha (DWoFED, 2015). Around 30% of the area is mountainous; 60% is plain; and 10% is a valley. Climatically, 11% of the woreda area falls under Dega (temperate) agro climatic zone; 83% is Woyna-Dega (sub-tropical); and 6% is Kola (tropical). The woreda has relatively enormous surface and ground water potential; comprising 28 streams and 180 springs. The most dominant soil types in the area are red (Nitosols) 65%; brown (Cambisols) 25%; and black (Vertisols) 10%.

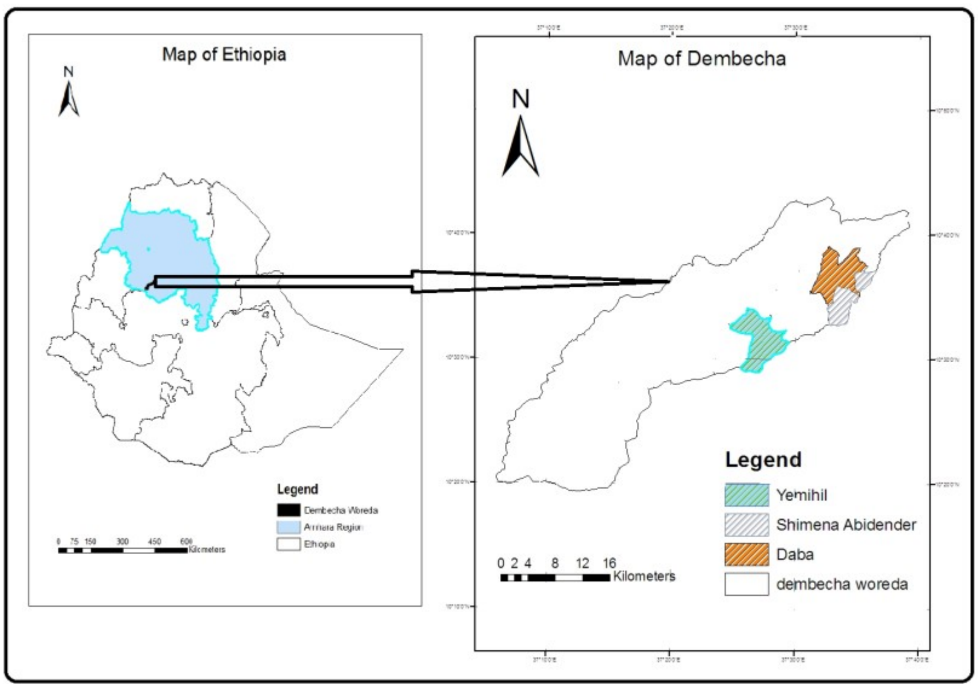

Figure 1 Map of the study area (Adopted from Ethio-GIS, 2007)

Based on projection from the Central Statistical Agency of Ethiopia (CSA, 2013), the woreda's population for July 2015 was 154,025. Among those 77,066 were men and 76,959 women. The total population of the urban residence was 28,062. Of those 14,382 were men and 13,680 women. On the other hand, the total population of the rural residence was 125,963 out of which 62,684 were men and the rest 63,279 women. About 85% of the woreda population was engaged in agriculture and 15% in other activities. The recently promoted traditional smallholder irrigation water management was not well documented or assessed by formal research study in Dembecha woreda. The lead researcher has purposely selected the site because of his prior knowledge of the area and the prevalence of irrigated agriculture.

3. Research Methodology

3.1. Sampling Techniques and Sample Size Determination

Three Rural *Kebele* Administrations (RKAs)[3]named Daba, Shimina-Abidender and Yemihil were selected purposefully for the study. The selection of RKAs was based on their irrigation potential and the number of streams and springs. Past and present irrigation experiences, accessibility, the lead researcher's prior knowledge of the area was also considered during selection of the sample RKAs. The total numbers of households in the three RKAs were 2,693. However, 2,486 total household irrigators were taken as a sample frame because the rest 207 households were not irrigators. From the irrigator households, 118 households were sampled for questionnaire survey.

The 118 households were systematically chosen from a stratified list of the total irrigator households categorized by the respective RKAs. To do this, the list of irrigation practicing households were first accessed from the registries of the offices of development agents (DAs) working in each RKAs and stratified by sex. Using this stratified list of irrigator households as sampling frame, 118 households (107 male- headed and 11 female-headed) were identified in a proportional to size sampling technique (Table 1).

Table 1 Sample households by RKA

	Total irrigator households by sex*		Sampled households	
Name of RKAs	Sex	N^0	№	%
Daba	Male	973	46	39
	Female	126	6	5
Shimina-Abidender	Male	568	27	23
	Female	28	1	1
Yemihil	Male	707	34	29
	Female	84	4	3
Total		2486	118	100

*Source: Development Agent (DA) offices at the study RKAs (February, 2015)

3.2. Data Sources and Determination Methods

The data used for this study were derived from both primary and secondary sources. The primary data included key informants' interviews (KII), structured questionnaires and observations of smallholder irrigation schemes and focus group discussions (FGDs). The KII

[3]Lower government administration unit of Ethiopia

were conducted to obtain general understanding on the smallholder irrigation water management practices of farmers; the water-sharing systems they employed; and the major water management problems encountered in the smallholder irrigation schemes. The samples included three DAs (one from each RKA); three water use committee members/WUC (one from each RKA); and three experts from the woreda agriculture office.

Both open and closed ended survey questionnaires were designed to generate household data. The designed questions focused on demographics, socio-economics, irrigation water-sharing, irrigation water management, irrigation challenges and conflicts. Prior administering the main survey, the questionnaires were pretested for fitness and certain amendments were made based on comments received from the preliminary survey Then, the revised questionnaires were translated into *Amharic* (the local language) to ease communication between respondents and enumerators. The data collections were done in February and March 2015 by the lead researcher assisted by trained enumerators. The lead researcher observed the daily activities of the irrigators in the study areas during the survey. This helped the lead researcher to conceptualize he reality of the irrigation water management and water-sharing challenges and conflict resolution methods of the irrigators in the area. Information gained in this way was used as triangulation to crosscheck the questionnaire survey data and to understand the ground reality regarding irrigation water-sharing and management practices. FGDs were conducted with open-ended questions in the entire three sample RKAs. A total of eighteen individuals participated in the FGDs, six from each RKA. From this number two of them were youngsters; two elders; and two female irrigators selected from each RKA. Moreover, secondary data from published and unpublished documents were compiled and used in the analysis.

3.3. Data Analysis Methods

Data were analyzed using descriptive statistics, T-test, Chi-square test, and qualitative narrations. The former methods were used to analyze the quantitative data. The latter (qualitative narration) was used to describe the qualitative data generated from KIIs, FGDs and field observations in an integrative manner.

Independent sample T-test was used to identify the existence of mean age and mean family size differences between farmers facing irrigation water shortages and those not facing irrigation water shortages. The Chi-square test was also used to detect the prevalence of any systematic association between nominal variables such as sex, education and different water users. The Statistical Package of the Social Scientists (SPSS Version 20) was used in data preparation and management. Results were further illustrated using Tables and graphs.

4. Results and Discussion

This part of the result deals with the analysis and interpretation of data collected through questionnaires, KIIs, FGDs and field observations. Demographic characteristics of the respondents and challenges faced in irrigation water managements are also analyzed.

4.1. Characteristics of the Sample Respondents

The total sample households for the study were 118. Among those 91% were males and the rest 9% were females. Table 2 indicates that 75 households faced water shortages on their farms. Of these 87% were male-headed and 13% were headed by females. On the other hand, out of 43 respondents that did not face irrigation water shortages, 98% were headed by males and the rest 2% by females.

Table 2 Information on irrigation water shortage by sex of respondents

	Farmers facing water shortage		Farmers not-facing water shortage			
Sex	№	%	№	%	Total	Chi-square
Male	65	87	42	98	107	χ^2 =3.918
Female	10	13	1	2	11	P =0.048
Total	75	100	43	2	118	

Chi- square test was run to observe the existence of association between male-headed and female-headed households in facing water shortage on smallholder irrigation schemes. Accordingly, the result showed statistically significant systematic relationship between the two groups of households (χ^2 = 3.918, P = 0.048). This shows that water shortages systematically differ across the sex of the household heads in the study areas (Table 2).

Age can influence the production and productivity of irrigated crop and might create production difference among the irrigation areas. In Table 3, the age of the surveyed households is summarized and presented. Based on that, the majority of the irrigator households (56.8%) were adults (36-64 years of age). The others (37.3% and 5.9%) belong to above 64 years (old farmers) and 18-35 years (young farmers), respectively. This indicates that adult farmers had more access to participate in irrigation activities in the study areas.

Table 3 Age, irrigation experience and marital profile of the respondents

Household characteristics	Frequency	%
Age		
18-35 age (young farmers)	7	5.9
36-64 age (adult farmers)	67	56.8
Above 64 age (old farmers)	44	37.3
Irrigation experience		
Less than 15 years	40	33.9
15-20 years	37	31.4
>20 years	41	34.7
Marital status		
Currently coupled	87	73.7
Never married	3	2.5
Divorced	14	11.9
Widowed	14	11.9

Regarding work experience in irrigation (Table 3), the majority of the respondents (34.7%) have greater than 20 years of experience in irrigation work. The other 33.9% possess less than 15 years' experience, and the rest 31.4% have 15- 20 years of experience in irrigation work. With regard to marital status of the sample household irrigators, the majority (73.7%) were coupled, 2.5% never married, 11.9 % divorced and the other 11.9 % were widowed (Table 3).

Table 4 Mean age and family size differences between farmers facing and not-facing water shortage for irrigation

Variables	Farmers facing water shortage		Farmers not-facing water shortage		T-test results	
	Mean	St. dev	Mean	St. dev	T- value	P-value
Age in years	38.4	10.18	39.9	10.80	- .778	0.438
Family size	5.37	1.566	5.93	1.737	-1.786	0.077

Independent-sample T-test (Table 4) was run to study the existence of water shortage variation among the difference ages family size groups of farmers in the study areas. Consequently, the result showed that the mean age of farmers facing and not-facing irrigation water shortages were almost similar (38.4 years for the former and 39.9 years for the latter);

indicating a non-statistical difference (t=-.778, p= 0.438) between the two groups of farmers.Similarly, the mean family sizes of farmers facing and not-facing irrigation water shortages were 5.37 and 5.93, respectively. The independent-sample T- test result also showed a weak significant value (t= -1.786; p=0.077). This indicates also that there is no statistical mean family size difference between the farmers facing and not-facing water shortage.

4.2. Water-sharing and Management Practices in Dembecha Woreda

For irrigated agriculture water is a fundamental resource. Otherwise it is not possible to grow crops. Water allocation and distribution rules and practices are equally important for ensuring equity and sustainability among the farming community.

Table 5 Irrigation water sources

Irrigation water sources	Water users by sources	
	No.	%
Hand dug wells	2	1.7
Streams or rivers	68	57.6
Springs	47	39.8
Natural ponds	1	0.8
Total	118	100

The sources of irrigation water for the majority of the farmers (≈58 %) in the study areas are streams. Some 40% farmers get it from springs and the rest 2.5% from hand dug wells and natural ponds (Table 5). With regard to farm irrigation techniques used by irrigators in the study areas, 74.6% reported that they were using furrow irrigation. The other 25.4% indicated that they were practicing flood method of irrigation (Table 6).

Table 6 Methods of applying irrigation water into the farms in the study areas

Methods of irrigation	Users by RKA (in %) Shemina-Abidender (N=29)	Daba (N= 52)	Yemihil (N= 37)	Total (N=118)
Flood irrigation	41.4	28.8	8.1	25.4
Furrow irrigation	58.6	71.2	91.9	74.6
Total	100	100	100	100

Among RKAs, Yemihil is the largest user of furrow irrigation followed by Daba. Over 58 and 41% of the farmers in Shemina-Abidender reported that they use furrow and flooding methods, respectively. Only 28.8% and 8.1% of the farmers in Daba and Yemihil, respectively reported using flooding methods. Considering the above data, the proportion of farmers using furrow irrigation is high in Yemihil and low in Shimina-Abidender RKAs (Table 6). This result conforms to the studies of Dejen et al., (2006) reported for two small-scale irrigation systems in Western Oromia, Ethiopia. Misker (2012) in Sanka traditional and Golina modern irrigation schemes in Eastern Amhara, Belay and Bewket (2013) in Dangila woreda and Etissa et al. (2014) in the central rift valley of Ethiopia have also reported similar traditional methods of irrigation practices. All these researchers reported that irrigators in their study areas commonly used furrow irrigation.

Table 7 Irrigation water supply timing

	Respondents	
Time of irrigation	№	%
In the morning	26	22
At the mid-day	1	0.8
In the after-noon	18	15.3
At night	14	11.9
Whenever water is available	59	50
Total	118	100

Table7 presents the timing of irrigating farms by the households in the study areas. Accordingly, among the household irrigators, 50% of them stated that they irrigate their farm fields whenever water is available. The rest 22, 15 and 12% of them indicated that they use to irrigate their farms during morning, in the afternoon and at night times, respectively. According to KIIs, irrigation in the study areas is practiced from November to April. In the other months (from May to October), the farmers use rainwater to cultivate crops and no irrigation is used. Most farmers irrigate their fields whenever water is available taking turns in rotation and these farmers face a problem of water loss when they irrigate their farmlands and reduce the irrigation water, they are using due to mid-day evaporation as revealed by the key informants. This assessment indicated that there are urgent needs for training the farmers about suitable water management practices.

Table 8 Frequency of crop cultivation by applying irrigation water

Frequency of crop cultivation per annum using irrigation:	Farmers facing water shortages		Farmers not- facing water shortages		χ2 – value
	№	%	№	%	
Once	14	18.7	1	2.3	χ2=6.58
Twice	61	81.3	42	97.7	p=0.01
Total	75	100	43	100	

With regard to frequency of cultivation using irrigation, more than 81% of the farmers facing water shortage reported that they cultivate crops twice a year against to only 19% who produce only once a year (Table 8). From those farmers who are not-facing water shortages, 98 and 2%, respectively produce twice and once in a year. Chi-square test results ($\chi2 = 6.577$, $p = 0.01$) showed a statistically significant relationship between farmers facing irrigation water shortages and those not-facing irrigation water shortages in frequency of irrigation. One can deduct from this that though there are problems related to irrigation water shortage, the majority of the farmers tackle the problems and produce crops twice a year. Therefore, if farmers get well managed irrigation water management potentials, they can even produce more than two times in a year.

According to KIIs, the main field crops grown using traditional smallholder irrigation in the studied schemes include: maize *(Zea mays)*, sugarcane *(Saccharum officinarum),* coffee *(Coffea arabica),* chat *(Catha edulis),* and vegetables such as potato *(Solanum tuberosum),* tomato *(Solanum lycopersicum),* cabbage (*Brassica oleracea*), carrot (*Daucus carota*) and green pepper *(Capsicum anuum).* Without irrigation, farmers cultivate teff (*Eragrostistef),* barley *(Hordeum vulgare)*, wheat (*Triticum vulgare*), maize (*Zea mays*), potato (*Solanum tuberosum*) and green pepper (*Capsicumanuum)* using rainfall. The first main cropping season is from June to November; during which households cultivate crops using rainfall. The second cropping season is from December to April. In this season, households cultivate crops only through irrigation.

Irrigation water in the study areas is distributed using rotation turns. Of the total respondent farmers, over 60% frequently use rotation turns to get irrigation water whilst some 38% of them rarely use rotation turns to access water. Few farmers (< 2%) reported that they do not participate in rotation turns to get irrigation water (Figure 2). As learned from field observations, water-sharing works are facilitated by scheme level water use committees elected among the users. At household level, the head is responsible for coordinating the activities. The irrigation water distribution is planned according to the existing system layout and actual topographic conditions, so that irrigation water can be simultaneously delivered into each rotation block or group. That is why each irrigation site is divided into different groups. In practice, water distribution shifts are established based on counting dates, instead of water needs by plants.

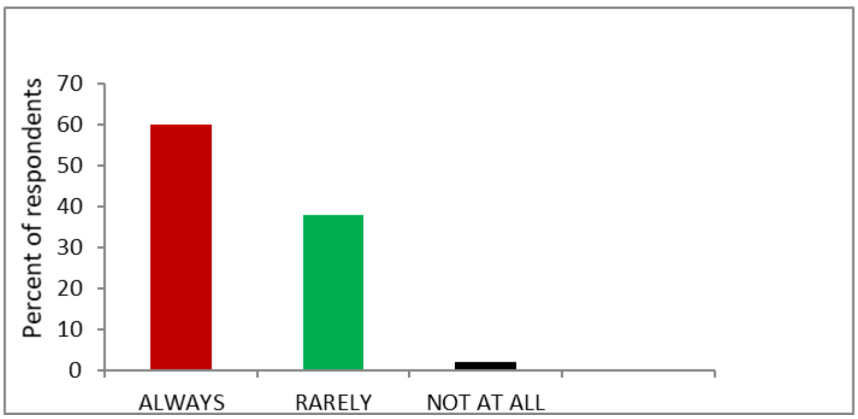

Figure 2 Frequency of usage of irrigation water turns

Intervals differ from season to season which depends on the amount of water in the study areas. The irrigation water rotation system practiced in the area is crucial for avoiding conflict among users and the peaceful coexistence of the community members. Hence, this practice should be assisted and supplemented by other stakeholders. Among 92 farmers who reported the existence of water user committees in their respective irrigation schemes (see Table 9), all indicated that the water use committees were headed more by men than by women. The use of water committees to manage water distribution is also reported in other different researches to have been operating in other similar areas of Ethiopia. For instance, Deribe (2008) in AtsbiWemberta and Ada'a, woredas; Belay and Bewket (2013) in Dangila woreda and Wotie and Hanaraj (2013) in South Achefer woreda, Ethiopia indicated that water distributions were managed by water committees. All these authors reported that irrigation waters were shared on rotation basis and the processes were managed by elected members of WUCs in their respective study areas.

Table 9 Irrigators' reports about water use committees

Question items	Response	№	%
Do you have WUCs in your RKA?	Yes	92	78
	No	26	22
	Total	118	100
If yes, do you have formal criteria to elect members of the WUC?	Yes	31	34
	No	61	66
	Total	92	100

As indicated in Table 9, out of the total 118 farmers interviewed, 78% reported the existence of WUCs in their irrigation schemes whilst 22% of them reported that no such committees were present in their respective schemes. As observed during field visits, the numbers of WUC members range from five to seven in Shimina-Abidender; were seven in Daba and Yemihil RKAs. In principle, the main function of the committees was distributing water among users, coordinating irrigation structural works and solving conflicts. During FGDs, participants expressed that WUCs were supported by DAs and the RKA police to enact governing rules and regulations in the irrigation schemes. The rules developed were documented in written forms and served to control irrigation operation and water management activities in the studied irrigation schemes.

Among 92 farmers who reported the existence of WUCs in their respective irrigation schemes, 61(66%) of them indicated the lack of formal rules (fixed criteria) to elect WUC members against the reports of 31(34%) respondents who remarked the presence of such formal rules (Table 9). In FGDs, participants noted that being model irrigator, honesty and having dignity in the community are considered as basic criteria to elect members of irrigation WUCs. These traditions conform to findings from other similar areas stating the absence of fixed formal criteria to elect WUC members beyond consideration of the individual's age, farming experience; honesty and acceptance in the community (e.g. see Belay & Bewket, 2013).

Table 10 Irrigators' responses about the performance of WUCs in resolving conflicts

Conflict resolving methods	Responses	№	%
Take immediate actions	Yes	33	36
	No	59	64
	Total	92	100
Suspend cases	Yes	64	70
	No	28	30
	Total	92	100
Use enforcing bylaws	Yes	25	27
	No	67	73
	Total	92	100

With respect to the performance of the WUCs in resolving water use conflicts, 36% of the 92 irrigators reported that they take immediate actions on cases appearing during water uses. But, 64% of them indicated that no immediate actions were taken by the committees when cases arise. About 70% of the respondents confirmed that the WUCs suspend cases to other days against the 30% who reported that the committees perform their duties with no postponement of cases to other times. Some 73% of the respondents remarked that the committees do not enforce internal bylaws established for conflict resolution purposes but 27% of them confirmed internal bylaws are enforced by the committees (Table 10). FGD results show that low level of efficiency, resistance by some WUC members and absence of external support cause reluctance among the committee members because participation in the irrigation management committee is not a full-time job. In addition, they have not been paid and compensated for the time they spent in irrigation management committee activities. Dejen et al. (2006) remarked that lack of support from the local stakeholders and inefficiency of the WUCs in enforcing rules and in resolving conflicts created frustration among irrigators.

4.3. Challenges of Irrigation Water Management

Smallholder irrigation has enormous potential to improve the income of poor rural households in developing countries like Ethiopia, but it is never free from problems. The major challenges encountered in the sector in the study areas are thus discussed in the following paragraphs.

The study on challenges of irrigation water management (e.g. Table 11) indicates that over 67% of the irrigators face water theft problems. Other many irrigators (>63%) also reported that they face rotation water turn abuses because of corruption and absence of effective sanction to punish abusers. For instance, more than 64% of the irrigators noted the prevalence of poor water distribution and management. About 60.2, 35.6 and 33.1% farmers likewise remarked facing water abstraction by upstream irrigators, canal siltation and water loss through leakage and seepage, respectively. Similar challenges on irrigation water use and management were reported in other comparative RKAs of Ethiopia (e.g. see Belay & Bewket, 2013).

Table 11 Farmers' opinions on irrigation water management challenges

Types of challenges	Responses	№	%
Water loss through seepage/leakage from canals	Yes	39	33.05
	No	79	66.95
Canal siltation	Yes	42	35.59
	No	76	64.41
Poor water distribution coordination	Yes	76	64.41
	No	42	35.59
Water theft problems	Yes	80	67.80
	No	38	32.20
Water shortage at tail-end irrigation	Yes	55	46.61
	No	63	53.39
Upstream water abstraction by using motor pumps	Yes	71	60.17
	No	47	39.83
Sanctions not imposed against illegal water users	Yes	81	68.64
	No	37	33.36
Rotation turn abuses	Yes	75	63.36
	No	43	36.44

Note: Numbers in brackets are percentiles

Irrigators were asked to give information on water distribution between upstream and downstream users. Accordingly, over 55% of the respondents in the study areas indicated that the distribution of irrigation water between upstream and end-stream users is unfair. Around 89% of these respondents confirmed that upstream users get more water than downstream users. This situation is accompanied by inequality in water distribution, untimely water deliveries and insufficiency of irrigation water, with consequent losses of agricultural productivity and livelihoods for the poor. Information from KIIs also confirms that irrigators at tail-end locations receive the least share of water in the study RKAs. Irrigators at the head-streams (over 88% of them) are benefiting more than the tail-end irrigators. These farmers get the chance to access the first waters from upstream areas as a result of location advantages (Table 12). On the other hand, the KIIs revealed that those who live closer to the irrigation farms get more chance to better water access. Bacha et al. (2011) remarked that location significantly influences households' access to irrigation. Similarly, Asayehegn et al. (2011)

noted that farmers' residences in relation to water sources significantly affect their participation in irrigation practices. Belay and Bewket (2013) also reported that water accesses are controlled by factors of location in northwestern Ethiopia. For most farmers in the study areas, the shortage of irrigation water occurs from January to April and severe scarcity is encountered in April, similar to what is reported in Belay and Bewket (2013) in northwest Ethiopia.

Table 12 Farmers' responses on water distribution between upstream and downstream users

Question items	Responses	№	%
Is irrigation water distribution fair between upstream and downstream users?	Yes	53	44.9
	No	65	55.1
	Total	118	100
If no which of them do get more water?			
Upstream users		58	89
Middle stream users		6	9
downstream users		1	2
Total		65	100
Which social group gets more water?			
Farmers with large family size		1	0.8
Rich farmers		13	11
Head stream farmers		104	88.1
	Total	118	100

4.3.1 Measures ofStabilizing Water Shortage in the Study Areas

In the FGDs, respondents discussed about ways of stabilizing water shortage in the study areas. In the discussions, hand dug wells were identified as effective mechanisms of stabilizing temporary water constraints. The uses of motor pumps were also recommended by the farmers' groups as best technologies to deliver water from deeper wells, streams and rivers. Growing drought resistant and early maturing crops and early planting were also among the coping strategies mentioned by the farmers' groups.

Table 13 Availability of irrigation water package

Question	Responses	№	%
Is there irrigation package in your area?	Yes	50	42.4
	No	68	57.6
	Total	118	100

During the survey, participant farmers were asked whether irrigation packages were introduced or not to the area in the past. Accordingly, over 57% of them noted that they didn't know any irrigation water management package (how much and when to irrigate) introduced in their respective RKAs. Conversely, 42.4% of the respondents indicated that they knew the existence of irrigation water management packages. Nevertheless, for farmers claiming that they have irrigation packages, their applications were not based on scientific knowledge. For most of them, irrigation package meant merely diversion of water to vegetable fields through furrows. This implies that smallholder irrigation crop production systems were not supported with latest technology and expert knowhow.

4.4. Water Conflicts and Mechanisms of their Settlement in the Study Areas

Conflict over the use of water is one of the main challenges of irrigation management in the study areas. During the field work, it was learned that there are competitions and conflicts for water among different irrigation water users. Competitions are growing common among motor pump users, modern river diversion water users and the users of traditional stream/spring diversions. This has caused some water-mills to stop operation and resulted in clashes between upstream and downstream water users.

Table 14 Farmers' responses for questions related to water conflicts

Questions	Responses	Number of respondents	
		№	%
Have you ever faced conflict over using irrigation water?	Yes	71	60
	No	47	40
	Total	118	100
If yes, what are the causes?			
	Water theft	5	7
	Increased number of users	29	41
	Water shortage	27	38
	Lack of proper control of water distribution	10	14
	Total	71	100

In the study RKAs, 60% of the farmers face conflicts related to irrigation water use. Several factors are attributed to the causes of the conflicts. Among 71 farmers who face water conflict, 41% relate the causes to increased number of users, 38% attach it to water shortage, 14% associate it with the lack of proper water management and 7% attach it to water theft (Table 14). In FGDs, crop damage due to free livestock grazing and crop theft are identified as major causes of conflict among irrigators in the study areas. Since crop thefts often happen at night times, it is very difficult to follow up and control the incidents. Moreover, there are conflicts between Shimena-Abidender and Daba RKAs over the use of water at River Korcha. Korcha river originates from Daba RKA and is also used as a source of irrigation water for Daba and Shimena-Abidender RKAs. FGDs revealed that water conflicts arising between the two RKAs irrigators are settled by joint committees comprising selected elders and priests from the two RKAs. The committees used to meet once a month to negotiate cases.

Irrigators were asked about the methods they use to manage conflicts in their respective areas. Based on that, about 66 and 22% of the irrigators indicated that when they face problems in using water, they report to the WUCs and going to RKAs leaders, respectively. Other 5 and 7% irrigators indicated that they report to social courts and to police to resolve water conflicts (Table 15).

Table 15 Farmers' methods of water conflict management

Questions	Respondents by RKA (in %)			Total
	Shimina-Abidender	Daba	Yemihil	
How do you manage water conflicts?				
Reporting to WUCs	83	71	46	66
Going to RKA leaders	17	17	32	22
Reporting to social courts	-	-	16	5
Reporting to police	-	12	6	7
How do you evaluate the strength of water use committees?				
Strong	12.5	18	-	11
Medium	33.3	37	26.7	38
Weak	54.2	39	73.3	49
Very weak		5		2

Comparatively, 83 and 17% of the respondents in Shimina-Abidender RKA report the cases to the WUCs and to the RKA leaders, respectively. About 71 and 17% of the respondents in Daba RKA also report to the WUCs and to RKA leaders, respectively to settle conflicts. Some respondents (12 %) in Daba RKA take the cases to the police. In Yemihil RKA, 46 and 32% of the respondents report their cases to the WUCs and to the RKA leaders, respectively. Only in Yemihil RKA, 16% of the respondents report the cases to social courts. The proportion of reporting cases to the WUCs to settle conflicts in the study areas is less in Yemihil RKA as compared to Shimina-Abidender and Daba (Table 15).

Among 92 farmers who reported the presence of water use committees in the study areas (see Table 9), over 54 and 33% of them correspondingly explained that the functions of the WUCs were weak and medium in Shimina-Abidender RKA, respectively (Table 15). However, some 13% of the respondents rated that the functions of WUCs were strong. Over 39 and 37% of the respondents in Daba RKA indicated the functions of the WUCs were weak and medium, respectively. Over 18% of them explicated that WUCs were strong. Moreover, in Yemihil RKA, over 73 and 26% of the respondents remarked that the functions of the WUCs were weak and medium, respectively. Though, the irrigators report their problems to the WUCs, the performance of the committees towards fulfilling the intended objectives with respect to managing the irrigation water is found to be low at all levels of the RKAs. The result of key informant interviews and FGDs also confirmed that resistance from some water users and lack of external support limit WUCs capacity and effectiveness.

4. Conclusions and Recommendation

The aim of this research was to assess the challenges of irrigation water management in smallholder schemes in the northwestern highlands of Ethiopia. It focused on three purposively identified RKAs namely Daba, Shimina-Abidender and Yemihil. Data were generated from a questionnaire survey of 118 irrigator households, KIIs and FGDs. The results showed that streams and springs played great role as irrigation water sources for the majority of the farmers. Over 60% of the irrigators in the study areas get water using rotation turns and over 74% of the farmers use furrows to access water to their farms.

Water-sharing works were facilitated by scheme level water committees elected among the users. At household level, the head was responsible for coordinating the activities. Therefore, smallholder irrigators elected their own irrigation WUCs in their respective study areas to facilitate irrigation water management practices and to solve conflicts which may arise related to the water usage. However, the performance of the WUCs towards fulfilling the intended objectives with respect to managing the irrigation water were found less satisfactory. WUCs were suspending different cases raised from irrigation users. They were unable to enforce internal bylaws that were enacted by the participation of the irrigation users and they failed to take immediate actions.

Generally, household survey results (i.e.63% respondents) revealed that shortage of water is the most important factor affecting irrigated agriculture in the study areas. Challenges which irrigators face during irrigation practices in the study areas were: water shortage, loss of water through seepage and evaporation, poor coordination of water distribution by WUCs, water theft problems and water shortages at the tail-end schemes, failure to control illegal water users, rotation turn abuses and water use conflicts. These all were important challenges faced by irrigators during their irrigation operations. It is suggested that government agencies should access expert guidance opportunities on irrigation water management to irrigation users. Appropriate institutional support should be also provided to WUCs to allocate fair distribution of water and to settle conflicts through training and by offering professional support. Farmers should be encouraged to harvest rain and underground water to stabilize water shortages. Irrigation canals need to be constructed using concrete stone-mortars to avoid water loss through seepage.

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