Global Academic Journal of Agriculture and Bio sciences

Available online at https://www.gajrc.com
DOI: 10.36348/gajab.2023.v05i04.004

OPEN ACCESS

ISSN:2706-8978 (P)
ISSN: 2707-2568 (O)

Original Research Article

Description and Evaluation of the Present Resource Use, Management Practices, and Socio-Economic Conditions in the Medo Watershed, Central Rift Valley Area of Ethiopia

Kedir Jemal[1*], Muleta Gadisa[2], Guta Bukaro[3]
[1]Wondo Genet Agricultural Research Center, Ethiopian Institute of Agricultural Research, Ethiopia

***Corresponding Author**
Kedir Jemal
Wondo Genet Agricultural Research Center, Ethiopian Institute of Agricultural Research, Ethiopia

Article History
Received: 05.07.2023
Accepted: 07.08.2023
Published: 29.09.2023

Abstract: Characterizing the socio-economic systems in integrated watersheds is to identify and prioritize production constraints for designing appropriate R&D interventions. The random sampling method was used to select 81 households, and both qualitative and quantitative data were collected. Formal and informal surveys were conducted to gather information about the socioeconomic and institutional issues. Descriptive statistics and diversity indices were used for data analysis. According to the results of the study, agriculture is the largest source of income in the study areas, followed by off-farm activities such as daily labor, handcraft and pension. The dominant crops grown in the watershed are maize, teff, and haricot bean, respectively. Livestock rearing is also the major means of livelihood in the study area. About 37%, 19% and 17% of the farmers owned cows, sheep and goat, respectively, in the Edo watershed. The watershed is characterized by a dynamic farming system. For instance, about 63% and 32% in the introduction of new varieties and declining in soil fertility changes over the last decade were recorded, respectively. About 58% of the households indicated that there has been a decreasing and irregularity in rainfall, while 20% of the households reacted that there is the emergence of animal and plant diseases, increasing temperature, and decrease in river flow and springs over the last 10 years in the watershed. The baseline study also identified that water erosion, deforestation, and over-tillage are the major causes of the degradation of natural resources in the watershed. In general, this study concludes that land degradation and biodiversity loss are serious concerns in the watershed. Awareness creation and strengthening capacity of rural communities on integrating crops, livestock, and natural resource management technologies for effective soil and water conservation measures should be enhanced for sustainable livelihood improvement.

Keywords: ArcGIS, Socioeconomic characteristics, Mapping, Medo Watershed.

INTRODUCTION

In developing countries where the economy largely relies upon rain-fed agriculture, sufficient water and fertile land are the main requirements for their progress (Bagherian, 2009). Nevertheless, these countries are characterized by low agricultural productivity, severe natural resource degradation, and high levels of poverty (Kerr, 2002). The increasing vulnerability of agriculture in developing countries is attributed to the inadequate expansion of irrigation and rainfall variability. Soil erosion, overgrazing, deforestation, and land degradation are also among the factors affecting the vulnerability of agriculture in developing countries (Khajuria et al., 2014). Natural resource degradation is a serious problem in Ethiopia, threatening agricultural development and rural livelihoods. The major natural resource degradation problems of the country include severe soil erosion, declining soil fertility, soil acidity and salinity, and deforestation, all of which result in recurrent drought and hence, a decline in agricultural productivity. Watershed management is seen as a way to mitigate soil erosion, overgrazing, deforestation, and land degradation problems because it can conserve and regenerate natural resources such as soil, vegetation, and water and can raise rain-fed agricultural production and productivity (Nasrabadi et al., 2013). It is also a means that leads to livelihood generation and raises income for the poor and landless through employment opportunities and reduces poverty since the whole ecosystem and people are involved in the process (Agidew & Singh, 2018; Hanumantha Rao, 2000; Kerr, 2002; Singh, 2018).

Watershed development involves developing the entire community and natural resources mainly through restoring and managing soil fertility, water quantity and quality, and vegetation cover. (Singh, 2018) further argues that soil and water conservation interventions reduce soil erosion and increase of surface and underground water. Watershed development contributes to the productivity and production of crops, land use, and cropping pattern, an attitude of the community and their participation, and socioeconomic conditions such as income, employment, and assets (Khajuria et al. (2014). Thus, watershed development is crucial to the sustainable production of food, fodder, water, and fuel wood and meaningfully addresses the social, economic, and cultural status of the rural community within the watershed (Hanumantha Rao, 2000; Khajuria et al., 2014; Nasrabadi et al., 2013). In the early 2000s, community-based integrated watershed development was introduced to promote watershed management as a means to achieve broader integrated natural resource management and livelihood improvement objectives within prevailing agroecological and socioeconomic environments (Gebregziabher et al., 2016). At the earlier watersheds, management had a narrow focus primarily for controlling erosion, floods and maintaining sustainability of useable water yield. Recently, watershed management is not only for managing or conserving natural resources but also for local people for betterment of their lives. Its management is more people-oriented and the process-based than only physical target-oriented (Gebregziabher et al., 2016).

Some impact studies have shown that investments in watershed management in the developing world pay off in economic terms. However, such impact studies do not typically include detailed socioeconomic components (Datta et al., 1998). Before that, a detailed biophysical and Socioeconomic characteristic of the watershed must be known for accurate problem-solving. Several challenges that threaten the efficiencies of watersheds for local community livelihood improvement exist in the area. These include the lack of technical provision and information to support the selection of interventions suitable for the local context and uncoordinated interventions, institutions, and actors within a watershed. Similarly, watershed management in most watersheds including the Medo more technical interventions to restore degraded lands and improve livelihood benefits. Before that, the socioeconomic characteristics of the watershed must be known in detail for accurate problem-solving. The essence of characterizing socioeconomic systems in the Edo integrated watersheds is to identify existing and potential production constraints and propose potential areas for targeting for designing appropriate R&D interventions, which is supported by the Climate Action through Landscape Management (CALM) Project. This requires huge information from several sources such as published, unpublished, and micro-level investigations. Baseline characterization helps understand the initial livelihood conditions of the people in the watershed before intervention. It builds the necessary foundation for the plan and obtains proper information for effective planning, implementation, and monitoring (Bonsa et al, 2020). Therefore, the study was conducted to characterize, identify, prioritize, analyze, and document baseline information on socioeconomic aspects, which is used as a benchmark for planning and impact monitoring of the Medo Integrated Watershed community.

RESEARCH METHODS

The description of the study area

The Medo Learning watershed is located in the Wendo district of the West Arsi Zone of Oromia Regional State, Ethiopia. It covers an area of 504 hectares and the Edo subwatershed is one of the main streams draining into the Rift Valley basins. The area is located around 12 kilometers northeast of Shashemane town and 250 km south of Addis Ababa. Geographically, it is located between 38°35'E - 38°38'E longitude and 7°05'N - 7°06'N latitude. Edo watershed, which belongs to the sub-watershed, is a main tributary to Lake Hawassa catchment at the low-lying areas (38º36′13′′E, 7º5′52′′N) outlet that is partially found in the central rift valley of Ethiopia.

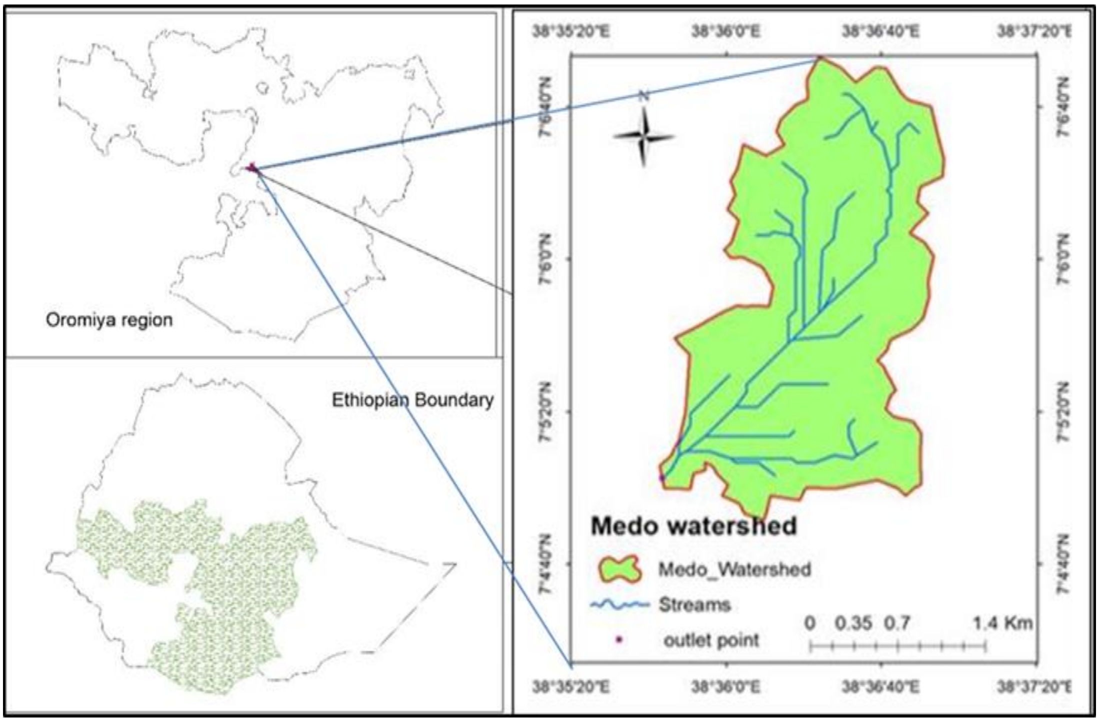

Figure 1: Map of the Edo watershed area

Sample size and sampling technique

According to Ananta (2009), the ideal sample should cover 20-25% of the households in the watershed as representative of socioeconomic aspects. Data were collected from 81 randomly selected households in the identified watershed in which 20% of the population of the watershed was selected. Formal and informal surveys were conducted to gather qualitative information about watershed socioeconomic issues. The informal survey involved the direct observation of the watershed issues, informal discussions with individual and group farmers, and key-informant interviews. A formal survey was conducted using a structured questionnaire to quantify and verify the informal survey findings.

Data Collection and Analysis Method

Both qualitative and quantitative data were collected. Factors expected to influence farmers' land management practices were also examined. PRA tools such as group discussion, trend analysis; problem ranking were employed to generate information. Quantitative data were collected using a structured questionnaire through interviews of households in the intervention site. The collected data were then coded and entered into SPSS software and exported to STATA 15, cleaned and analyzed using descriptive statistics.

RESULTS AND DISCUSSION

Demographic Characteristics of the Respondents

According to the sampled respondents, 85% were males, while the remaining 15% were female households (Table 1).

Table 1: Distribution of respondents by gender in the watershed.

Gender of respondent	N	%
Female	12	14.81
Male	69	85.19
Total	**81**	**100.00**

Source: Baseline survey data, 2021

The respondents were divided into three age groups (i.e. up to 15, 16 to 64, and above 64 years of age). The idea behind these classes is that the middle group (16-64 years) is the most productive age group in farming and the overall average age of the households was 40 years. As age is one of the vital characteristics of society, it plays a significant role in the type of employment pattern, particularly in agriculture, as the use of child labor on farm activities mostly prevails (Bonsa et al., 2020).

Table 2: Household respondents age characteristic in the watershed

Age Category	N	%
Up to 15 & 16 - 64	73	90.12
>64	8	9.88
Total	**81**	**100.00**

Levels of education

Education plays an important role in the overall growth and development of any country. The level of education affects the planning and managerial abilities of farmers in decision-making. In the watershed, only 45.68% and 43.21% of the male and female children in the age of 6-13 years go to school. This result is below half and on the other hand, only about 20% of the children in the age of 12 to 18 years go to secondary school in the watershed (Table 3). The number of educational institutes was increasing, and institutions were being created by the government sector; lack of educational institutions, poor economic conditions, and lack of access to far institutions was observed.

Table 3: Percentage of males and females going to school by age category in the watershed

Education category	N	%
Male children 6-13 years	37	45.68
Female children 6-13 years	35	43.21
Any children in the age of 12 to 18 years	16	19.75

Source: Baseline survey data, 2021

Asset ownership by the community in the watershed

The survey result on asset ownership in the watershed showed that 97.4% of households owned main farm tools such as spades, hoes, axe, machetes, wheel Barrow, and Knapsack sprayer, 77% owned communication tools such as radio, TV, and mobile phone, 71.2% owned energy power such as solar power and energy saving stove, 76.4% owned corrugated roof houses. Few households owned transportation assets such as carts, motorbikes, Bajajs, and irrigation assets such as motorized water pumps (Appendix Table 1). About 59% of households owned an average cell phone, while in addition to calling services, it is also used as a radio. About 28%, 16%, and 15% of households owned a radio, solar power, and Tv, respectively, while on average, households owned one corrugated roof (Table 4).

Table 4: Asset ownership and livelihood system of the community in the watershed

Items	No of samples HH		%	
	owned	Not owned	owned	Not owned
TV	12	69	11.14	85.19
Radio	23	58	28.4	71.6
Cell phone	48	33	59.26	40.74
Sofa	36	45	44.44	55.56
table	65	16	80.25	19.75
Wooden box	30	51	37.04	62.96
Wooden bed	53	28	65.43	34.57
Metal bed	2	79	2.47	97.53

Land ownership of the respondents

Land is a scarce resource, hence its optimal use is essential. Farm size is one of the major determinants of the financial status of farmers, which in turn affects their ability to adopt modern farming practices. Operational land holding plays a vital role in the family laborers' employment and income generation. The main problem in the study area was small and fragmented land holding, which resulted in management difficulties and ultimately less productivity. On average, households has land allocated for annual crop of about 0.54ha. Land allocated for grazing and degraded land were 0.029ha and 0.015ha, respectively. On the other hand, households on average rented 0.103 ha and rented out 0.049 ha of land (Table 5).

Table 5: Land ownership of the households in the Edo watershed land in hectare (n= 81)

Variable	Mean	Min	Max
Cropland	.539	.02	1.75
Irrigable land	.019	0	.5
Cropland in rented	.103	0	1
Rented out land	.049	0	4
Grazing land	.029	0	.25
Degraded land	.015	0	.5

Source: Baseline survey data, 2021

Most of the land tenure system of households in the watershed was found to be state or own, whereas only a few were accessed through gifts from someone. Since the average landholding in the watershed was small, the average rented in and sharecropper cropland holding of households was negligible (Figure 2). This study also indicated that land shortage is a basic problem that results in small-scale production on fragmented and degraded land.

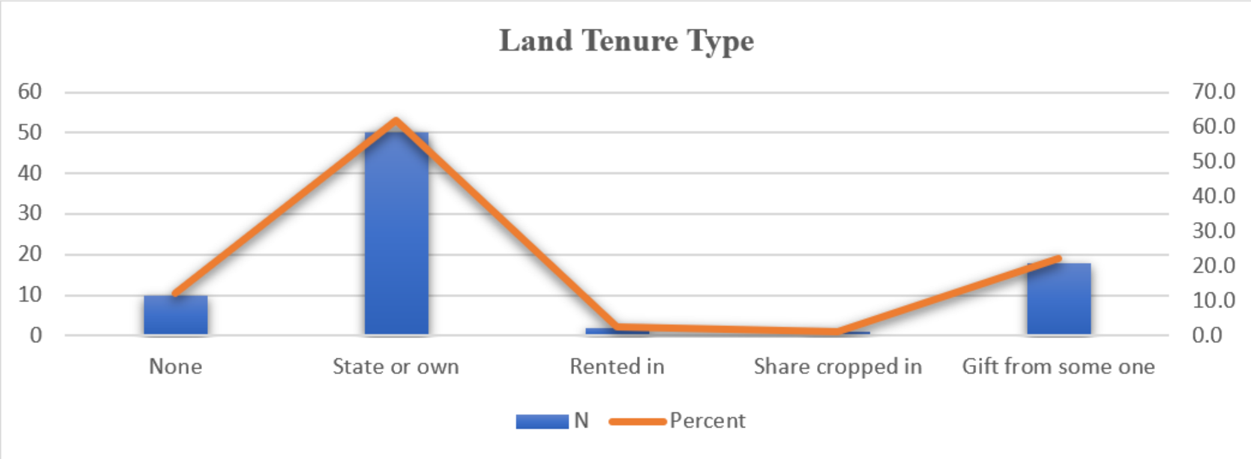

Figure 2: Land tenure type in the Medo Watershed
Source: Baseline survey data, 2021

The source of household income

According to the results of the study, agriculture (68 %) is the largest source of income for farmers in the study areas, followed by off-farm activities such as petty trade, daily labor, remittance, handcraft, and pension. This indicates that most farmers living in the study area depend on agriculture for their livelihood. In addition to this, among the agricultural activities, farmers earn the highest income from livestock sales (9.88 %), which is followed by income from sales of forest and casual labor, respectively (Appendix Table 1) and (figure 3).

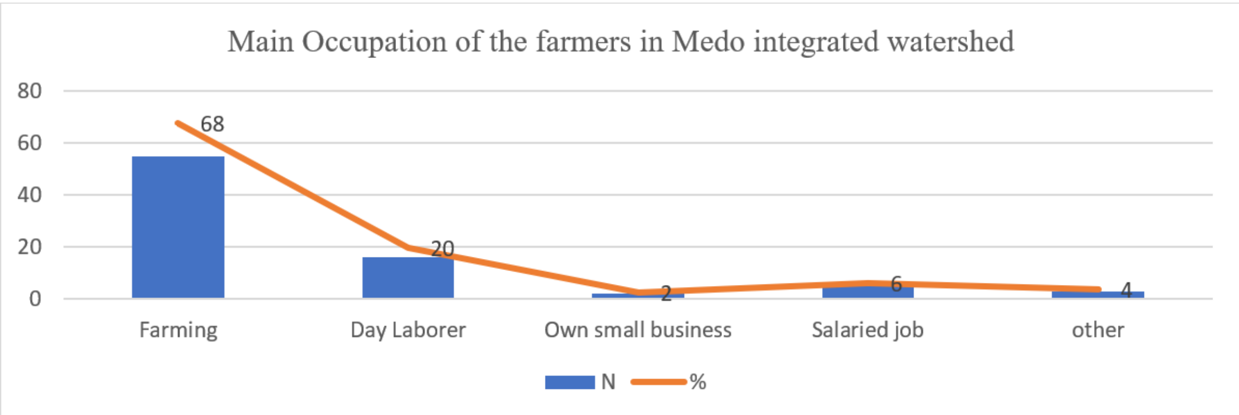

Figure 3: The main occupation of the farmers in Edo integrated watershed
Source: Baseline survey data, 2021

Land Use and Livelihood

The Medo integrated watershed is characterized by a cereal-based farming system and home gardens. Land use of the watershed is described as cultivation land (land covered by annual crop), forestland (natural and plantation), grazing land, and agroforestry (home garden) are the major land uses.

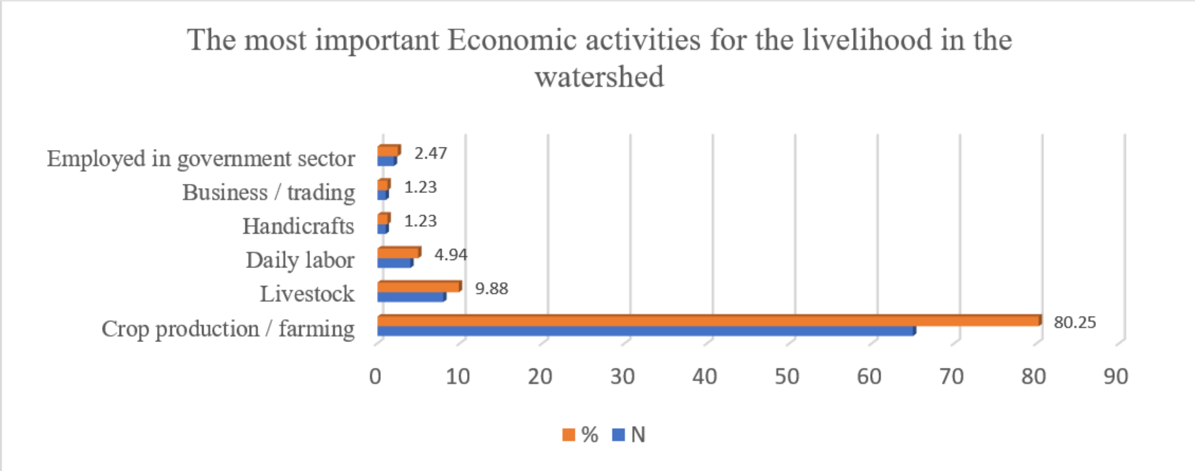

Figure 4: The most important economic activities for livelihood in the watershed
Source: Baseline survey data, 2021

Of the households in the watershed, about 98% have arable land, which can be used for crop production. Among those households, about 78% registered their land and got certified at the woreda level, of which about 66% registered land is in husband and only about 17% is in both husband and wife, but some 22% did not register and so did not get certified (Table 6). On the other hand, the majority of households in the watershed use oxen as a traction for plowing their land (94%), whereas a very small number of households use tractors. Among households using oxen for plowing their land, only 44.4% have their own oxen, proving that most oxen traction users do not have their own oxen (Figure 5). According to the survey results, avocado (33%) and Eucalyptus (79%) are the major trees planted in the watershed. The purpose of planting these trees includes but is not limited to for sale (37%), for fuel (33%), and 12% and 16% for house construction and fodder, respectively.

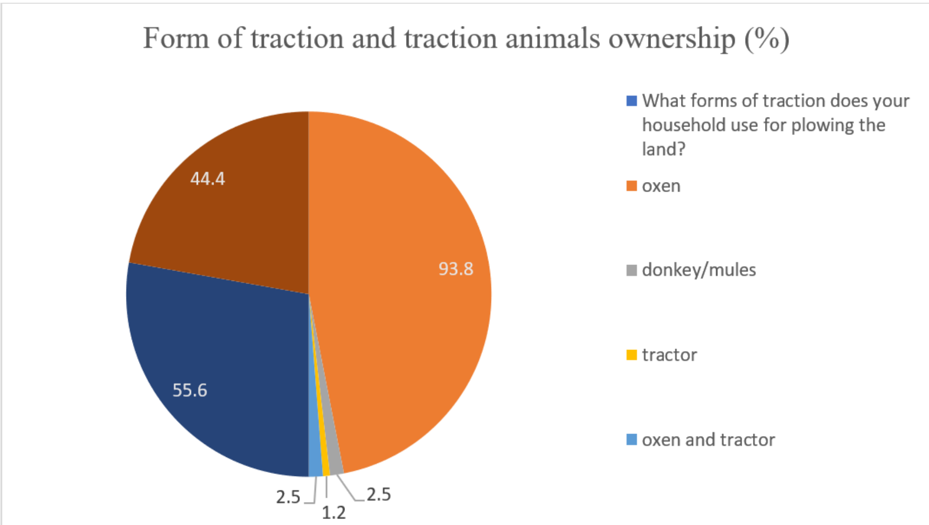

Figure 5: Form of traction and traction animals' ownership
Source: Baseline survey data, 2021

Farmers' perception of farming system dynamism

According to the perception of the households, the watershed is characterized by a dynamic farming system. For instance, the changes over the last decade were the introduction of new varieties and declining soil fertility, which are 63% and 32%, respectively (Figure 6).

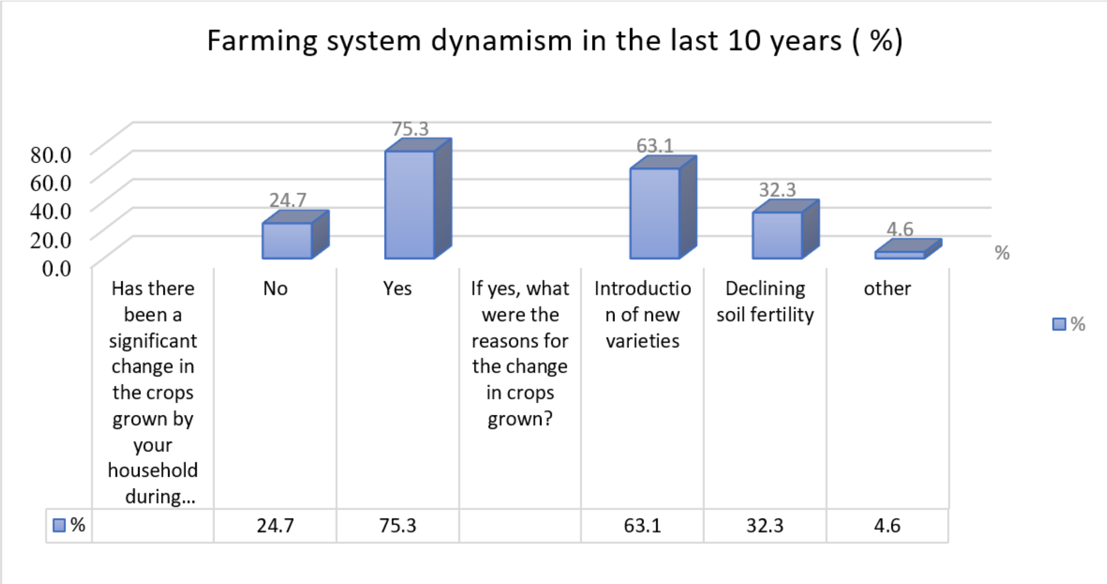

Figure 6: Farming system dynamism in the last decade
Source: Baseline survey data, 2021

Farmers' Food Security Perceptions

According to the perception of the households in the watershed, 61.73% of them faced food shortages with normal rainfall and 76.54% of the households faced food shortages with less than normal rainfall. Similarly, about 47% of households have received food relief in the decade, while 13.58% of them have participated in food-for-work projects.

Major Causes of Degradation of natural resources

The baseline study identified that water erosion, deforestation, and over-tillage are the major causes of the degradation of natural resources in the watershed. The appropriate tillage practices have to create a conducive soil environment for germination, establishment, and plant growth with little soil disturbance. Most of the plots practicing over tillage were overall (26 %), deforestation (37 %), and water erosion (34.5 %) (Table 7).

Table 6: Perception of major causes of natural resource degradation in the area

Degradation of natural resources in the area	**N**	**%**
Inappropriate tillage	2	2.47
Over tillage	21	25.93
Deforestation	30	37.04
Water erosion	28	34.57
The status of soil capability in terms of soil fertility	**N**	**%**
High	2	2.60
Medium	54	70.13
Low	6	7.79
Deteriorating	15	19.48
Total	77	100.00
What steps did you take in soil conservation	**N**	**%**
Building biophysical conservation structures	54	88.52
Improving cover crops	5	8.20
Minimum tillage	2	3.28

Source: Baseline survey data, 2021

Household perceptions of soil type and fertility of their operational holdings

Soil color is an easily observable soil property and gives an immediate indication of soil condition. The survey identified four types of soil colors that are red, black, and stony colors. The majority of the plots in the Medo integrated watershed are black type while red and stony are the other soil colors found in the watershed (Figure 7).

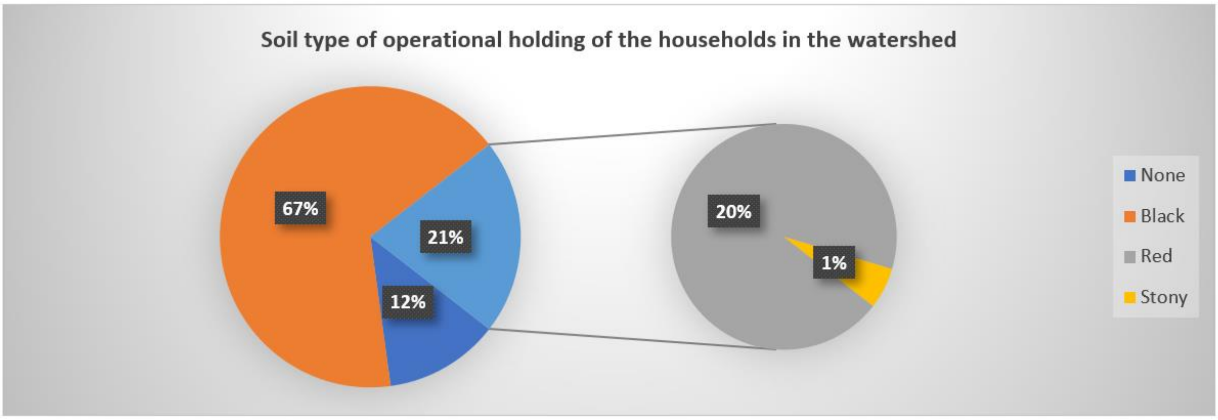

Figure 7: Soil types of plots owned by sample households in the watershed
Source: Baseline survey data, 2021

Soil erosion is one of the biggest global environmental problems resulting in both on- and off-site effects. The economic implication of soil erosion is more serious in developing countries because of the lack of capacity to cope with it and to replace lost nutrients. Such processes aggravate erosion and thus declining productivity, resulting in a population-poverty-land degradation cycle. On the other hand, poor soil fertility status due to erosion, intensive farming, and leaching of nutrients causes low crop productivity and finally results in food insecurity. Hence, assessing soil fertility status is very essential to take an intervention to secure soil fertility and ensure the food security of society. In particular, an attempt was made to identify the soil fertility status of the plots in the watershed. Accordingly, the baseline assessment in the watershed identified the status of soil quality and vulnerability in the watershed. According to the results of the study, the soil quality status of the plots in the watershed is mainly medium (72.5%) followed by low and high soil quality, which are 23.75% and 3.75%, respectively (Figure 8).

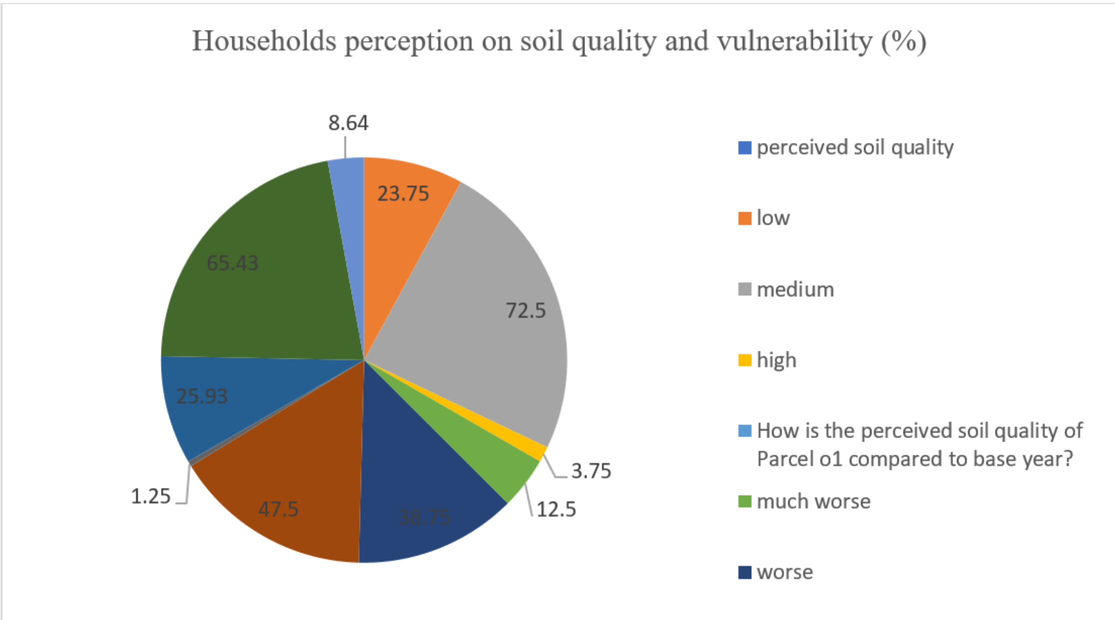

Figure 8: Household perception of soil quality and vulnerability
Source: Baseline survey data, 2021

Soil and water conservation in the watershed

Survey results revealed that about 58% of the households responded that there is a decreasing and irregularity in rainfall and about 20% of the households responded that there is the emergence of animal and plant diseases. Additionally, the increase in temperature and decrease in river flow and springs during the last 10 years were perceived by informal surveys in the watershed (Figure 9).

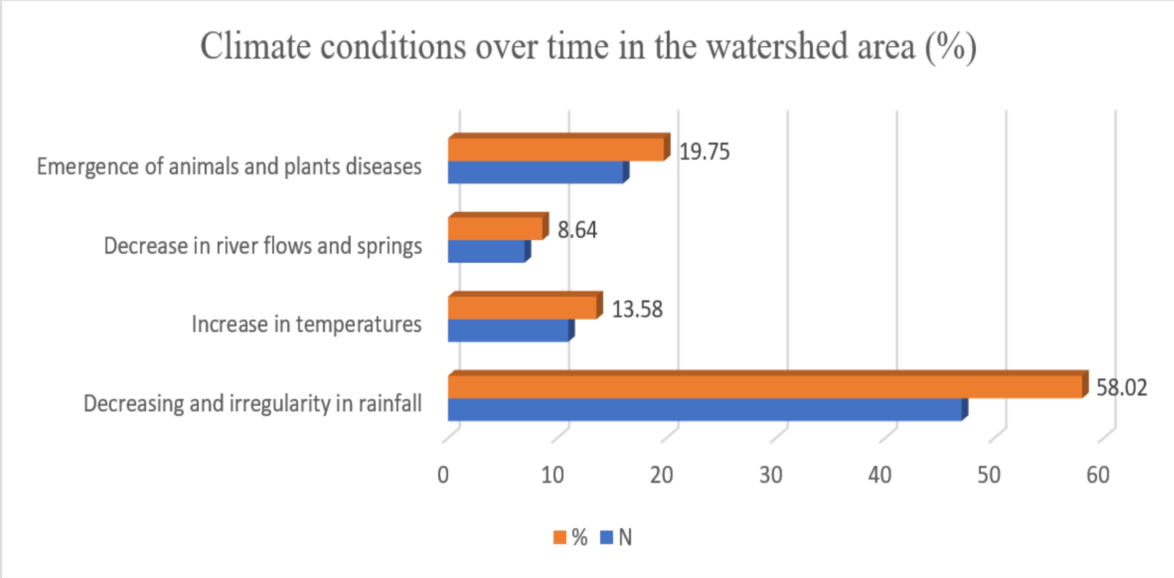

Figure 9: Climate over time in the watershed area
Source: Baseline survey data, 2021

Among others, about 84% of the households have carried out soil and water conservation measures on their plots, of which about 41% constructed soil bunds and 28.4% said to have constructed or used fanyajuu practice. The cut-off drains, stone bunds, cut-off ditches, and trees were also used by 41%, 7.41%, 7.41%, and 23.46%, respectively. Soil and water conservation (mainly physical structures) have been constructed at different times and in different agroecologies. These include different forms of bunds, fanyajuu, bench terraces, check dams, half-moons, micro basins, and ditches. Therefore, the households were asked if they had benefited from the SWC projects so far and about 39.5% received assistance, of which only about 31% said that the executed measures were effective in such a way that it increased moisture (65.7%), reduced erosion (17.1%) and increased soil fertility (11.43%) (Table 7).

Table 7: Soil and water conservation in the watershed

Soil and water conservation	**No of samples HH**		**%**	
	Yes	**No**	**Yes**	**No**
Soil bunds	33	48	40.74	59.26
Fanya jug	23	58	28.40	71.6
Stone bund	6	75	7.41	92.59
drainage ditch	6	75	7.41	92.59
cutoff drain	34	47	41.28	58.02
Trees	19	62	23.46	76.54

Source: Baseline survey data, 2021

Crop Production

Area, production, and yield of crops

The results showed that more than 77% of households produced maize, while 42% for teff and 50% of haricot beans were produced in the watershed (Figure 10).

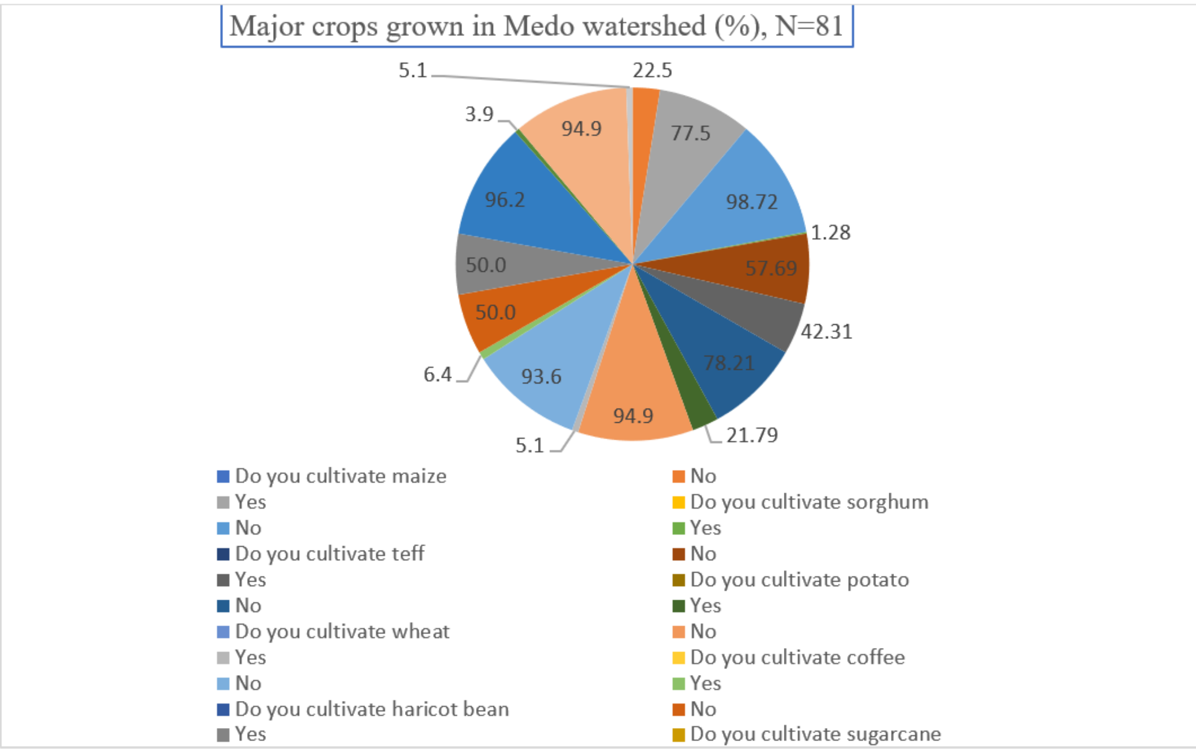

Figure 10: Major crops grown in the Medo watershed
Source: Baseline survey data, 2021

There has been significant growth in cereals in terms of area cultivated, yields, and production in the past two decades, but yields are low by international standards and overall production is highly susceptible to weather shocks, particularly droughts. Soil degradation from erosion and soil compaction also threatens crop yields (Abebe, 2022).

According to the farmers' response, the areas allocated for maize, haricot bean, and teff were on average 0.34, 0.16, and 0.15 hectares, respectively. The overall result showed that although they have small operational holdings, the farmers devoted more of their land to the production of cereal crops such as corn and teff (Table 8).

Table 8: Mean area coverage in hectare for the major crops grown in the watershed (n=81)

Variable	Mean (ha)	Std. Dev.	Min	Max
corn	.335	.269	0	1.3
Sweet potato	.045	.106	0	.50
Haricot bean	.159	.189	0	1.0
wheat	.01	.051	0	.30
Sugarcane	.018	.083	0	.50
Teff	.141	.158	0	.75

Source: Baseline survey data, 2021

Cropland hold and irrigation conservation practices

The Medo-integrated watershed is a learning and experimental site. Hence, this watershed provides an opportunity for the application of improved technology for better outcomes. However, understanding the economic feasibility of all improved management strategies and technologies is essential to know their costs and benefits under different scenarios. Cropland holding and land under irrigation conservation practices were at medium and low levels in the study area of the watershed (Table 9).

Table 9: Cropland holding and irrigation conservation practices

Cropland holding conservation practice	N	%
High	8	10.81
Medium	50	67.57
Low	5	6.76

Cropland holding conservation practice	**N**	**%**
Not available	11	14.86
Total	74	100.00
Land under irrigation conservation practices		
High	1	1.23
Medium	4	4.94
Low	74	91.36
Not available	2	2.47
Total	81	100.00

Source: Baseline survey data, 2021

Crop production and marketing

In this watershed, crops produced are supplied to the district market to generate income for farmers. The survey results show that farmers sell their produce to retailers rather than to local assemblers and intermediaries. Almost 80% of the destination market for farmers marketed the crop to retailers was Shashemene. Similarly, 43% of farmers sell their produce immediately after harvest in this watershed (Table 10).

Table 10: Marketplaces and status of commercialization in the watershed

The market for your household to sell agricultural produce	**N**	**%**
None	8	9.88
Farm gate	1	1.23
Kella	1	1.23
Shashemene	65	80.25
Wosha	4	4.94
Farm gate	2	2.47
Households usually sell crops immediately after the harvest	46	56.79

Source: Baseline survey data, 2021

Market Constraints

The study revealed that the major challenges of agricultural product marketing are lack of market price information (48.4%) followed by lack of storage facilities (17.2%) and poor infrastructure (15.6%). Similarly, limited transport service and low agricultural product prices are also challenges for households in this watershed (Figure 11).

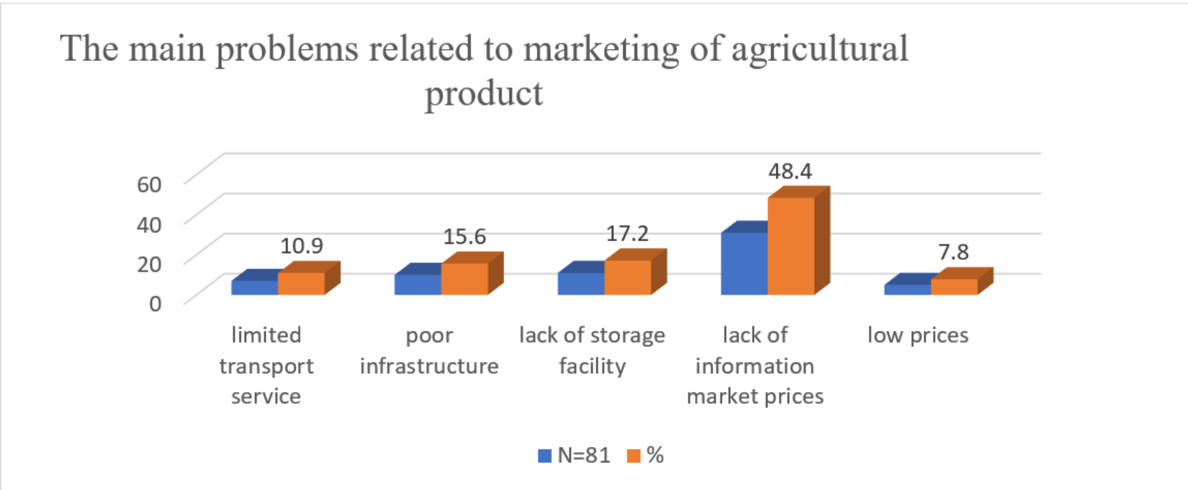

Figure 11: Main problems related to marketing of agricultural products

Source: Baseline survey data, 2021

Input Use

Sampled households in the watershed accessed agricultural inputs from different sources, namely cooperatives, local traders, and research centers, the results showed that 82% of households accessed input of agricultural technologies from cooperatives, 9% from local traders, and about 4% from research centers (Table 14). This shows that the input supply for agricultural technologies is mainly through cooperatives in the watershed. Seeds of improved crop varieties used in the study area were Limu, BH-540, and local varieties for maize; Dendea and local seeds for wheat; Nasir and Awassa Dume for common bean; and local seeds for potato, barley, and teff, respectively. The types of fertilizer used were DAP, urea, NPS, and a limited amount of organic fertilizer from manure and compost for crop production. There was no agricultural machinery and they used backward-type plows of animals.

Table 11: Agricultural input supply in the watershed

Inputs	No sample HH		%	
	Yes	No	Yes	No
Inputs	81	0	100	0
Pesticides	63	18	77.78	22.22
Fertilizer	25	56	30.86	69.14
Manure	7	74	8.64	91.36
Compost	13	68	16.05	83.95

Source: Baseline survey data, 2021

Crop disease prevalence

Table 12: prevalence of crop diseases over years in the watershed

The prevalence of crop diseases over the years	N	Percentage
Increased	56	69.14
Decreased	13	16.05
No change	12	14.81
Total	**81**	**100.00**

Source: Baseline survey data, 2021

Livestock production

Livestock is an integral part of agriculture and provides meat, milk, cash, draft power, hauling services, insurance, and social capital (FAO, 2019). The study revealed that 27.16 % of households in the watershed own a donkey. Livestock rearing is also the major means of livelihood in the study area. About 37%, 19%, and 17% of the farmers owned cows, sheep, and goats, respectively, in the integrated Medo watershed; similarly, the watershed community assessment results show that 29.63% own chickens. (Figure 12).

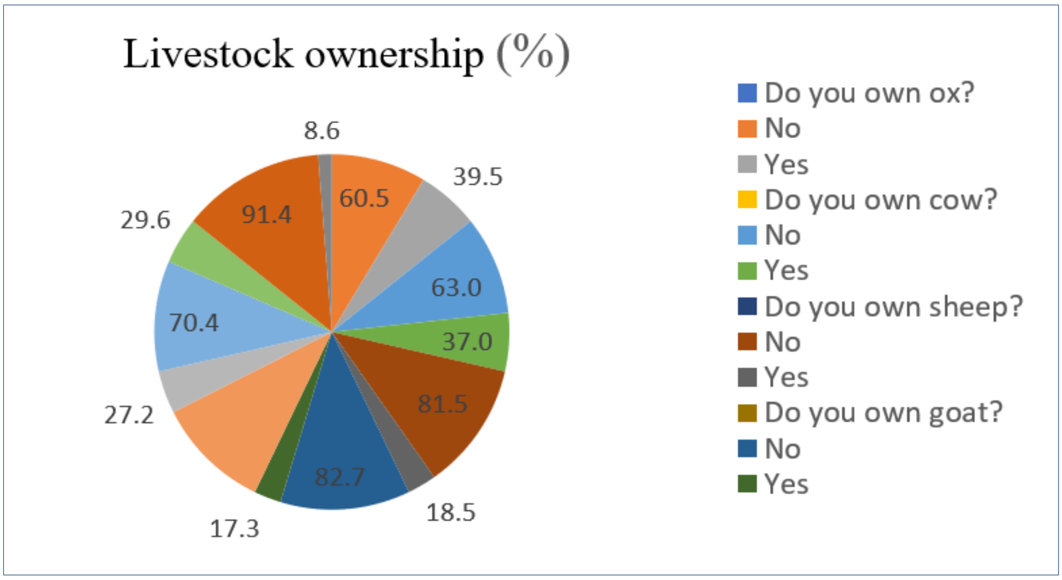

Figure 12: Livestock ownership

Source: Baseline survey data, 2021.

Farmers in the area earn income from their animal sales. Some households were engaged in animal fattening. The result showed that 37% of households sell their live animals, of which about 31% are after fattening and the remaining 69% are without fattening. Only 16% of the households have access to improved breed animals (Appendix table Table 1).

CONCLUSION AND RECOMMENDATIONS

The socioeconomic characteristics of Edo integrated learning watershed households (HH) survey results revealed that on average, they allocated 0.54 ha of land for the annual crop. Land allocated for grazing and degraded land were 0.029 ha and 0.015ha, respectively. On the other hand, households on average rented 0.103 ha and rented out 0.049 ha of land. The results showed that the average landholding in the watersheds is often fragmented and less than one ha; therefore, landholding is the major constraint for crop production in the area. According to the study, agriculture is the largest source of income for farmers in the study areas, followed by off-farm activities such as petty trade, daily labor, remittance, NGO, handcraft, and pension. This indicates that the majority of farmers living in the area depend on agriculture for their livelihood. Livestock rearing is also the major means of livelihood in the study area. About 37%, 19%, and 17% of the farmers owned cows, sheep, and goats, respectively, in the integrated Medo watershed. Moreover, about 58% of the households responded that rainfall amount quantity showed a declining situation with an irregular distribution in the last ten years, while 20% of respondents indicated the emergence of new animal and plant diseases. Besides, an increase in temperature and a decrease in river flow and springs were other changes observed in the area. Among others, about 84% of the households have carried out soil and water conservation measures on their plot, of which about 41% constructed soil bunds and 28.4% are said to have constructed fanyajuu. Similarly, the households in the Edo watershed have also used cut-off drains, stone bunds, cut-off ditches, and trees, which are 41%, 7.41%, 7.41%, and 23.46%, respectively. The vast majority of respondents (88%) had no cooperative membership, and most of them (94%) had a low level of benefit from cooperatives. On the other hand, households responded that though there is an irrigation association, they are not beneficiaries of the association.

Based on the aforementioned findings, the following suggestions were given: -

- ❖ Supplying improved technologies (i.e. improved varieties) for annual and perennial crops to improve land productivity and production.
- ❖ Provision of improved breeds of livestock and modern beehives by organizing young and less land through integrated improved beekeeping practices with multiple trees as means of income-generating activities.
- ❖ Generally, prioritizing the identified problem and preparing intervention of different technologies and development plans by participating communities and different potential stakeholders to solve the problems by considering the existing opportunities of the watershed.

Acknowledgments

The authors gratefully acknowledged the Climate Action through Landscape Management (CALM) Project and the Ethiopian National Meteorological Agency for funding and providing us with climate data.

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Not applicable

Author Contributions: K.J.A.: idea conceptualization, methodology setup, data curation and analysis, investigation, original draft, writing, and revision of the manuscript, editing, visualizing. M.G.: idea conceptualization, methodology, editing, review, visualization, and supervision. G.B...: review, editing, visualization, writing, and revision of the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding statement: This study was carried out with the support of the Climate Action through Landscape Management (CALM) Project, Ethiopian Institute of Agricultural Research.

Data Availability Statement: The data that supports the funding of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

REFERENCES

- Agidew, A. M. A., & Singh, K. N. (2018). Factors affecting farmers' participation in watershed management programs in the northeastern highlands of Ethiopia: A case study in the Teleyayen sub-watershed. *Ecological Processes, 7*, Article 15.
- Anantha, K. H., Suhas P. W., & Sreedevi T. K. (2009). Baseline Socio-economic Characterization of Watersheds; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Patancheru 502 324, Andhra Pradesh, India.
- Bagherian, R. (2009). Community participation in watershed management programs. *Journal of Social Sciences, 5*(3), 251-256.
- Bonsa Fentale Jilo, Gemeda Terfassa Fida, Desta Negayo Komicho.(2020) Socio-economic and Biophysical Resources Characterization of 'Warja' Watershed in Adami Tulu Jido Kombolcha District, East Shewa Zone, Oromia, Ethiopia.

American Journal of Modern Energy; ISSN: 2575-3908 (Print); ISSN: 2575-3797 6(6): 101-116

- Mamo, A. A. (2022). Socio-Economic Characterization of Community in Watershed Management: Case of Abaya-Chamo Sub-Basin Project Districts of Southern Ethiopia.
- Worku, A., Lemenih, M., Fetene, M., & Teketay, D. (2011). Socio-economic importance of gum and resin resources in the dry woodlands of Borana, southern Ethiopia. *Forests, Trees and Livelihoods*, *20*(2-3), 137-155.
- FAO. (2019). The future of livestock in Ethiopia. Opportunities and challenges in the face of uncertainty. Rome. 48 pp. License: CC BY-NC-SA 3.0 IGO.
- Hassen, G., Bantider, A., Legesse, A., & Maimbo, M. (2021). Assessment of Design and Constraints of Physical Soil and Water Conservation Structures in respect to the standard in the case of Gidabo sub-basin, Ethiopia. *Cogent Food & Agriculture*, *7*(1), 1855818.
- Hanumantha Rao, C. H. (2000). Watershed development in India: Recent experience and emerging issues. *Economic and Political Weekly, 35*(45), 3943–3947
- Mohajan, H.K. (2013). Ethiopia: A socio-economic study. *Journal of Business Management and Administration,* 2329-2954.
- Kerr, J. (2002). Watershed development, environmental services, and poverty alleviation in India. *World Development, 30*(8), 1387–1400.
- Khajuria, A., Yoshikawa, S., & Kanae, S. (2014). Adaptation technology: Benefits of hydrological services watershed management in the semi-arid region of India. *Journal of Water Resource and Protection, 6*, 565–570.
- Berhe, M., Hoag, D., Tesfay, G., & Keske, C. (2017). Factors influencing the adoption of biogas digesters in rural Ethiopia. *Energy, sustainability and society*, *7*, 1-11.
- Nasrabadi, A., Karami, E., & Ahmadvand, M. (2013). Determinants of participation in watershed development projects in Khorasan, Iran. *Journal of Agricultural Science and Technology, 15*(6), 1085–1094.
- Gadisa, N., & Midega, T. (2021). Soil and water conservation measures in Ethiopia: Importance and adoption challenges. *World Journal of Agricultural & Soil Science*, *6*(3).
- Singh, C. (2018). Is participatory watershed development building local adaptive capacity? Findings from a case study in Rajasthan, India. *Environmental Development, 25*, 43–58.
- Wolde-Selassie, A. (2001). The socio-economic role and status of Handicraftsman among the Kambaata of southern Ethiopia. *International Journal of Ethiopian and Eritrean Studies*, 1430-1938.