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Economic Analysis of Integrated Watershed Management Practices, the case of Horuwwa Watershed in Gombora District, Central Ethiopia

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Abstract

Integrated watershed management practice was taken as the basic operational unit to rehabilitate degraded watershed and improve agricultural productivity in the study area. However, its economic analysis was rarely evaluated. Therefore, this study assessed economic analysis of an integrated watershed management practice at Horuwwa watershed in the Gombora district. Data were collected from 117 farm households which were selected from the major watershed through random sampling. The multiple linear regression analysis result revealed that six independent variables were significant in explaining the factors affecting the farmers' household income in the watershed management practices. These variables were gender, age, farm size, labor, off-farm, irrigation and livestock unit. The chi-square test result of the variables gender (χ^2 = 4.082) and land size (χ^2 = 4.572) were found to be statistically significant at the 95%. Annual household income of downstream beneficiaries of the watershed was significantly higher than upstream beneficiaries. The most determinant factors for household annual income were irrigation access, TLU, farm size and off-farm income. The average contribution of income generating activities of IWSM practices in household annual income was 41.3%. Thus, IWSM is not only effective in increasing crop and livestock production but also it has high contribution in household annual income. Therefore, the result of the study suggests working on raising the awareness of farmers' about the economic benefits of an integrated watershed management practices and to design a strategy to diversify their livelihoods and further investigation should be carried out.

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Introduction

The integrated watershed management approaches have been viewed as useful systems for planning and implementing natural resource and agricultural development for many centuries (Brooks and Eckman, 2000). Integrated watershed management (IWM) is a relatively new concept that has broader scope. Its objectives may be taken as “the protection, improvement, and rational use of water, land, and other renewable natural resources in a watershed, in order to reach the optimal goals of ecological, economic and social benefits” (Tefera and Stroosnijder, 2007). In this sense, IWM may be seen as embracing a more holistic philosophy to managing natural and human resources in a watershed. In particular, it goes beyond the approach that aims at maximizing the availability of water quantity to the exclusion of all other considerations.

In Ethiopia, watershed development planning has been started in 1980’s with large watersheds (MoARD, 2005). However, large efforts remained mostly unsatisfactory due to lack of effective community participation, limited sense of responsibility on assets created and unmanageable planning units (MoARD, 2005). Watershed development involves: Human resource development (community development), Soil and land management (conservation and use), Water management (conservation and use), Afforestation, Livestock management, Pasture (fodder) development, and Agricultural development, and rural energy management. After some years’ experience, the ministry of agriculture and WFP technical staff developed a simple participatory and community-based watershed planning guideline which includes integrated natural resource management interventions, productivity intervention measures and small scale community infrastructures (MoARD, 2005; German *et al.*, 2007).

Watershed management in the Ethiopian highlands therefore urgently needs improvement and conservation of their natural resource for sustainable development and improving food security. Because agriculture is the main sector of the Ethiopian economy and contributes approximately 42% to the gross domestic product (GDP) and employs over 80% of the population (MoFED, 2010; Diao, 2010; ATA, 2013; Georgis *et al.*, 2010). Sustainable livelihood and increased food production in agricultural based developing countries require the availability of sufficient water and fertile land. Water especially affects greatly the prosperity of people and their development potential and health (Tesfaye, 2011).

Economics of watershed management is therefore an approach which aims at optimizing the use of land, water and vegetation in an area to alleviate drought, moderate floods, prevent soil erosion, improve water availability and increase fuel, fodder and agricultural production on a sustained economical basis.

Thus, adoption of sustainable participatory integrated watershed management as the platform for integrated land and water management and improving the livelihood of the community.

The SWC activities had a positive impact on reducing soil erosion and increased land productivity. At the same time, the program has been criticized for prioritizing mechanical measures while ignoring other sustainable land management components, such as conservation land management practices, improved land-use systems and livestock management (Bishaw 2001; Eyasu, 2002; Bekele, 2003; Osman and Sauerborn, 2001).

According to Bouwer (2000), an economic analysis of integrated watershed management research have been given the priorities and directions for future natural resource management and socioeconomic development for the local communities by fulfilling the conditions like irrigation, livestock, agroforestry practices. With regard, currently in the study area no unified framework though which policy-makers can effectively access information and best practices that academics in the field of environmental and resources economics have developed with regard to economics of integrated watershed resources.

Therefore, this study aims to analyse economic importance of watershed management the case of Gombora District. As well having the research questions (1) Do you understand the improvement of the productivity of land/water use systems and the livelihoods of local communities from sustainable ecosystem services? (2) What are the socio-economic factors influencing IWM for sustainable livelihood opportunities whose needs are met from a watershed's resources? (3) What are the expected benefits of IWM for the local community? (4) How to describe the conservation and management of natural resources within watersheds for sustainable production?

Material and methods

Description of the study area

The study were conducted in Gombora district (GD), which is one of the districts in Hadiya zone, Central Ethiopia. Gombora district is located about 259 km south of Addis Ababa and about 28 km from Hosanna, the capital town of Hadiya zone. It is geographically located between 7033′ and 70 37′ N 370 35′ and 370 40′ E.

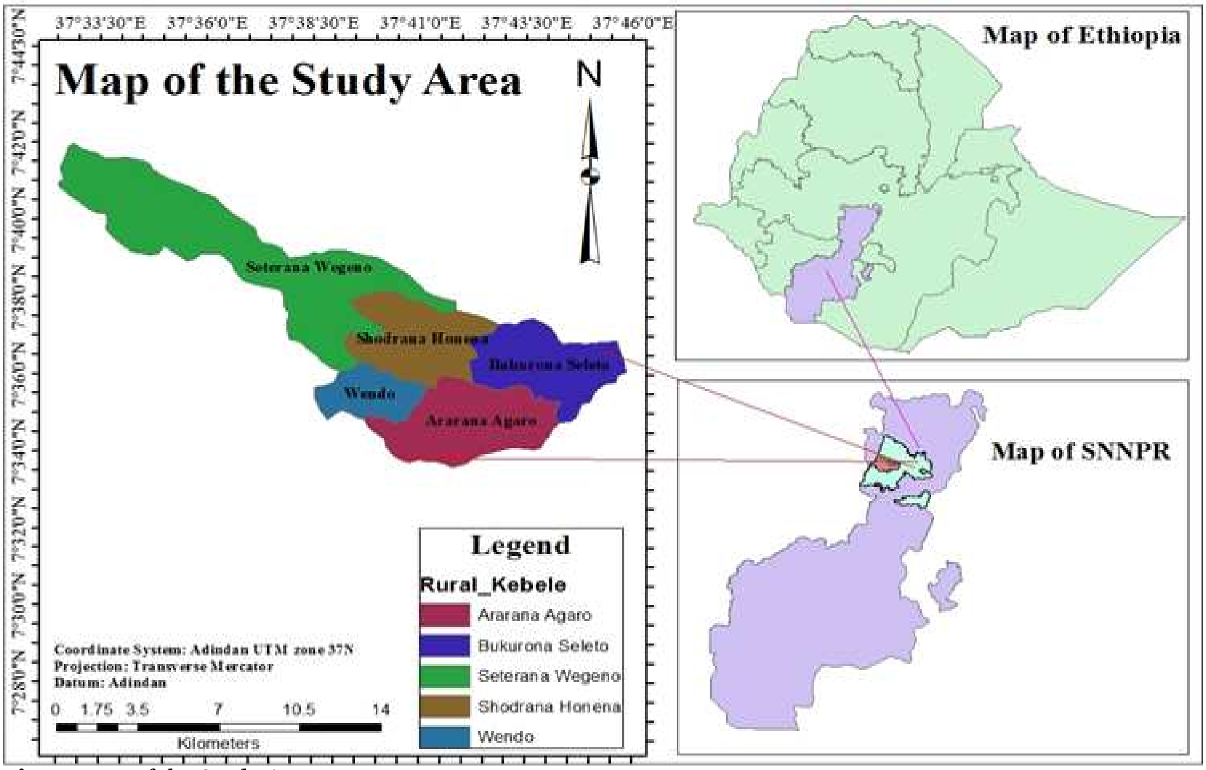

Fig. 1. Map of the Study Area.

The total land area coverage of the district is 52,325 ha which comprises a total of 24 Kebeles. It is bounded by four different districts' such as Lemo in the east, Yem Special Woreda in the west; Misha and Gibe in the North, and Soro in the south as indicated in the figure below (GWFEDO, 2015). The demographic characteristics of the study area could be described as follows: Gombora district has 24 Kebeles (KAs) with a total population of 102,332; with 50,225 males and 52,107 females. The population density of Gombora district is about 270 persons per square kilometer.

The economic activity of the people in the district depends mainly on mixed agriculture (crop-livestock production). It is characterized by subsistence-level mixed farming of rain-fed crops and livestock production associated with trees planted for agroforestry. The most commonly cultivated crops in the study sites include "enset" (*Ensete venrtricosum*), "teff" (*Eragrostis tef*), wheat, maize (*Zea mays*), coffee (*Coffea arabica*), barley (*Hordium vulgare*) and "chat" (*Catha edulis*) in order of their importance, respectively. "Enset" is the staple food crop for the majority of the community, while coffee

(*Coffea arabica*) and "chat" (*Catha edulis*) are the dominant cash crops in some PAs. Fruits such as avocado (*Persea americana*), banana (Musa paradisiacal), mango (*Magnifera indica*), White sapota (*Casimiroa edulis*), papaya (*Carica papaya*), and bullock's heart (*Annona senegalensis*) and cultivated for household consumption and to some extent income generation. The farming system of the watershed can be described as mixed farming with main cash crops and presence of surplus production. Crop and livestock production are the major farming activities. The major crops grown are cereals like wheat, "teff", barley, oats, maize, and pulses like faba bean, peas, and chickpea. The total livestock population is 16,552 livestock units with the typical herd/flock composition of cattle, sheep, goats, donkey, horse, mule as well as chickens and bees.

Sources and methods of data collection and sampling technique

The study were used both primary and secondary sources of data. These include household survey questionnaire, focus group discussions (FGDs), field observations, and key informant interviews. Secondary data were also gathered from past studies, reports, books, journals, and internet sources. The household survey questionnaire was conducted to gather data about demographic and socioeconomic characteristics of sample households and various sustainable land management practices practiced by farmers of the study area. The questions were both closed-ended and open ended types. Accordingly, the survey questionnaire would be administered between January and February 2023. A formal survey instruments were used to collect data from the households' via interviews. This period was chosen mainly to avoid interfering with farmers' peak farming activities. Hence, it is easy to interview the sample farm households and collect the required data. Before full implementation, the structured household questionnaire was pre-tested as a pilot survey in the sample villages. The pilot survey ensures that the present questionnaire was relevant and meaningful to the average respondents and to decide which questions were relevant for the purpose of the study.

The study area, Horuwwa is one of the sub watersheds which are existed in Bukuro-saleta kebele in Gombora district, in which different soil & water conservation have been undertaken. The major watershed was delineated via using ArcGIS 10.3 method. This critical watershed, which is a cluster of sub-watersheds (Abecho, Lendancho, Anene and Chobora) having 3,250.5ha of intervention area and 2,242 households with total beneficiaries of 2,024.

Data for this study were collected from purposively selected watershed (Horuwwa). The sample farm household heads were drawn through a simple random sampling technique.

The reasons for the drawn of this major watershed were based on their watershed management potential, household livelihoods and accessibility, i.e. including years (age) since the integrated watershed management involvement started access to markets, elevation, population, average rainfall, agroecology, landscape and success rate of the watershed. Success rate has been assessed based on evidence related to rehabilitated natural resources of the area; availability of food, fodder and fuel, agroforestry practices, income-generating interventions (such as beehives); increased groundwater potential and stream recharge; improved vegetative cover; and reduced soil erosion and flooding.

Sample size determination

The total numbers of households in the study watershed were 2,242. Of which 102 male-headed and 15 female-headed a total of 117 sample households were selected randomly from the study watershed.

These sample households were determined using (Yemane, 1967) formula:

$$n = \frac{N}{1 + N(e)^2} = \frac{2242}{1 + 2242\,(0.09)^2} = \frac{2242}{19.16} = 117$$

Where, n is the sample size

N is the population size

e is the level of precision (9%).

Methods of data analysis

The data of the study were analyzed by both quantitatively and qualitatively. The quantitative data were analyzed using various statistical tests based on the level of measurement of the variables involved. Stata 13.0 and Microsoft excel 2016 was used to analyze inferential and descriptive statistical data. Using descriptive statistics, we compare and contrast different categories of sample units with respect to the desired characteristics.

To evaluate household annual income, all sources of income such as crop and livestock sales, agroforestry practices and value of crops and livestock products retained for household consumption using annual average local prices were considered. The off-farm income was also computed as part of gross household income. The income data were collected from January, 2023 to March, 2023. Test for equality of income among households who were used different types of income generating activities such as improved breeds of livestock including modern beehives, cash for work program and irrigation in household gross income was computed using one way ANOVA. Least Significance Difference (LSD) was used to compare the household annual income (Morgan *et al.,* 2004). Mean comparisons of each source of household annual income and gross annual income from the major watershed were tested using Independent Sample T test and calculating the net benefits of the households.

Empirical model

Determinants of total income at household level

In this analysis, the dependent variable is the household annual income and independent variables are the socioeconomic factors expected to affect household annual income are: sex of household head, age of household head, labor equivalent of the household, size of cultivated area, irrigation access, size of livestock in terms of Total Livestock Unit (TLU), off-farm income and education of household head. To identify the factors that influence household annual income, multiple linear regression models will be used. Multicolleaniarity would be examined using Variance inflation factor (VIF). Finally, a total of 8 explanatory variables were entered in to the linear regression analysis.

The analysis indicates which determinants are more important for the improvement of total household income. Normality of the income variable was tested using histogram of the residuals. Mathematically, the final model is expressed as:

$$Y = \beta o + \beta_1 (Sex) + \beta_2 (Age) + \beta_3 (Education) + \beta_4 (farm\ size) + \beta_5 (Labor) + \beta_6 (Off\text{-}farm) + \beta_7 (Irrigation) + \beta_8 (TLU) + \varepsilon \quad \ldots\ldots (1)$$

The residual term $\boldsymbol{\varepsilon}$ is assumed to be normally distributed with expectation 0 and variance δ^2. The unknown parameters β_1, β_2..., β_8 are called the regression coefficients and β_0 is constant.

The explanatory variables are expressed as:

Access to irrigation

Irrigation supplements moisture, which enables farmers to maximize agricultural production. It is assumed to have a direct relation with the total income of a household. Access to irrigation for household is a dummy variable, 0 if a household has access to irrigation and 1 otherwise.

Farm size

Total cultivated land is the total sum of the household's own and/or rented in/out from/to other households and measured in hectares. This did not include the grazing and fallowing lands. Farm land is the major input for agricultural production in rural households.

Education level of a household head: In the study area, the head of the household is responsible for the co-ordination of the household activities. It is likely that educated farmers would more readily adopt IWSM technologies and may be easier to train through extension support. The variable entered in the model as dummy variable with zero if a household head can read and write, and otherwise one.

The number of livestock owned

This is a continuous variable measured in terms of TLU. Households with higher livestock holding would lead to higher probability of getting excess livestock for selling and hence generating additional income, particularly the owner of improved varieties of livestock including modern beekeeping could earn higher income.

Gender of the household head

This is a dummy variable with 0 for male and 1 otherwise. Male household heads are expected to have higher income compared to female household heads because of better labor inputs used in male-headed households.

Age of a household head

Age is a continuous variable and measured in years. It influences whether the household benefits from the experience of an older person, or has to base its decisions on the risk-taking attitude of a younger farmer. Advanced aged household heads are more reluctant to accept new IWSM technology and agricultural production styles than younger household heads. Thus, age of household head is hypothesized to have negative contribution to household income.

Labor equivalent

This is a continuous variable measured in terms of adult labour force. It is expected that households with more labour equivalent could have more income.

Off-farm income

This is a continuous variable measured in ETB. It is expected that households with more off-farm/non-farm income could earn more gross income because they might introduce improved technologies.

Results and discussion

Socioeconomic Characteristics of Sample Respondents.

Table 1. *Sample size of the study watershed (Horuwwa).*

No	Name of the sub-watershed	Total No. of HHs	Sample size
1	Abecho (Saleta)	768	34
2	Lendancho (Wondo)	552	30
3	Anane (Honena)	520	29
4	Chobora (Setera)	402	24
	Total	2,242	117

(Source: Own computation, 2023).

Status of the sample household head

Based on the survey result of (Table 2) there are more male-headed sample households (83.8%) than female-headed households (16.2%). The analysis of chi-square indicates that 78.1 and 21.9% of male-headed and female-headed sample households were participants of integrated watershed management practices respectively.

Table 2. Status of household heads.

Variables		Participant (98)		Non-participant(19)		Chi-square value (χ^2)
		Respondents	Percent	Respondents	Percent	
Gender of the HH head	Male	92	93.9	16	84.2	4.082*
	Female	6	6.12	3	15.8	

(Source: Survey result, 2023).

The chi-square result (χ^2 = 4.082) of this variable is statistically significant at the 95% level of significance. This means there is a significant association between gender of a household head and his/her decision to participate in watershed management programs. Particularly, women are the most affected by environmental hardships; for instance, they need to walk long hours to fetch increasingly scarce water, firewood, and animal dung in addition to attending livestock. Their participation in watershed development planning, implementation, and management is crucial to ensure that they equally benefit from the various measures (MoARD, 2005).

Age Status of the sample household heads

The following (Figure 2) indicates that about 15.38% farmers were ages between 25-35, also 55.56% sample respondents were between 36-45, and the remained 27.35 were aged above >45 years old.

Table 3. Education status of the household heads.

Variables		Participant (98)		Non-participant(19)		Chi-square value (χ^2)
		Respondents	Percent	Respondents	Percent	
Educational Status of the HH head	Literate	72	73.5	12	63.2	
	Illiterate	26	26.5	7	36.8	1.302*

(Source: Survey result, 2023).

Educational status of the household heads

The educational status of the sample households revealed that 73.5% of the sample households are literate. Among literate households, 72 and 63.2% were found to be participants and non-participants of integrated watershed management practices respectively. The chi-square result (χ^2 = 1.302) of this variable is statistically insignificant at the 95% level of significance. Hence, there is no correlation between the educational status of the household heads and their participation in watershed management programs. This may be because of the bottom-up approach of the practices which enables farmers' to discuss thoroughly the importance and economic benefits of the integrated watershed management practices.

Table 4. Access to credit service.

Variables		Participant (98)		Non-participant(19)		Chi-square value (χ^2)
		Respondents	Percent	Respondents	Percent	
Access to credit services	Yes	26	26.5	7	36.8	
	No	72	73.5	12	63.2	0.231*

(Source: Survey result, 2023).

Access to credit services

The analysis of access to credit services received by farmers showed that 26.5% and 73.5% of the farmers have and do not have access to credit services respectively. The chi-square result (χ^2 = 0.231) of access to credit services is statistically insignificant at the 95% level of significance. Therefore, there is no relation between access to credit services and farmers' decision to participate in watershed management programs.

This could be because of farmers' fear about their inability to pay back the credit within the prescribed period of time, which could lead to punishment.

Table 5. Access to off-farm income.

Variables		Participant (98)		Non-participant(19)		Chi-square value (χ^2)
		Number	Percent	Number	Percent	
Access to off-farmincome	Yes	28	28.6	7	36.8	
	No	70	71.4	12	63.2	0.072*

(Source: Survey result, 2023).

Land holding size of the respondents

The statistical analysis of this study revealed that the sample households have 1ha (8.547%), 2ha (32.48%), 3ha (37.61%), 4ha (19.99%) and 5ha (1.709%). The chi-square result (χ^2 = 4.572) of this variable is statistically significant at the 95% level of significance. Therefore, there is a significant association between land tenure security and farmers' decision to participate in watershed management programs. This means if farmers feel a sense of tenure security, their interest to participate in watershed management program increases.

The significant impact of cultivated land holding to the household total income implies households with large land size can produce more and increase their total income. Thus, land holding size is an important input in rural poor households to increase their annual income. Because agriculture is the main source of income and livelihood for more than 85% of the country's population (World Bank, 2008), land access is a critical issue in Ethiopia. Which is in harmony to study results of Aikaeli (2010) in Tanzania and Getaneh (2011) at Lake Tana basin of Ethiopia that land size had a positive and significant effect on household total income.

Table 6. Analysis result of stakeholder support.

Variables		Participant (98)		Non-participant(19)		Chi-square value (χ^2)
		Respondents	Percent	Respondents	Percent	
Stakeholder support	Yes	30	30.6	8	42.1	.013*
	No	68	69.4	11	57.9	

(Source: Survey result, 2023).

Access to off-farm income

Farmers' involvement in off-farm income generating activities is expected to help them to support their income. About 28.6% participants and 36.8% non-participants were participated respectively and significant at 95% of the chi-square result (χ^2 = 0.072). Thus, in this study, it is hypothesized that off-farm income is positively correlated with the farmers' income to participate in integrated watershed management practices.

Table 7. Analysis result of major crops yield.

"Teff" production	Respondents	Percent	Cumulative	Kg/ha
Most common	5	4.27	4.27	2,500
Very common	70	59.83	64.10	490
Common	42	35.90	100.00	370
Total	117	100.00		3,360
Wheat production	Respondents	Percent	Cumulative	Kg/ha
Most common	41	35.04	35.04	2,700
Very common	59	50.43	85.47	1,400
Common	17	14.53	100.00	1,200
Total	117	100.00		5,300
Maize production	Respondents	Percent	Cumulative	Kg/ha
Most common	8	6.84	6.84	1,700
Very common	36	30.77	37.61	900
Common	73	62.39	100.00	800
Total	117	100.00		3,400

(Source: Survey result, 2023).

Stakeholder support

Getting stakeholders involved and utilizing their input in a watershed management program is a key point. Therefore, 30.6% of the sample households stated that stakeholders provide the necessary support for watershed management programs. However, the remaining 69.4% of them stated that stakeholders do not provide the necessary support. The chi-square result (χ^2 = 0.013) of this variable is statistically insignificant at the 95% level of significance. Therefore, there is no correlation between stakeholders support and farmers' decision to participate in integrated watershed management practices. This is in agreement with idea stated that for successful implementation of solutions to the physical and economic problems of a watershed, a broad, representative array of stakeholders should be involved (Said *et al.*, 2006).

Table 8. Agricultural activities of the local farmers.

Farmer's activities	Respondents (Number)	Percent (%)	Cumulative
Use of commercial fertilizers			
Urea	39	33.33	33.33
DAP	78	66.67	100.00
Total	117	100.00	
Amount of Urea/DAP	Respondents (Number)	Percent (%)	Cumulative
<50kg/ha	2	1.17	1.71
50-100kg/ha	46	39.32	41.03
>100kg/ha	69	58.97	100.00
Total	117	100.00	
Using other farm input	Respondents (Number)	Percent (%)	Cumulative
Improved seed	84	71.79	71.79
Pesticides and herbicides	21	17.95	89.74
Compost	9	7.69	97.44
Farm management	3	2.56	100.00
Total	117	100.00	
Causes of yield decline	Respondents (Number)	Percent (%)	Cumulative
Yes	28	23.93	23.93
No	89	76.07	100.00
Total	117	100.00	
Reasons to yield declining	Respondents (Number)	Percent (%)	Cumulative
Fertility decline	21	17.95	17.95
Lack of sufficient inputs	87	74.36	92.31
Farm management	9	7.69	100.00
Total	117	100.00	
Reason to income decline	Respondents (Number)	Percent (%)	Cumulative
Soil Degradation	61	52.14	52.14
Land Fragmentation	26	22.22	74.36
Climate Change	30	25.64	100.00
Total	117	100.00	

(Source: Survey result, 2023).

Analysis of major crop grain yields

The significant difference in "teff", maize and wheat grain yields among before the watershed practices and after the watershed practices reflects the difference in soil fertility status among the sub watersheds. This indicates that IWSM has great contribution in increasing the yield of "teff", maize and wheat grains. Even though maize grain yield was higher in the treated sub-watershed than the untreated one, no significant difference was observed. This might be due to the fact that farmers have used animal manure mostly for their plots found near their home, and most of maize crops were sown near homesteads. This study finding is in agreement with the study findings of Wani *et al.,* (2003) studied that the maximum and minimum "teff" grain yield in Horuwwa IWSM were 2500 kg/ha and 370 kg/ha, respectively; and the maximum and minimum wheat grain yields were 2700 kg/ha and 1200 kg/ha, respectively.

Table 9. Analysis of livestock production.

Livestock production	Respondents	Percent	Cumulative
Most common	17	14.53	14.53
Very common	37	31.62	46.15
Common	63	53.85	100.00
Total	117	100.00	

(Source: Survey result, 2023)

From the above (Table 7) we concluded that the crop grain "teff" about 70(59.83%) was very common; thus wheat crop about 41(35.04%) is the most common and also the maize is about 73(62.39%) is more common in the study area. The high increased "teff", wheat and maize grain yields after the practice of IWSM might be related not only to soil and water conservation measures of IWSM, but also to application of chemical fertilizer, animal manure and compost. As the farmers mentioned, even though they have used similar amount of chemical fertilizer in the treated and untreated sub-watersheds, they were unable to get similar results in the two sub-watersheds. This might be due to the reason that chemical fertilizers could be washed away by run-off before major watershed. If there is no enough moisture in the soil, reduction in nitrogen fertilizer by 38% in Veitnam, increased maize yield by 18% (Wani *et al.*, 2010) which is similar to the findings above and to Belaineh and Lars (2005), growing of irrigation access forced the farmers to practice different fruits and vegetables. This enables them to diversify their production cropping patterns. Intercropping of wheat with vegetables was common in the irrigation area. The increase in irrigation access could be attributed to the increase of water availability and construction of small water harvesting structures by IWSM practices. The variation in perception among the respondents concerning the increment of major crops grain yields after IWSM in the study area could be explained through the difference in exposure, position of their agricultural land, understanding of their environment or in realizing the impact of the on-going IWSM measures in their surroundings.

Table 10. Multiple linear regression estimates of the determinants for household income.

Variables	Coefficients	Stand. error	t-value	p-value
Constant	4096.234	1762.802	2.231	0.012
Sex of hh head	-2354.120	1455.300	-1.301	0.105
Cultivated area	4034.632	1125.224	2.153	0.020
TLU	786.139	206.327	2.573	0.005
Off-farm	0.647	0.214	2.302	0.007
Labour equivalent	590.161	437.263	1.431	0.142
Age of Hh head	-52.231	51.123	-1.032	0.256
Access to irrigation	-3010.420	1020.617	-2.504	0.007
Household heads education	-761.364	1272.056	-0.631	0.417

(Source: Survey result, 2023).

Agricultural activities of the local farmers

IWSM practice can contribute to climate change adaptation and resilience building of agriculture-dependent households when weather information is available so that households can make informed decisions related to their livelihoods and especially agriculture. Accordingly, about 66.67% of households use commercial fertilizers, 58.97% uses more than 100kg/ha, 71.79% uses improved seed, yield declining about 74.36% lack of sufficient inputs and income decline 52.14% soil degradation respectively in total (Table 8).

Table 11. Results of regression analysis.

Variables	B	S.E.	Wald	df	Sig.	Exp (B)	95% C.I. for EXP(B)	
							Lower stream	Upper stream
Gender	– 2.532	1.097	5.541	1	1 .016*	0.075	0.009	0.634
Off-farm income	1.157	0.640	3.162	1	.054	3.165	0.872	11.364
Farm size	1.737	0.768	5.020	1	.025*	5.607	1.247	25.983
Livestock holding	0.273	0.135	3.47	1	0.064	1.307	0.967	1.712
Labour	– 572	0.286	3.855	1	0.048*	0.549	0.312	.986
Access to credit sv	−0.867	0.582	2.182	1	0.137	0.415	0.130	1.327
Extension service	−0.620	0.163	13.265	1	0.000**	0.523	0.370	0.746
Slope	– 1.572	0.475	10.610	1	0.001**	0.206	0.071	0.520
Constant	5.428	3.045	3.504	1	.067	287.804		

*P < 0.05, **P < 0.01 (Source: Survey and analysis result of this study)

(Source: Survey result).

Livestock production

The farmers have started to use the *sesbania sesban* for their livestock as a supplementary feeding. The positive contribution of IWSM in increasing of milk yield from local and cross breed dairy cows and honey production from local and modern beehives could be attributed to the improvement of forage availability by planting different exotic and local forage see11dlings and closing of the area from animal and human interventions. IWSM has also improved the availability of local forage grasses in the communal closed areas. This result is similar to the findings which states improved nutrition through adoption of improved forage and better crop residue management could substantially raise livestock productivity (Girma and Misra, 2007). Water availability for livestock drinking was also increased after the practices of IWSM measures as perceived by individuals.

About 53.85% livestock production were common in the study area. According to the respondents and direct observation, major grazing areas available were small grazing areas near homesteads and crop aftermath (stubble and weeds) together with farm boundaries. The flat land was totally devoted to crop production. Introduction of modern beehives through formation of user groups and individuals has started in the treated hillside. Beekeeping is strategically relevant as it complements natural resource management activities and provides a means to address landless and poor households, who might not have access to other income earning activities.

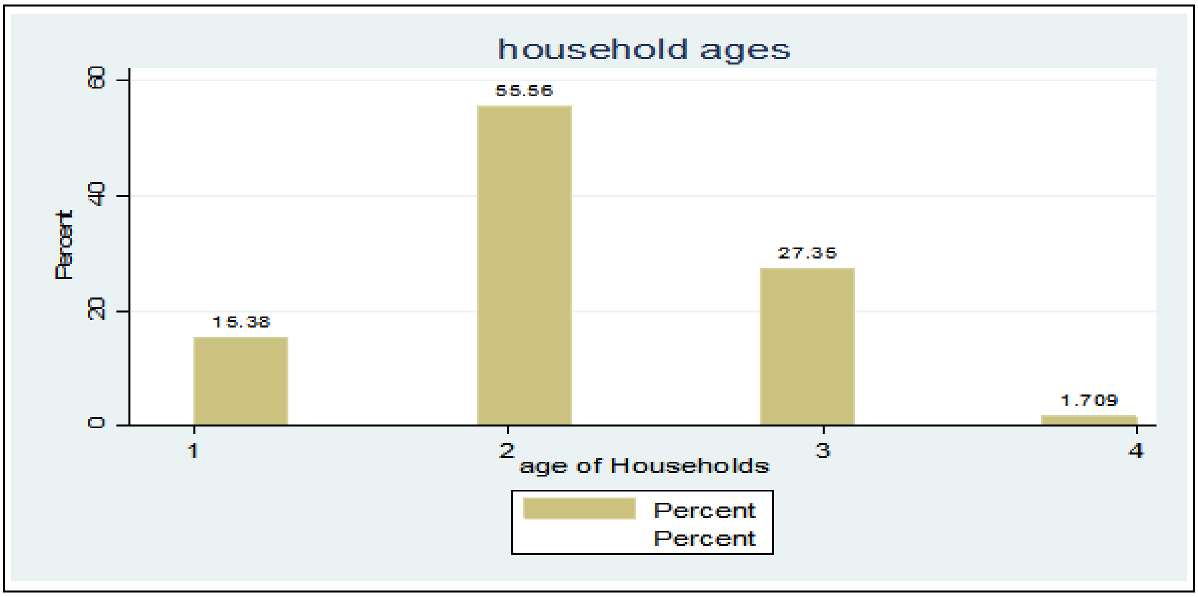

Fig. 2. Age status of the household heads.

This study result is similar with the finding stated, it has been effective in establishing start-up with new hives for individuals and cooperatives and efficient in that significant income is being produced with small investments (Hebert, 2010) and the same to Meaza (2010) reported that modern beekeeping have created improved livelihood in terms of better income so as enhancing capability to buy household demands; productive investment like buying animals, saving and expenditure in different needs of the households. Gebregziabher and Gebrehiwot (2011) revealed that the difference in farmers' income about the contribution of IWSM to livestock productivity could be related to livestock management system, livestock number before and after IWSM, different in adoption of the technologies and geographical positions among the households of the watershed. Some of the respondents had grazing land access outside the watershed and had owned more livestock after IWSM. As it was pointed out in the group discussion, poor farmers were able to buy livestock after IWSM and started to share grasses from the communal area. Therefore, those who keep a high number of livestock and those who used to take the share of the poor were the ones resisting expansion of zero grazing and said that their milk yield was decreased after IWSM.

Determinants of total income at household level

About 86(73.5%) sample households uses agricultural output for the purchase of medicine 79(67.52%), equipment 83(70.94%), clothes 84(71.79%), animal sale 78(66.67%), house improvement 83(70.94%), school expense 86(73.5%) and farm rent 45(38.46%) respectively.

The coefficient of irrigation access was negatively and significantly associated with the household total income as expected. From the sampled households 73.8% of them revealed that in addition to increasing of annual income, there was an increase in the variety of foods in their diet due to the introduction of fruits and vegetables in the irrigation site. Land size was positively and significantly associated with household total income as expected. The magnitude of its coefficient was higher than the magnitude of the other coefficients. Livestock holding in TLU was positively and significantly associated with household total income. Off-farm/non-farm income influenced the household total income significantly with a positive sign. It is tre to sa this is similar with the study that states small scale irrigation had an important impact on food security for populations directly involved in production of irrigated crops, also producing a greater variety of food, some of which was used for local consumption, but most of which was sold to produce income (Hebert, 2010). Getaneh (2011) and Wagnew (2004) also reported that households with irrigation access had more and significant total household annual income than non-users.

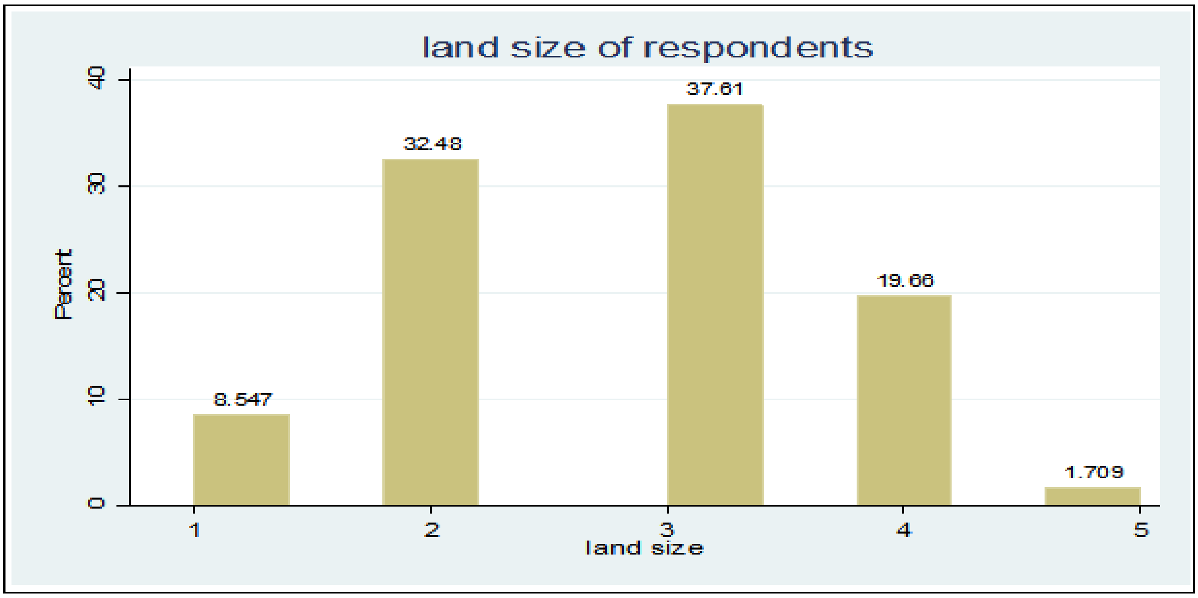

Fig. 3. Land holding size of the respondents.

Contribution of IWSM practices in terms of improved breeds of livestock, increasing forage availability and introduction of modern beehives. From the farmers' point of view, beekeeping enabled them to purchase additional livestock feed and livestock number like oxen and dairy cows. Livestock production contributes to total household income directly through the sale of livestock and their products and indirectly through use as a source of draught power and manure for crop production activities.

The findings of Pandit *et al.*, (2007) study revealed that the positive and significant associations of TLU with total household annual income indicates that large total livestock number have high contribution to household annual income is in harmony with this study. Even if the result of this study shows that TLU has a positive impact on household annual income, increasing the number of livestock may increase the cost of production and might have negative impacts to the watershed. The highest relative advantage in household annual income contribution was recorded from the utilization of both irrigation and improved livestock practices in integrated way. The implication of this is that introducing of integrated watershed management practice is better to improve household annual income rather than introducing only one type of technology.

Analyses of factors affecting farmers' involvement in integrated watershed management practices

Gender of the household head

Gender equality makes good sense. One study calculated that agricultural productivity in Sub-Saharan Africa could rise by 20% if women had equal access to land, seed, and fertilizer (FAO, 2009). The statistical analysis of this study showed that 83% of the sample households are male-headed and 17% are female-headed. Unlike to our expectation, the binary logistic regression analysis of this variable was found to be statistically negative and significant at the 5% level of confidence.

Labor force

The statistical analysis of the study showed that the mean agricultural labor force of the sample households is 2.3 persons ranging from 2 to 5 with a standard deviation of 0.95. Contrary to our expectations, the result of the regression analysis revealed that the agricultural labor force is found to be statistically negative and significant at the 5% level of confidence. This means as the number of the agricultural labor force of a household increases, the farmer's decision to participate in watershed management programs decreases. This could be because of the farmer's negative attitude towards the program and/or lack of information about the long-term benefits of the practice.

Extension services

Agricultural extension services in the study site are carried out at the kebele's level using extension officers. There are three extension officers, also known as development agents (DAs) in each kebele specializing in plant sciences or crop protection, natural resources management, and livestock production. In this study, agricultural extension services are intended to educate farmers and assist in resolving their agriculture-related problems, thereby motivating them to decide to participate in watershed management programs hence increased production. Contrary to our expectations, the regression analysis of this variable revealed that frequency of agricultural extension service is found to be statistically negative and significant at the 1% level of confidence. This means as the frequency of agricultural extension services received by a farmer increases, his/her decision to practice in integrated watershed management decreases.

This could be explained by the fact that the quality of services received may be affected by the inadequate number of agricultural extension workers and inadequacy of working facilities such as lack of transport service which is in line with the study done in Ethiopia (Amsalu, 2015).

Farm size

Land is an important means of agricultural production in rural areas. It plays a central role in producing crops and rearing livestock. In this study, having large farm size is associated with producing and supplying more farm produce for the market. The survey result showed that 81.6% of the sample households have less than 2 ha of farmlands. Only 18.4% households have farmlands ranging from 2 to 3 ha. Corresponding to our expectations, the result of the regression analysis revealed that farm size is found to be statistically positive and significant at the 5% level of confidence. This suggests that as the farm size of a household head increases, his/her decision to participate in watershed management program increases. This could be explained by the fact that farmers having large farm size are more optimistic in getting better production than their counterparts (Arun, *et al.*, 2012).

The slope of a farmland

Slope of a farmland affects the rate and amount of soil loss from fields. This forces farmers to control or mitigate the impact of erosion on fields that are situated on steep slopes and hence slope influences the decision of farmers to participate in watershed management programs. Contrary to our expectation, the regression analysis result of this variable is found to be statistically negative and significant at the 1% level of confidence. This may be due to farmers' lack of knowledge about the effects of slope for soil nutrient losses from their farmlands.

A study conducted by Miheretu and Yimer (2017) in the Northern highlands of Ethiopia also indicated that the slope of the plot does not significantly influence the adoption of chemical fertilizers. But Wossen *et al*., (2015) reported that the slope of the plot affects the adoption decision of farmers on land management practices positively and significantly.

Credit access

Availability of credit facilitates IWSM practice and increase investment in social services. It is more essential to introduce farm technologies including fertilizer and the like. According to the findings of academicians (Ametemariam, 2009) credit programmes enable farmers to purchase inputs or acquire physical capital needed for technology adoption. Consistent with this result most of the interviewed households have confirmed that credit access facilitated to obtain farm inputs like fertilizer, improved seeds, oxen and farm implements.

Livestock holding

Farmers raise and sell animals as source of additional income**.** The number of people who had earned income from sale of livestock had increased from 57 to 67% after the practice of IWSM intervention. Livestock production constitutes a very important component of the agricultural economy of developing countries, a contribution that goes beyond direct food production to include multipurpose uses, such as skins, fiber, fertilizer, and fuel, as well as capital accumulation. Furthermore, livestock is closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability.

Off-farm activity

The further argue that "rural non-farm employment is understood by employment of rural household members in the non-farm sector and rural non-farm income is the income thereby generated. Farmers' involvement in off-farm income-generating activities is expected to help them to support their income. Thus, off-farm income is positively correlated with the farmers' decision to participate in integrated watershed management practices.

Conclusion

Integrated watershed management (IWSM) practice has a positive and significant impact on major crops grain yield with the increasing of soil fertility. It has high contribution to livestock productivity in terms of milk, egg and honey yields. Even though there was a difference in farmers' household income about the economic effects of IWSM on their livestock products, most of the farmers explained that honey and milk yields have been increased after the practice of IWSM due to the increment of forage and water availability and introduction of improved breeds of livestock. Furthermore, downstream households have significantly higher mean annual income than upstream households of the watershed because they were irrigation users. Multiple linear regression model analysis also shows that having more livestock, irrigation access, off-farm income and large size of cultivated land have significant contribution in household annual income. Therefore, integrated watershed management is not only effective in increasing crop and livestock production but it has also high contribution in household annual income.

It was also identified that the majority of soil and water conservation practices in the watersheds resulted in a significant positive impact on water availability and land productivity. The achievements made in reducing natural resources degradation problems, increasing income generation opportunities and contributing to the betterment of livelihoods of people have increased the IWSM practices to be embedded within various government organizations and NGOs working in the study areas.

The Integrated Watershed management has contributed to the analysis of innovative technologies, necessary inputs, materials, capacity building efforts, regular monitoring or evaluation, field supervision and technical back up with the objectives of intensification of productivity, income generation and improvement of livelihoods by the knowledge and efforts of local communities need to be encouraged and recognized with adequate technical support.

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