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Research Article

Assessing the Socio-Economic and Biophysical Recourses for the Identification and Prioritization Constraints of Selected Watershed in Eastern Hararghe, Oromia, Ethiopia

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Abstract

Watershed development is an important component of rural development and natural resource management strategies in many countries. To implemented community based participatory integrated watershed management program by CALM P4R at selected watershed, the baseline survey study is important to solve biophysical and socioeconomic related problems. The study was conducted to assess the socioeconomic status, potential and constraints of selected watershed identified, to assess biophysical data of model watershed documented and to prioritize issues for interventions in model watershed indicated in the East Hararghe zone for further improvements to promote Sustainable and productive livelihood through the integration of different watershed components in participatory approach. Household interview and biophysical resources assessment followed by watershed mapping techniques were used for the data collection. Purposive sampling methods were used to select 121 households in three watersheds. Descriptive statistics by frequency distributions, means and percentage and diversity indices were used for data analysis. The results indicated that problems were identified and prioritized by the community of the watershed. Overall results indicated that land degradation and soil erosion were a serious concern and watershed management programs could be strengthened. Different prioritized problems in relation to soil fertility management, soil, water conservation and water shade management and Agro-forestry, forage development and forestry practices concerns across the watershed. Soil erosion control measures, soil fertility enhancement practices, SWC practices, niche compatible multipurpose trees introduction, home garden agroforestry and other interventions were proposed. Awareness creation and strengthening capacity of rural communities on integrating natural resource management technologies for effective soil and water conservation measure should be enhanced through participatory integrated watershed management were proposed.

Keywords

Watersheds, Characterization, Socio-Economic, Constraints and Potential, Interventions, Stratified Sampling, Baseline Data

1. Introduction

Land degradation has been the major problem in most developing countries of the world. Ethiopia is one of the Sub-Saharan African countries that are seriously affected by land degradation, which accounts for 8% of the global total. [1] Notably, land degradation in the form of soil erosion and declining fertility is a serious challenge to agricultural

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productivity and economic growth in Ethiopia [2]. Indeed, land degradation in Ethiopia is largely an outcome of the existing 'resource-poor' agricultural production system, which is characterized by uncertain rainfall, low inherent land productivity, lack of capital, inadequate support services and poverty. Consequently, the problem has been severe to the extent that it affected lives and livelihoods in particular and development in general. To change the situation of land degradation, the concept of watershed management was implemented in Ethiopia in 1980s as a way of redressing the degradation of the natural resource base and increasing land productivity. Although attempts to reverse land degradation following watershed approaches dated back to 1980s in Ethiopia [3-5]., many programs were unsuccessful, and the technologies and practices were often abandoned by farmers as soon as they stopped being forced or paid to adopt them. The major limitation of the past attempt was the dominant view that labeled watershed problems as engineering problems, and technical solutions for controlling erosion, reducing runoff and flooding, and enhancing groundwater recharge were often designed and implemented with little regard for their impacts on people's livelihoods, on farm profitability, or on social equity. Thus, the watershed development was applied in a rigid and conventional manner without community participation and with little attention to farmer objectives and farmer knowledge as important reasons for these failures.

Ethiopia is known for having a steadily growing population, feeding the growing population either requires more production through productivity increment or increased production through area expansion. The combined effect of growing intensification, further pressure on marginal lands and lacking proper curative measures, exposed agricultural farmlands to erosion. As a result, Ethiopia is considered as one of those Sub Saharan African (SSA) countries most seriously affected by land degradation (Ethiopia Forest Climate Change Commission [10]. 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. Given the severity and extent of the problem in the country, it is well believed that land degradation will still persist long. Which occurs due to rainfall, however, its impact varies considerably with the level of land management interventions. 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. 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. 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 [6].

This has led to various environmental issues, including climate change, pollution, land degradation, deforestation, water scarcity, and loss of biodiversity, which pose a high risk to the country's political, economic, and social landscape [11].

The unwise utilization of natural resources and failure to protect the environment could lead to consequences such as floods, landslides, droughts, desertification, and loss of land productivity, ultimately resulting in population displacement and increased rural-urban migration [12].

Nowadays, different integrated watershed development activities have been carried out in Ethiopia to reverse the ongoing situation by restoring the degraded landscapes and primarily improving the livelihood of the farming communities with the financial support provided by IDA, GEF, GIZ, and the World Bank [13]. Furthermore, various studies have indicated that adopting various landscape-level natural resource management strategies—such as offering better crop and vegetable varieties, initiating irrigation systems, enhancing agricultural practices, and implementing soil and water conservation techniques—has positively impacted the livelihoods of the watershed community [14]. As a result, the Oromia Institute of Agricultural Research initiated the Climate Action through Landscape Management project in 2022 G. C. to deliver results-oriented support and encourage field-based initiatives aimed at enhancing participatory watershed management practices to mitigate land degradation.

Consequently, the socioeconomic assessment of watersheds was identified as one of the essential proposed activities. The selected community watershed in east Hararghe zone is affected by Land degradation which is a significant drag on rural growth and poverty reduction; and reduces their resilience to climate change and undermines livelihood security. Notably, land degradation in the form of soil erosion and declining fertility is a serious challenge to agricultural productivity and economic growth in Community watershed. The problem has been severe to the extent that it affected lives and livelihoods in particular and development. The community watershed is also faced improper use of agricultural lands, lack of water supply, reduction of vegetation caver, drought impacts, over floods, increased soil erosion, decreasing of availability of water and food, decreasing of fuel, fodder and fiber at all.

Since social and economic factors typically encompass the socioeconomic aspects and provide detailed demographic and other pertinent information regarding the watershed residents and various stakeholders [15]., this research was designed to gather and record the baseline data on socioeconomic aspects by identifying key socio-economic challenges and opportunities in the Arado, Gohe and Yaya learning watershed for planning and impact evaluation.

To address these challenges, implementing participatory watershed management is important solution. Because of this the micro watershed are targeted under Climate Action through Landscape Management (CALM) Program. Baseline study on socio-economic and biophysical characterization and prioritization of major constraints of watersheds is rarely assessed in the study area. Therefore, this study was initiated to assess the baseline survey information on socioeconomic and biophysical characterization of watersheds as benchmark for planning selected East Hararghe watershed. Thus, the specific objectives of this study was

1. To identify major socio-economic & biophysical constraints and potentials in the watershed.
2. To integrate the socioeconomic and biophysical information for prioritizing the watersheds.
3. To document baseline information on socioeconomic & biophysical for planning and impact monitoring.

2. Material and Methods

2.1. Descriptions of the Study Area

The selected watersheds in East Hararghe zone are located in the Kersa, Baile and Metta districts. The Watershed is the watershed found in kersa (Arado), Babile (Gohe) and Meta (Yaya) districts. The watershed is targeted for climate Action through Land scape Management (CALM) Project in the districts.

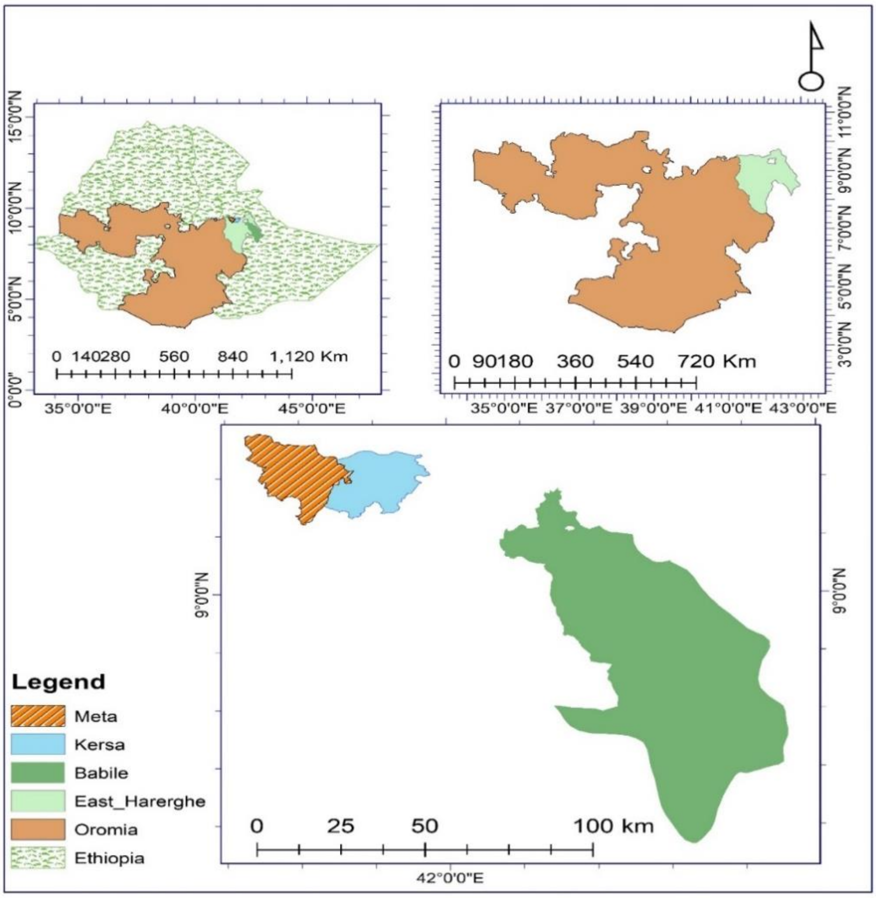

Figure 1. Study community watershed map.

2.2. Criteria for the Watersheds Selection

The watershed site were selected with the districts CALM focal persons and target research groups jointly involved. The criteria for the watersheds selection; Interest and commitment of local population to participate, accessibility, reversibility of degradation and potential for rehabilitation, visibility and demonstration potential, mix of different land-use, expected benefits, and success, representativeness and potential for replication elsewhere, the experience with improved natural resource management practices, as agriculture main driver of the local economy, Experience from previous projects, Achievable results with the available resources etc. Accordingly we selected three community watershed site (Kersa, Baile and Metta) districts.

Table 1. The characteristics of watersheds in the Kersa, Baile and Metta districts.

Characteristics	Kersa	Babile	Meta
Agroecological	Highland	Lowland	Midland
Geographic location	$9^0$28'23'' N, 41^0 42' 46'' E	9^0 16' 40'' N, 42 18 26 E	9^0 73' 86'' N, 42^0 94' 64'' E
Kebeles	Lencha Wajira	Bishan Babile	Hawi Bilisuma
Watershed name	Aredo	Gohe	Yaya
Watershed area (ha)	449.799	408.461	565.739
Altitude (m.a.s.l)	2349-3231 m	950-2000 m	2275-2495 m
Location	45 km from Kersa town, 54 km from Harar, 535 km east from Addis Ababa	5 km from Babile town, 31 km from Harar, 557 km east from Addis Ababa	25 km from chelenko town, 84 km from Harar, 532 km east of Addis Ababa
Rainfall (mm)	1000-14000 mm	650-1100 mm	850 to 900 mm
Temperature	10-17.5 ℃	15-28 ℃	17 - 27 ℃
Total population	2010	1700	2136
Total number of HH	502	459	510
Land Holding	0.46 hectare/household	0.48 hectare/household	0.45 hectare/household
Major crops grown	Maize, Wheat, Barley and Pulses, Chat, potatoes, onion and Vegetables	Maize, Wheat, Barley and Pulses, Chat, potatoes and Vegetables	Maize, Wheat, Barley and Pulses, Chat, potatoes and Vegetables
Livestock types	Cattle, goat and sheep	Cattle, goat and sheep, camel	Cattle, goat and sheep
Major soil types	Chromic LuviSols	Leptososs	Rendzic Leptososs
Market access	15 km Water town	5 km Babile town	4 km Kulubi town

2.3. Research Methodology and Design

A multistage sampling methods were employed and selected based on their agro ecologies clustered, three watershed from each cluster were purposively selected, from each watershed, one kebele were chosen purposively, based on their criteria seated. Finally, households for interview were selected randomly in the watershed. Population size of the study was determined. Sample size was calculated with the simple random sampling method based on proportional to population size using Yamane [7] formula presented below

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

ε = *adjusted margin of error* [ε = (pe/ t) = 2 (0.05/ 1.96) = 0.051]

N = minimum returned sample size, N = population size (household in the watershed) = 178, e = the degree of accuracy expressed as a proportion = 0.05, ρ = the number of standard deviations that would include all possible values in the range = 2, t = t-value for the selected alpha level or confidence level at 95% =1.96.

Sample size of households were selected in the community watershed. Accordingly, kersa, Meta and Babile households were selected, therefore, the total sample size 121 were interviewed.

Table 2. Sample size of households in the interviewed.

Distracts	watershed	Kebeles	Agroecology	No of HH Heads			Sample of HH Heads		
				Male	Female	Total	Male	Female	Total
Kersa	Aredo	L. Wajira	High land	409	93	502	30	11	41

Distracts	watershed	Kebeles	Agroecology	No of HH Heads			Sample of HH Heads		
				Male	Female	Total	Male	Female	Total
Meta	Yaya	H. Bilisuma	Mid land	410	100	510	30	10	40
Babile	Gohe	B. Babile	Low land	381	78	459	30	10	40
Total				1200	271	1471	90	31	121

2.4. Methods of Data Collection and Type of Data Collected

The data was collected at the household level using structured questionnaires. Both secondary and primary data were collected and used in this study. The main sources of secondary data were published and unpublished documents and reports and past case study papers. Primary data were collected using various instruments such as key informant interview using semi-structured checklist, group discussion and expert interview, unstructured questionnaire and field observation of events in the different concerns of watershed management.

2.4.1. Data Collection

The input of all inquiries from each individual and focus group checklists' data were collected for analysis. Information was collected from households using a questionnaire, which comprised nine modules: Basic information on household composition and characteristics were collected. Age, gender, HH size, land holding, level of education, marital status, role of HH, role of HH were collected. Land use pattern, farm and nonfarm asset ownership, crop production in the watershed like major crops grown in the watershed, general plot information, input used, agronomic practices, crop marketing, livestock production and marketing: Livestock ownership, product and marketing, & livestock feed sources. Household income and livelihood diversification includes; household income sources and its share to the total contribution. Natural resources management (NRM). Extension services, information sources and saving and credit access. Major Constraints and major potentials/opportunities in the watershed were assessed.

2.4.2. Method of Data Analysis

The collected data were checked, arranged, coded and entered using microsoft excel and analyzed using statistical Package for Social Science (SPSS version 26.0). Both quantitative and qualitative methods were used in analyzing the information collected using different instruments. Qualitative data obtained using semi-structured questionnaire; interview, observations, focal group discussion and document analysis were analyzed qualitatively using appropriate words and with other qualitative data analysis methods such as thematic analysis and others. For quantitative data, descriptive statistics such as percentages and frequency were employed to analyze the gathered data. Also the data generated through quantitative method was organized and statistical computations were made to explore the inherent relationships among the different variables. The sample type frequency, summary statistics (mean, standard deviation, percentage, tabulation and others), and cross tabulation were displayed. Pair wise ranking also were used to analysis the farmers 'constraints in socioeconomic conditions and resource-use patterns of the watershed. Using state by calculating Pearson's correlations for each explanatory variable we can detect multi collinear. Pearson's correlations by calculating variable at 5% significant level.

3. Result and Discussion

3.1. Socio-economic Characteristics of the Respondents

Age of the household head: The age of the sampled household heads had a range from 20 to 60 years and the average age of the sampled household heads was 40.08 years with standard deviation of 11.07 (Table 3) This means that, on average, smallholder farmers in the study areas were relatively middle-aged household that participated in interview. Age of the household was found to be positively associated with adoption of watershed management program and statistically significant. Middle age strong labor required to maintain SWC activities than old one. This study agrees with the study by Belete L [8]. Family Size of the household head: The average family size of the sample farm households was 6.42 with minimum of 2 and maximum of 16 persons. Therefore, the study populations of the surveyed areas were relatively higher household sizes than national household average size of 5.1 members per household [9].

Table 3*. Age, family size, land holding of HH respondents (n = 121).*

Variables		Kersa	Metta	Babile	Total
House hold Age	Mean	35.42	43.89	35.45	40.08
Family size	Mean	5.19	6.11	8.05	6.42
Land holding	Mean	0.46	0.45	0.480	0.471

Land holding: Average land holding size of households in the study areas was 0.431 hectare. According to the survey data, the land of the sampled household heads had a range from 0.125 to 0.475 ha and the average land of the sampled household heads was 0.471 ha with standard deviation of 0.77 and had a small average of land to agricultural production. Land shortage is cited among the priority problems faced by farmers, especially for those young household heads. Gender of the household heads. Sample households were composed of both male and female household heads. The result of the study indicated that out of the total 121 sample respondents, 97 (80%) of them were male while the rest 24 (20%) of them were female. The result revealed that the percent of male headed households of participated in watershed were higher than that of female headed households (table 4).

Table 4*. Gender, Marital status and educational levels of HH of respondents (n = 121).*

Gender of HH	Kersa	Babile	Metta	Total
Male	40(93.02%)	32(80%)	25(65.8%)	97(80.2%)
Female	3(6.97%)	8(20%)	13(34.2%)	24(19.8)
Total	43	40	38	121
Marital status of HH				
Married	43(100%)	36(80%)	34(89.5%)	113(93.4%)
widowed	0	3(8%)	3(8%)	6(5%)
Divorced	0	0	1(2.63%)	1(0.83%)
single	0	1(2.5%)	0	1(0.83%)
Total	43	40	38	121
Education level of HH				
Uneducated	12(27.91%)	15(37.5%	18(47.4%)	85(70.2%)
Informal education	7(16.3%)	0	6(15.8%)	13(10.7%)
Grade 1-4	9(20.93%)	9(15%)	3(7.89%)	21(17.36%)
Grade 5-8	6(13.93%)	12(30%)	6(15.8%)	24(19.83%)
Grade >9	9(20.93%)	4(10%)	5(13.2%)	18(14.87%)
Total	43	40	38	121
Labor contribute				
100%	36(83.72%)	33(8.25%)	25(65.79%)	94(77.68%)
75%	5(11.63%)	7(17.5%)	8(21.1%)	20(16.53%)
50%	2(4.65%)	0	1(2.63%)	3(2.45%)
25%	0	0	2(5.26%)	2(1.65%)
10%	0	0	1(2.63%)	1(0.83%)
No	0	0	1(2.63%)	1(0.83%)
Total	43	40	38	121
Role of HH				
HH head	42(97.7%)	38(95%)	32(84.21%)	112(92.56%)
Spouse	1(2.33%)	1(2.5%)	1(2.63%)	3(2.48%)

Gender of HH	Kersa	Babile	Metta	Total
Son /daughters	0	1(2.5%)	5(15.8%)	6(4.96%)
Total	43	40	38	121

Marital statuses of the House hold Head: With regard to marital status, from the total sample respondents as it is indicated in the table 4: About 93.4% married, 5% widowed, 0.83% Divorced and 0.83% Single. The proportion of married respondents was much larger than the remaining widowed categories. Hence, there is real difference in marital status of watershed management in the study areas. Educational status of sample Household Head: Education is very important for the farmers to understand and interpret the agricultural information coming to them from any direction, Of the total 121 respondents, as indicated in the table 4, illiterate respondents were 70.2%, Grade 5-8 were 19.83%, Grade 1-4 were 17.36%, Grade >9 were 14.87% and informal education were 10.7% respectively. A better educated farmer can easily understand and interpret the information transferred to them by development agents and others. Labor is one of the major resources owned by farm families. Owen farm labour contribution 100% of the respondents were own only house hold head labor. With regards to the labor contribute of the respondents, 77% of the respondents were household head labor, the remaining others was family labor and others, it can be indicated that farming in the watershed was the main type of traditional farming system in study site. Role of house hold House hold Head: With role of household were 92.6% household head and 5% were son/ daughter and others 3% were spouse. Results of this study indicated that the farming systems are mostly done by household head because of the responsibilities has given to head of household in the watershed families members and presented in table 4 above.

3.1.1. Land Use Pattern, Farm and Nonfarm Asset Ownership

(i). Land Ownership

Major land use patterns and practices were indented in the three land use in the watersheds. The frequency distribution of respondents interviewed with land allocated for annual crops were 103 (85.12%), land allocated for perennial crops were 12 (9.9%), and the rest 6 (4.95%) of the respondents interviewed were pasture/shrub land, irrigated land allocated for annual crops and Plantation practiced on their farm lands in the watershed. The distribution by watershed were kersa allocated land for annual crops 83.72%, for annual crops by irrigation 4.65%, for perennial crops like chat 9.3%, and least were for shrubs land 2.33%. Babile allocated land, for annual crops 82.5%, for perennial crops 12.5%, and least were for pasture/shrubs land 5%. Meta district allocated land for annual crops 89.5%, for perennial crops 7.89%, and least were allocated for plantation 2.63% around farm boundary (Table 5).

Table 5. *Land use patterns of HH of respondents (n = 121).*

Land use patterns	Kersa	Babile	Metta	Total
land allocated for annual crops	35(81.39%)	33(82.5%)	34(89.5%)	103(85.12%)
Irrigated land allocated for annual crops	2(4.65%)	0	0	2(1.65%)
Land allocated for perennial crops	4(9.3%)	5(12.5%)	3(7.89%)	12(9.9%)
Fallow land/pasture/shrub land	1(2.33%)	2(5%)	0	3(2.45%)
Plantation	1(2.33%)	0	1(2.63%)	1(0.83%)

(ii). Farm Tools and Non-farm Assets Ownership

Samples household heads has (min=2 and max=20 farm tools), 100 (82.6 %) of household heads had farm tools and 21(17.4%) of household heads had non-farm assets in the watershed. Household assets are an indicator of household's wealth and resilience during shocks and crises. Household assets are usually as stocks of capital that are exploited when they are vulnerable to various shocks. For instance, during hunger months, farmers sell or exchange their household items for money and food. This predisposes further to biting and spiral poverty. The survey has indicated that household assets range from corrugated roof house, spade, hand hoe, axe, to television, Bajaj, solar power, mobile and radio. The survey has indicated that 34 numbers of the households in kersa, 34 numbers of in Babile and 32 numbers of in metta household had a hand farm tools for farming. However, this study showed that fewer households own the tools. The table below shows the percent of the respondents who had the household asset, corrugated roof house, spade/akaafaa, hoe (gasoo), axe (qottoo), machete (haamtuu), radio, mobile phone, solar power, etc (Table 6).

Table 6. Farm tools and non-farm assets ownership of household (n = 121).

Variables	Mean	Std. Deviation	Minimum	Maximum
Corrugated roof house	1.17	0.38	1	2
Hated roof house	1.95	0.21	1	2
House in town	1.93	0.24	1	2
Akafaa	1.09	0.28	1	2
Gasoo	1.33	0.47	1	2
Qottoo	1.14	0.35	1	2
Machet	1.14	0.35	1	2
Water pump	1.95	0.19	1	2
TV	1.90	0.30	0	2
Radio	1.66	0.49	0	2
Mobile phone	1.38	0.48	1	2
Solar power	1.66	0.47	1	2
Knapsack Spray	1.95	0.19	1	2
Water can	1.86	0.34	1	2
Handsaws	2.12	1.64	1	20

Farm tools and non-farm assets ownership in the three districts of household.

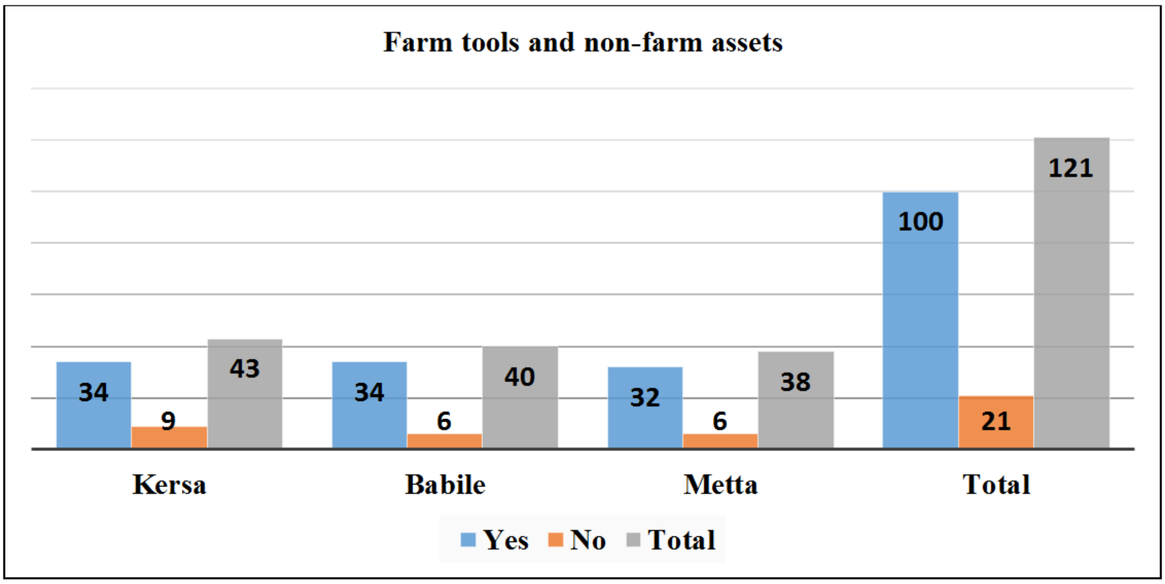

Figure 2. Farm tools and non-farm assets.

(iii). Major Crop Production in the Watershed

Major Crops grown in the watershed: Smallholder farmers in the watershed grow a number of food crops per unit farm whether through simultaneous or sequential intercropping systems. The major food crops include cereals: Maize 97 (82.2%), sorghum 68 (56.2%), wheat 16(13.22%), barley 32 (26.45%), Pulse, fiber and oil crops: Common bean 36(29.75%), faba bean 29(23.97%), field Pea 6(4.95%). Horticultural and root Crops: chat 96(79.34%), mango 24(19.83%), sweet potato 10(8.26%), potato 45(37.19%), onion 36(29.75%), and 30(24.79%), just mentioning a few, It is not uncommon in the smallholder that the food produced does not last the farming households to the next growing season i.e. twelve months. It is shown in the following (table 7) that there is no difference between the watershed farmers, and between the districts in terms of food crop production. In the study watershed, belg rains are used for land preparation and planting of long cycle crops such as maize and seed bed preparation for maher crops. The maher rains are used for planting of cereal crops like maize and sorghums and vegetable crops like onion and potatoes. Annual crops comprise grains and horticultural crops. Cereals (*Maize*, *Wheat* and *Barley*) are cultivated as a staple food crop pulses like beans, and pea are produced both for consumption and market. Potato, garlic, onion and sweet potato are the major vegetables and root crops (Table 7).

Table 7. *Major crop production in the watershed by respondents (n = 121).*

Major Crops grown in the watershed	Kersa	Babile	Metta	Total
Maize	40	32	25	97
Sorghum	4	38	26	68
Wheat	6	0	10	16
Barley	30	0	2	32
Common bean	18	8	10	36
Faba bean	10	9	10	29
Field bean	6	0	0	6
Chat	30	32	34	96
Mango	0	24	0	24
Sweet potato	3	0	7	10
Potato	33	0	12	45
Onion	16	0	20	36
Ground nut	0	30	0	30

As a result fallowing or rotating crops is rarely practices. About 91% percentages of respondents contained their farmland from one location and 6% has on two location. More crops growing in those watershed are maize 72(59.5%) at Kersa and Meta, sorghum more growing in Babile 32 (26.45%), cash crops like chat 6(4.95%) in meta and 2(1.6%) practiced. Concerning variety of seeds 66.94% about local seed were planted and 33.06% were improved seeds. Major respondents were obtained yield in 5.81 quintals at kesa, 6.34 quintals at babile and respondents were obtained yield in 5.35 quintals at Meta.

3.1.2. General Plot Information of Farm in the Watershed

(i). Land Ownership

A total of 112 (92.6%) respondents owned a land, the rest 9 (7.4%) shared/rented in three watershed. About 70% of respondents owned average land size (0.467 ha). Since majority of respondents continuous cultivation on the same piece of land is a common practice across study watershed. A total of 36 (29.75%) respondents indicated that their soil is Red, a total of 73 (60.33%) respondents indicated as their soil color is black, 7(5.78%) respondents indicated their soil color is grey and 5(4.13%) respondents indicated their soil color is brown. A total of 56 (45.28%) respondents were responded that their farm plots is flat, 42(34.71%) respondents their farm plots was medium, and 23(19.01%) respondents said their farm plots was steep slope. A total of 71 (58.68%) respondents were responded that their farm was low in soil fertility, 24(19.83%) respondents their farm was medium in soil fertility, and 16(13.22%) respondents said their farm was high in soil fertility. Concerning soil erosion, a total of 28 (23.14%) respondents were responded that their farm plots slightly eroded, 36 (29.5%) respondents were responded that their farm plots moderately eroded and 57 (47.11%) respondents were responded that their farm plots severely eroded.

Table 8. *Plot information of farm in the watershed (n = 121).*

Farm plot information		Kersa	Babile	Metta	Total
Average land size (ha)	Variables	0.46	0.46	0.45	0.467
Land ownership	Owned	37	37	38	112
	Shared/rented in	6	3	0	9
Soil color	Red	4	32	9	36
	Black	38	10	25	73
	Grey	1	4	2	7
	Brown	0	3	2	5

Farm plot information		Kersa	Babile	Metta	Total
Plot slope	Flat	17	24	15	56
	Medium	19	8	15	42
	Steep	7	8	8	23
Soil fertility	Low	26	22	23	71
	Medium	10	17	7	24
	High	7	1	8	16
Soil erosion	Slight	15	7	6	28
	Moderate	15	9	8	36
	Severe	22	15	20	57

Inputs used per plots	Kersa	Babile	Metta	Total
Average NPS	18	24	9	51
Average Urea	17	23	11	51
Conventional compost	32	40	28	100
Vermin compost	0	0	0	0
Farm yard manure	32	40	28	100
Herbicide	20	20	30	70
Insecticide	20	10	20	50
Fungicide	25	10	25	60
Yield obtained	581.94	634.50	535.1	1,751.54

(ii). Farmers Input Used in the Watershed

Farmers in the watershed used Improved technologies under practice include application of chemical fertilizer (NPS and UREA), the use of high yielding crop varieties, and practicing compost/manure (natural fertilizer). Farmers used improved crop varieties of 30.58% and comprise 69.42% used local seeds of the total and chemical fertilizer is applied by 42.15% of the farmers while natural fertilizer is practiced by 82.64% of the farming households. The use of improved seed covers 30% of the total cropland and chemical fertilizer 42% while natural fertilizer covers 82% of the total cropland. The use of natural fertilizer is more for horticultural crops followed by permanent crops. Shortage of cash, price of fertilizer, absence of credit facilities and timely provision of chemical fertilizer are among the factors that constrain the use of chemical fertilizer.

Table 9. Farm plot information in the watershed (n = 121).

Inputs used per plots	Kersa	Babile	Metta	Total
Average seed	27	22	26	75
Improved variety of seeds	11	11	15	37
Local seeds	35	24	25	84

(iii). Agronomic Practices

Farmers in the watershed used agronomic practices: Inter cropping, mono cropping, crop rotation, double cropping, home garden, different sowing method techniques, tillage practice, and crop residue left on their farm plots. Crop production is generally growing in the watershed about 98% of the respondents mentioned that their piece of land where they cultivated the crops. Yield of different crops as affected by location, sowing methods and variety of crops. About 90.08% of respondents indicated that they were using inter cropping cereals with pulse while the rest 74.38 %, 80.16%, and 82.64% were cereal-cereal, cereal-horticulture and cereal-fruit trees inter cropping respectively. About 89.26% of respondents indicated that they were using mono cropping while the rest 82.64 % were not using mono cropping. Concerning crop rotation cereals with pulse were dominated as respondents indicated. About 82.64% of respondents indicated that they were using 1st crop as double cropping while the rest 74.38 % were using 2nd crop as double cropping. Concerning of home garden about 92.56% of respondents indicated that they were practicing home garden while the rest 82.64 % were not practicing home garden. The respondents indicated that they were used both row planting (80.99%) and broadcasting (81.82%) sowing method techniques. The respondents indicated that they were used both conventional (81.82%) and Conservation (81.82%) tillage practice in the watershed. The respondents indicated that they were 50% crop residue left on their farm (Table 10).

Table 10. Agronomic practices in the watershed by farmers.

Farm plot information and Farmers perception		Kersa	Babile	Metta
Inter cropping	Cereals -Pulse	38	35	36
	Cereal-cereal	35	25	30
	Cereal-horti	35	26	36
	Cereal-fruit	18	50	32
Mono cropping	Yes	37	26	37

Farm plot information and Farmers perception		Kersa	Babile	Metta
Crop rotation	No	34	31	35
	Cereals -Pulse	20	35	45
	Cereal-cereal	33	46	20
	Cereal-horti	20	40	40
Double cropping	1st crop	38	34	28
	2nd crop	34	33	23
Home garden	Yes	32	40	28
	No	44	31	37
Sowing method	Row planting	36	33	29
	Broadcasting	23	38	38
Tillage practice	Conventional	34	37	28
	Conservation	36	27	36
Crop residue left	0%	33	36	30
	50%	32	37	33
	100%	17	50	33

(iv). Crop Consumption and Marketing

The respondents said that the type of crops grown in these land classes varies from one area to another. The respondents grow maize for their own household consumption as compared to sale. Cereals crop mainly produced for consumption. Production of these crops has dropped during these three decades due to diminishing land sizes and reduced soil fertility and land use change made to chat production. The main economic activities are food crop production, cash crop production and livestock production. The major crop mainly produced for consumption and market. About 17Qt **(**80.95% of the cereals) for consumption, about 17Qt (85% of potato) for market, about 8Qt (75% of Onion) for market and, about 16 kg (89% of Chat) for market (Table 11).

***Table 11**. Household crop consumption and marketing in the watershed.*

Crop Production Use (Consumption/Marketing)					
Crop name	Quant./produce (kg)	Quant. Consume.	Quant. soled	Percent (%)	
				Consume	Soled
Maize	10	8	2	80%	20%
Sorghum	5	4	1	80%	20%
Wheat	4	4	0	100%	0%
Barley	2	1	1	50%	50%
Chat	18	2	16	11%	89%
Onion	10	2	8	25%	75%
Potato	20	3	17	15%	85%
Groundnut	1	0	1	0%	100%

Crop Production Use (Consumption/Marketing)					
Crop name	**Quant./produce (kg)**	**Quant. Consume.**	**Quant. soled**	**Percent (%)**	
				Consume	**Soled**
Total	70	24	46	34%	66%

The respondents said that Chat, Potato, and Onion production gives high comparative advantage in marketing. As it is indicated in the table 11 Maize is widely grown in Kersa and Meta woredas while Sorghum is widely grown in Babile woreda. Wheat is widely grown in Meta, Chat is widely grown in Meta and Babile woredas while Onion is widely grown in Meta woreda. Potato is widely grown in Kersa woreda while Groundnut is widely grown in Babile woreda (Table 12).

Table 12. *Household crop consumption and marketing, across watershed.*

Crop name	**Kersa**	**Babile**	**Meta**	**Total**
Maize	26	13	21	60
Sorghum	1	19	3	23
Wheat	1	1	2	4
Barley	1	0	1	2
Chat	3	7	8	18
Onion	1	0	4	5
Potato	11	0	1	12
Groundnut	0	1	0	1
Total				121

(v). Livestock Production and Marketing

(a). Livestock ownership, product and marketing:

The majority of the farmers in selected watershed were mixed crop-livestock producers maximum of = 5 and minimum of = 0. Livestock including local cow, bread cow, ox, bulls, heifers, calves, sheep, goats, donkey, as well as chicken, and bee were kept by farmers in the watersheds. Both indigenous and exotics livestock were found in the watersheds. The majority of the farmers in selected watershed were mixed crop-livestock producer. Livestock species including local cow, bread cow, ox, bulls, heifers, calves, sheep, goats, donkey, as well as chicken, and bee were kept by farmers in the surveyed watersheds (Table 13).

Table 13. *Livestock ownership in selected watershed.*

Livestock ownership (numbers)	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**
Local cow	1.33	0.48	0	5
Cross bread cow	0.33	0.18	0	1
Milk	0.98	0.19	0	2
Oxs	1.97	0.20	0	4

Livestock ownership (numbers)	Mean	Std. Deviation	Minimum	Maximum
Local Bulls	1.77	0.43	0	2
Local Heifers	1.86	0.36	0	2
Calves	1.81	0.41	0	2
Sheep	1.82	0.40	0	4
Goats	1.76	0.44	0	4
Donkey	1.53	0.34	0	2
Local Chicken	1.64	0.50	0	2
Exotic Chicken	0.63	0.20	0	1
Egg (poultry)	0.99	0.20	0	2
Traditional honey bee	1.61	0.50	0	2
Transition honey bee	0.93	0.28	0	1
Modern honey bees	0.97	0.20	0	1

In Babile the largest group of animals were cows, followed by bulls, heifers, calves, sheep, donkeys, and goats. In Kersa and Meta watersheds the livestock consisted mostly of goats followed by oxen, chickens, and poultry and honey bees. About 83% of the respondents owned some livestock in addition to engaging in crop production activities. Local cows were the most popular stock kept by about 13% of the households, followed by goats, oxen, and sheep. The average ownership of different types of animals was 1.33 (local cow), 0.33 (cross bread cow), 0.98 (milk cow), 1.97 (ox), 1.77 (local bulls), 1.86 (local heifers), 1.81 (calves), 1.82 (sheep), 1.76 (goats), 1.53 (donkey), 1.64 (local chicken), 0.63 (exotic chicken), 0.99 (poultry), 1.61 (traditional honey bee), 0.93 (transition honey bee), and 0.97 (modern honey bees). Local cows were the most popular stock kept by about 13% of the households, followed by goats (11%), Ox (10%), and sheep (10%) (Table 13).

Livestock ownership and production across watershed

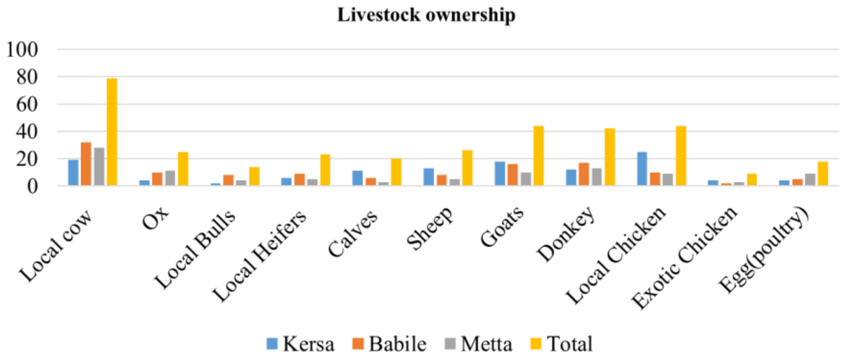

Figure 3. Livestock ownership.

(b). 1. Feed sources in the watershed

Table 14. Livestock feed sources in the watershed.

Feed type for livestock	Frequency	Percent (%)	Rank
Crop residues	50	41.32	1st
Green feed (cut & carry)	35	28.92	2nd
Grazing in the field	20	16.53	3rd
Improved forages/fodder	10	8.26	4th
Concentrates of different types (Nug, cake)	6	4.96	5th
Total	121	100	

Shortage of feed is one of the limiting factors in livestock production. Major feed resource for cattle: The data in table 13 indicates that the major sources of animal feed are crop residue 50(41.32%), green feed or crop straw 35(29.92%), grazing land in the field contribute 20(16.53%), improved forage covers 10(8.26%), the rest and industrial by-product 6(4.96%). However, the productivity of livestock has been decreasing substantially due to continuous drought, population pressure and shortage of grazing land into crop production.

(c). Household annual income sources

Cattle fattening, vegetable production, livestock production, and crop production are income sources of households. The main economic activities are food crop production, cash crop (chat) production and livestock production. The most important crops sold are chat, potatoes and onions. The major crops most commonly grown are Maize, Wheat, Barley and Pulse, Chat and Vegetables are the known cash crops. The watershed also suffers from problems of population pressure, land shortage, soil erosion, and droughts.

Table 15. Household income sources in the watershed.

Main sources of HH income	Average in birr
Cattle Fattening	30,000
Vegetable production	10,000
Crop production	10,000
Livestock production	8,000
Others income	5,000
Tree plantation	4,000
Fruit production	2,000

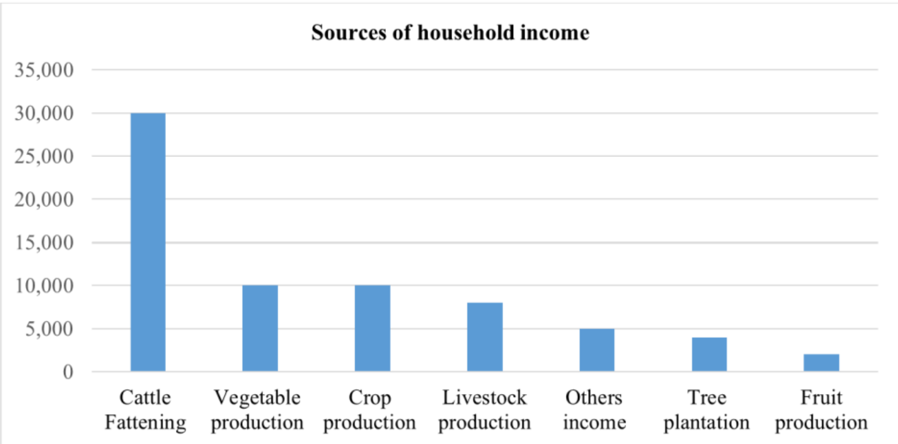

Figure 4. Income sources.

(vi). Natural Resources Management (NRM)

(a). Conservation structures using physical structures

The respondents were aware of the SWC, making physical and biological measures for conservation of natural resources. In this survey, an attempt was made to see the participation of rural households in SWC activities on their holdings by their own initiatives. Overall the knowledge of SWC benefits in farmland is medium. The respondents were asked about the indigenous soil and water conservation practices used by farmers in different watershed. The survey intended to quantify their level of use in the respective watersheds.

Physical/Mechanical SWC; Bund (soil bund (43%) more practiced at Babile and stone bund (54%) practiced at Kersa watershed). As it is indicated in the table 16 Terrace (52%), Cutoff drain (52%) and Water way (52%) are widely practiced at Kersa watershed while others is not widely practiced in Kersa woreda. Gully control like Stone Check dam (65%) were more practiced in kersa watershed, brush wood (61%) were more practiced in Meta and local material (46%) were more practiced in Babile watershed. Biological SWC; Planting grass (Vetiver grass, Elephant grass, Desho grass), and elephant grass is planting grass used by farmers of respondents. About 50% Vetiver grass were more planted in Meta watershed, 44% Elephant grass and 46% Elephant grass were more planted in Kersa and Meta watershed respectively and 43% Desho grass more planted in Meta watershed. Tree Plantation: About 17% road side plantation, 41% farm boundary plantation, 50% hedge row plantation and 5% buffer strip plantation were planted in the watershed. About 95.86% area closure were not used in the watershed while only about 4.13% were used as an area closure in the watershed. This shows that they are acquainted with integrated watershed management approaches (Table 16).

Table 16. Soil and water conservation practices used by farmers in different watershed.

Physical/Mechanical SWC		Kersa	Babile	Metta	Total
Bund (m)	Soil	27	43	30	100
	Stone	54	8	38	100
Terrace (m)	Yes	52	26	21	99
	No	32	36	33	101
Cutoff drain (m)	Yes	52	26	21	99
	No	32	36	33	101
Water way (m)	Yes	52	26	21	99
	No	32	36	33	101
Gully control	Stone Check dam	65	14	20	99
	Brush wood	7	30	61	98
	Local material	30	46	22	98
Biological SWC: Planting Grass	Vetiver grass	20	30	50	100
	Elephant grass	44	10	46	100
	Desho grass	27	30	43	100
Tree Plantation	Road side	5	3	9	17
	Farm boundary	18	11	12	41
	Hedge row	18	23	15	56
	Buffer strip	2	2	1	5
Area closure (ha)	Yes	1	1	3	5
	No	42	39	35	116

(b). Tree species existed in the watershed

One third of the total Farmers HHs, in all watersheds, planted trees mainly for construction and fuel wood production purpose. Some farmers have planted agroforestry tree species that are vital for both watershed protection and the forest yield increase. This might be due to the absence of natural forests in the vicinity where one can easily get construction wood. Most tree species existed in the watershed: *Eucalyptus camaldulensis, Cordia africana, Olea europea var africana, Croton macrostachyus, Ficus vasta, Acacia Senegal, Acacia Senegal, Casuarina equisitifolia Erythrina abyssinica, Psidium guajava, Mangifera indica, Annona seneglensis, Zizipus species, Casimiroa edulis, Carissa edulis.* Distribution of tree species is scattered 108(89%) and their abundance is low 98(81%) in the watershed. Land scarcity households were the main reason that trees were planted in scattered pockets instead of blocks especially for this purpose.

Table 17. Distribution of tree species.

Forms of existed tree species		Kersa	Babile	Metta	Total
Distribution	Scattered	37	40	31	108
	Dense	6	0	7	13
Abundance	High	2	0	1	3
	Medium	4	4	12	20
	Low	37	36	25	98

(c). Tree species extinct in the watershed: Most tree species extinct in the watershed: *Podocurpuse, Allophilus abssyinicus, Doviyales abysinicus, Entada abyssinica, Vernonia amygdalina, Acacia albida, Acacia dicures, Milletia fruginea*, Albezzia gummifera

Table 18. Causes of extinct tree species.

Causes of extinct	Frequency	Percent (%)
Deforestation	94	77.69
agricultural expansion	23	19.01
Population growth	1	0.83
Urban expansion	2	1.65
Others	1	0.83
Total	121	100

Major causes of extinct of tree species in the watershed are deforestation (77.69%) and agricultural expansion (19%). Deforestation and agricultural expansion in Kersa and Meta were responded by 32 (26.44%) respondents in both. Babile watershed were deforested 30(24.79%) and agricultural expanded 3(2.28%) were responded by respondents.

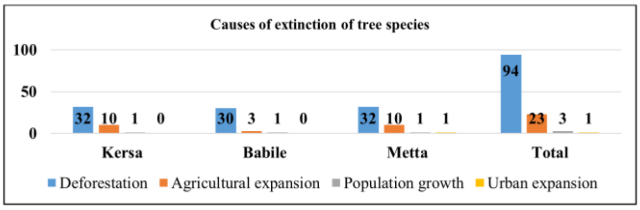

Figure 5. Major causes of extinct of tree species in the watershed.

(d). Wild Life Existed in the Watershed

Distribution of wild life in the watershed is scattered 108(89.26%) in forms of existed, Abundance of wild life is also low 97(80.16%) in forms of existed in the watershed.

Table 19. Forms of extinct wild life.

Forms of existed wild life		Kersa	Babile	Metta	Total
Distribution	Scattered	37	40	31	108
	Dense	6	0	7	13
Abundance	High	2	0	2	4
	Medium	4	4	12	20
	Low	37	36	25	97

(e). Wild life extinct in the watershed:

Major causes of extinct of wild life in the watershed are deforestation (66.94%), agricultural expansion (21.49%), Population growth (8.26%) and Urbanization (2.48). Kersa and Meta watershed were more affected in extinct of wild life in the watershed.

Table 20. Causes of extinct wild life.

Causes of extinct wild life	Frequency	Percent (%)
Deforestation	81	66.94
agricultural expansion	26	21.49
Population growth	10	8.26
Urban expansion	3	2.48
Others	2	1.65
Total	121	100

(vii). Extension Services, Information Sources and Saving and Credit Access

(a). Saving and credit access

Access to credit is an important constraint to farmers while making technology choices for maintaining reasonable consumption levels in the face of risk and managing variability in income over time. For smallholder farmers, the use of improved inputs like fertilizer and new varieties and investments in land and water management options highly depends on timely availability and input.

Table 21. Sources of credit access for farmers in the watersheds.

Sources of credit access	Frequency	Percent (%)
Government	2	1.65
Sinqee Bank	11	9.10
NGO	2	1.65
Informal sources	107	88.43
Total	121	100

Once credit is available, the cost of capital (rate of interest) influences its use. When the rate of return from the adoption of a new practice is higher than the cost of borrowing, the use of credit from a given source becomes economically attractive. Farmers also face special problems in accessing credit for consumption and medium-to-long-term investments, as many credit institutions prefer to extend credit for short-term productive activities. Spending on soil and water management may also be regarded as natural resource investments that do not provide immediate payoffs to small farmers. This makes it especially difficult to secure loans at market rates of interest. Farmers gain credit access from various sources, formal and informal. The formal sources of credit in three watersheds comprised mainly the Sinqe Bank (9.09%). The remaining 88.43% borrowed from informal sources (village moneylenders, relatives, and friends). In terms of accessibility of credit, 93(76.86%) of the sample farmers did not utilize the credit at all. About 28(23.14%) from both formal and informal sources. In three watersheds, farmers' responses indicated that about 93 of the farmers did not use credit.

Table 22. Extension services, credit access and information sources.

Extension services, information sources and credit access		Kersa	Babile	Meta	Total
Extension services	On crop management	13	18	13	44
	on dairy and livestock management	12	12	6	30
	On natural resource management	3	4	11	18
	On others	6	9	13	28
Credit access	Yes	18	6	4	28
	No	24	34	35	93
Source of information about agricultural technologies	Fellow farmer	14	5	17	36
	Zone/district Agric. Extension agent	19	28	18	65
	Research Center.	2	1	0	3
	Media (Radio, Television)	6	5	2	13
	University	0	1	1	2
	NGO	0	1	1	2

(b). Extension services for farmers

Agricultural extension services include interventions/activities by government that facilitate the access of farmers, their organizations, and other value chain actors to knowledge, information, and technologies and assist them to development. Farmers in the watershed have got the extension service on crop management 44(36.36%), dairy and livestock management 30(24.79%), On others Agricultural extension services 28 (23.14%) and natural resource management 18(14.87%).

(viii). Sources Information for Farmers

Information sources used to disseminate agricultural research findings to farmers for on farm activities include researchers, extension officers, knowledgeable farmers, research institutions; mass media, commercial and government agencies. The information obtained can help farmers identify efficiencies that lead to higher productivity and profitability, lower input costs, and optimized fertilizer use. Most farmers in the watershed have got the new technology information through DA and zone /district agricultural office (53.72%), Farmer to farmers (29.75%), and Media (Radio, Television) (10.74%). Concerning about the farmers' food security that produced their own production and all income sources in the watershed, their family's food security in the last 12 months were 47.11% of food shortage above 9 months next to 35.54% of food shortage up to 3 months in the watershed, about 15.7% were no surplus and no foo in year by respondents.

Table 23. Family's food security in the last 12 months.

Food	Frequency	Percent (%)
Food surplus	2	1.65
No surplus and no foo in year	19	15.7
Food shortage up to 3 months	43	35.54
Food shortage above 9 months	57	47.11
Total	121	100

(ix). Socio-economic and Biophysical Character Relation with Watershed Management

Pearson's correlations of gender, age, family size, education, occupation, marital status, labor contribute and role of household with participation of respondents in the watershed. Middle age strong labor required to maintain SWC activities than old one. Farmers who have a large farm land are more likely to invest in soil conservation measures. Male households are better exposed to modern SWC technologies and have more power to make adoption decision than female households. A better educated farmer can easily understand the information from DA and others & transferred to others. Larger HH size with sufficient labor source tend to conservation activities due to the laborious nature of conservation work which needs more labor force. This study agrees with the study by (Belete L., 2017) [8].

Table 24. Gender, age, family size, education, occupation, marital status, labor contribute and role of household with participation of respondents in the watershed.

Socio-economic characteristics	Participation in Watershed management with P value
Gender	0.013*
Age	0.027*
Family Size	0.041*
Land holding	0.020*
Education	0.022*
Occupation	0.661
Marital status	0.402
Labor contribute	0.511
Role of house hold	0.320

Correlation significant at less than 5% probability level

3.2. Bio-physical Resources Survey: Topography of Watershed

Table 25. Slope class of the selected watershed.

Watershed Landscape (relief feature) by slope-class						
0-3% (flat)	>3≤8% (undulate)	>8≤15% (rolling)	>15≤30% (hilly)	>30≤50% (steep)	>50% (mountain)	Total
0.0	11.0	50.0	163.0	97.0	128.0	449
0.0%	2.4%	11.1%	36.3%	21.6%	28.5%	100%

About 0.0% of the area is flat, 2.4% undulating, 11.1% rolling; 36.3% hilly, 21.6% steep and the rest 28.5% are mountainous.

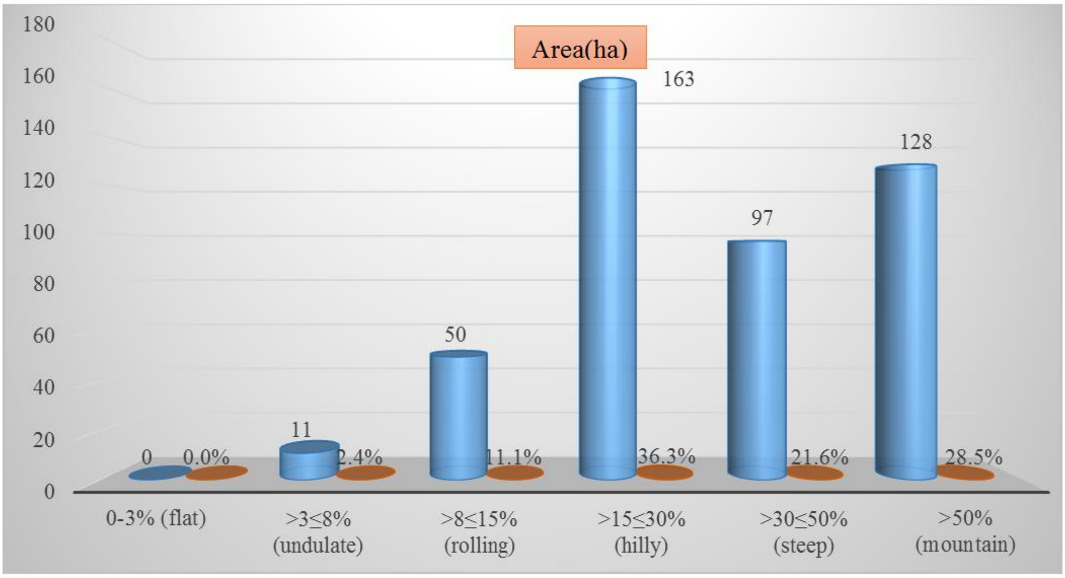

Figure 6. Topographic feature, by slope-class.

3.2.1. Land Use Land Cover Pattern of Watershed

Land use & cover of watershed: The major watershed sizes to a total of about 449 ha. Farmland comprises about 50%, homestead 3%, grazing/pastureland 2%, hillside/ degraded land 26%, shrub/bush 19% and others 0.2% of the wetland.

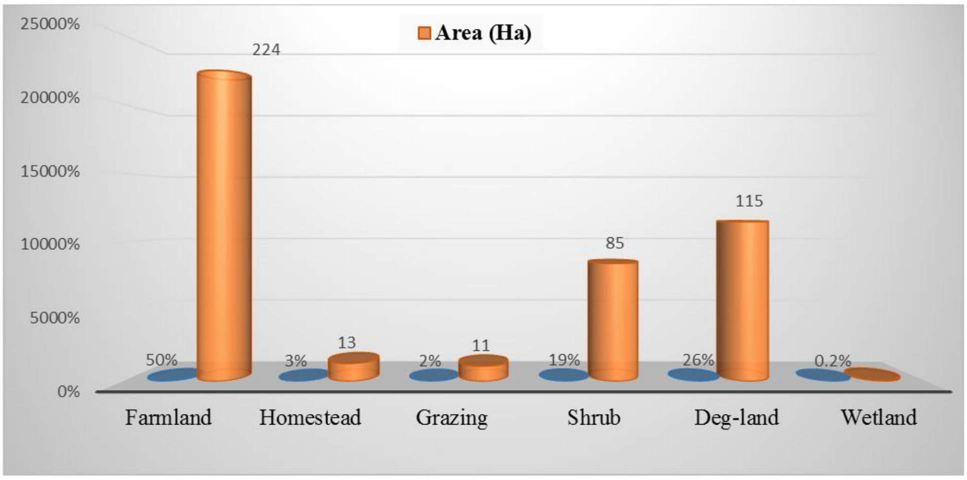

Figure 7. Land-use land cover pattern of watershed.

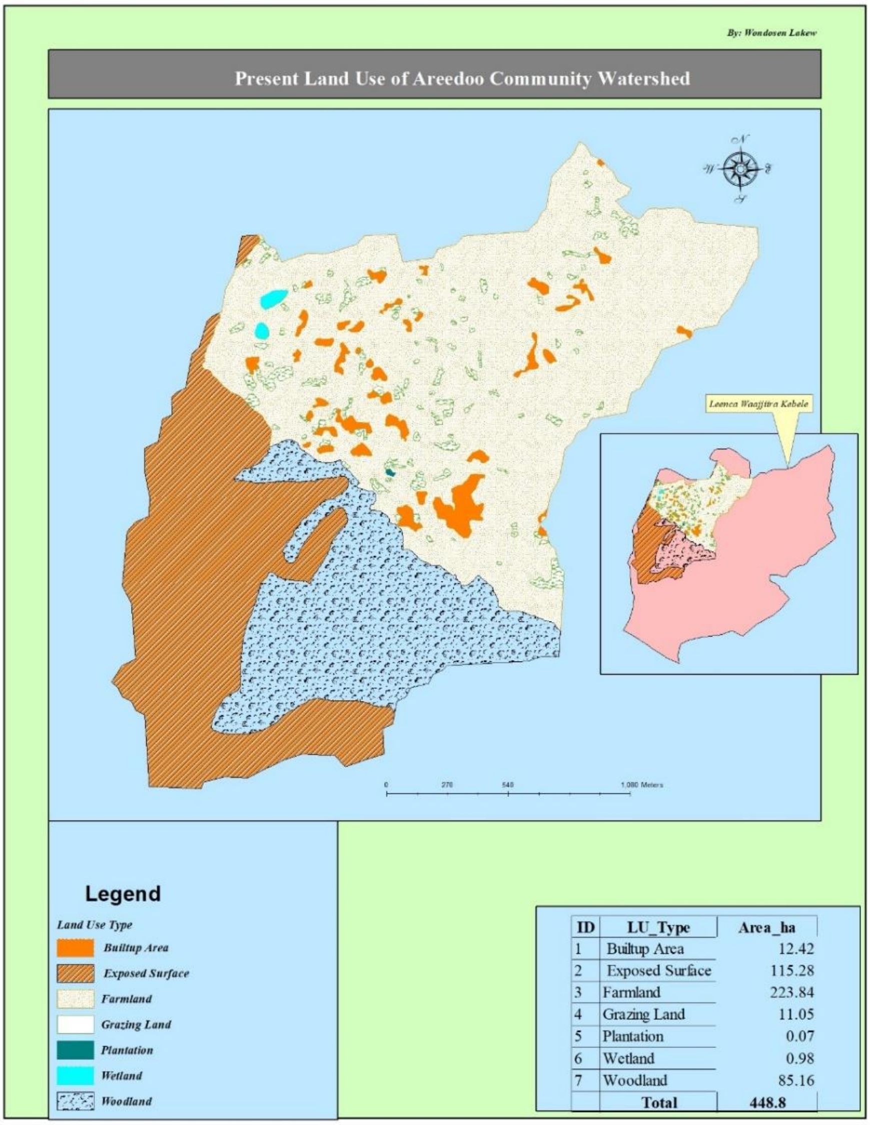

Figure 8. Land use land cover map.

3.2.2. Major Soil Types of Arado Watershed

The major soil types of watersheds in area (ha). Chromic Luvi Sols 286 ha, Eutric Cambi-Sols 99 ha, Eutric Phluvi Sols 2 ha, and Rocky Surface 62 ha.

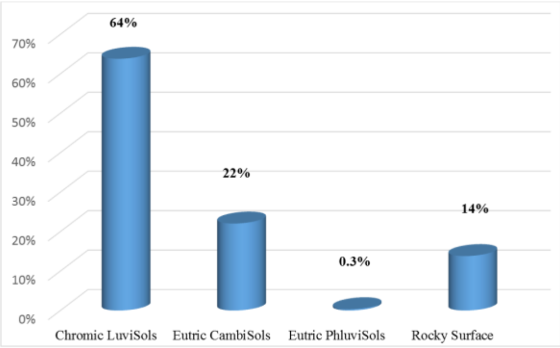

***Figure 9**. Major soil types of watershed.*

3.3. Major Constraints in the Watershed

The farmer's respondents were asked what they perceived as major constraints to their agricultural production.

Land and soil related & Production related constraints

Soil erosion, soil fertility, deforestation, land shortage, and climate change, Agricultural inputs (time, price, fertilizer etc), Crop productivity, Crop disease and Storage pests.

Livestock related constraints: Feed and fodder, Grazing system and Animal disease

Major resources potentials and opportunities are existed in the watershed for development. Those resources potentials and opportunities are: Suitable agro ecology, availability of labor force, all weather road, forest resources, transport service, sand and coble stone (mining), informal institutions (dabo/guza), artificial lakes/ponds, schools, health center, river, youth and women associations, farmers' cooperatives, livestock resources, and market access.

***Table 26**. Major constraints in the watershed.*

Major constraints in the watershed	Frequency	Percent (%)	Ranking
Soil erosion	18	14.9	1st
Deforestation	16	13.24	2nd
Soil fertility	13	10.72	3rd
Feed and fodder	11	9.11	4th
Agricultural inputs (time, price, fertilizer etc)	10	8.33	5th
Crop productivity	9	7.41	6th
Land shortage	8	6.62	7th
Climate change	7	5.83	8th
Grazing system	6	4.92	9th
Crop disease	5	4.1	10th
Storage pests	5	4.1	11th
Animal disease	4	3.3	12th
Credit access	3	2.5	13th
Employment opportunity	3	2.5	14th
Inflation	3	2.4	15th
Total	121	100	

***Table 27**. Major potentials /opportunities in the Watershed.*

Major potentials & Natural resource	Frequency	Percent (%)	Ranking
Suitable agro ecology	18	14.9	1st
Availability of labor force	16	13.2	2nd

Major potentials & Natural resource	Frequency	Percent (%)	Ranking
All weather road	13	10.7	3rd
Forest resources	11	9.1	4th
Transport service	10	8.3	5th
Sand and coble stone (mining)	9	7.4	6th
Informal institutions (dabo)	8	6.6	7th
Artificial lakes	7	5.8	8th
Schools	6	4.9	9th
Health center	5	4.1	10th
Permanent river	5	4.1	11th
Youth and women associations	4	3.3	12th
Farmers cooperatives	3	2.5	13th
Livestock	3	2.5	14th
Market access	3	2.4	15th
Total	121	100	

4. Conclusions

The study was collected the existing baseline data from Kersa, Babile and Meta district watersheds. The data was focused on the socioeconomic characterization of the production systems and resource use and management patterns. Constraints and opportunities of natural resources management in selected watershed were identified, documented and prioritized. The major constraints HHs; soil erosion, soil fertility, deforestation, land shortage, climate change, agricultural inputs (time, price, fertilizer etc)**,** crop productivity, crop disease, pests, feed and fodder, grazing system, animal disease were identified. The major opportunities in the watershed identified: suitable agro ecology, availability of labor force, all weather road, forest resources, and transport service. The researchable issues for interventions in the watershed were identified, based on the assessment results the following recommendations given below.

5. Recommendations

Intervention area for Future Research/Recommendations are;

1. Soil fertility improvement and management:
   1) Characterization of soil chemical and physical properties and parameters.
   2) Introducing of organic fertilizers preparation and application system to increase integrated use of organic and inorganic fertilizers use.
   3) Promotion of bio fertilizers and vermi-compost technologies to enhance soil fertility.
   4) Providing awareness creation for farmers on preparation of organic fertilizers.
   5) Promotion of inter cropping and others.
   6) Promotion of compost preparation to enhance soil fertility.
2. Soil and water conservation and watershed management:
   1) Rehabilitation of degraded lands activity (using Physical and Biological).
   2) Promote different agronomic and physical soil and water conservation measures based on their agro-ecology.
   3) Promotion of integrated conservation agriculture and
   4) Promotion low-cost gully and degraded land rehabilitation.
   5) Introduction of model watershed development for enhancement of soil fertility. Creating awareness on maintenance of damaged soil and water conserving structures to increases their sustainability.
   6) Introducing different water harvesting technologies in the watershed.
   7) Demonstration and awareness creation on farm in-situ water harvesting practices.
2. Agroforestry and plantation forestry, forage development and forestry practices.
   1) Promote multipurpose fruit tree species in the watershed.
   2) Introduction of agroforestry practices in area.
   3) Integration of multipurpose trees with crop production.
   4) Awareness creation on effects of deforestation and forest degradation on climate change.
   5) Demonstrating of multipurpose tree integration with

other cash crop like fruit tree.

6) Integration of forage trees with crop production for animals.

Abbreviations

CALM P4R	Climate Action through Landscape Management Program for Result
SWC	Soil and Water Conservation
SSA	Sub Saharan African
NRM	Natural Resources Management
HH	House Hold
SPSS	Statistical Package for Social Science
CSA	Central Statistical Agency
DA	Development Agent
Ha	Hectare
NPS	Nitrogen, Phosphorous & Potassium

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Author Contributions

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Conflicts of Interest

The authors declare no conflict of interest.

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