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ACRONMYS

ADO	Agricultural Development Office
CSA	Central statistics authority
PRA	participatory rural appraisal
HH	House holds
PA	Peasant Association
SWC	Soil water conservation
WSM	Watershed management

EXECUTIVE SUMMARY

The importance of multiple economic, social and environmental benefits derived from land based resources has increased in recent years. Sound management of these resources is therefore prerequisite to sustainable resource-based production systems.

Watershed management which in essence is the application of land resource management systems is considered by many to be the most appropriate approach to ensuring the preservation, conservation and sustainability of all land-based resources and improving the living conditions of people in the uplands and lowlands. Integrated Watershed management with participation of all the relevant key actors has become widely accepted as the approach best suited for sustainable management of renewable and non-renewable natural resources in upland areas.

The report contains all the detail components of the existing Watershed conditions of the specific study area as a micro-catchment level, especially focused on the command land and its nearby surroundings, methods, and objective of the study, its existing land use pattern. Climatic situation and the topographic features with the present status of vegetation cover are also stated out. More-over the soil type and major Watershed problems with their relevant solutions are included in the study report.

Water for irrigation can be abstracted by gravity systems from river source. Gravity abstraction system will be done directly by diverting the river water with or without regulating structure based on the elevation difference between the river bed and the command area.

Strategies and selected techniques for integrated Watershed management are briefly discussed. These include vegetative or agronomical practices (tree planting, grassland improvement, controlled grazing, vetiver grass, mulching, re-vegetation, area closure and grass strip) and the Engineering measures or structural practices (check dam cutoff drain; gully rehabilitation, waterway and bund construction. In general the proposed HadhesaWatershed covers a total size of **81 km^2** which is short and narrow nature.

1 INTRODUCTION

1.1 General

Unsustainable land-use, in combination with Hadhesa Watershed steep topography, fragile soils, and climate, is the driving cause of soil erosion. Unsustainable land-use practices include deforestation, agricultural expansion into fragile ecosystems, over-cultivation, overgrazing, and poor road construction. High demands for arable land results in extensive deforestation, reducing the total forest cover.

Deforestation is most severe in the northwest of the country, where farming of very steep slopes has resulted in catastrophic erosion and slope failure. Acute land scarcity has led to the over cultivation of land. Fallow periods have grown much shorter or have become non-existent. In many cases, cultivation periods have been extended, up to two to three times per year, with very limited soil inputs or soil conservation measures. Over-cultivation has had a major impact on reducing soil fertility and productive capacity. Farmer response to offset low production yields by over-cultivation that only worsens land degradation. A practical way to break out of this cycle is to increase both soil nutrient capital and soil organic matter through the simultaneous application of organic inputs (e.g. animal manure) and chemical fertilizers.

Despite government efforts to reduce the size of cattle herds, overgrazing remains a serious problem. Overgrazing is characterized by a significant reduction in plant cover, soil organic matter content, and soil biological activity. As a consequence, there is increased exposure to erosion by rainfall, which degrades the soil physical structure and reduces soil nutrients.

Agriculture practiced on the slopes of hills and mountains caused land degradation and soil erosion. The increasing levels of soil erosion and reduced soil fertility in mountainous areas of the proposed Watershed have resulted in ecosystem degradation, lowered agricultural yields which severely impacted on farmers' livelihoods and their economy.

The scope of this study includes the general presentation of existing Watershed problems and the proposed management practices and strategic attempt to promote natural resources management that would be acceptable by farmers and promotes the livelihood of the Watershed inhabitants as well as increasing the base flow of Hadhesa River. In general, this Watershed management study at feasibility level has been conducted in February 2018 basing on the acquired geophysical, biophysical, socio-economic information as per the agreement made between BBG, Engineering, P.L.C and Oromia Irrigation Development Authority.

1.2 Objectives

1.2.1 General objective

The Watershed study aims generally on management of the land surface and vegetation so as to conserve and utilize the water that falls on the Watershed, and to conserve the soil for immediate and long term benefits to the community. Besides water it also aims at wise utilization of natural local resource for improving agriculture and allied occupation.

1.2.2 Specific Objectives

- ❒ Study the existing land use land cover to understand socio-economic and ecological problems and potentials;
- ❒ Investigate soil erosion and potential sediment transport to downstream particularly to proposed weir site;
- ❒ Take information from the socio-economic assessment on socio-economic situation in the Watershed;
- ❒ Identify existing and potential problems related to soil erosion, land degradation and socioeconomic problems that should be addressed in the short and long-terms;
- ❒ Identify Soil and water conservation measures in conjunction with overcoming the problems and enhancing sustainable land productivity and agricultural production;
- ❒ Prepare alternative land use plan to fill identified gaps on land and natural resources management; and
- ❒ Design appropriate Watershed management plan

2 METHODOLOGY AND APPROACH OF THE STUDY

Prior to starting the assessment, checklists and questionnaires were prepared. The checklists and questionnaires were designed for the assessment of both secondary and primary data on geophysical, biophysical and socio- economic issues at different levels. The study has strictly used the prepared checklists and questionnaires. Basic data of the geophysical and biophysical situations of the Watershed, social and economic environment were collected using different methods and tools. The data encompasses qualitative, quantitative and descriptive information about the geophysical, biophysical and socio-economic situation. Information on the existing National and Regional governments' policies, strategies, and proclamations related to natural resources management was collected. The method employed in collecting primary and secondary data and analysis of problems is discussed below:

2.1 Data Collection

2.1.1 Secondary data collection

The assessment was focused on qualitative and quantitative data collection. As related to quantitative data collection, secondary data were collected from different government offices including district and Agriculture Development centers, Environmental Protection, and Water Resources, and Health Offices. National and International literatures related to the required area of assessment have been cited and reviewed.

2.1.2 Primary Data Collection

Information assessment based on participatory rural appraisal (PRA) has been applied to collect qualitative data. Discussions were conducted with individuals who are working to facilitate and support development at district and community levels and some focus groups from the agricultural community and other development oriented institutions that have stake in the project area. The following major topics were raised to initiate discussions amongst the discussants.

- ❒ Major socio-economic activity of the community;
- ❒ Land holding, land distribution and land tenure issues;
- ❒ Farming practices including use of organic and inorganic fertilizers, chemicals and improved seeds;
- ❒ The role of the community in Watershed management;
- ❒ Community reaction to the proposed project;
- ❒ Participation of women in development activities; and
- ❒ Other means of income generation activities.

In addition, the surveyor undertook field observations in the Watershed is with consideration of Agro-ecology, soil, topography, deforestation and soil erosion situations. Discussions were also conducted with target community members, Extension workers, district level professionals.Furthermore, the assessor had opportunity to observe past erosion and land degradation situation in addition to the secondary data.

2.1.3 Data Analysis Methods

Land capability classes were the major methods used in analyzing the Watershed problems, potentials and selection of Watershed management options because effectiveness of interventions often depend on land capability classes which is always governed by major irreversible natural factors such as climate, topography soil system etc. Looking into this would enable to understand existing socioeconomic problems and potentials and diversification options for intervention during preparing Watershed management strategies and plans.

3 DESCRIPTION OFWATERSHED

3.1 Location

Hadessa irrigation project is found in Oromia Regional State, Arsi Zone, Shirka District and Jawiwachu and Sojisade kebeles. The Watershed is found at 7⁰32’0” to 7⁰36’0”N and 39⁰20’0” to 39⁰32’0”E and it has different land forms ranging from Flat or almost flat, gentle slopping, undulating plain, Rolling plain and Hilly plains with localized steep slopes with an elevation ranges 1924 to 2065masl minimum and maximum elevation respectively. Moreover, the project site is far 20km distance from district capital.

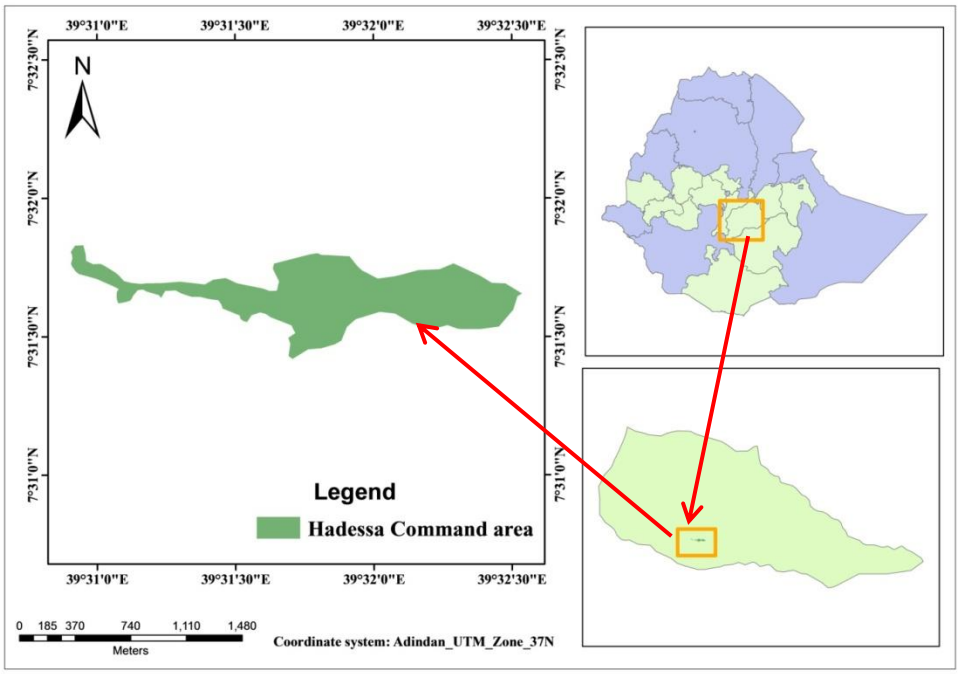

Figure 3-1: Location of Command Area

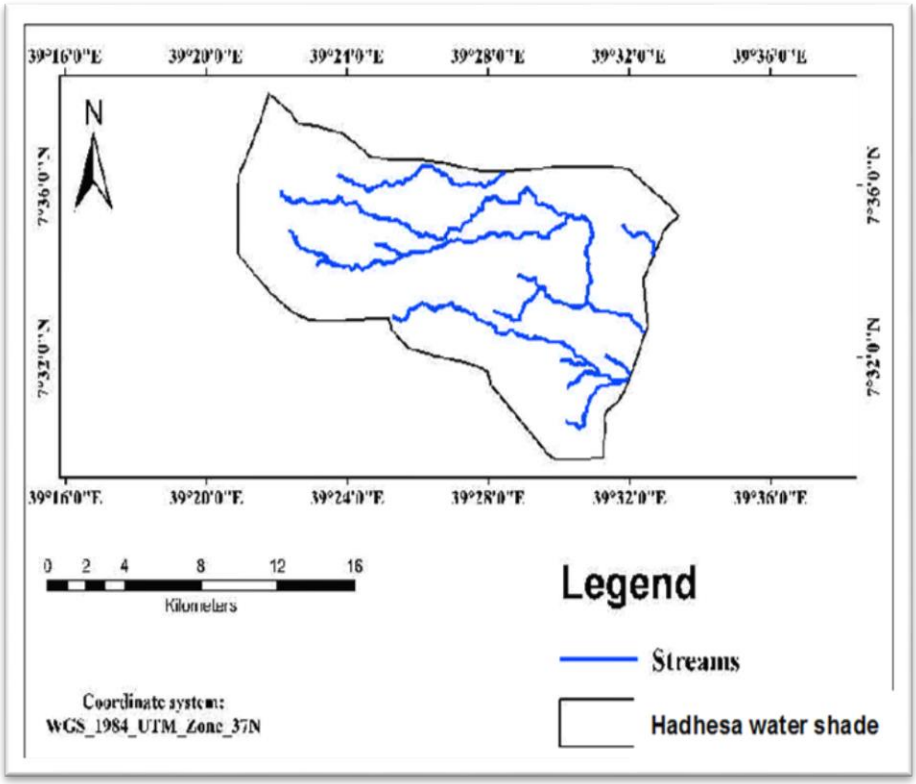

Figure 3-2: Map of Hadesa Watershed area

3.2 Climate

Climate is the important factor determining the success or failure of agriculture. It influences agricultural operations from sowing of crop to the harvest and particularly rain fed agriculture depends on the mercy of the weather. The crops are to be sown at the optimum period for maximum yield. In dry lands, the time of receipt of rainfall decides the sowing date. The study of climate helps to minimize the crop losses due to excess rainfall, cold/heat etc. It helps in forecasting pests and diseases, choice of crops, irrigation and other intercultural operations through short, medium and long-range forecasts. It helps to identify places with same climatic conditions (Agro climatic zones). This will enable to adopt suitable crop production practices based on the local climatic conditions. It also helps in the introduction of new crops and varieties, which are more productive than the native crops, and varieties. Ticho meteorological Station is the nearest station from which the climatic data were inferred.

3.3 Rain fall

Precipitation refers to the water (moisture) received in the form of rain, snow, hail, fog, dew or a combination of them. However, rainfall is the most important form of precipitation in the tropics and subtropics in which its efficiency is measured by its yearly amount, distribution and duration.

The area is characterized by bi-modal rainfall pattern that extends from April to Mid-November with dry spell period in mid-November to mid-march. However, as it was described by the farmers, the rainfall of the area is characterized by late onset and early offset as well as inadequate in its amount. Even though the area is characterized by bimodal rainfall pattern, the moisture obtained during the short rainy season is not enough for crop production. Therefore, the total average annual rain fall is calculated to be 1265mm. Maximum rainfall occurred in the month of August which is 165 mm as shown in Table 3-1

Table 3-1 Monthly and effective rain fall

Month	Rain (mm)/month	Eff rain (mm)
January	46	42.6
February	87	74.9
March	135	105.8
April	155	116.6
May	101	84.7
June	95	80.6
July	157	117.6
August	165	121.4
September	144	110.8
October	103	86
November	54	49.3
December	23	22.2
Total	**1265**	**1012.5**

3.4 Temperature

The prevailing temperature considerably influences selection of crops and their growing periods. The optimum temperature plays an important role on the growth period and the production of crops. The mean maximum annual temperature of the area is 20.9^0c and the mean minimum annual temperature is 5^0c, in the month of January December respectively as illustrated in Table 3-2. Thus, in command area mostly low to moderate temperature ranges are occurred which is favorable for the growth of various crops in the area.

Table 3-2: Monthly average temperature in project area

Months	Min Tem(°c)	Max Tem(°c)	Average Temp(°c)
January	6.2	20.9	13.55
February	7.2	21.6	14.4
March	8.0	21.2	14.6
April	8.9	20.2	14.55
May	9.0	20.7	14.85
June	8.1	20.8	14.45
July	8.4	19.5	13.95
August	8.1	19.1	13.6
September	8.1	19.3	13.7
October	7.5	18.7	13.1
November	5.9	19.2	12.55
December	5.0	20.2	12.6

3.5 Morphology

The major landform in the Watershed include flat, gentling slopping to undulating and rolling to steep sloppy hills as depicted in table 3-3 below. the average slope of the Watershed is determined from the topographic map of scale 1:50,000 and is estimated to be about 0-3% with flat or almost flat, 3-8% gentle slopping, undulating plain, 8-15% rolling plain and greater than 15% slopes is characterized by hilly plains with localized steep slopes.

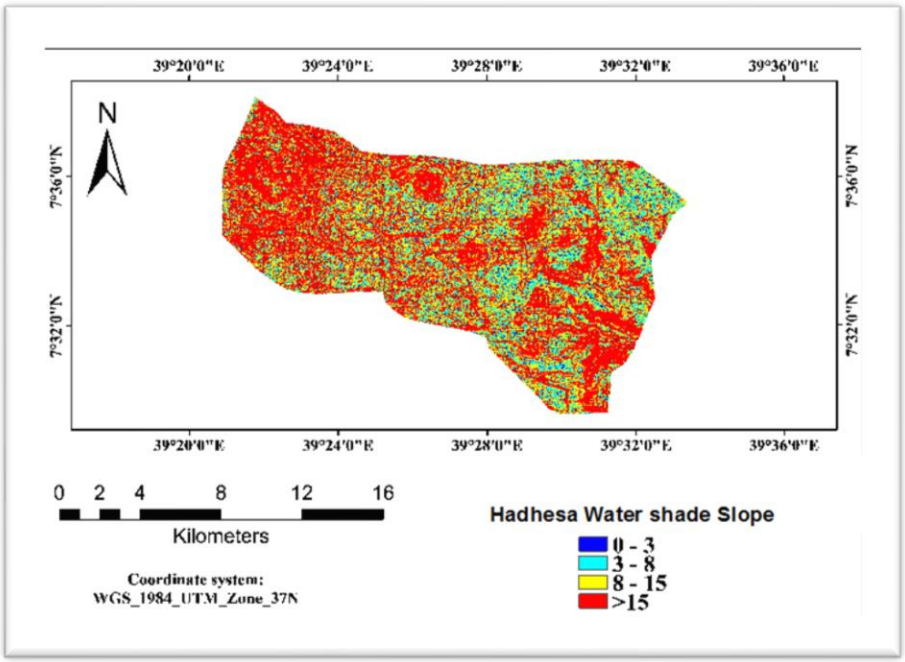

Figure 3-3 Map of Hadessa Watershed slope

Table 3-3 Land form, land slope and area of Watershed

SN	Slope Class (%)	Land form	Area (ha)	(%)
1	0 -3	Flat or almost flat	1215	15
2	3 -8	Gentle slopping, undulating plain	1215	15
3	8-15	Rolling plain	1620	20
4	>15	Hilly plains with localized steep slopes	4050	50
	Total		**8100**	**100**

3.6 Geology and Soil

3.3.1 Geology

Hadessa weir and canals site investigation report of geologists' describes that the proposed Watershed, which is a sub basin of Shebele, is dominated by a huge volcano system. It corresponds to the eruptive events that occurred during the early Miocene to Pliocene period and classified in the shield group basalt. The common rock type for this material is basalt with large amount of interbeded scoraous lava, volcanic ash and other acidic rocks such as rhyolite and trachyte with rare ignimbrites. Agglomerates and paleo-soils are also common. At the bottom of the Watershed, the area is completely overlain by recent flood materials, which are mainly covered by silt to clayey deposits.

3.3.2. Soil

Geology, climate and vegetation have been the major soil forming entities active in the Watershed area. Vertisols is the soils of this category are mostly deep to very deep, imperfectly to poorly drained, dark grey, dark yellowish brown to black clays. They have surface mulch and mostly well developed slickensides in the lower part of their horizons. These soils are mostly formed on flat plains, the clay fraction of which is dominated by expandable ratio of 2:1 lattice clays (montmorillonite), with or without gilgai. The gilgai micro relief is manifested as a series of hollows and mounds. The soils are deep to very deep, very poorly drained, medium to heavy textured, dark reddish brown in the top soil and dark grey over dark gray to dark reddish brown in the substratum. The profile development of these soils is generally weak to moderate. Topsoil structure is weakly to moderately developed, sub-angular blocky over massive subsoil. Consistence is hard to friable (moist) sticky and plastic (wet) throughout.

Cambisols;- these major soil units are well, moderately well to somewhat excessively drained, shallow to deep, light to heavy textured, with variable colors. The soils are formed on a wide range of parent materials and colliuvial /alluvial materials derived from these rocks. The soils have a moderately developed subsoil horizon, which is only in an initial stage of development. Structure is weak to strongly developed angular blocky, occasionally prismatic in the topsoil over moderate angular blocky to massive in the subsoil. Consistence is hard when dry, friable to firm when moist and slightly sticky and slightly plastic when wet. The soils have favorable physical characteristics depending on topography and climate, thus they are intensively to moderately cultivate for peasant subsistence agriculture in the basin.

Fluvisols:- these soil groups are found adjacent to the main rivers and streams, that are subject to annual flooding, receiving fresh sediments from each flood. Therefore, the soils show very little or no profile development. The soils are moderately deep to deep, poorly to imperfectly drained, medium to light textured and are stratified. Their color is variable differing from yellowish brown to dark reddish brown.

Leptosols:- These soils observed mainly, where steep main rivers and stream channels and steep hill and mountain side slopes are prominent in the basin. The soils are generally young, which are limited by their topsoil horizon over an initial development of subsoil horizon or directly over an altered parent rocks from which they have developed. Soil depths are shallow to very shallow with limited profile development and thus are usually prone to draught. They are excessively to somewhat excessively drained, reddish brown to dark reddish brown to very dark reddish brown. Structure is mainly weak to moderately developed, fine to medium sub-angular blocky. Consistence is friable (moist), slightly sticky and slightly plastic (wet).

Apart from offering limited grazing resources, they have little sustainable agricultural potential, although some are currently cultivated. The susceptibility of these soils to erosion is one of the reasons, which precludes their sustained use for agriculture. The soils are cultivated out of sheer necessity exacerbating the existing serious erosion problem. The Leptosols might have developed on a relatively young surface and were probably only moderately deep to deep by origin. However, since they occur on steep slopes, they are exposed to high degree of erosion, which is responsible for further decrease in depth.

Luvisols:-the soils are developed in the basin only in well drained areas at higher altitude. They are mainly developed in variable parent materials on sandy-granite colluvial in-situ on limestone parent rock (Gibaba area), and in the south of the basin on sandstone plateaux of Duhum, Elkere and north westernGinir. The soils are generally well to moderately well drained, moderately deep to deep predominantly heavy textured clays, with sandy clay subsoil over soft weathering rocks, if shallow and moderately deep. Structure is moderately developed medium sub angular blocky over moderately to strongly developed medium to coarse sub angular blocky. Consistence is hard (dry), friable to firm (moist), sticky and slightly plastic (wet). They are non calcareous. The soils have good workability. The soils are used mainly for cultivation of maize, sorghum, chat, beans and vegetables. Top soils are dark brown grey and dark reddish brown over brown sub-soils

3.5. Length of Growing Period Analysis

As indicated in the above climate condition of the specific study area, tropical moist climate is the most preferable term for this area. Rainfall occurs for six months of the year (which is commonly known as Kiremt). According to the climatic data heavy rain occurs over longer periods, between the months of May to October heavy rain will be occurred. Other aerodynamic factors such as average monthly relative humidity (%), sunshine (hrs/day) and potential evaporation ETo (mm/day) are basic indicators of this demarcated agro climatic condition of the project area. Basically the altitude of the command area falls between 2065 to 2443 m.a.s.l. This shows that the area falls in to the Weyina-dega agro-climatic zone. To this effect the type of crops to be produced in this area is tropical moist crops and illustrated in Table 3-4.

Table 3-4 Length of growth period class

No	LGP(Days)	LGP Description	LGP Code
1	< 45	Arid	LGP1
2	46 - 60	Semi-Arid	LGP2
3	61-120	Sub Moist	LGP3
4	**121-180**	**Moist**	**LGP4**
5	181 - 240	Sub humid	LGP5
6	241- 300	Humid	LGP6
7	>301	Per Humid	LGP7

Therefore, the proposed Watershed area failed under121-180 LGP which is sub humid nature.

3.7 Land Use and Land Cover

3.7.1 Land Use Pattern

The farming system in the Watershed is mixed with dominantly oxen plough cereal crop production and livestock rearing. Accordingly, the major land use types in the Watershed include food crops cultivation, grazing, very spared and patches of shrub/bushes, manmade plantations, settlement and miscellaneous lands. Based on primary and secondary data calculated and readjusted by the feasibility study professional, about 76.54% of the total land is under food crop cultivation, 2.47% grazing land and bush/shrub lands, 1.48% occupied by manmade and natural trees plantation, 2.22% also occupied by settlement.

Table 3-5: Land use pattern of Watershed

SN	Land use	Kebele Area in (ha)	Area (%)
1	Cultivated land	6200	76.54
2	Grazing/pasture land	200	2.47
3	Forest land	180	2.22
4	Bushes and shrubs	120	1.48
5	Settlements	800	9.88
6	Others	600	7.41
	Total	**8100**	**100.00**

Source: *_District Agricultural Development Office*

3.7.2 Vegetation Cover

It is well understood that Vegetation in a Watershed plays multiple effects that include intercepting raindrops, reducing surface runoff, and there by control erosion, maintain soil fertility and maintain the microclimates. It also helps to enrich ground water resources. Hence, in this Watershed, the vegetation cover is found in good conditions and along farm boundaries intensive cultivation and bushes and shrub vegetation in northern and eastern hillsides. Economically and ecologically important indigenous trees are covered in the middle and at foot of the Watershed. Nevertheless, the existing forest coverage becomes decline from time. This is because peoples living in the Watershed are highly dependent on forest resources. They used for firewood, construction, charcoal making and the like. Moreover, rapid population growth fevers for expansion of cultivation land also and to use marginal lands for cultivation of crops. On the other hand, since livestock grazing systems is traditional the soils are exposed to erosion.

Table 3-3: Major tree species in the Watershed

No	Vernacular Name	Scientific name	Remark
1	Bargamoo	*Eucalyptus spp.*	Used for fuel and others
2	Gatirraa	-	Used for timber purpose
3	Seritii	*Asparagus Africana*	Used for medicinal purpose
4	Bakkanniisa	*Croton macrostachys*	Used for different purpose
5	Ejersaa	*Olea Africana*	Used for timber purpose
6	Bush and shrubs	*Different bushe& shrubs*	Used for fuel and others
7	Others	*Different spp*	Used for different purposes

3.8 Water Resources Situations

Hadessa River is collects water from one small permanent river in the Watershed area on the way flowing to the diversion weir site. Collecting water from the feeding streams, the stream discharges design flood of **134.73m³/s** at the diversion weir site. The proposed diversion water amount is **140l/s**, which shows that the proposed project has potential for irrigation development. The estimated surface runoff sediment deposits and coefficient is presented under the irrigation design section of this report volume. Very large part of the sediment is often deposited in the river bed and surrounding low laying areas.

Photo 3-1: Proposed Hadessa river flows

3.9 Extent of Soil Erosion

The major Watershed problems in developing countries are flood, sediment, erosion damage, water management problems and other special problems caused by various factors such as climate variability, deforestation, over population etc. To describe the flood damage, information on amount and value of land exposed to the flood hazards in the Watershed; frequency of flood occurrence; significance of small frequent flood or large infrequent flood in total flood problems; limitations; and other pertinent problems are considered.

The problem of sediment damages considered in the context of the following cases: reservoir sedimentation, channel silting, drainage, irrigation development, and loss of agricultural land. The problem of erosion damages studied under the following contents: extent of sheet erosion; gully and channel erosion; downstream damage due to sediment deposition; effects on agricultural production due to erosion; and general effects on Watershed

3.10 Experiences in Soil and Water Conservation

Reported applied major SWC technologies that have been observed in the Watershed includes, soil bunds, stone bunds, hillside terraces, check dam, and cut-off drain. In addition, indigenous SWC have been practiced in the Watershed area. Some of these include traditional farm-ditches, water draining channels; traditional waterways contour farming, crop rotation, application of manure fertilizer, management of scattered trees on croplands, and grass strips along the farm boundaries. In general, importance and advantages of those traditional SWC practices are categorized under three groups;

1. Soil fertility improvement,
2. Safe removal of excess run-off from farmlands, protecting farmland from run-on coming from up slope lands. The location and design of these indigenous SWC varies with land use, topography, and orientation of the farm plot and availability of run-off disposal areas. Traditional cut-off drains are mostly located at the upper edge of the farm boundary, while traditional waterways are located along the farm boundaries where the boundary are along slope of the land, regardless of the slope steepness and orientation. The size of the structures is small and the gradient is too steep. In most cases, the traditional ditches are temporary structure that is constructed every rainy season.

The indigenous SWC measures are not able to control soil erosion and gulley formation but have contribution to reduce soil erosion and control run off and flood. However, some physical structures such as traditional and even technology based cut-off drains, and farm ditches are aggravating soil erosion problems both in the constructed lands and in adjacent farmland. This problem was occurred due to high run off and lack of proper. Some gradient of these structures is very steep that is almost along the slope, consequently, this has resulted in scouring effects and formation of gullies along the farm boundaries.

In some cases, run-off overtopped due to minimized cross-sections of the structures and lead to serious soil erosion on low-lying lands. Some farmers also dispose run off on to any type of open areas, which has created rock outcrops. The traditional waterways, which are supposed to carry a large amount of runoff from traditional cut-off drains and farm ditches, are bare gullies without check dams, grasses or stone paves. As per the farmers view, these were happened due to land fragmentation, lack of disposal areas and unwillingness of some farmers to accept and pass run-off coming from upslope and adjacent lands. However, during survey, there is no as such physical measures that have been implemented before on the ground.

3.10.1 Socioeconomic Base

The socio-economic base of the people in the Watershed is agriculture. Farmers of the Watershedarea follow mixed farming system, which comprises field crop production and livestock rearing. But, crop production receives more attention particularly in the southern part than livestock rearing because required grazing land shortage. Crop production is carried out dominantly with food crop cultivation in the central and southern most parts while livestock rearing dominates in the northern areas where patches of shrub lands and hill slopes exist. The crop products are the major source of income followed by livestock. Majority of the HHs practice primarily crop cultivation while the rest minority conducts both on closely equal basis. There is no off-farm income earning means such as small scale trading, handicrafts and daily laborer employments.

3.10.2 Population and Human Settlement Pattern

A survey trial was made to collect information on socio-economic conditions in the Watershed using participatory rural appraisal tools. Informal and random discussions with community members were conducted during the information assessment. Community members of different social groups, including women participation, were purposely contacted. Group discussions and consultations with the representatives of communities, development agents, experts and heads of wereda Agricultural development offices have been conducted to have more understandings on common interests of the community. The socioeconomic data were collected from development agents working in the Watershed. Some information has also been obtained from wereda water Resources development and irrigation experts. The aim was to cross-check the findings with formal statistic information from the Ethiopian Central Statistics Authority (CSA). However, the demographic information acquired from the wereda is used due to the fact that the information collected from the district is not the recent data.

The total population that extracts its livelihood from the Watershed accounts for over **1296 H.H**, which is organized into **10016** families in Jawiwachu and Sojisade PAs. The average family size is about **6** persons per household. The general nature of the settlement pattern is rural and traditional, which is sparsely scattered throughout the area. The villages are located on the escarpments, foothills and among farming areas of the Watershed. The settlement pattern is considered to be less advantageous from the Watershed management aspects. Because homesteads may affect spatial planning of land management activities on one hand and the homestead are not convenient for provision of social services like water and electricity supply.

Table 3-6 Population number in the Watershed

Kebele	Population of the study area						Households		
	2007 census result			Projected population(2018)					
	Male	Female	Both	Male	Female	Both	Male	Female	Both
Jawiwachu	1578	1540	3118	2184	2132	4316	478	123	601
Sojisade	2035	2083	4118	2817	2883	5700	591	104	695
Total	3613	3623	7236	5001	5015	10016	1069	227	1296

Source: CSA, 2007 based and District Sector Offices

3.11 Existing Farming System

The farming system in the Watershed area comprises field crop production, livestock rearing and coffee production. Agriculture is the main economic base of the community in the Watershed. Crop production dominates over livestock rearing particularly in the central and southern areas of the Watershed. The results of household survey show that coffee production is the major source of income followed by livestock. Majority of the people practices crop agriculture and the rest practice both crop and livestock husbandry on equal basis.

The economic extraction in the Watershed is therefore fully depends on agricultural production and forest coffee production. Food crop cultivation dominates in allover Watershed area to the fact that human population that require daily food is exponentially growing, for which all possible spots of land has to be cultivated. This has been done in the Watershed if not in district wide that livestock grazing areas have been converted to food crop cultivation. The field crops production system focuses on production of cereals, pulses, and oil crops. Its trend is oxen operated traditional subsistence agriculture..

3.11.1 Crop Production

Cereals and pulses such as maize, tef, wheat, barley, wheat oil crops and pulse crops are the major annual crops that grown in the Watershed. Likewise, forest coffee production is the very common practice which is the source of income for most of the district farmers. The distribution and diversification of crops vary with size of land holding of the farm HHs. Although, the reported current productivity of land for some selected crops is depicted on Table 3-6.

Table 3-6: Major Rain fed Crops in the Watershed

No	Crop type	Land preparation (months	Sowing (month)	Harvesting (month)	LGP, Days
1	Tef	June	Mid-June	Mid – Oct	150 days
2	Maize	March	Mid-April	Late – Nov	150 days
3	Sorghum	March	Late-March	Late- Dec	180 days
4	Wheat	May	Early-June	Early – Nov	150 days
5	Barley	May	Early-June	Early – Nov	150 days
6	Beans	June	Mid-June	Nov	130 days
7	Vegetables	June	June	Oct-Nov	120-140 days

***Source**: District Agricultural Development Office*

According to the results of the discussion with agricultural extension agents and farmers, the productivity of crops is decreasing year after year at alarming rate. The main responsible factors for the declining trend of the agricultural productivity include, but not limited to, soil erosion and progressive decline in soil fertility, decreasing farmland size, variability of rainfall and limited access to and limited use of improved agricultural inputs.

In project area there is no any saving and credit associations through which households get agricultural inputs by credit and access to market for their agricultural produces. The crop calendar in the Watershed is also identified through discussion with the community members and extension workers. Farming operation and crop production process is carried out throughout a year. Land ploughing is done by traditional farm implement known as maresha and ox power, which cuts soil in shallow depth and very small width. The cultivation frequency reaches 3-4 times for cereal crops and 2-times for pulse crops. Out of the four times ploughing before a crop seeding, half of the ploughing is conducted across slopes because along slopes plough only could not meet fine tilting of the earth. This ploughing across slopes contributes to soil erosion.

3.11.2 Livestock Production

Livestock production is one of the means of livelihood of the people next to crop production in the district and around the project area. But in the project area crop production is widely practiced than livestock production. About 75% of the lively hood of the community generated from crop production and the remaining 25% only from livestock production. The area is reputed for its livestock production but the community doesn't consider livestock holdings as a prestige in the district. The domestic animals found in the district are cattle, Goats, sheep, Horses, males, Donkeys, and chickens. Oxen are the only animals being used for ploughing in the district and around the project area. The sources of forage for the animals are natural grasses on communal grazing land both in dry and rainy seasons. Crop residue is also a source of feed in dry season after the harvest of crops.

There is a shortage of animals feed during dry season after the crop residues are removed until the rain begins to rain. Since free grazing is a common practice in the district after the harvest of crops, animals feed whatever they get searching over a large area of land and then drink water in dry season to overcome the problem of shortage of animal feed. There is also a shortage of grazing land in rainy season due to the fact that the farmers change grazing land to cultivated land from time to time.

Table 3-7: Livestock population in the catchment

Type of Livestock	Number found in the district	Number found in catchment	Remarks
Cattle	218588	2365	Indigenous type
Sheep	60368	500	Indigenous type
Goat	49937	395	Indigenous type
Donkey	2380	70	Indigenous type
Horse	1763	-	Indigenous type
Mule	16234	-	Indigenous type
Poultry	102539	3275	Indigenous & Breed type

***Source**: District Agriculture Development Office*

3.12 Firewood and Energy Supply

The Watershed rural households' major energy sources include firewood, cow dung, and crop residues. Most households get firewood from existing natural forest and private eucalyptus plantations around homesteads and along roads and foot paths. Collecting fire woods from nearby forest lands and requires few hours traveling particularly for those in the project areas. Most households have access to forest lands, because they are dependent on forest coffee production.

The existing natural indigenous forest gives them easy to collect fire woods from their surroundings. However, the cooking facility (stoves) is also traditional (open fire three stone feet stoves) that consumes more firewood because of high energy loss. These remain one of the most important factors that have been underlying to the prevailing deforestation rates and loss of economically and ecologically important trees. The long started energy saving closed stoves introduction and promotion efforts of agriculture development extension agents, however, have not widely practiced and the use of kerosene for cooking is hampered by the kerosene high price, which is beyond affordability of poor households.

3.13 Socio-economic and Infrastructures

The socio-economic infrastructures development in the Watershed is relatively good as compared to other rural areas in the country. Theses existed some socio-economic infrastructure include all whether and dry whether roads; town and rural water supply; school and health facilities and mobile telecommunication. All such social services are available in the Watershed and nearby areas. Local market places for agricultural produces exist in all PAs and towns in the vicinity that communities' are able to access to all socio -economic services.

Agricultural development centers with three different subject matter agents in each Peasant Administrations (PAs), health posts and health extension agents are also exist in each PA that farmers obtain agricultural and health advice services within their area and there is array of manpower to implement the proposed Watershed management plan. Nevertheless, an information record in all sector issues is scant. For example, there is no market information system other than personal contacts. Records on agricultural produces and marketing are similarly either none existent or very scant that information obtained from different sources remains different.

3.13.1 Food Security

Despite moderate deforestation and land mismanagement presented in the preceding sections, most people in the Watershed is food self-sufficient, except few landless HH, although it is difficult to generalize as people are food secure. This is to the fact that most families' agricultural produce subsist their family food need at least for 8 to 12 months a year. In addition to families food and their income source to meet social obligations also comes from sales of coffee and livestock products. Moreover, other sale of fuel wood, charcoal and honey also play significant role for livelihood of the community. However, at present food production and their income sources are continuously decreasing with the decrease in land productivity and people exponential increase on constant land area. This requires land productivity enhancement and creation of off-farm income sources. This Watershed management should halt the decline in crop productivity through arresting soil erosion and land degradation and enhancing soil fertility. Heavy dependence on rainfall farming should also be changed. Appropriate technologies for both improved agricultural production and land management should be implemented with possible off-farm opportunities.

3.13.2 Farmers Attitude

As related to the possible Impact of the proposed Watershed management Plan, agriculture professionals and farmers expresses that a well-planned Watershed management would save lands from degradation and hence restore the lands previous productivity and production. The farmers openly confess that they have damaged their lands although they are aware of that most of their actions and activities are damaging their land system. They rationalize the process of damaging their lands is unavoidable because of deep rooted and extreme poverty, which obliges them always to run for daily survival.

Steep slopes are cultivated for annual food crops without any investment to protect the lands from soil erosion and ecological disruption, because of cultivable land shortage. They agree to start combating the land degradation if low cost technologies are available to use and some material and technological supports available to cover issues beyond their capacity. In relation to the priority needs and constraints of the community, the focus group discussion has the following perceptions and feelings focusing on the social and economic constraints they face.

- ❒ Progressively increasing human and livestock pressure in the Watershed area;
- ❒ Soil erosion and land degradation as well as declining trend of land productivity and deepening poverty;
- ❒ Absence of additional or off-farm income generating activities;

All focus group participants are very much aware of the importance of sustainable management of natural resources and hence land productivity that enhances increased agricultural production. They also aware of the importance of agricultural inputs like organic and inorganic fertilizers, chemicals and improved seeds to increase crop yields. Nevertheless, they feel that the prices of inorganic fertilizers, chemicals and improved seeds are exorbitant and not affordable to the poor farmers in the Watershed. Preparation of organic fertilizers is being produced by many farmers in the Watershed with guidance from agriculture and rural development agents. In case of inorganic fertilizer, chemicals and improved seeds use, they report that provision of credit to buy inputs is not satisfactory.

3.14 Policy and Legislations

The Oromia Regional National State has issued a land use/land administration, proclamation, which is within the framework of Federal Proclamation 456/20051 (Rural Land Administration Proclamation of the Federal Government of Ethiopia). According to this proclamation and its reinforcement policy, land users are obliged to properly manage their lands otherwise they lose their ownership right. The people ownership right is referred to use right with no time limit 9 but with strong obligations to sustainably conserve and develop natural resources and protect the land from any land quality damage related to deforestation, overgrazing, soil erosion and other inappropriate use of land. This proclamation confirms that any citizen who is 18 years of age or above and wants to engage in agriculture for a living shall have the right to use rural land.

As a good action of this, farmlands inventory and registration have been carried out and certification of the land use right has been carried out to farmers in the Watershed on individual farmer basis. The proclamation also states that there will not be land redistribution after the land certifications except may be in irrigation lands. This would encourage the land users' sense of ownerships, and subsequently to manage their lands on sustainable basis.

The Rural Land Administration and Use Proclamation sets out the following points:

- ❒ Land is the property of the government and the people and not subject to sale or transfer;
- ❒ The rights, limitations and obligations of individual people to hold and use rural land;
- ❒ The rights, limitations and obligations of communities to hold and use rural land in common;
- ❒ The rights, limitations and obligations of Investors to hold and use rural land in common;
- ❒ The rights of transfer of land and of resources developed on that land to heirs,
- ❒ The rules regarding deprivation or termination of use rights,
- ❒ The rules regarding issuing ownership books, consolidation of holdings and redistribution of land
- ❒ The rules regarding the development of land use plans, irrigated land, resettlement

As related to the above mentioned regulations and policy, there are four types of land tenure systems namely individual ownership; communal ownership, contractual and share cropping of the different forms.

4 WATERSHED MANAGEMENT PROBLEMS

The major watershed problems in developing countries are flood, sediment, erosion damage, water management problems and other special problems caused by various factors such as climate variability, deforestation, over population etc. To describe the flood damage, information on amount and value of land exposed to the flood hazards in the watershed; frequency of flood occurrence; significance of small frequent flood or large infrequent flood in total flood problems; limitations; and other pertinent problems are considered.

The problem of sediment damage is considered in the context of the following cases: reservoir sedimentation, channel silting, drainage, irrigation development, and loss of agricultural land. The problem of erosion damage is studied under the following contents: extent of sheet erosion; gully and channel erosion; downstream damage due to sediment deposition; effects on agricultural production due to erosion; and general effects on watershed's economy. Water management problem includes details on irrigation needs, drainage, water supply required for agricultural and non-agricultural uses and other management needs. Special problems include landslide, all weather, erosion etc.

Table 4-1: Summary of Watershed problem of the study area

SN	Major problems	Root causes	Actual and potential impact
1	Deforestation	✓ Unwise utilization of natural resources ✓ Expansion of cultivation in to marginal lands	✓ Shortage of forest resources ✓ High workload on women in collecting fire woods fetching ✓ Reduced yield of water sources
2	Soil erosion	✓ Deforestation ✓ Overgrazing ✓ Improper land use practice ✓ Traditional type of farming system ✓ Ploughing steeply slope ✓ Rainfall temporal intensity and variability ✓ High human and livestock population pressure	✓ Diminished land holding ✓ Low land productivity ✓ Decline of soil fertility ✓ Shortage of forest resources and high workload on women in collecting fire woods and water fetching ✓ Loss of land due to gully erosions ✓ Sedimentation problems to low-lying lands and downstream ✓ Flood problems due to unchecked run off concentration in rainy seasons ✓ Reduced yield of water resources ✓ Reduced diversity of crops
3	Low land productivity& crop production	✓ Soil erosion and decline of soil fertility ✓ Low diversification of crops ✓ Poor cultivation practices ✓ Limited culture of irrigation ✓ Lack of agricultural inputs ✓ Relying on rain fed crop production	✓ High pressure on land and natural resources leading to low yield of crops and seasonal shortage of food and vulnerability to food insecurity ✓ Low income of households ✓ Seasonal migration of labor to potential areas
4	Low livestock production	✓ Shortage of grazing lands and poor management of available grazing lands ✓ Low productivity of grazing lands ✓ Shortage of forage	✓ Low income of households ✓ Low diversification of foods ✓ Enhanced poverty of households
5	Low-income of the households and increasing poverty	✓ Low diversification of income sources ✓ Poor saving habit and low access to saving and credit services ✓ Lack of knowledge	✓ Decline in assets reserves ✓ Vulnerability to food insecurity ✓ Labor migration ✓ Pressure on natural resources

5 LAND CAPABILITY CLASSIFICATION

Land capability classification in Ethiopia is the SWCR (Hurni, 1988) system, which is one of the most widely used systems. The method was modified from the USDA classification to suit the Ethiopian condition. In this method of land capability classification, the land is classified based on limiting factors, which directly or indirectly related to the situation of existing natural resources. Land capability classification could not indicate the land suitability for a crop that the productivity and economic potential are not part of it. The limiting factors are the once which has the worst condition in the range of slope and physical characteristics of the land.

The purpose of working out the land capability classification is to identify the land capability classes to use either for food crops or grazing or Forestry development without further deterioration of the natural resources .It also helps identify appropriate land management measures by showing the best suitable land use with each soil conservation requirements. In view of the above, land capability assessment for Hadessa Watershed has been carried out by using the SWCR (1988) land capability classification method including participatory land use manual of SLUF (October 2006).

The land resource data, which includes topography, and physical characteristics of the land are summarized and presented in Table 5.1. The Land capability classification was carried out for considerable number of mapping units classified by slope ranges and soil systems but difficult to retrieve all in small scale map.

The following are the major procedures for working out the land capability classification:

- ❒ Divide the Watershed area into mapping units based on the slope ranges
- ❒ Collect the physical characteristics of the land for each mapping unit and
- ❒ Determine the land capability classes by using the SWCR land capability classification methods.

Table 5-1: Descriptions of Watershed land capability classes

Slope ranges (%)	Soil type	Soil depth (D)	Past erosion (E)	Top soil Texture (T)	Drainage (W)	Infiltration (I)	Stoniness/ Rockiness (S)	LCU
0-3	Fluvisols	>100cm	Moderate (E)	Silt loam to sandy loam	Well drained	Moderate	Nil	I
	Chromic-Luvisols	>100cm	Moderate (E)	Silt loam to sandy loam	Well drained	Moderate	Nil	I
	Eutric-Leptosols	>100cm	Severe (E)	Silt loam	Well drained	Moderate	Nil	I
3-8	Chromic-Luvisols	100-150	Severe (E)	Clay loam to silty loam	Perfectly drained	Moderate	Nil	II-E
	Eutric-Leptosols	100-150	Severe (E)	Silt loam	Perfectly drained	Moderate	Fairly stony (10-15%) (S)	II-E
8-15	Chromic-Luvisols	100-150(D)	Very severe (E)	Clay to sandy loam	Perfectly drained	Moderate	Nil	IID,E,
	Eutric-Leptosols	50-100(D)	Very severe (E)	sandy silt	Perfectly drained	Poor (I)	Fairly stony (10-15%) (S)	II-D,E, I,w
>15	Chromic-Luvisols	50-100(D)	Very severe (E)	Clay to sandy loam	Perfectly drained	Poor (I)	stony (15-20) (S)	III-D,E, I,w
	Eutric-Leptosols	50-100(D)	Very severe (E)	sandy silt	Excessive	Poor (I)	stony (20-30) (S)	IV-D,E, I,w

Table 5-2: land use unit type

Soil conservation requirement class	I	II	III	IV	VI	VII	VIII
	Land suitable for annual crops				Landsuitable for Perennialcrops	grazing with specialmanagement andLand suitable forforestry	Swampyareas,river beds

Table 5:3: Descriptions of HadessaWatershed land capability classes

SWCRC	LCU	Slope Ranges (%)	Physical characteristics of Soils and limiting factors
I	I	0-3	✓ Soil depth over 150 cm ✓ Fluvisols, chromic Luvisols ✓ Nil erosion ✓ Perfectly to well drained area ✓ No limitations that restrict the choice of plants
I	I	3-8	✓ Soil depth 100-150 cm ✓ Slight Erosion ✓ Good infiltration ✓ Chromic Luvisols, EutricFluvisols ✓ Requires moderate conservation
II	ID,E,I	8-15	✓ Moderate soil depth ✓ Moderate soil erosion ✓ 50-150 cm Effective soil depth ✓ Moderate permeability of soils ✓ Clay to sandy and silty loam ✓ Suitable for crop production, but it requires SWC measures
III	III D,E,I	15-25	✓ Severe soil erosion ✓ Clay to sandy loam texture, poor infiltration ✓ Eutric, Leptosols&chromic Luvisols 50-100 effective soil depth ✓ Suitable for annual and perennial crops and pasture with conservation measures
IV	IVE, I,D	25-35	✓ EutricLeptosols, and EutricLuvisols ✓ Limiting factor very severe soil erosion ✓ Shallow soil depth land is suitable for annual and perennial crops
VI	VIIE,D	35-50	✓ EutricLeptosols, and EutricLuvisols ✓ Limiting factor very severe soil erosion ✓ Shallow soil depth land is suitable for perennial crops, or forest development and conservation
VII	VIIIE,DI,T	>50	✓ EutricLeptosols ✓ Limiting factor very severe slope steepness and surface run off ✓ Shallow soil depth ✓ The land unit is not suitable for any human activity except ✓ Protection of natural vegetation.

Accordingly, the land capability classes (SWCR, 1986) of the Hadessa Watershed are I, II III, IV,VII, and VIII with shallow soil depth, Infiltration and past erosion as major limiting factors. In this classification, the area is suitable for annual crop production, development of perennial crops, grass land fodder development, Forest development and area closure. But integration of intense physical and biological SWC measures in crop production and livestock grazing areas are critically important to reduce land resources degradation and sustain the productivity.

Table 5-4: Proposed land use options and conservation plan to Hadessa Watershed

SWCRC	LCU	Crop land	Grass Land	Forest and shrub land	Bare land
I	I	✓ Drainage improvement by bed and furrow system farming ✓ Green manuring ✓ Compost	✓ No grass land	✓ Convert into agro-forestry	✓ No bare land
II	I	✓ Contour and strip cropping ✓ Grass strip ✓ Alley cropping ✓ Combination of grass strip and bunds ✓ Soil or stone bunds ✓ cutoff drains and ✓ Waterways on hill bottoms	✓ No grass land	✓ Convert into agro-forestry	✓ No bare land
III	IIIE,D	✓ Soil or stone bunds ✓ Cut of drains and ✓ Waterways on hill bottoms ✓ Green manure ✓ Alley cropping ✓ Contour cropping ✓ Combination of grass strips and bunds	✓ Gully treatment and rehabilitations ✓ Grazing land management ✓ Controlled grazing system ✓ Fodder production ✓ Cut and carry system	✓ Incorporate moisture conservation structures ✓ Micro basins ✓ Protection of existing trees ✓ Hillside terraces	✓ Plantation of leguminous plants ✓ Divert run on coming from up slopes
IV	IVE,D	✓ Soil or stone bunds ✓ Cut of drains and Waterways on hill bottoms ✓ Green manure ✓ Alley cropping ✓ Contour cropping	✓ Gully treatment and rehabilitations ✓ Grazing land management ✓ Controlled grazing ✓ Fodder production ✓ Cut and carry system	✓ Incorporate moisture conservation ✓ structures ✓ Micro basins ✓ Protection of existing trees ✓ Hillside terraces	✓ Plantation of leguminous plants ✓ Divert run on coming from up slopes
VI	VIE, D	✓ Change to agro forestry system ✓ Establish perennial crops	✓ Grassland improvement	✓ Convert into agro forestry	✓ Plantation of leguminous

		✓ Stone and soil bunds ✓ Bunds stabilization·	✓ Plantation of fodder trees ✓ Cut and Carry systems	✓ Gully erosion control ✓ Protection for natural regeneration	plants ✓ Divert run on coming from up slopes
VII	VIIE, D	✓ Change to forestry system ✓ Establish perennial crops ✓ Hillside terracing and micro basin construction ✓ Tree plantation	✓ Grassland improvement ✓ Plantation of fodder trees ✓ Cut and Carry systems	✓ Convert into agro forestry ✓ Gully erosion control ✓ Protection for natural regeneration	✓ Area closure ✓ Tree & grass Plantation ✓ Run off control ✓ Gully control
VII	VIIIDI,T	✓ No cultivation	✓ No grazing	✓ Area closure ✓ All possible planting	✓ Area closure

6 WATERSHED MANAGEMENT PLAN

The planning of a watershed deals with the watershed description, watershed problems, proposed management programs, effects of interventions, and comparison of benefits and cost.

6.1 Watershed Description

The description of a watershed should give a clear picture of the watershed's condition by including sufficient information on physical features of the watershed and problems encountered. The factors to be mentioned for watershed description are location, size and shape, climate, geology, slope, surface drainage, physiography, watershed needs, land use and cover conditions, and economic data. The description of the location includes the name of river basin tributary, physiographic region, principal communication lines associated, and the latitude and longitude of the watershed. Under the heading size and shape, the size of watershed, either in the unit of km2 or hectare, and shape of watershed, long and narrow or fan shape should be mentioned.

About the climate of a watershed the following details are collected: precipitation (forms, annual, seasonal and monthly distribution, storm patterns, rainfall intensity, duration and its area distribution), temperature (maximum and minimum, soil temperature etc.), evaporation, relative humidity, wind velocity and its duration, and solar radiation. In the description of the geology of a watershed, the following geological information should be included: nature of parent rocks, fractures, faults, weathering, ground water recharge and extent of outcrops.

The slope includes the degree of slope, length of slope, mean slope of land surface and proportion of different areas of watershed falling under various slope groups. Regarding the surface drainage, the following information details are required for the description: (a) nature of stream flow, i.e. whether it is perennial, intermittent, ephemeral, spring fed or seasonal, (b) drainage network: stream orders, density and length of streams etc. and (c) morphological characteristics of streams. For describing soils of a watershed, information details about major soil groups existing in the watershed and their hydrologic grouping, physical and chemical properties of the soils etc. are collected.

The description of the physiography of a watershed consists of details of elevation of different parts of watershed, mountain ranges etc. Digital elevation models provide good physiographic information. Under the heading watershed needs, contents such as sources of surface and subsurface water (ground water), water use for domestic, irrigation, power generation and recreation purposes, future needs of water exploration etc. are recorded.

Under the description of land use and cover conditions, the following details are considered: (a) existing land use and cover condition: forest lands, range lands, cultivated lands, waste lands, habitations, and miscellaneous uses, (b) forests: types and area under each type of forest, hydrologic conditions, legal status, present management, area under regeneration, filling and logging practices, and rights and forest fires, (c) range lands: extent and their major classification, closure, grazing practices, grazing incidence, cattle population (number and types), important grass species, their distribution and hydrological conditions, (d) agricultural lands: extent, land use capability classification, area under each class and subclass, major crops, rain fed areas with suitable crops grown, and orchards and their area.

The economics and social data are needed to determine the cost–benefitratio of the project formulated for watershed management. The data to be collected for this purpose are: the economic condition of the population, profession and dependence on resources, market and marketing practices, and return from various resources e.g. from forests, range lands, agricultural lands including irrigated as well as rain-fed.

6.2 Existing Development Opportunities

There are ample of potentials, which are good opportunities in the Hadessa Watershed that will be used in the process of natural resources management and socio-economic development. These opportunities that are identified during the study are briefly presented below.

6.2.1 Physical Resources Opportunities

Climatic conditions including precipitation, atmospheric temperature and humidity are good for agricultural development in Woina-Dega area. The area receives over 1265mm average annual rain fall. The distribution time of the rainfall is also good as compared to some other regions of the country. This provides an average crop-growing period of 150 days a year. Water harvesting is another opportunity from the relatively ample rainfall. Streams in the watershed are perennials to use for small-scale irrigation particularly in the upper reaches.

Water resources development such as springs and streams diversion, ponds construction and sub-surface ground water exploitation would be seen in relation to the available rain fall.

Landscape is also good for diversion of perennial water streams flowing from northern areas and the streams water can be diverted for irrigation with low cost as their channels are shallow. These resources and their developing potential should be seen as a key factor to improve people's livelihoods through providing opportunities for sustainable food production, domestic water supply, income generation, restore and enhance land productivity, support the rehabilitation of degraded lands and enhance the development of natural resources.

The agro-ecologic potential that is suitable for introducing some multi-purpose trees and shrubs, which could be used as fruits and animal feed as another opportunity. This also gives possibility for reclaiming and rehabilitating the degraded lands and converting to productive units for crops, fodder or trees. Soils are inherently fertile. These soils, together with good soil moisture improvement will have a good potential to support land productivity and overall agricultural production, if they are properly managed and used. Tree planting need has greatly changed. Ethiopia is focusing and advocating on the indigenous tree plantation as a means to avert the vicious circle of land degradation and household energy deficiency due to deforestation. In this regard, Oromia National Regional state has already put clear plan of planting trees in each rural PAs of the region.

6.3 Socio-Economic Opportunities

Local technical knowledge is available to integrate with scientific knowledge, which is available and already in hand. Most farmers understand that soil erosion and land degradation are the main problems negatively impacting their agricultural production systems. These farmers will be easily convinced to accept changes and implement sustainable management for their lands and natural resources. Technical manpower to organize and coordinate farmers around watershed and improvement of socio-economic development is relatively available (3 subject matter specialists and health extension agents in each (PA) in the watershed. These potentials have to be appropriately organized and used for the improvements. There are changes on the country's laws and regulations.

The current federal and regional land use and land tenure lows and policies oblige the land users to avoid cultivation on steep slopes and implement proper land management practices on any land held by the user so that there would be opportunity to push farmers to sustainable management of natural resources and the land for reducing land degradation. There are many more opportunities in the watershed to be used in the watershed management plan implementation processes. These opportunities have been envisaged during the process of this plan.

6.4 Strategic Principles in Watershed Management

Watershed management plan is a process of guiding and coordinating use of land and water resources in a Watershed base. Watershed Management should provide desired economic, ecologic and social benefits without adversely affecting resources of downstream or upstream. The basic task of Watershed management is to relate land use and its management practices to places where they best suite. In addition it requires the involvement of all parties that include region, zone and Wereda professional/experts and other relevant organizations as well as communities using the land.

Therefore, the strategic approach in Watershed management should be Participatory from planning to implementation processes to understand and avoid, where possible, the nature and extent of the production and sustainability problems affecting farm households in particular and the country economy at large. Mistakes made at this stage may be costly and take time to reverse. Many planning details will be affected by the circumstances of whether the government departments or nongovernment organizations with a primary interest in the results will be the ones to carry it out.

Within the participatory planning process, basic problem and root causes of a Watershed area need to be assessed and identified involving all possible stakeholders. These have been conducted in the assessment of the Watershed and shown that the core problems are land shortage and land degradation due to indiscriminate exploitation of land and natural resources for subsistence agricultural production and other socio-economic needs and obligations. Some very steep slopes that are not suitable for cultivation are under annual crops while the country's laws prohibit cultivation of slopes having a gradient of more than 30% without adequate traditional or improved soil conservation measures. These lands are usually very poor in vegetation cover.

Absence of traditional conservation measures, lack of manure or crop residue to improve soil fertility and the emphasis given to annual crops rather than perennial crops aggravate soil erosion in the Watershed. In addition, absence of vegetation cover on cropland particularly in dry season cause a loss to large quantity of soil moisture and less amount of organic matter in the soil. In general, if the losses in these cultural practices continue on high slopes without other proper conservation measures, the Watershed will severely devastated. The devastation is to the fact that soil erosion and moisture deficit constitute important ecologic, social and economic problems and are essential factors that have adverse role in the sustainability of an ecosystem. It reduces the availability of the basic plant nutrients required for crops, trees and other plants and decreases the diversity and abundance of soil organisms. Sediments deposit in social infrastructures like streams & irrigation canals and roads, together with wide range of chemical pollutants that are readily adsorbed on the surface of the sediments degrading the quality of the water delivered for agricultural, municipal and industrial use. Erosion control is therefore essential for proper land and water management.

Soil and water conservation strategy for proposed Watershed management is strictly follows 'Conservation Based/integrated Agricultural Development'. The Watershed plan proposes about 17800 hectares of which the proposed Watershed delineated for the development of conservation based agricultural practices. All agricultural practices in this area shall be integrated with soil and water conservation activities focusing on the stability of the agro ecology and on the rational and efficient use of the land resources.

The conservation based agricultural management system employs, among others, physical soil conservation measures such as farmland bunds, hillside terraces and micro-basins, gully and river bank check dams etc and biological soil conservation measures that include alley cropping, inter cropping, relay cropping and under sowing. These practices reduce soil erosion and sedimentation problems. Such measures will sustain and increase land productivity and agricultural production and hence improve the income of the farmers in the Watershed. This approach aims at attaining the maximum potential from rain fed and small scale irrigated agricultural production to meet the increased demand for food and also to create additional off-farm income that leads to a better socio-economic environment for the rural people. Finally, this approach responds to maintaining the sustainable productivity of the Watershed through integration of Watershed management components activities.

6.5 Proposed Management Programs

In this report, the proposed management programs for agricultural lands, irrigation, drainage, flood protection, forest lands, grazing lands, and some special problems are described.

7 CONSERVATION MEASURES COMMON TO ALL LAND USE TYPES

Wide ranges of activities have been identified under each specific objective. These along with each specific objective are presented below.

7.1 Tree planting

Slope Range: All
Soil Range: All except highly degraded land
Tree planting for conservation is an activity to improve the vegetative ground cover, thereby reducing runoff and soil erosion and producing wood. Tree planting supports many other conservation activities when combined with them. Tree planting by itself is a soil and water conservation measure because the tree roots stabilize the soil and the tree protects the ground from the impact of raindrops.

Specifications

Select planting site after consultation with the concerned community. Pit has a width of 25 cm, and a depth of 40 cm. Generally, they are spaced 2 m apart, and for eucalyptus trees 5 m. In highly degraded areas, apply **Area Closure** for 1–2 years before planting. Pits are kept open for 3-12 months before trees are planted in order to support soil formation around them. In areas with two cropping seasons per year, plant trees during the first rains.

Effects

Tree planting by itself conserves soil and water. Only a minimal amount of soil is moved through pitting. Thus, the slope remains stable and resistant against erosion. Especially in wet agro ecological zones, tree planting does not require any additional conservation measures. Trees provide close canopy, improve infiltration of moisture in the soil, provide mulch and organic matter, recycle nutrients, and provide high protein manure or animal feed. They also produce wood and other products for various uses.

7.2 Grassland improvement

Slope Range: All
Soil Range: All
Grassland improvement includes all activities aimed at improving the productivity of grassland whereby runoff and soil erosion are reduced. Activities include the introduction of better forage species, moisture conservation, and removal of unpalatable species, the cutting of shrubs, regular weeding and maintenance of fertilization

Specifications

Introduction of better forage species can be done by seeding, applying introduced species of grass or legumes, or using seed collected from native species in a particular zone. Another way of introducing better forage species is planting sods which are cut from areas with dense stands of such plants. Only part of the plant may be removed for quick re-growth of the remaining plant. Moisture conservation is possible either directly with improved grass cover attained through Controlled Grazing or Area Closure or with physical structures as applied to cultivated land. Removal of unpalatable species is very important for grassland improvement. Weeds and grass not suitable for forage can be regularly cut out and stored in composts for natural fertilizer production. Cutting of shrubs that impede forage production is necessary. They can then be used for fuel wood. Regular weeding and maintenance through cutting, **Cut and Carry** and hay making increases production and improves the density of the grassland. Fertilizing with natural or artificial fertilizers can improve production and result in better conservation of the area.

Effects

Grassland improvement has two main effects: first, it increases the productivity of the area for fodder and second, it reduces runoff and soil erosion as there is better ground cover..

7.3 Controlled grazing

Slope Range: On gentle, well-covered rangeland

Soil Range: All except heavily degraded soil

Controlled grazing is defined as direct utilization of grassland with livestock in such a way that no degradation of vegetation and soils occurs, allowing the grass to recover and to retain the quality of the rangeland. Controlled grazing can be in rotation or continuous if well managed.

Specifications

Rotational grazing is the best method of providing for periodic recovery of grassland. There is a shortage of grazing land in the second half of the dry season for which additional fodder must be produced on fodder banks or in **area closure**. Usually little management is needed once the vetiver barrier is established. Cutting the top produces more tillering and a denser hedge is the result. It does not produce any runners, and any spreading can easily be controlled with the plough. However, care is needed when vetiver is freshly planted, as all plants, even Vetiver are soft at that time and can therefore be grazed by livestock, which need to be kept away until the vetiver grass is matured and no longer palatable to animals.

Continuous grazing requires careful decisions about the number and type of livestock allowed to graze on a certain area. The maximum number allowed varies during the year, being highest after the rainy season when the soil is dry, but low during the rainy season and again especially at the end of the dry season. Therefore, additional fodder has to be produced in Area Closure, by Re-vegetation and with **Grassland Improvement** to overcome shortages in periods of limited access to grassland.

Effects

All forms of controlled grazing provide for better animal fodder, in amount as well as in quality, and help to prevent degradation of grassland and conserve soil, water and vegetation.

7.4 Vetiver

Slope Range: All

Soil Range: All

Vetiver grass (*Vetiveriazizanioides*) is a tough grass, which is very suitable for erosion control in various forms. In its general appearance a vetiver plant looks like a big, coarse clump of grass. It can grow very tall; under favorable conditions the erect stems (culms) can reach up to 3 m in height. It develops a dense, interwoven root system. Its growing point (crown) is below the surface; therefore, it can withstand fire or grazing (however, the mature plant is not palatable to animals). Thus, when well developed, it forms a dense, indestructible barrier. And due to its vegetative multiplication it can easily be controlled so that it does not spread into crops.

Specifications

Vetiver barriers are planted along the contour in two alternating rows, 10 cm apart, with 10 cm spacing. The vertical interval of the Vetiver barrier may vary from case to case: on cultivated land on slopes below 15% the vertical interval is 1m. Spacing with a 1 m vertical interval means that on a3% slope, the Vetiver strips will be 33 m apart, and on a 15% slope, only 7 m apart, still sufficient for ploughing between the strips. On slopes above 15%, the vertical interval is two-and-a-half times the depth of the rework able soil. In gully rehabilitation the Vetiver barriers may be very close, just 1 m apart, depending on local conditions. Vetiver barriers are planted along the contour, be it on cultivated land or along gully slopes. They can also be used along road or river embankments. With their dense root system they develop into a very good stabilizer.

The leaves and stems of the vetiver plant slow the silt-loaded runoff at A and cause it to deposit the silt behind the plant at B, while the water continues to flow down the slope at C, but at a much slower pace. The plant's strong root system, binds the soil beneath the plant to a depth of up to 3 m, forming a dense curtain-like wall, thus the roots prevent rilling, gullying and tunneling..

Effects

Vetiver barriers can effectively build up terraces and provide good grass for thatching. Vetiver is particularly suitable for mattress filling since it has an insect repelling effect. Vetiver strips do not harbor any rats or snakes.

7.5 Mulch

Slope Range: All (combined with contour structures on steeper slopes)
Soil Range: All, in particular shallow and degraded soils, but less suitable on heavy soils where water logging is a problem Applying mulch means covering the soil with crop residues such as straw, maize and sorghum stalks, tree leaves, or other plant material, or standing stubble. The cover protects the soil from the hot sun and from the impact of raindrops, minimizing soil crusting, erosion and runoff. Maintaining crop residues or mulch on the field reduces soil erosion and has a considerable potential for the restoration and maintenance of soil fertility.

Specifications

Applying mulch is of the most practical use with row crops such as maize and sorghum, and for widely spaced perennial fruit trees such as mango, avocado, citrus, inset and banana.

What to use as mulch:
Large amounts of organic materials are needed to get the full benefit of mulching. Any organic debris (straw, pruning from hedgerows, weeds removed from the fields) can be used. Research findings show that using mulch on maize increased biomass production so much that it compensated for the mulch used and the remaining crop residues were still enough to feed the cattle. There, farmers were first worried about not having enough fodder for their animals when mulching.
When to use mulch:

- ❒ Under conventional tillage: plough under the mulch before planting the main crop
- ❒ to incorporate it into the soil.
- ❒ Under conservation tillage: keep the mulch on the field while the crop is growing so the mulch controls weeds.

Effects

Applying mulch is an effective method to reduce soil erosion, in particular on slopes up to 15%. A crop residue covering the ground intercepts raindrop impact, prevents splash erosion, and slows down the water flow and increases infiltration. It also encourages insects and worms to make holes into the ground, thus increasing the permeability of the soil and enabling rainwater to soak into the soil. And it reduces evaporation and increases the moisture content of the soil. On the other hand, it protects the soil from getting burnt and crusted by the sun. It increases the organic matter and nutrient content of the soil. Mulch also suppresses weeds. All of these effects help to increase yields.

7.6 Grass strip

Slope Range: Slopes with gradients of less than 15%

Soil Range: All

A grass strip is a ribbon-like band of grass laid out on cultivated land along the contour. Usually, grass strips are about 1 m wide and spaced at 1 m vertical intervals. They are mainly used to replace physical structures on soil with good infiltration (sandy, silty) on gentle slopes. Cattle must be excluded from this measure all year long to provide for sufficient length of the grasses to slow runoff and retain soil sediment.

Specifications

Grass strips are planted along the contour or along Cutoff Drain. Spacing with 1 m vertical interval means that on a 3% slope, grass strips will be 33 m apart, and on a 15% slope, only 7 m apart, still sufficient for ploughing between the strips.

Effects

Grass Strip helps to reduce runoff and to filter out sediments carried by runoff. They are especially suitable on soil with good infiltration and where the climate is not too dry for dense grass development. If grazing is totally prevented, the grass strips will effectively build up into terraces and provide good fodder for cattle which can be used with cut and carry.

7.7 Area closure

Slope Range: All

Soil Range: All

Area closure is a protection system to improve land with degraded vegetation and/or soil through natural regeneration. No livestock are allowed to graze, and no human interference tolerated for 2–3years, until a 50% natural grass cover is obtained. Utilization of these areas has to be planned and initiated as soon as a satisfactory state of recovery has been reached

Specifications

Area closure is a temporary action to protect degraded land until a certain degree of recovery has been attained. In area closures no specific actions are taken, except that all human and livestock interference is excluded. Sometime after natural recovery, the grass may be cut regularly to minimize fire incidence. Hay can be prepared and fed to livestock. During the time of closure, a decision must be made in consultation and with the agreement of the community members involved about how to increase the productivity of the closed area while maintaining the conservation mandate. There are three main possibilities for the management of area closures: Return the area to cultivation while applying proper conservation measures. Use it as grassland while applying proper grassland conservation and development measures. Develop it into forestland while applying forest conservation and development measures.

Effects

Soil and water conservation is best attained through dense ground cover by grass and legumes, while roots stabilize the soil. Growth of vegetation is improved considerably after the exclusion of livestock from the area and future use can be decided according to the conservation status and local need.

7.8 Bund

Slope range: 3–50%

Soil range: All soils in wet, clay soil in moist agro- ecological zones

A graded bund is defined similar to a **level bund**, with the only difference being that it is slightly graded sideways, with a gradient of up to 1%, towards a waterway or river. Such a gradient is for surplus runoff to be drained if the retention of the bund is not sufficient. Tied ridges with top heights lower than the bund height serve to retard such flow and to provide small basins for water storage.

Specifications

The vertical interval between two bunds is 1 m for slope gradients of less than 15%. For steeper slopes, the vertical interval must be two-and-a-half times the depth of rework able soil. For a typical cross-section, refer to level bund because it is not different from this. No gaps can be provided for ploughing oxen to cross (as for level bunds) because the graded bund serves as a drainage line which cannot be interrupted. Whenever possible, use and improve traditional waterways in the area where you intend to apply graded bunds. Discuss with farmers the measures lined out before you implement them. Make the waterways one year before the graded structures to stabilize them before use. If the bunds are long, the basins behind them must be increased towards the waterway, as more and more runoff will have to pass during storms. The size of the ditch can be 25 cm deep by 50 cm wide at the beginning of the bund, but 50 cm deep by 100 cm wide after about 100–150 m when the bund reaches the river or the waterway.

Effects

Graded bunds retain normal amounts of runoff in their basins, but they can drain excess runoff from heavy storms which would cause overflow and down slope destruction on level bunds. Most of the soil eroded between two bunds is deposited, while some will be drained sideways during heavy storms and lost from the land. However, graded bunds are more effective than level bunds in wet areas as well as in moist areas with clay soils

7.9 Check dam

Slope Range: All

Soil Range: Take care on deeply weathered rock or loosely accumulated deposits

A check dam is an obstruction wall across the bottom of a gully or a small river to reduce the velocity of the runoff and prevent deepening or widening of the gully. Check dams can be made of any material available locally, such as stones, live or dead branches, wooden poles, gabions, etc

Specifications

Below are a gully cross-section and a section along the gully to show dimensions and the vertical interval of check dams (the picture shows stone check dams): The vertical interval between check dams is equal to the height of a check dam; e.g. for stone check dams, it is 1 m (as its height is 1m). If made of stone, such a wall is up to 1m high and about 1m thick and has a depression in the middle to allow runoff to flow through.

Note the hyperbolic shape: the centre of the check dam has to be at the lowest point to guide the water flow to the gully centre. Check dams can be easily applied in all gullies less than 2 m deep and 5 m wide

Effects

Check dams prevent the widening and deepening of a gully, and help to fill it up with sediment. They reduce the velocity of runoff in the gully. The potential energy is absorbed below the vertical drops of the over fall. Sediments are deposited behind the check dams so that the slope gradient of the gully is also reduced.

7.10 Cutoff drain

Slope Range: 3–50%

Soil Range: All

A cutoff drain is a channel used to collect runoff from the land above and to divert it safely to a waterway or river, thus protecting the land below from excessive erosion. Cutoff drains usually protect cultivated land from upslope forestland or grassland

Specifications

Assuming 70 mm/hr storm intensity, a poor grassed cutoff drain, a hilly pasture above the drain, clay loam soil, and a freeboard of 20 cm in the drain, the dimensions of the cutoff drain, given for different sizes of the catchment are as follows: The gradient of the cutoff drain should not exceed the maximum gradient given. However, in some cases, it will be necessary to follow a natural line instead of a technical one. If the maximum gradient is exceeded, take care about erosion in the drain, improve the grass cover, or apply Check dam.

Effects

Cutoff drains protect down slope land from upslope runoff and erosion. This cutoff drain protects the terraced cultivated land to the right from excessive runoff from the grassland to the left and above, where controlled grazing is used with tied cattle. At the point where the cutoff drain enters the waterway, stone protection is needed and a check dam has been constructed in the waterway.

7.11 Gully rehabilitation

Slope Range: 0-30%

Soil Range: All but take care on deeply weathered soils or loosely accumulated deposits

A gully is formed when rill erosion expands by deepening and widening into a growing channel. As the channel deepens, it undercuts its head- and sidewalls, eventually forming a steadily expanding gully. Gullies eat deep into the land, mostly in accumulated sediments or deeply weathered soils, and often on good arable land. And if the gully is not checked, more and more land gets lost

Specifications

First of all keep in mind: 'prevention is better than cure'. Save money and labor by treating a gully in its early stage, when it is easy, rather than waiting until it is too late. There are three major principles for controlling gullies:

1. Reducing the runoff coming into the gully by conserving water in the catchment so that it does not reach the gully e.g. by Bunds, mulch, micro basin, trench or area closure, etc.

2. Diverting the water away from the gully with a cutoff drain or safe waterway.

3. Conveying the water safely through the gully by reducing its speed and breaking its erosive force with Check dams and or various vegetative barriers. In order to stop further undercutting of the gully head, a reshaping of the gully head is needed. The reshaped gully head has to be protected by grass or a stone rip-rap. In order to re-vegetate the gully walls, reshaping is also necessary here to allow the seed or seedlings to take root, as plants cannot establish themselves on the vertical gully walls. The gully and its immediate surroundings must be closed to animals (area closure for the gully). Check and control the water flow with check dams or vegetative barriers, so called score checks' (e.g. vetiver or sisal, and trees later on) on the gully bottom. At a later stage and depending on the agro ecological zone you are in, useful trees such as fodder trees or fruit trees such as bananas can be grown on the gully bottom.

Effects

Gully rehabilitation is a cumbersome process – but not at all hopeless. A rehabilitated gully can become productive land once again, thus transforming this line of destruction into a line of production. In addition, the bordering productive land remains intact, instead of falling victim to the gully's destructive forces if the gully goes unchecked.

7.12 Re-vegetation

Slope Range: All

Soil Range: All

Re-vegetation is a system of forage establishment on land with an unsatisfactory vegetation cover. Such land may be newly constructed bunds, cutoff drains, waterways or degraded land and gullies. Forage includes grass, legumes and selected trees and bushes.

Specifications

Three steps are important for re-vegetation:

1. Exclude all grazing animals throughout the year. Use **cut and carry** instead.
2. Regularly cut the weed which grows during the rainy season, so that grass and legumes can develop.
3. Plant sods of grass and legumes. Such sods can be taken from good natural grassland nearby or from forage nurseries. However, native species will grow best, and are well known to the farmers for their quality and value.

Effects

Re-vegetation is the most effective way to conserve soil and water. Grass is able to reduce soil erosion greatly if established well. Grass also helps to stabilize bunds and other structures significantly if cattle are excluded from grazing all year. Re-vegetation provides forage which is essential for livestock.

7.13 Waterway

Slope Range: 3–50%

Soil Range: All, but take care on deeply weathered subsoil

A waterway is a natural or artificial channel along the steepest slope or in the valley used to accommodate runoff. Artificial waterways as discussed here need to be paved with grasses or stone. Traditional waterways need improvement according to the technical standards given.

Specifications

On cultivated land with graded structures, waterways must be placed every 250 m to avoid graded ditches that are too long. Waterways must always be constructed and grass developed on them one year before graded structures are applied on the land. If there is enough land, cross-sections of waterways should be gentle, as shown below: If, for lack of land, only narrow waterways are feasible, they must be made deeper, up to 1 m, and more narrow, about 1.5 m.

In such cases, the bottom of the waterway has to be paved very densely with big, flat stones. In long waterways and difficult situations, gabions made of wire nets can be used as a drop structure.

Effects

Waterways enable runoff water that is not stored behind bunds or does not infiltrate on the land during a storm to be drained safely to the next river.

8 EXPECTED BENEFITS OF WATERSHED MANAGEMENT

8.1 Economic benefit

The direct benefit to the beneficiaries would increase income through generation of additional income and off farm schemes including creation of employment opportunity. Besides the watershed management plan implementation is expected to improve the food self-sufficiency and security status. The local inhabitants are required to benefit from the availability and supply of food and household items to the market with affordable prices. The regional economy will be benefited through indirect, multiplier benefits. These benefits would be reflected in the form of:

- ❒ Increased income and employment
- ❒ Stabilization or increase in crop or pasture yields. Stabilization of yield refers to those situations where conservation prevents a decline in yields that would occur if erosion is unchecked. Increase in yield can also come from improved nutrient supply through organic matter, market crop production, agro-forestry, etc.
- ❒ Improved livestock production from increased quantity and quality of fodder, for example from grass strips, alley cropping or bund embankments

8.2 Social benefit

The benefits of watershed management interventions will also yield social benefits that can be measured in qualitative and quantitative bases. Some of these include:

- ❒ Improvement in water supply owing to increased infiltration of rainfall
- ❒ Social respect to women, currently very poor households and jobless youth whose means of income generation is increased and social value is improved
- ❒ Prevention of flooding from downstream socio-economic infrastructures
- ❒ Improved soil moisture and human and livestock water supply
- ❒ Improved supply of fuel wood and construction materials

9 ANTICIPATED RISKS

Some lagging situations always happen in project implementation. Such anticipated lagging situations are categorized as anticipated risks during project implementation, which include:

- ❒ Slow response of financing and co-implementing agencies
- ❒ Change in institutional set up and government policy priorities
- ❒ Shortage of loans and rural credit
- ❒ Provisional market price failure to produces specially for income generating products

10 SUSTAINABILITY

In principle, sustainability issue needs to be seen from institutional, economic, technical and environmental perspectives. In this context, the watershed plan completion does not mean similar land and natural resources management will discontinue at a specific date. It rather means that the watershed management project communities are owners of the assets created by the project starting as early as the first date of the plan implementation start and relevant partners like extension agents and different sector agricultural specialists are always there to provide advice and technical support to the farmers that no one will be handing over or handing in the project activities and responsibilities. In this context, it is the community itself that will implement in all stages in the watershed implementation including their labor and materials required for implementation.

The achievements also will be for the benefit of people who own the lands and have done the implementation of the watershed management activities. The envisaged objectives are in line with current priority need of the communities as well as the federal and regional governments' polices & strategies. These include ensuring household food security through sustainable management of natural resources such as water, soil and vegetation's.

Accordingly, the government will support sustaining the achieved results and continuation of subsequent watershed management activities. Since the communities implement all aspects of the plan, develops sense of ownership and their capacity will be enhanced towards ensuring continuity and sustainability of the achievements. The plan has a capacity building component that aims to increase communities' capacity, which could enable to sustain achievements. As the watershed management is not a one-time activity, the results of the achievement could crate confidence to farmers to continue and protect and maintain the implemented WSM activities.

Once implemented activities started providing benefits, and farmers' observed positive changes in their livelihoods, they will be encouraged to maintain, sustain and continue similar activities. Similarly concerned responsible bodies will be involved in all stages of the watershed management including planning to monitoring and evaluation activities. Once the plan implementation ends, they will have an increased capacity to continue, follow up and assist communities to sustain achievement.

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In general, in this Watershed management plan, capacity building, transfer of knowledge and skills to community, and local levels staffs such as extension workers and wereda experts are considered as entrance to ensure the sustainability of the intended purposes. Provision of credit for cooperatives/groups and upgrading works should be considered during the implementation of the Watershed management plan.

11 MONITORING AND EVALUATION

The effectiveness of the plans and actions implemented, physical and economic developments achieved, have to be monitored and evaluated periodically. Regular follow up of the selected interventions should be continuous process. Moreover, during and after implementation, the success of the plan interns its broad goals, the success of individual components, and the effectiveness of institutional and administrative managements should be evaluated and monitored both by local and regional government departments.

Monitoring is an internal project activity designed to provide constant feedback on a program, the problems it faces and the efficiency with which it is being implemented. Thus, monitoring helps to assess the progress of the project implementation and take timely decisions and corrections, if there are mistakes.

11.1 Monitoring

Monitoring enables the responsibly body and its partners to assess performance and success of the project implementation and enable to provide technical support and timely decisions. A monitoring system should focus on close follow up and ensure that:

- ❒ Activities are implemented according to specified timeframe;
- ❒ A high community participation is maintained in the implementation of the activities;
- ❒ Role players involvement in the implementation of the planned activities;
- ❒ Problems are readily identified and solved appropriately;
- ❒ Areas that require technical, administrative and financial support; etc.

11.2 Evaluation

Evaluation is to review changes and impacts as the result of Watershed plan implementation. It helps assess achievements at results level like impact, outcomes and outputs and this has to be conducted in two levels

(i) local government level evaluation, which should be conduct in period of every six months and

(ii) Regional level evaluation, which would be conducted on yearly basis. Both evaluation and monitoring should focus on relevance, performance/success, and sustain ability of the achieved benefits and strategies.

11.3 Reporting

Reporting is one of important in Monitoring and Evaluation processes. Role players at different levels ranging from extension centers to regional level should develop monthly, quarterly, and annual reports on regular basis. The report should contain physical and financial issues and indicate achievements and constraints faced in the implementation process. Sharing of these findings is valuable learning tool and is necessary to identify the causes of the problems and design prompt remedies. The physical activities report formats will be developed by BOA and BWR offices.

12 TIME SCHEDULE FOR SOIL WATER CONSERVATION PLAN

Sequencing of activities on the basis of priority and prerequisites are important for the implementation of Watershed management interventions. At end, planning the implementation should embody sequencing. Implementing of all activities has to be on their suitable period of time respecting farmers' requirements. The farming calendar of the farmers should be also respected for implementation of Watershed management interventions. Therefore, selection of appropriate season from the view point of technical aspects and farming systems should be one of the major considerations in planning implementations of interventions.

The duration of implementation period within a year will depend on the quantity of work involved for each intervention, which indirectly depends on the size of areas to be treated and availability of inputs etc. Considering the above mentioned issues and other related, time schedule for the soil and water conservation and land management core activities implementation is planned for 10 years (Table 12-1). Labor and tools for the Watershed plan implementation is assumed to come from farmers andfree of fee because they are owners of the activities and benefits.

Table 12-1: Time Schedule for Proposed Watershed Management Activity

No	Activity	Unit	Qty	Total PD	Year					Remarks
					Y1	Y2	Y3	Y4	Y5-10	
A	**Engineering Measures**									
1	Soil and stone bund	km	4000	600000	800	800	800	800	800	
2	Bund maintenance	km	200	6000	40	40	40	40	40	
3	Hillside terrace and micro-basin construction	km	150	22500	30	30	30	30	30	
4	Check dam construction	M^3	100000	70000	20000	20000	20000	20000	20000	
5	Maintenance of gully structures	ha	75	150	15	15	15	15	15	
6	Cut-off drain construction	M3	90	22500	18	18	18	18	18	
7	Artificial waterway construction	km	100	300000	20	20	20	20	20	
8	Waterway maintenance	km	200	100000	40	40	40	40	40	
B	**Biological Measures**									
1	Seedling plantation	km	300	-	60	60	60	60	60	
2	Bund planting	km	150	4500	30	30	30	30	30	
3	Gully planting	km	140	2100	28	28	28	28	28	
4	Hillside enrichment plantation	km	100	1500	20	20	20	20	20	
5	Hedgerow planting	km	100	1500	20	20	20	20	20	
6	Grass-strip	km	1000	15000	200	200	200	200	200	
7	Compost preparation	M^3	124000	86800	24800	24800	24800	24800	24800	
C	Area closure	ha	36		36					>30%slope
D	Training for HH and extension agents	No	1050	210000	210	210	210	210	210	

***NB**:- Cost of each activities will be covered by the community*

13 CONCLUSIONS AND RECOMMENDATION

13.1 CONCLUSIONS

Watershed management implies the judicious use of all resources (i.e. land, vegetations and water of the watershed) to achieve maximum production with minimum hazard to the natural resources and for the well being of people and environment. The task of watershed management includes the treatment of land by using the most suitable biological and engineering measures in such a manner that the management work must be economical and socially acceptable.

The various factors affecting the task of watershed management are: watershed characteristics (shape and size, topography, relief, and soils); climatic characteristics (precipitation, and amount and intensity of rainfall); watershed operation; land use patterns (vegetative cover, density, and state i.e. type and equality); social status of inhabitants; and water resources and their capabilities.

The major control measures adopted for Hadhesa watershed management works are the vegetative measures or agronomical practices (tree planting, grassland improvement, controlled grazing, vetiver, mulch ,grass strip and area closure) and the engineering measures or structural practices (check dam, cutoff drain; gully rehabilitation, waterway and bund construction.etc.).

13.2 RECOMMENDATIONS

The recommended strategies for watershed management options are based on the information acquired from the study and the information analysis against scientific basis and the country's laws and policies on the land use and resources management. Soil erosion halting strategies have received considerable attention with views of controlling land degradation and the loss of land productivity on one hand and controlling sediment load problem in the planned irrigation structures and other downstream socio-economic infrastructures on the other.

For the interventions for sustainable agricultural intensification, integration of resource conservation into all forms of land use and land productivity enhancement through improvement in agricultural inputs has been envisaged. It considers some non-reversible situations like landlessness, for which options different from land use, such as on-farm and off-farm income generating activities, have been recommended.

Accordingly, broad ranges of possible interventions and techniques have been recommended. In the process, land capability classification has adequately reviewed and used in addition to indigenous knowledge of farmers, professional experiences and views. The following specific factors are therefore considered in the selection of watershed management recommendations.

- ❒ Existing practices and experiences of the community
- ❒ Problems and opportunities and priority needs expressed by the community, specially women groups, during group discussions
- ❒ agro-ecologic condition of the area
- ❒ Potentials and constraints of the watershed
- ❒ Proven capability of the chosen interventions to control soil erosion and avoid land degradation
- ❒ Integration potentials of different interventions' technologies
- ❒ Feasibility of the technologies and their application and adaptation in the land use and farming system

The overall impact expected in reducing flood and sediment deposition on the downstream socio-economic infrastructures and irrigation structures.

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