Socio-economic Contribution of Integrated Watershed Management and Its Sustainability in Enderta Woreda, Southeast Tigray Zone, Ethiopia

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Abstract

As a reaction to the intricate problems of land degradation and economic development, an integrated watershed management method has been introduced. Tigray Region—one of the most impacted regions by food insecurity and land degradation—has implemented an integrated watershed management strategy. This study examined the socioeconomic benefits of integrated watershed management, including household income, employment, health services, education, and irrigation in Enderta Woreda. It also examined the sustainability of these benefits, measuring changes in spending, income, purchasing ability, and construction material usage. The study employed both qualitative and quantitative methods to gather the required data. Statistical Packages for Social Sciences (SPSS) was used to analyse the acquired data. Correlation and regression were performed to show average annual revenue and its association with irrigation. As a result, respondents said that access to education, employment, and food security had increased. However, there has been a decrease in migration and poverty. In addition, income had increased steadily between 2014 and 2015, rising from 960 USD to 1127 USD per household. However, due to recurrent drought and crop failure, it dropped to 614 USD in 2016. This led to a decrease in the purchasing ability, dietary adjustments, and cropping intensity. As a result, the study's findings demonstrate that integrated watershed management has, in general, improved and diversified household income sources and amounts. The variability of the yearly rainfall distribution continues to be a determining factor in the extent of improvement and contribution to the livelihoods of the local inhabitants within the research region.

Keywords: land degradation, land rehabilitation, food security, irrigation, cropping intensity

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Introduction

Ethiopia has been highly affected by land degradation mainly due to deforestation, soil erosion, resource mismanagement, and rapid population growth (Gebregziabher et al., 2016; Temesgen et al., 2014; Tefera, 2002; Desta, 2000; Taddese, 2001; Tedla and Lemma, 1998). Consequently, the natural resources (vegetation, soil, and water) that support more than 85% of the rural population have been severely degraded resulting in poverty and food insecurity. As reported by Melaku (2013), about 70 % of Ethiopia's highland population and an area of over 40 million ha are affected by land degradation. Similarly, a report by Tefera (2002) shows annual productivity loss in the Ethiopian highlands is estimated to be 0.12-2.0%. To reverse the problem of land degradation and thereby improve the livelihoods of the people, extensive rehabilitation interventions have been implemented throughout the country. For instance, the land rehabilitation project with the World Food Programme (WFP) and Food-for-Work assistance was aimed at addressing the problems of food insecurity through the construction of soil conservation structures, community forestry, and rural infrastructure works (Alemu and Kidane, 2014).

In Ethiopia, Watershed management programs commenced formally in the 1970s (Gebremeskel et al., 2019; Haregeweyn et al., 2012; Nyssen et al., 2008); in response to the famine in the northern part of the country during the period 1973-1974 (Gebregziabher et al., 2016). Tigray Region, one of the areas affected by land degradation, has also been actively involved in rehabilitation intervention, which includes reforestation and afforestation, and soil and water conservation programs. However, the practices of watershed management accompanied by the integration of disciplines (social, technical, and institutional) in the 1990s were the most important reasons for the observed impressive success (Balehegn, et al., 2019. Through farm-level diversification, higher incomes, participation in building structures, and irrigation techniques, the community's standard of living has improved (Chisholm and Woldehanna, 2012). According to a study by Lixian (2002) on benefits of Integrated Watershed Management (IWM) with respect to socio-economic aspects in China, the productivity of land and per capita income of farmers have increased by 1-2 times; grain production has increased by 1-2 times in rain-fed land; In irrigated land, the increase was 3-4 times and Per capita grain supply has reached 300kg-400kg. A study conducted by Gebrehaweria (2012) in three different

regions of Ethiopia found that crop productivity and additional area for cultivation increased over the years as a result of land rehabilitation activities. It also increased the availability of water for supplementary small-scale irrigation and the introduction of new agronomic practices. Indeed, Farm income increased by an average of 50%, which resulted in a 20-90% improvement in farm household food security; and access to health and education improved between 20% and 50% as compared to conditions prior to watershed management interventions (Gebrehaweria et al., 2016).

However, to the best knowledge of the researchers, very few studies have been carried out on the sustainability of the improvements and contributions to the socio-economy and the livelihoods of the people who rely on the watersheds in Enderta woreda. Therefore, this study was conducted with the aim of: -

- Examining the contribution of integrated watershed management on improving the livelihoods of the households, that rely on the watershed
- Assessing the sustainability of these contributions.

Materials and methods

Selection and description of the Study area

Enderta is one of the 36 woredas in the Tigray Region of Ethiopia. The woreda is located between 13^0-14^0 North and at 39^0-40^0 30' east covering a total land area of 1446.49 square kilometres (fig.1A). Enderta Woreda has a moderate population density. The total population is estimated at 114,277 of these 57,472(50.3%) were male and 56,805(49.7%) were female in the year 2007 (FDRE Population Census Commission, 2010). Out of the total population, almost all live in rural areas. The average family size is five and the population density of the woreda is 79 people per square kilometre. The estimated total population of Chelekot is approximately 3300 (Enderta Woreda Agricultural Extension Office, 2016). Crop and Livestock production are the main economic activities in the woreda. More than 80% of the population living in the woreda is engaged in subsistence farming with land holding size of less than one hectare.

This study was conducted at randomly selected village of Enderta woreda named Chelekot. Chelekot is located about 16 km southeast of Mekelle town. The mean annual temperature of this

area ranges between 16˚C - 20˚C and average annual rainfall ranges between 500 - 1000 mm. The area is characterized by erratic rainfall and frequent droughts (Gebre et al, 2015). The rainy season occurs between June and September and the subsistence agricultural production is almost entirely dependent on this timing of the rainfall.

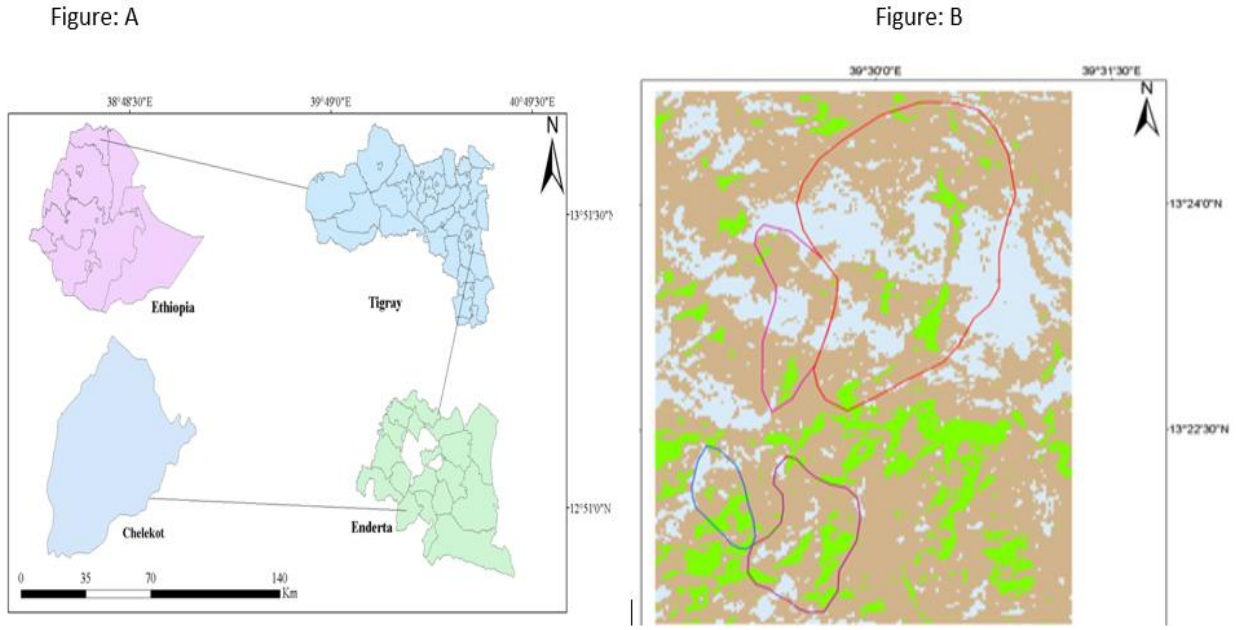

Figure 1: Map of the study area

To select the study area and sample household, a three–stage systematic sampling design was done, where in the first stage, the watershed was selected due to its accessibility and it is an area with good experience in integrated watershed management practices. In the second stage, representative catchments were selected from the watershed using a simple random sampling method (fig.1B) Chellekot watershed has upper and lower catchments which are separated by the village of Chelekot. The researcher selected the upper four catchments due to their extensive rehabilitation activities and supplementary economic activities. Further, the researcher selected two catchments from the left side of the river called Chelekot and the other two catchments from the right side of the river. This selection was made because of the variation in slope and intensity of rehabilitation on two sides of the watershed.

Sources and methods of data collection

To collect the necessary data, the study used both primary and secondary data sources. Primary data was collected using household surveys, interviews, focused group discussion and field observation.

To conduct the household survey a questionnaire consisted of various variables, such as irrigation, irrigable land, number of irrigators, frequency of irrigation in a year, income, employment, health service, and the like, address the different socio-economic advantages the farmers enjoyed before and after the intervention of the integrated watershed management in the watersheds and about their perception about the sustainability of these advantages were distributed. The researchers employed 5 enumerators and training was given on how and when to collect the data. Consequently, there was a team leader and the researcher was monitoring them continuously. A key informant interviews were also carried out with development agents in the watersheds as well as with the officers of the district Agriculture and Rural Development office.

To verify the data collected using the questionnaires and to add more data, a focused group discussion sections was also carried out with some elderly people who have lived in the catchments for a long time. Hence, from each of the sample catchments, one focused group discussion with a size of 6 members was conducted and the focused group discussion was managed by the researchers. In addition to the data from household surveys, interviews and focused group discussions, data for irrigation and related issues as well as food security were collected from Woreda Agriculture and Rural Development office reports.

Sample size and sampling technique

To employ the household survey, 104 household respondents were selected from the list of all village inhabitants of the respective Kebele administrative office using a systematic sampling technique. The total number of samples was determined using Kothari (2004) formula;

$$\mathrm{n} = \frac{z^2.p.q.N}{e^2(N-1) + z.p.q}$$

Where;

N= size of population

z= the value of the standard at a given confidence level

n=size of sample

p= estimated population of a given characteristic

q=1-p=0.5

e= Desired precision/ acceptance error (the researcher wants to be accurate within 10% of the true proportion (10/100=0.1).

Data analysis

Having collected all the necessary socio-economic data and making the necessary verifications, they analyzed using Statistical Packages for Social Sciences (SPSS) and descriptive analyses were carried out. Descriptive analysis such as arithmetic mean, percentages, and frequencies was used to examine the household characteristics and major economic activities. Moreover, to determine the relationship between the average income of the households from irrigation and other determinant factors such as the size of irrigable land, frequency of production from irrigation, and its trend, both correlation and simple linear regression analysis were carried out.

Results

Socio-economic contribution of Integrated Watershed Management

Irrigation and beekeeping are the determinant activities that contribute to improving the socio-economic status of the community. The data from the Agricultural and Rural Development Office of the district indicated that the number of irrigators increased during the first phase of implementation (2006-2011) and the first four years of the second phase (2011-2015) of the integrated watershed management. Besides, the total area under irrigation increased during the first five years and decreased in the last study year; which is from 850 ha in 2015 to 520 ha in 2016. The increasing rate of the irrigated land was negative before 2011 (Figure 2). However, it has been increasing from year to year as a result of the redistribution of the previously degraded land for farmers and rehabilitation. In addition, the improvements in skill and awareness developed by their counterparts and the development agents help farmers to increase their interest and further involved on irrigation activities. On the other hand, the correlation analysis

on irrigated land in the five years under study indicates, a weak positive relationship (R^2=0.20). Similarly, the record of annual income of irrigators and the area of irrigated land shows a weak positive relationship (R^2=0.34).

As we can compute from the regression equation,

Y=56.418x+13059 Y is the average annual income of the irrigators

Y= 56.418(0) +13059

Y= 13059 ETB

Where; 13059 is the average annual income of irrigators if irrigated land was zero in 2011. However, the recorded average annual income of the irrigators in 2011 was 40,000 ETB (2000 USD). Therefore, the contribution of irrigation to the annual income of the irrigators is twofold compared to the annual income they receive from other activities.

With an R^2 value of 0.714, a comparison of the amount of irrigable land and the number of irrigators shows a direct relationship. The extent of irrigable land and the number of irrigators increased between 2011 and 2015, but declined in 2016 (Figures 2 and 3).

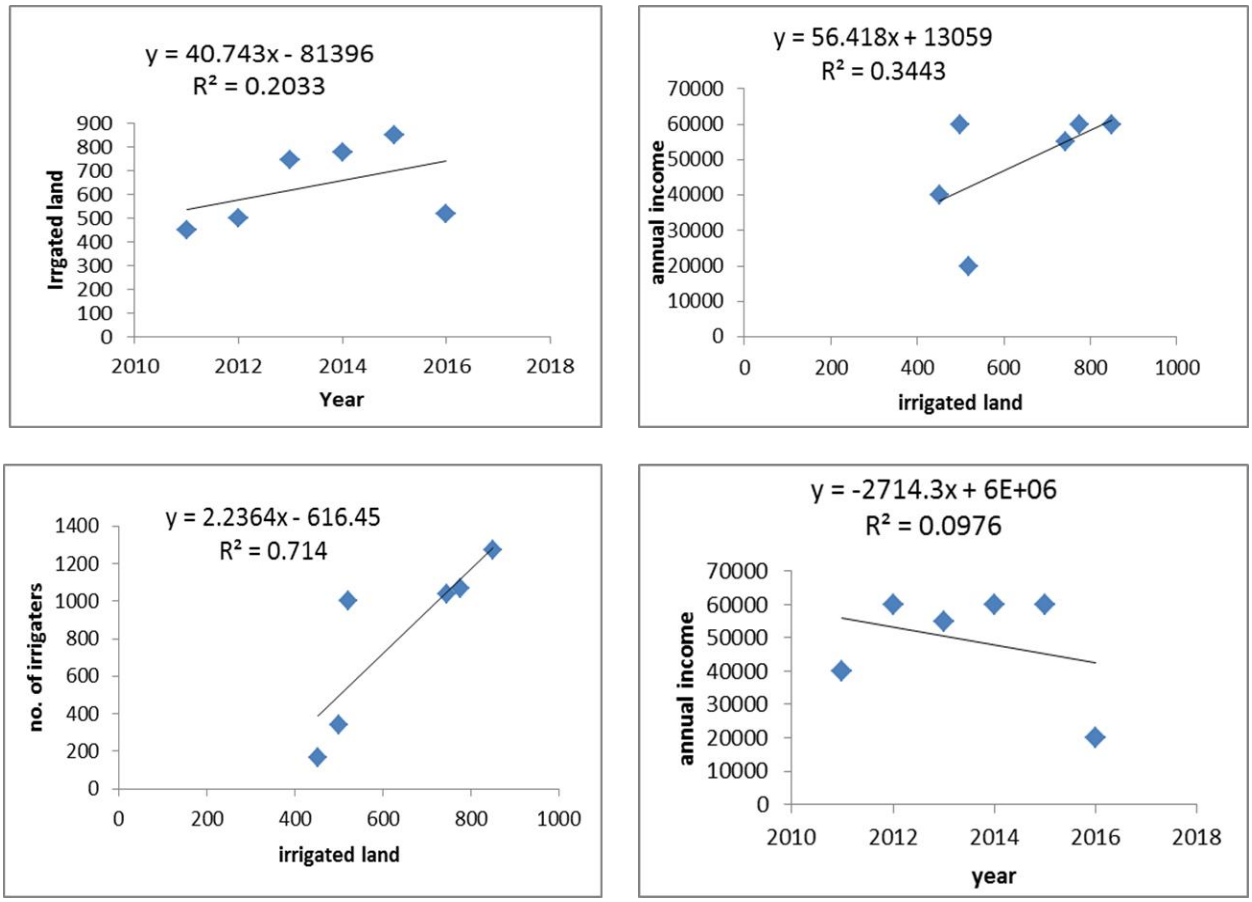

Figure 2: Irrigation and related socio-economic issues

The size of irrigable land and the average yearly revenue of irrigators are directly correlated, as seen in Figure 2. Thus, an irrigator's income is influenced by the area of land that may be used for irrigation. Low quality and quantity of cash crop production, as well as market accessibility, are additional factors that impact annual revenue. High transportation expenses and a deficiency of transportation services are associated with market inaccessibility. An additional issue facing the location is price volatility and a deficiency in market networking. The most difficult elements in terms of both quantity and quality are the cost of pesticides and fertilizers and the difficulty of obtaining enhanced crops.

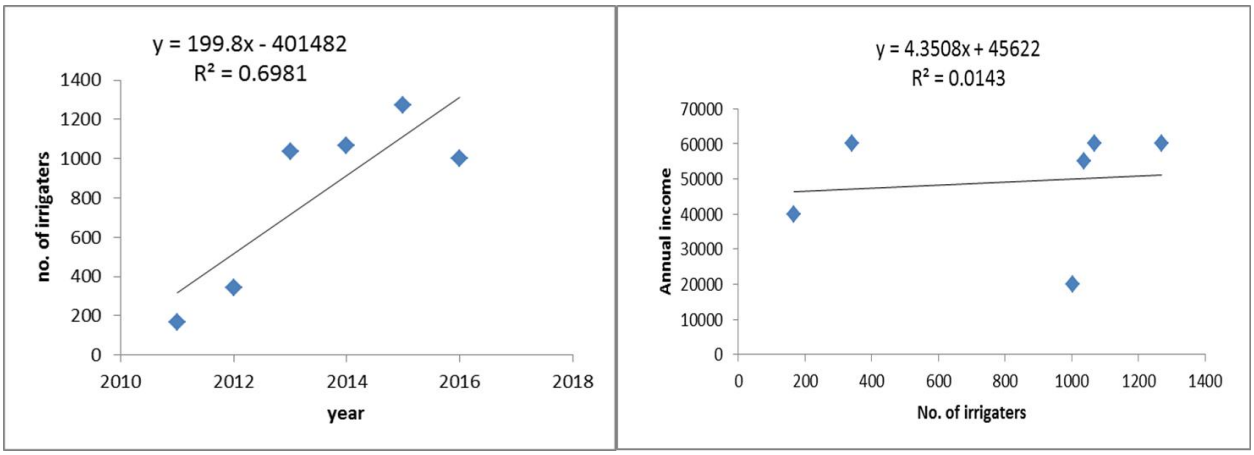

Figure 3: the trend of the number of irrigators and comparison between average annual income and number of irrigators

As it can be seen from figure 3, numbers of irrigators have increased through time except in 2016 which reduced to 1002 from 1271 irrigators in 2015. Besides, the average annual income and a number of irrigators have very weak positive relationship (R^2=0.014).

The other opportunity for irrigation is increasing cropping intensity though it decreases from 3 times in the years of 2011-2015 to 2 times in 2016. According to the local farmers, this variation in total area of irrigation, number of irrigators, and cropping intensity mainly happened because of rainfall variability. Additionally, irrigation helps farmers to produce diversified fruits, vegetables, and crops. As observed by the researchers and mentioned by the respondents, Mango, Avocado, Papaya, potato, tomato, onion, Carrot, cabbage, haricot bean, beetroot, peas, and maize are produced in the study area.

Figure 4: Diversified vegetables and crop in the field study, April 2017; Photo by: Amleset G.

As witnessed by the study participants and researchers' observation, the irrigation practice is an indicator of improvement in moisture availability. This brought an opportunity to produce better from diversified crops and improve their income from diversified sources. This can be evidenced by comparing annual production from rain fed agriculture and irrigation.

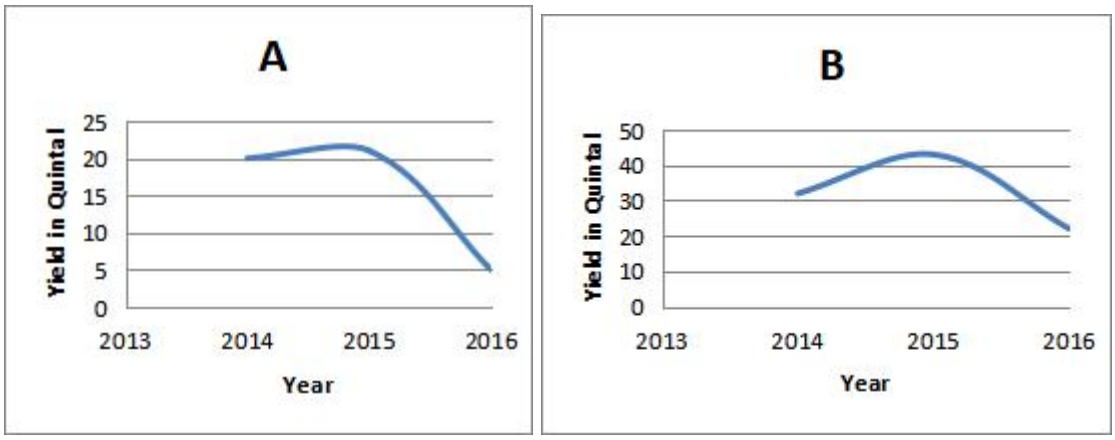

Figure 5: Annual total crop production (A); Annual total cash crop production (B)

As can be seen from Figure 5, irrigation has brought about an additional household income. During the drought year (2016), the average production from rain-fed agriculture was 5 quintals

per household. Spending a year with this amount of quintal is very difficult. The ultimate solution came from the irrigation activity that is 20 quintals. In this case, it is not only about increasing production but also income and employment through engaging in constructions for soil conservation activities and involving in irrigation activity throughout the year. In general, a reduction in yield because of water shortage or a change in weather in one season can compensate for the coming season of the year.

Beekeeping is the human activity of maintaining honey bees. Beyond income generations, this activity has aimed to reforest and rehabilitate the disturbed environment and keep the youth from migrating to urban areas. In the study area, there is an association that has 20 members called as Tiuemti Association which is named after the catchment name for beekeeping. This association has 105 beehives and 55 of them are under production currently. Within 8 months in the year 2015/16, they earned about 60000 birr, and when compared with the last year, in the same period, there was an increase of 5 beehives and more than 5000 birr in income. The respondents witnessed that, integrated watershed management has an increasing effect on their income through rehabilitating their environment and generating employment. Witnesses did, however, note that there is resistance and disinterest among the group members.

Contributions of IWM to livelihood

A livelihood comprises the capabilities, assets (stores, resources, claims, and access), and activities required for a means of living (Chamber and Conway, 1992). In this study; employment, income, education, health service, food, and job opportunity are the most important measurements of livelihood. The contribution of integrated watershed management in employment, income, education, health service, food security, job creation, poverty, and migration was analysed; and the trend was rated in this study. Accordingly, 83 percent of the participants assured that their livelihood is improved as indicated by a reduction in poverty (81 percent), migration (66 percent); and increasing in food security (61 percent), educational access (88 percent) and employment (78 percent).

According to the district officials and survey respondents, employment in beekeeping, irrigation, structure constructions to rehabilitate and conserve the environment, and other social sectors reduce youth migration. Students from kindergarten to grade 10 are attending in their village due

to the increasing capacity of their families to afford the costs for cloth, stationeries, and other related payments for their children and contribute to the construction of a school in their village. Moreover, this reduces the suffering of disadvantaged groups from lack of access to Education.

According to the Enderta Woreda Poverty Reduction and Food Security Department (2017), in 2013/14 and 2014/15, 766 individuals got economic aid from the safety net program in two ways: direct aid for elders (314) and through public work for youngsters (452). The number of individuals who need support was lower as compared with the last drought year, 2015/16, which was 314 elders and about 1000 youngsters. Taking into consideration these three years of recorded data, poverty may decrease, but not be that significant and inconsistent.

Table 4: Contribution of integrated watershed management on livelihood

Indicator	Level of contribution (%)			Total response (%)
	Increase	Decrease	Same	
Poverty	1.92	81.73	16.35	100
Migration	11.53	66.35	22.12	100
Educational access	88.46	10.58	0.96	100
Food security	60.58	20.19	19.23	100
Tourism	-	-	100	100
Job opportunity	77.88	0	22.12	100

Source: Survey study, 2017

Food security is a broad and complex concept that is difficult to measure using a single measure. The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Commonly, the concept of food security includes both physical and economic access to food that meets people's dietary needs as well as their food preferences. It is determined by per capita income, health status, political stability, market issues, availability and quality of water, knowledge of basic nutrition, and others. The study shows a change in food access and availability; however, it is not enough to say the community in each Catchment is secured in food. For instance, most respondents (99 percent) noted that they eat three times a day however; it has the same diet content due to the interest in selling and earning income for other expenses such as educational materials, traditional celebrations like '*tsebeltsadik*', buying cloth and shoe for their children.

Sustainability of integrated watershed management

The results in the above section shows that integrated watershed management has been improved the economic and social status of the community. In addition, it is undeniable the interest and capability of farmers in irrigation have increased, and production and productivity have also improved. In line with that, they produced for market consumption in addition to their household consumption, changed their housing style into modern type, owned motor pumps, and accumulated household assets (e.g., television, cell phone, bed, satellite dishes, and fridge) after the implementation of integrated watershed management. This resulted from having an opportunity for education and employment, an increase in per capita income, getting food on time, getting medicine during sickness, and bringing a healthy and productive citizen. However, the focus of this section is to evaluate the sustainability of each success by comparing income and expense; frequency of getting food, content of diet, and material of construction for their house, and frequency of buying cloth and shoes in three consecutive study years.

The average annual household income in 2014, 2015 and 2016 was 960 US Dollars, 1127 and 614 US Dollars, respectively. The annual increment rate was 17 percent between 2014 and 2015 and -45.5 percent between 2015 and 2016. This implies a variation in household income in different production periods because of the shortage in agricultural input supply, invasion of plant disease, and climate variability especially shortage/absence of rainfall.

Unlike the household income, the household expense has been increasing over the three years. For those three respective years, the average annual expense was recorded as 805, 866, and 866.8 US Dollars. Though it is not fast growing and declining like household income, in between 2014 and 2015; 7 percent, and in between 2015 and 2016; 0.06 percent increment rates were recorded for annual expense. Therefore, there is inconsistency in annual household income and in expense. The figure below presents the status of per capita income and expense for 2014, 2015, and 2016 using trend line.

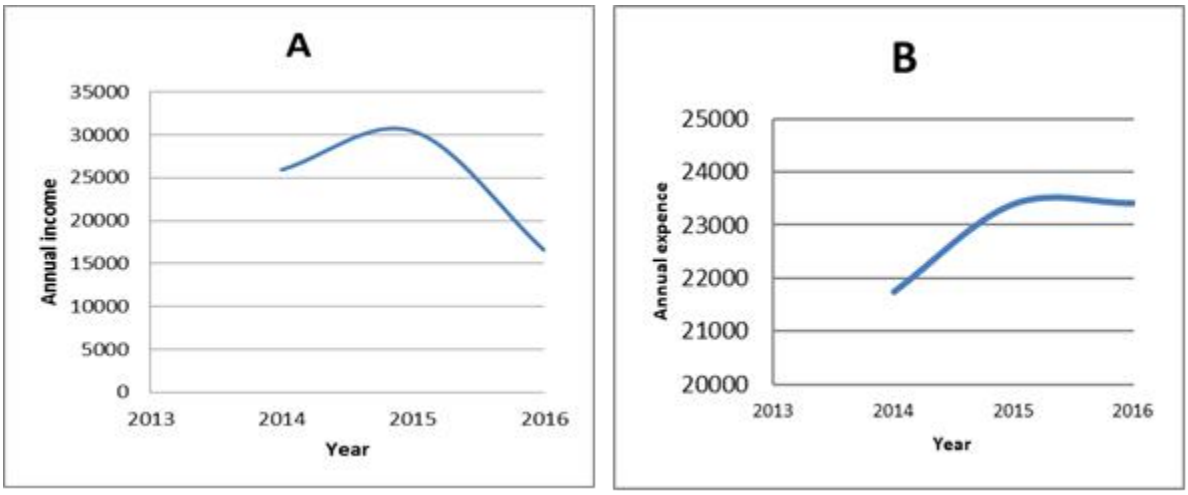

Figure 6: (A) Annual income (B) Annual expense

According to the respondents, support from their relatives who are employed in private and governmental organizations, debt from microfinance institutions, selling their animals and aid from government and other donor agencies are the sources of money for extra-expenditure.

Consistency of livelihood wellbeing can be measured using different variables. In this paper, the researchers used frequency of getting food per day, frequency of buying cloth and shoe per year, material used for house construction and content of diet.

Table 5: Summery of livelihood sustainability indicators

Year	Frequency of getting food per day	Average Frequency of buying cloth and shoe	House construction material	Content of diet
2014	3	2	Composed of soil, stone and wood (*Hidmo*)	One type
2015	3	2	Composed of soil, stone and wood (*Hidmo*)	Diversified
2016	3	1	Corrugated iron	One type

Source: Survey study, 2017

The household survey result indicates that all members of the family get food three times a day. Also, the whole family bought clothes and shoes two times a year in 2014 and 2015 but only once in 2016. Their house was "*Hidmo"* for the years 2014 and 2015 then converted to a house

covered by corrugated iron in 2016. The content of the diet was one type in 2014 and converted to diversify in 2015 then back to one type in 2016. The inconsistency is shown in the frequency of buying clothes and shoes and the content of the diet. This is related to crop failure, food inaccessibility, and decreasing in income and production following the recurrent drought.

Discussion

Contribution: Different studies (Pathaket.al; 2013, Chisholm and Woldehanna, 2012, Singh et.al; 2010 and Wamalwa; 2009 as cited in Worku and Tripathi; 2015) throughout the world on the socio-economic contributions of integrated watershed management indicate that employment opportunities are provided from irrigation, beekeeping, milk production, poultry and extra. A similar study (Tesfaye, 2011, Wani, et.al; 2013 and Terefe, et.al; 2015) indicated, this IWM approach helps farmers to improve and diversify their agricultural productions. Similarly, the research finding in Chelekot shows irrigation and beekeeping as major economic activities contributed by integrated watershed management. Besides, the community's participation in structural constructions and reforestation activities (in cash or in kind) help farmers to get an additional income and employment opportunities. Experiences from Ethiopia, India and China shows; farmers are producing various types of fruits such as Avocado, Mango, Papaya; vegetables such as Tomato, Potato, Carrot, Cabbage, Onion, pepper, broad beans, peas, spinach and crops mainly Maize. These employment opportunities bring an increase in income and reduced migration significantly (table 4).

Sustainability: Even though numerous studies demonstrate the advantages of the IWM program, sustainability doesn't arise as a big issue. It is not limited to integrated watershed management; it also pertains to the sustainability issue, which includes conservation, provision, enhancement, and additional activities. According to Yimer (2015), various environmentally strategic initiatives are not independent of the requirements for a successful SLM. As reported by Linger et al. (2011), achieving sustainability repays the efforts made by governments, communities, and land users. Further, Agricultural production is safeguarded and enhanced for small-scale subsistence and large-scale commercial farmers alike, as well as for livestock keepers. However, with similar results Mena et al. (2018) reported that the sustainability of the benefits which brought by integrated watershed management and the approach itself becomes challenging mainly due to recurrent drought and market shocks.

Challenges for sustainability: Most of the integrated watershed management practices and funding are to rehabilitate the degraded environment and improve agricultural productivity. However, there are post-production challenges mentioned by study participants as well as other literature; such as, lack in transport service and limited market linkage (Gebregziabher et Al., 2016 and Mena et al., 2018), which affects the quality and value of the end-products. This situation contradicts with the principle of the agro enterprise process 'Produce what you can sell! Don't try and sell what you have produced. According to Pujara (2016) a business organization owned, controlled, and financed by its members for their mutual benefit named as farmers group and cooperation is recommendable. Besides, getting organized is the first step to winning a common challenge (Shaun et al., 2009). As Pujara (2016) says, Control comes via membership rights to vote for and become directors and the directors hire the manager and establish the policy under which the manager operates. Some of the advantages of the organization are collection in one place to bulking of produce so that volume of produce can be achieved and the traders will be attracted to visit the farmer's place, regular supply is possible, Price fluctuation can be managed, easy to collect market information, collection of product and transport to reduce marketing cost and post-harvest loss can be minimized.

In this case, the experience of market linkage initiative countries (MLI) of East Africa shows that, Before the project, the typical situation observed was that smallholders delivered low-quality commodities (maize, beans, groundnuts, etc.) due to poor crop conditioning and lack of cooperation. However, following the improvement in collection and storage facilities the post-harvest loss reduces in these countries from about 4-5 percent to 1-2 percent (USAID, 2011). Besides, the project gives training on leadership and marketing information systems. Moreover, traders were participants during the training and it helps to introduce and create linkage directly.

Conclusion and Recommendation

Integrated watershedmanagement has an undeniable contribution in improving the socio-economy and livelihood of the community. Farmers and youngsters are involved in irrigation activities, beekeeping, and increasing cropping intensity up to 3 times per annum. As a result, they got educational access, health services, and reduced migration. However, with those contributions sustainability is a matter. The productivity of the land and cropping intensity has fluctuated from one year to the other. This is the result of the reduction in water availability

which is caused by the existence of recurrent drought. Though the effect of integrated watershed management is long-term, the result indicated that the economic activity of the community is still dependent on rain-fed agriculture. Though the recurrent drought and dependency on rain-fed agriculture are the major factors affecting the sustainability of the IWM contributions; pesticides, lack of quality, and market shocks has their share. Therefore, taking experiences from other countries such as India, China, and MLI countries (Kenya, Burundi, Rwanda, and Uganda) stakeholders should play their role in organizing the farmers in a group and help them to work on their common interest and benefit. In addition, the government should give a separate place and the self-funding or self-supporting farmers group and cooperation can build a warehouse to collect their production altogether. To practice this, the government should have a marketing team in addition to environment, land, and water management teams.

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