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Research Article

Socio-economic and Bio-physical Characterization of Wadego Watershed, Oda-Bultum Woreda, West Hararghe zone, Ethiopia

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Abstract

Baseline characterization is important component of watershed development of rural development and natural resource management strategies in many countries. Hence, the study was designed to; assess and document major biophysical and socio-economic constraints and potentials of Wadego watershed. Firstly, Wadego watershed boundary was delineated and its map was developed based on the preliminary outlet identified with the help of GPS reading. The households for interview were selected randomly from the small householders in the watershed based on proportional to population size. Accordingly, data was collected from 120 sample respondents using various instruments such as: key informant interview using semi-structured checklist, focused group discussion, expert interview, unstructured questionnaire and field observation on bio-physical resources and different concerns of watershed management. Collected data was summarized using descriptive statistics. The result indicated, out of the total 120 sample respondents socio-economic status were; 87.5% of them were male while the rest 12.5% were female, 93% were married, 51% were un educated. The major crops grown in the watershed were Maize, Sorghum, Khat, Teff and others while, Barley and Field Pea were the least grown ones. The result of the survey has indicated 37% uses improved variety, while 64% uses local variety. According to respondents, the slop class of the watershed was 56, 29, and 15% flat, medium and steeply slops respectively. Moreover, soil fertility class was 25%, 54% and 21% low, medium and high respectively in the watershed. Generally, the survey result have characterized and documented bio-physical and socio-economic status as: average land owned half hectare, densely populated, different slope class in the watershed, land shortage, feed problems, presence of soil fertility and erosion problems, climatic problems etc. in the watershed. Accordingly, researchable issues on different prioritized problems concerning to; soil fertility management, soil and water conservation, Agroforestry practice, forage development and forestry practices in the watershed have given prioritization and therefore, adapted and generated technologies nearby research center i.e. Mechara Agricultural Research Center and any concerned research institutions and also development work oriented NGO'S has to intervened the watershed by research development work. Accordingly, intervention areas forwarded are: Creating awareness on climate variability and change and SWC techniques, introducing different biophysical soil and water harvesting technologies, demonstration and awareness creation, Participatory demonstration on different Agroforestry and plantation forestry practices, introducing multipurpose plant species like Bamboo variety in the watershed.

Keywords

Constraints, Potentials, Wadego Watershad, Watershed Management

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1. Introduction

According to Blackburn, J. & Holland J. (eds.) [6], a watershed is a topographically delineated area that is drained by a stream system i.e. all of the land draining its rain, snow melt and ground water into a stream or river. At the earlier watershed management had a narrow focus primarily for controlling erosion, floods and maintaining sustainability of useable water yield. However, recently watershed management is not only for managing or conserving natural resources in a holistic manner, but also to involve local people for betterment of their lives. Its management is more people oriented and process based, than only physically target oriented [1]. Factors that contribute to the success of watershed management are multidimensional, including biophysical, institutional and socioeconomic elements. The presence of supporting institutional structures and the extent of community participation were also other factors found to significantly influence the 'success' of watershed management [7] The lack of integration from the different disciplines, sectors and limited level of participation of the stakeholders are among the limiting factors contributed to low level of success [3].

Baseline characterization helps understand the initial livelihood condition of the people in the watershed before intervention. It builds necessary foundation for the plan and obtains proper information for effective planning, implementation and monitoring [4]. Due to demographic Pressure the average landholding in the Ethiopian watersheds is often fragmented and less than one ha [8]. The fragmented landholding (3-5 parcels) coupled with the improper land use system, nutrient depletion, drought and drainage problem, low crop and livestock productivity worsened the situation. Deforestation for cultivation, wood for fuel and construction, overgrazing, conversion of marginal lands to agriculture is escalating the problem of soil erosion and land degradation than ever [5]. Ethiopia is considered as one of those Sub Saharan African (SSA) countries most seriously affected by land degradation. This in turn has its own negative impact on achieving food and nutrition self-sufficiency as the agriculture sector by virtue of its dependence on availability of rainfall and soils is the most vulnerable sector to the impacts of land degradation, flooding and drought. Since long, watershed management approach integrating different soil and water conservation measures remained a remedy to at least maintain these challenges to a tolerable level.

Soil erosion is one of the most serious global environmental issues, with both on-site and off-site consequences [10]. About 16% of the world's agricultural land is affected by soil degradation [11]. Of all the processes that result in land degradation, water erosion is the most threatening. It accounts for 56% of the total degraded land surface in the world. In Africa alone, 5-6 million hectares of productive land are estimated to be affected by land degradation each year [12, 13].

Soil erosion is a more serious problem for developing countries, including Ethiopia, because their dependence on the soil is more direct. Erosion reduces the routable depth, removes organic matter and nutrients from the soil, and decreases the capacity to hold water. The leading causes of erosion and environmental degradation are population pressure, agricultural land mismanagement, deforestation, and overgrazing. In Ethiopia, the average annual rate of soil loss is estimated to be 12 tons/hectare/year [14]. It can be even higher on steep slopes with soil loss rates greater than 300 tons per hectare per year or about 250 mm per year when vegetation cover is sparse [15].

Although several studies [16-22] were conducted in Ethiopia on soil and water conservation, a considerable part of the country's soil and water conservation issues are not investigated. Investigators have focused mainly on the nature of soil and water conservation, the perception of soil and water conservation by farmers, and the perception of soil fertility and the cause of soil erosion. They found a high degree of soil erosion in Ethiopia in general.

Obviously, the final goal of watershed management is to reduce vulnerability of inhabitants to the adverse impacts of extreme weather induced hazards and enhance their adaptive capacity through availing water, fertile soil, and livestock feed; reducing risk of floods, and increasing household income.

The CALMP4R project is designed to overcome the major shortfalls observed in sustaining the long-years effort of projects in sustainable land management. The program envisages incentivizing initiatives helping ensure good practices are disseminated more broadly through government programs of five thousand community watersheds. Therefore, the CALM4R initiatives can be taken as an opportunity to achieve well-improved success stories in natural resources management of the region.

Accordingly, Wadego micro watershed was selected among the model watershed in the west Harerghe zone; due to land degradation in the form of soil erosion and declining fertility, reduction of vegetation caver, drought impacts, over floods, increased soil erosion, decreasing of availability of water and food, decreasing of fuel and fodder at all are a serious challenges to agricultural productivity and economic growth in Community watershed. Therefore, Climate Action through Landscape Management (CALMP4R) Program targeted the micro watershed with objective of 1. to identify and document major biophysical and socioeconomic constraints and potential of the watershed. 2. to document baseline information on biophysical and socioeconomic aspect.

2. Methodology

2.1. Description of the Wadego Watershed

Mechara Agricultural Research Center has selected Wadego micro watershed, which is recognized/registered under Oda Bultum Woreda of Bureau of Agricultural office. Agro ecology this watershed was woyna dega (midland): altitude ranges 1700-2000 m.a.s.l, long period mean rainfall of the watershed is 1053 mm and annual temperature is 20.20 ℃ [9]. The area of watershed is 995 hector and about 982 house holders live in the watershed.

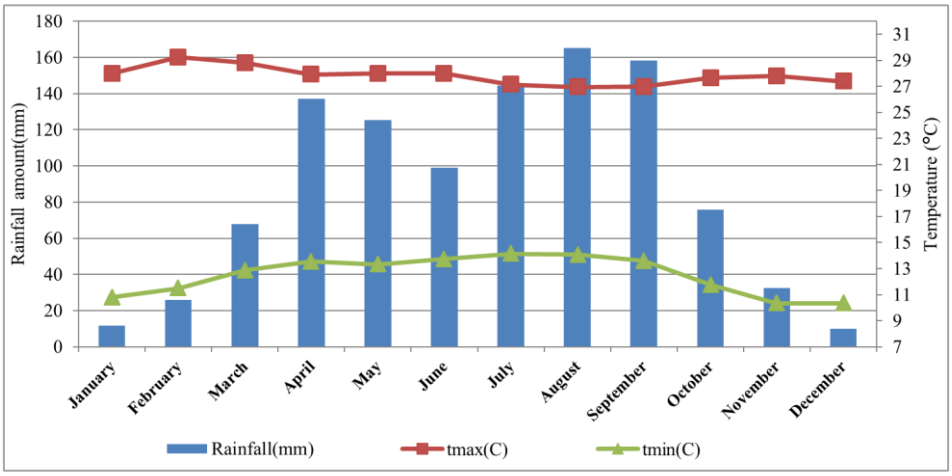

Figure 1. *Mean monthly rainfall and maximum, minimum and average temperature at Bedesa weather station [9].*

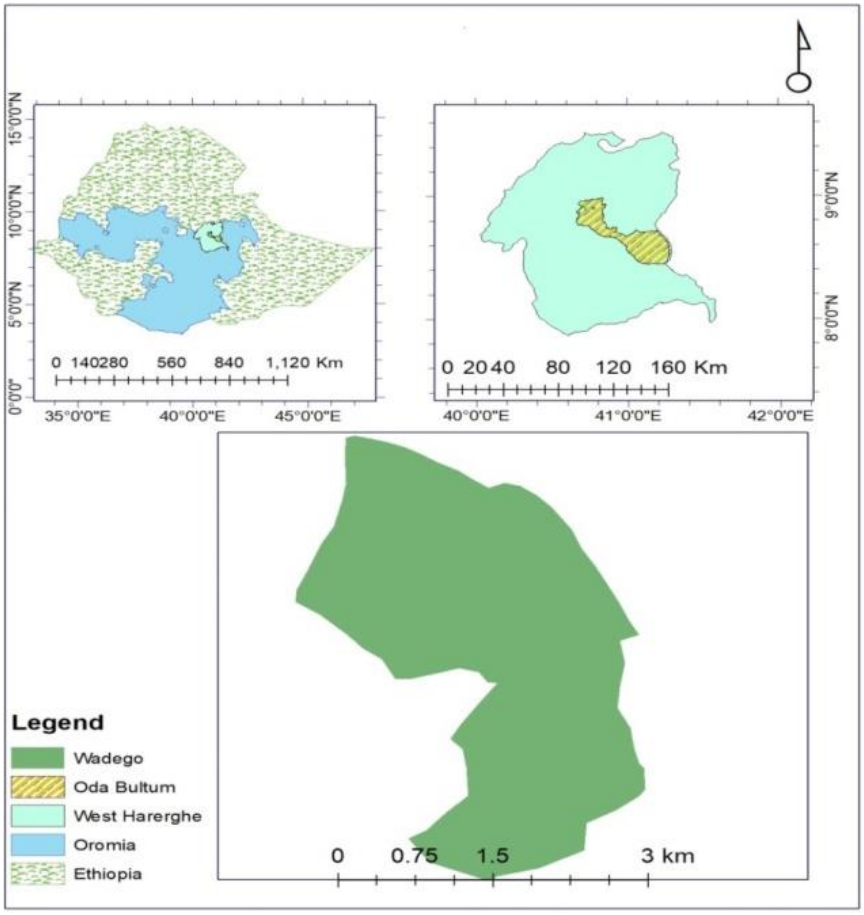

Figure 2. *Locational map of Wadego watershed.*

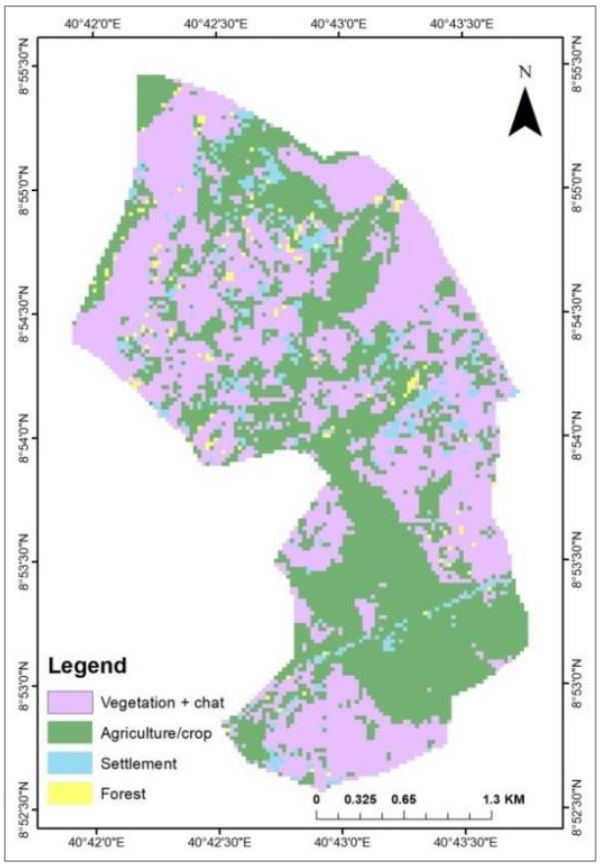

Figure 3. Land use map of Wadego watershed.

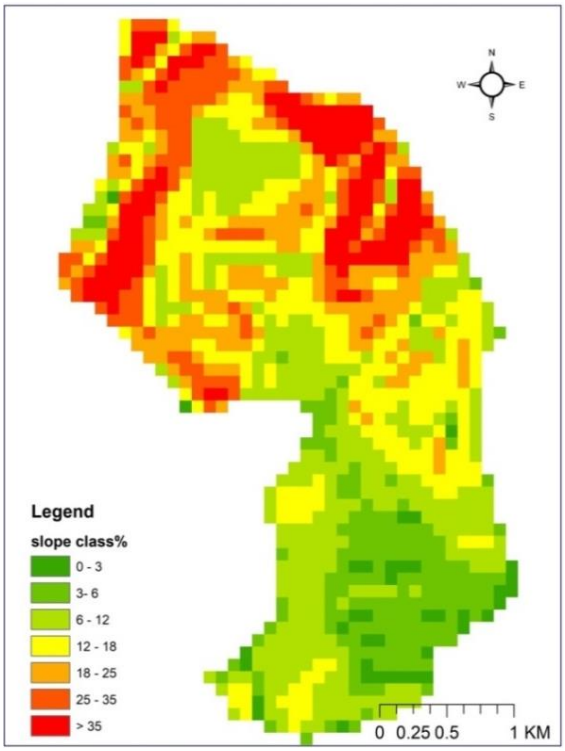

Figure 4. Slop class of the Wadego watershed.

Table 1. Description of the slop class of the figure 3.

Slope class	Description
0-3	Nearly level
3-6	Gently sloping
6-12	Moderately slopping
12-18	Strongly slopping
18-25	Moderately steep
25-35	steep
>35	Very steep

2.2. Data Type and Collection Methods

Both secondary and primary data were collected and used for this study. The sources of secondary data were published and unpublished documents. While, the Primary data was collected using various instruments such as: key informant interview using semi-structured checklist, group discussion, expert interview, unstructured questionnaire and field observation on resources and different concerns of watershed management.

Key informant interview was conducted to generate general understanding of the watershed management, the major technical, institutional and natural challenges of natural resources management in the watershed. The Key informant and open-ended interview was done by arranging cluster of female headed, male headed and youth of different agro-ecologies the watershed. The households for interview were selected randomly from the small householders in the watershed based on proportional to population size using [2] was employed to determine the required sample size at 95% confidence level with degree of variability = 0.5 and level of precision (e) = 7.5%.

$$n = \frac{N}{1+N(e)2} \quad (1)$$

Where n is the sample size, N is the population size (total household size), and e is the level of precision. Accordingly, 120 farmers were interviewed.

Accordingly, information was collected from households using a questionnaire, which comprised of: basic information on household composition and characteristics, identification & consent, land use pattern, farm and nonfarm asset ownership, Crop Production in the watershed, Livestock production and marketing, household income and livelihood diversification, natural resources management (NRM), extension services, information sources and saving and credit access, major constraints in the watershed, major potentials / opportunities in the watershed.

2.3. Method of Data Analysis

The data collected from household survey were checked, arranged, coded and entered and analyzed using Statistical Package for Social Science (SPSS version 20.0).

Data collected from key informant interviews and focus group discussions were summarized, using descriptive statistics that include frequency distributions and percentages.

3. Results and Discussions

3.1. General Socio-Economic Characteristics of the Watershed

The results (Table 2) indicated that regarding the general socioeconomic characteristics of households, such as Sex, marital status and educational level of the household, etc. Such socio-economic characteristics help in knowing the community for planning an intended intervention for the implantation of watershed management. These characteristics also determine the extent to which the community will adopt the intervention and can be helpful in devising a strategy for entering into the community development work.

From the total sample respondents 7% was single while the rest 93% were married households. The proportion of married respondents was much larger than the remaining widowed categories hence; there is real difference in marital status of watershed management married and single watershed management in the study areas.

Education is very important for the farmers to understand and interpret the agricultural information coming to them from any direction. From the total 120 respondents, the proportion of education status were; uneducated (51%), informal education (21%), grade 1-8 (18%), and grade >9 (11 %) (Table 2). As half of the population in this study was educated people they can teach the rest uneducated for the management of this water shade.

Table 2. *Household respondent's characteristic in Wodago watershed.*

	Characteristics	Frequency (#)	Percentage (%)
Sex	Male	105	87.5
	Female	15	12.5
Marital status	Married	112	93
	Single	8	7
Education level	Uneducated	61	51
	Informal education	25	21
	Grade 1-8	21	18
	Grade > 9	13	11

3.2. Crop Production

Crop production is one of the major agricultural activities undertaken by community in the Wodago watershed (table 3). The major crops grown in the watershed were Maize, Sorghum, Khat, Teff and others. Maize and Sorghum were the major grown crops while Barley and Field Pea were the least grown ones. Moreover, fewer farmers produce horticultural crops such as coffee (8%), Mango (7%), Tomato (6%), and Banana (4%).

The result of the survey has indicated 37% uses improved variety, while 64% uses local variety.

The results (Table 4) of baseline survey were indicated that in the watershed, corrugated roof house and solar power were the major used tools by many farmers. While, few farmers uses water pump.

Table 3. *The major crop produced in their rank of production (farmers practice) in the watershed.*

S.N.	crops	frequency	% growers
1	Maize	21	18
2	Sorghum	15	13
3	Khat	13	11
4	Teff	12	10
5	Chick pea	11	9
6	Coffee	10	8
7	Common bean	9	8

S.N.	crops	frequency	% growers
8	Mango	9	7
9	Tomato	8	6
10	Banana	5	4
11	Field Pea	3	3
12	Barley	3	3
Total		120	100

Table 4. Major Farmer's tools in the watershed in their rank.

S.N.	Tools	Frequency	% of holders
1	Corrugated roof house	15	12
2	Solar power	14	12
3	Spade	13	11
4	Hoe *(Gasoo)*	13	11
5	Axe *(qottoo)*	12	10
6	Machete *(Mencaa)*	12	10
7	Slashes	11	9
8	Mobile phone	9	8
9	Knapsack spray	8	7
10	Radio(Functional)	7	6
11	Hat roof house	5	4
12	Water pump	1	1
	Total	120	100

Survey has provided the following basic land scape and soil characteristics of the watershed;

1. Plot /farm ownership (owned = 95%, shared/ranted = 3% and owned and shared/ranted = 2%)
2. Plot/farm soil color Red = 22%, Black = 61% Grey = 12% 4. Brown = 5%
3. Plot /farm slope; Flat = 56%, Medium= 29%, Sleepy = 15%
4. Plot/ farm Soil fertility; low = 25%, Medium =54%, High = 21%
5. plot/farm Soil erosion; Slight = 37%, Moderate =32%, Severe = 31%
6. Average land holding size = 0.63 hectare

3.3. Agricultural Input Used in the Watershed

The results from household survey revealed the average farm input of NPS and Urea fertilizer was 25 kg each, 1000 kg conventional compost, 1300 kg FYM, one-liter herbicide and insecticide each and 2 liter fungicide.

Table 5. Average farm inputs in the Wadego water shade.

NPS	UREA (kg)	Compost		FYM (kg)	Lime (kg)	Herbicide (l)	Insecti-cide (l)	Fungicide (l)
		Conventional (kg)	Vermin compost (kg)					
25	25	1000	0	1300	0	1	1	2

3.4. Cropping Patterns in the Water Shade

Survey result has indicated that out of the total house hold surveyed only 40% uses double cropping. Chickpea grown as a second crop following the first crop maize accounts about 78% and Teff as grown as a second crop following the first crop common bean at wadego watershed. Moreover, cropping patterns in the watershed; inter cropping of cereal-pulse (60%), cereal-cereal (19%) others (21%) and rotation of; cereal-pulse (49%), cereal-cereal (28%), others (24%). Tillage practice: Conventional (54%) and Conservation (46%).

3.5. Crop Marketing

The main economic activities are food crop production, cash crop in the watershed are; khat, Tomato, chickpea, common bean, maize and coffee (Table 6 below).

Table 6. Major crops sold in watershed by farmers in the watershed.

S.N.	crop	frequency#	% of farmers sale
1	Khat	67	56

S.N.	crop	frequency#	% of farmers sale
2	Tomato	18	15
3	Chickpea	11	9
4	Common bean	8	7
5	Maize	6	5
6	Coffee	10	8
	Total	120	100

3.6. Physical/Mechanical and Biological Soil and Water Conservation Measure Used in Wodago Watershed

The result indicated that soil bund and water-way soil and water conservation measure practice were used by many farmers (25% each), followed by cut off drain (23%) and the least was Fanya Juu (3%) (Table 7). Hedge row/khat (74%), farm boundary (16%) and Road side planting (10%) were the dominant biological soil and water conservation measures (Table 8).

Table 7. *Physical/Mechanical Soil and water conservation measure used in the watershed.*

S.N.	Conservation measure used	frequency(#)	% of farmers practice it
1	Soil bund	30	25
2	Water way	30	25
3	Cut off drain	27	23
4	Terrace	15	12
5	Stone bund	10	8
6	Soil bund and Stone bund	6	5
7	Fanya Juu	2	2
	Total	120	100

Table 8. *Biological Soil and water conservation in the watershed.*

Biological Conservation measure used	frequency(#)	% of farmers practice it
Road side planting	12	10
Farm boundary	19	16
Hedge row/Khat	89	74
Total	120	100

3.7. Livestock Production

Livestock production is the one of major livelihood of communities and it plays significant role in diversifying the income of farming communities in the watershed. Farmers in the watershed have different live stocks. Accordingly local cow owned by (20%) of farmers, (oxen, local bulls, goats, and donkey 11% each) (Table 10). Among the livestock types, cattle and goats which are the major marketable livestock commodities.

The common animals used by respondents farmers in the community of watershed area are Local cow, Ox, Local Bulls, Local Heifers, Sheep, Goats, Donkey, Local Chicken, & Egg(poultry). Oxen are used to plough cropland & sale, cows for milk, goats for sale, and donkeys for transport.

Table 9. *Descriptive statistics of livestock production in the water shade.*

livestock	frequency#	% of farmers owned
Local cow	24	20
Ox	13	11
Local Bulls	13	11
Cross breed bulls	0	0

livestock	frequency#	% of farmers owned
Local Heifers	7	6
Cross breed Heifers	0	0
Calves	11	9
Sheep	4	3
Goats	14	11
Horse	0	0
Mule	0	0
Donkey	14	11
Local Chicken	12	10
Exotic Chicken	2	2
Traditional honey bees hive with colony	5	5
Modern honey hive bees with colony	1	1
Total	120	100

The major livestock feeding source in Wodago watershed are crop residues followed by improved forages. Besides, green feed (cut & carry), concentrates of different types, stubble grazing, hay making and grazing in the field are the other feed types in the water shed (Table 10). The contribution of grazing in the field was lower these is because of shortages of grazing land occur due to expansion of crop lands which resulted from increased population as well as degradation of the land.

Table 10. *Livestock feed sources in the watershed.*

S. No.	Feed type	Frequency#	% of farmers used
1	Crop residues	30	25
2	Improved forages/fodder	26	22
3	Green feed (cut & carry)	21	17
4	Concentrates of different types (Nug cake)	18	15
5	Stubble grazing	11	9
6	Hay making	9	8
7	Grazing in the field	5	4
	Total	120	100

3.8. Major Constraints and Opportunity

Table 11. *Major Constraints and opportunities ranked in order of importance in the watershed.*

constraints	Frequency#	% of respondent
Land shortage	12	10
Agricultural inputs (time, price, quantity supply)	11	9.2
Soil fertility	11	9.2
Grazing system	10	8.3
Feed and fodder	10	8.3
Soil erosion	10	8.3
Inflation	10	8.3
Crop disease	10	8.3
Employment opportunity	9	7.5
Climate change (temperature, rain fall, drought, etc)	9	7.5
Storage pests	9	7.5

constraints	Frequency#	% of respondent
Electricity	9	7.5
Total	120	100

3.9. Major Opportunity

Table 12. Major Opportunity Ranked in Order of Importance in the Watershed.

S. N.	opportunities	Frequency #	% of respondent
1	Availability of labor force	11	9.2
2	Informal institutions (*Dabo, Ikub and* etc)	9	7.5
3	Suitable agro ecology	9	7.5
4	Schools	9	7.5
5	Farmers cooperatives	8	6.7
6	Health center	8	6.7
7	Forest	7	5.8
8	Permanent river	7	5.8
9	Saving and credit institutions	9	7.5
10	markets access	6	5.0
11	Livestock clinic	6	5.0
12	All weather road	5	4.2
13	Transport service	5	4.2
14	Drinking water	5	4.2
15	Youth and women associations	4	3.3
16	Artificial lakes	4	3.3
17	Source of seed	4	3.3
18	Electricity	4	3.3
	Total	120	100

4. Conclusions and Recommendations

The survey result have characterized and documented bio-physical and socio-economic status as: average land owned half hectare, densely populated, different slope class in the watershed, land shortage, feed problems, presence of soil fertility and erosion problems, climatic problems in etc. in the watershed.

The result indicates that, the proportion of married respondents (93%) was much larger than the remaining unmarried respondents. This implies that the communities in the water shade are capable for practicing the agricultural technology introduced for them.

From the total 120 respondents, the proportion of education status were; uneducated (51%), informal education (21%), grade 1-8 (18%), and grade >9 (11%). Education is very important for the farmers to understand and interpret the agricultural information coming to them from any direction. As half of the population in this study was educated people they can teach the rest uneducated for acceptance of the agricultural technology introduced for them and the management of this Wadago water shade.

The major crops grown in the watershed were Maize, Sorghum, Khat, Teff and others while, Barley and Field Pea were the least grown ones. Moreover, fewer farmers produce horticultural crops such as coffee (8%), Mango (7%), Tomato (6%), and Banana (4%).

The result of the survey has indicated 37% uses improved

variety, while 64% uses local variety.

This may be due to lack of improved varieties or lack of information about the improved varieties. Therefor we recommend the concerning bodies to bring the improved varieties in the water shade.

The survey result indicated that, corrugated roof house and solar power were the major used tools by many farmers while water pump was used by few farmers. The result indicated that the plot /farm slope; Flat (56%), Medium (29%), Sleepy (15%). Plot/ farm Soil fertility; low (25%), Medium (54%), High (21%). As 56% of the water shade is flat slop and 54% of land has medium fertility, different agricultural activities can be under taken in the water shade and it is suitable for the management of this water shade.

The results from household survey revealed the average farm input of NPS and Urea fertilizer was 25 kg each, 1000 kg conventional compost, 1300 kg FYM, one liter herbicide and insecticide each and 2 liter fungicide per hectare. As amount use of fertilizer is below national recommendation concerning bodies have to teach farmers to use the recommended use of these agricultural inputs.

Cropping patterns in the watershed; inter cropping of cereal-pulse (60%), cereal-cereal (19%) others (21%) and rotation of; cereal-pulse (49%), cereal-cereal (28%), others (24%). Tillage practice: Conventional (54%) and Conservation (46%).

The main economic activities in the watershed are food crops and cash crops. Khat, Tomato, chickpea, common bean, maize and coffee were the main cash crops.

The result indicated that, soil bund and water-way soil and water conservation measure practice were used by 25% of farmers each. Hedge row/khat (74%), farm boundary (16%) and Road side planting (10%) were the dominant biological soil and water conservation measures. Presence of these much biological water conservation implies the farmer in this water shade have commitments of planting trees that can regulate the ecosystem.

Livestock production is the one of major livelihood of communities and it plays significant role in diversifying the income of farming communities in the watershed. Among the livestock types, cattle and goats which are the major marketable livestock commodities. The common animals used by respondent farmers in the community watershed area are Local cow, Ox, Local Bulls, Local Heifers, Sheep, Goats, Donkey, Local Chicken, & Egg (poultry).

The major livestock feeding source in Wodago watershed are crop residues followed by improved forages. Besides, green feed (cut & carry), concentrates of different types, stubble grazing, hay making and grazing in the field are the other feed types in the water shed. The contribution of grazing in the field was lower these is because of shortages of grazing land occur due to expansion of crop lands which resulted from increased population as well as degradation of the land.

Accordingly, researchable issues on different prioritized problems concerning to; soil fertility management, soil and water conservation, Agro-forestry, forage development and forestry practices in the watershed have given prioritization. Therefore, adapted and generated technologies nearby research center (Mechara Agricultural Research Center) and any concerned research institutions and also development work oriented NGO'S has to intervened the watershed by research development work.

Accordingly, intervention areas forwarded are: Creating awareness on climate variability and change and SWC techniques, introducing different biophysical soil and water harvesting technologies, demonstration and awareness creation, Participatory demonstration on different Agroforestry and plantation forestry practices, introducing multipurpose plant species like Bamboo variety in the watershed.

Abbreviations

NGO	Non-Government Organization
CALM4R	Climate Action Through Landscape Management Program for Result
SWC	Soil and Water Conservation

Author Contributions

Wasihun Gizaw: Writing - original draft
Shimelis Dekeba: Writing - review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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