

SELALA QUTER 2 SMALL SCALE IRRIGATION CANAL

EXSTETION AGRONOMY DIVERSION

FEASIBILITY STUDY REPORT

JUNE 2016E,C

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**ABRIVATIONS**

ARDO	Agriculture and rural development offices
DA	Development Agent
ETC	Crop evapotranspiration
ETO	Reference evapotranspiration
FAO	Food and agriculture organization of the United Nations
GOV	Governmental organization
GIWR	Gross irrigation water requirement
HA	Hectare
IPM	Integrated pest management
KC	Crop coefficient
L/S/HA	Litter per second per ha
M ASL	Meter above sea level
M/S	Meter per second
M <sup>2</sup>	Meter square
MM	Millimeter
NIWR	Net irrigation water requirement
NGO	Non- governmental organization
PCA	Proposed command area
PET	Potential evapotranspiration
QT	Quintal
RH	Relative humidity
SWC	Soil and water conservation
UTM	Universal Transverse Mercator

## 1. INTRODUCTION

### *Back Ground*

The Amhara national regional state has a wide area coverage different agro ecological zones and varying soil types and high potential of water resource. Moreover the region has huge number of animals, including endemic ones, and variety of crops with different cultivars. As far as crop production is concerned, it is the main crop growing region in the country and contributes a lot for domestic as well as foreign markets.

However due to severe land degradation and soil erosion, high population pressure ,recurrent drought, backward agricultural implementation practices followed by farmers and high incidence of different crop pests (insect pests, diseases, weeds, rodents, birds, wild animals and storage pests) the region is still on the poverty line.

It is known that encouraging efforts have been done on the agriculture sector to reduce the dependency of agriculture on rain fed and utilize the water resources that the region do have so as to assure the food security of the region and to improve the individual household income .To alleviate the existing food shortage problems and to feed the domestic

industries as well as to produce sufficient quantity of exportable quality standard agricultural products the agriculture sector has to be transformed from the present back ward and subsistence agriculture to modernize higher level

Irrigation scheme development plays vital role to increase crop production and productivity either by supplementary or full irrigation. It stabilizes crop production by protecting against drought and by increasing crop yields and quality. It also permits farmers to grow high value (cash) crops and crops that improve their diet. Therefore, development of irrigation projects, which is supported by effective research, extension and credit services, adequate and timely supply of agricultural inputs, like fertilizers, improved seeds, agro-chemicals and farm implements, is very indispensable to overcome the existing food shortage and other crucial needs. -

On this basis, this study was carried out to introduce modern irrigation development to the study area by diverting Selala River. Silala is a perennial river which has a potential to irrigate 60 hectares of land. The proposed command area will be on the right sides of the River .As it has evaluated during the study period, the attitude of the farmers/beneficiaries towards the project is positive and are eager to see the permanent diversion structure to be constructed as soon as possible. The study of Silala small-scale irrigation project was carried out by West Gojjam Zone Irrigation and Low Land Development Department. In this

agronomic report the study methodologies and various analysis required in the study of irrigation projects area discussed.

### ***1.1. Objectives***

#### **General objectives:**

Introduction of modern irrigation development, by diverting Silala river to the command area, so as to enhance production and productivity, to increase the income and improve the living standard of the beneficiaries; consequently to bring about food self-sufficiency of the area and produce surplus for sale gradually, is the major objective of this project study.

#### **Specific objectives:**

- To study the existing physical features and agricultural situations of the study area /agro-ecology, soil, land use, etc. /.
- To identity and assess the potential and main constraints in the project area.
- To assess the existing crop production situation
- To assess agricultural inputs requirement, crop protection, agricultural extension services, and yield projection.
- To propose the necessary intervention and ensure the possible increase in productivity.

- To propose suitable cropping pattern and crop calendar with appropriate technologies.
- To analyze and compute crop water requirements and irrigation intervals of the proposed crops for the project area.

## ***1.2. Methodology of the Study***

The methodology used in this study was aimed at clearly defining and describing the agronomic situation of the project area, outlining the major crop production constraints and developing recommendations for the implementation of this irrigation project.

A compressive agronomic survey was carried out in Burie Zuria Woreda, Gibigdele kebli. The study was conducted through field observation, primary and secondary data collections.

Observation of gross command area, assessment of cultivated land, traditional irrigation practices and cropping mixes are the first tasks carried out during the study.

Primary data collection was carried out by interviewing key informants and making group discussions with the project area local farmers. Secondary data were also collected from the kebele agriculture development offices using prepared checklists.

Existing farming and cropping systems, agronomic practices, crop production constraints, farmers' inputs demand and utilization, credit

access, etc, were collected from the local farmers by using key informant interview method. In addition, physical observations and surveying of the project area (command area characteristics and soil survey) as well as direct measurements were made within the command area.

For Silala small scale irrigation project study, climatic data were collected from Tilili meteorological stations. The water requirements of the recommended crops were determined using a computer software program (Cropwat 8.0), which is used for irrigation planning and management that has developed by land and water development of FAO.

## **2 THE PROJECT AREA**

### ***2.1 Physical Features***

#### **1.2.1. Location**

Silala Small-Scale Irrigation Project is found in Amhara National Regional State (ANRS), West Gojjam Administrative Zone, Burie Zuria Woreda, specifically in Gibgedel kebele. It is about 5km far, to the North from Burie town; the capital of the woreda. As the road access to the project site a dry weathered from Burie to the kebele which is accessible.

The proposed project command area (PCA) lies at an elevation range of masl and 2175.15 between the coordinates of 290667.17 UTM Northing and 11889290.83 UTM Easting.

### **1.2.2. Climate**

According to the Traditional Ethiopian Agro-Ecological Zones classification, by taking the amount of mean annual rainfall, mean air temperature and elevation of the area into consideration, the project area is said to be found in *Wina Dega* agro-ecological zone.

The source of meteorological data used for the project area is Tilili meteorological station. Rainfall (mm), minimum and maximum temperature (°C), relative humidity (%), sunshine hours (hr) and wind speed (m/sec) data were collected.

#### **1.2.2.1. Rainfall**

The rainfall pattern of the proposed project area is unimodal; and the main rainy season is summer (“Meher” or “Kiremt”), which extends from May to September. The mean annual rainfall that the project area received is 1604.5 mm.

Generally, the rainfall of the project area is characterized by its variability both in amount and distribution. Thus, the main bottle neck for successful crop production in the area is the nature of uneven distribution of rainfall. “Meher” or “Kiremt” rainfall is largely received in the months of mid-June, July, August and early September. Had it been well distributed throughout the growing season the amount of rainfall may have been sufficient for the growth of crops.

#### ***1.2.2.2. Temperature***

The prevailing temperature considerably influences selection of crops and their growing periods. Optimum temperature plays an important role on the growth period and the production of crops. In the project area the mean daily maximum air temperature are 28.7 °C (March); whilst the mean daily minimum air temperature ranges between 5.3 °C (December). The annual mean minimum and maximum air temperature of the area is 10 and 25.2 °C, respectively.

#### ***1.2.2.3. Sunshine hours duration, relative humidity, wind speed***

The sunshine hours duration of the project area ranges from 4.1 to 8.9 hours/day, i.e., in July to January, respectively. Relative humidity (RH) in the project area varies from the lowest 42% ( April ) to the highest 78% (July and August ) and the mean relative humidity is 59%.

High desiccating wind in the form of storm not only increases crop water requirements, due to increased evapotranspiration, but also adversely affects the growth and yields of crops depending on the crops growth stage, at which it occurs. However, the wind speed, experienced in the area, ranges from 53 (October) to 111 km/day (May) which is low and not likely to cause any damage to the crops.

### ***1.3. Command Area Characteristics***

#### ***1.3.1. Topography***

Topography is an important factor for the planning of any irrigation project so long as it influences method of irrigation, drainage, erosion, costs of land development, mechanization, labour requirement and choice of crops.

Topographically most of the cultivated lands of the project area are found between flat to slightly sloping lands. In general, the command area lies from flat to nearly level slopes. Hence, the slope of the command area has identified to be more suitable for surface irrigation.

### 1.3.2. Land use pattern

Land use in the study area is dominated by traditional rainfed *Meher season* peasant farming on individual holdings and grazing of livestock on private and communal grazing lands. Of the total area of the kebele, where the project area is found, 89% and 5% are cultivated lands, respectively, which is the largest share of the area. Generally, the present land use patterns of the project kebele are presented on Table 1.

**Table 1 Existing land use pattern of Gibigedel**

Land use Pattern	Gibigedel kble	
	Area in (ha)	% Cover
Cultivated land	1450	89
Grazing land	80	5
Forest and bush land	30	2
Water body	5	0.3
Useless land	4	0.3
Others	56	3.5

<b>Total</b>	<b>1625</b>	<b>100</b>
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**Source: Gibigedel kebel agriculture development office**

### **1.3.3. Surface characteristics**

A surface characteristic includes stoniness, rockiness, water logging, flooding, etc. of an area. The presence of rock fragments influences the nutrient status, water movement, use and management of the soil. As to the stoniness and rockiness of the command area, it has estimated that the command area has very few stones. This situation is more of suitable for crop seedling emergences.

The command area soils are red colored soils. The project area has slight to moderate erosion or flooding hazards (based on field observation). On the other hand, soils of the command area have workable soil depths for crop production.

### **1.3.4. Soil**

From filed observations the soils of the command area were identified dominantly as red coloured clay loam textured soil .Concerning the soil surface almost all the command area soils have red coloured soils. In addition to this, soils of the command area have no water logging characteristics during wet and dry cropping season .This condition will be good for crops to be grow both in wet and when modern irrigation scheme commences

#### **1.4. Vegetation Cover**

According to data obtained from Gibgedel kebele Agriculture development office, from the existing land use pattern the forest and bush land cover of the kebele is estimated to be 3 %. The vegetation cover of the kebele includes trees, bushes, and shrubs. Some of the major trees grown are: *Bahir Zaf (Eucalyptus globulus)*, *Girar (Acacia abyssinica)*, *Woirra (Olea africana)*, *Cheba (Acacia nilotica)*, *Shinet (Myrica salicifolia)*, *Shola/Warka (Ficus cycomorus )* ; *Sesa* and from bushes: *Agam (Carissa edulis)*, *Atat (Maytenus arbutifolia)*, *Abalo (Terminalia brownie)*, *Kitkita (Dodonaea angustifolia)*, *Kega (Abyssinian rose)*, and also there are shrubs climbed and associated with some bushes such as *Azo Areg (Amharic)* and *Ayti Areg(local name)*.

#### **1.5. Water Resource**

In the project kebele Gibigedele , However, traditional irrigation systems are started since long years ago and still are under use in the project kebele by constructing traditional diversion structures on these River. Silala is the River on which modern small-scale irrigation diversion scheme is now studied.

#### **1.6. Existing Crop Production**

In the project area almost all the households are dependent on subsistence agriculture where the average productivity has been substantially decreased due to different constraints particularly moisture stress, serious pests attack on crops, low level or lack of use of modern technologies, etc.

To identify the agricultural production development problems and propose the mitigation measures, specifically the constraints of crop production developments, a field survey has been under taken.

Through investigation of the farming systems and socio-economic aspects of the project area it has tried to select appropriate crops and technologies for Silala small-scale irrigation project with their improved management practices.

### **1.6.1. Rain fed crop production**

#### ***1.6.1.1. Farm land, draft power and labour***

##### **Land**

Land belongs to both the government and individual farmers in the project area. The average size of cultivated land per household is 0.75 ha and the farmland is also cultivated annually. In the project area almost all the households have fragmented farmlands and the average number of fragmentation is three-four.

Having farmlands at different locations is considered by local farmers as a good opportunity. This is due to the need for risk aversions such as hail damage, flood injury, land sliding and also from the aspects of faire distribution of productive, fertile and irrigable farmlands among farmers. In proper looks, fragmented farmland holdings can reduce the efficiency

of farmers, so as not suitable for proper time utilization and crop field management.

The average farmland holding of the farmers is decreasing through years as the land is shared for their children owing to the annual increment of population. In such situation, to satisfy the additional food requirements, yields would only be increased by employing intensification approaches through the application of irrigation water, use of appropriate farm managements, and introduction of improved farm inputs including farm implements as well as better cultivation techniques.

### **Draft power and labour**

In the project area, oxen are the main source of draft power. The total numbers of oxen and households found in the project kebele are more than 2237. According to Gibgedel kebele development agents' and interviewed farmers' suggestions, farmers in the project area have no serious shortage of farm oxen to accomplish their farm activities in time.

Farmers, who have no farm oxen, grow crops using a traditional land renting agreement, that is, by renting their farm lands to those who have oxen at a crop share of 50 percent or equal share of the yield obtained. Nonetheless, input (fertilizer) costs are equally shared both by the sharecropper and land renter. Another option of the land owners, who have no oxen, to grow crops is that exchange of human labour by oxen labour, mostly at equal exchange rates.

In the project area, when farmers face a problem of shortage of labour for planting, weeding, harvesting, threshing, etc activities, they use community labour, where group of farmers work together. The known group working types and locally called “*Debo*” and “*Wonfel*”.

The major agricultural activities and time where community labour are needed and used are during crops (pepper transplanting), weeding and hoeing, harvesting, and threshing (Table 7).

When shortage of labor becomes much pronounced the farmers use hired labour at the rate of 300 birr per person per day for both male and female laborers. This is specifically done during weeding and harvesting period. The existing labour and oxen requirements for various farm operations of major crops for 1ha of land, in the project area, are presented on table2

**Table 2 Existing labour and oxen requirement for major crops and various farm operations.**

Crop type	Man Oxen	Land Preparation	Sowing (Fertilizer application)	Weeding and cultivation	Harvesting	Threshing
Wheat	M	14	4	8	32	16
	O	16	4	0	0	34
Barley	M	16	8	53	32	18
	O	16	6	0	0	34

Teff	M	4	4	25	10	16
	O	8	14	0	0	48
Maize	M	4	12	48	10	16
	O	8	8	0	0	48
Millet	M	4	8	120	60	18
	O	4	4	0	0	32
Bean	M	4	12	34	8	8
	O	8	8	0	0	12
Potato	M	4	12	28	28	-
	O	8	8	0	0	-
Onion	M	4	48	48	48	-
	O	8	0	0	0	-

**Source:** Gibgedel kebele Agriculture and Rural Development Office (DAs), 2014.

M = Man-days      O = Oxen-days

### ***1.6.1.2 Cropping pattern and crop calendar***

The rainfed agriculture is mainly based on Meher (*Kiremt*) rainfall. In the project area rainfed cropping season starts commonly from May and extends until September and a wide range of crops are grown during this span of time.

The area coverage by different crops (cropping pattern) varies from year to year specifically depending upon climatic factors, i.e., mainly due to early or late start of Meher rain. In addition, farmers' preferences, soil conditions, market price situations and feed habit of the society also determine the cropping pattern. Maize, Teff, Wheat, and Barley are the major staple food crops, whereas, Bean, Potato and Pepper are the minor staple crops grown in the area, field pea, linseed, onion, cabbage, beet root, and carrot are some of the crops used most of the time for market as cash incomes.

At kebele level, where the project area is found, Maize is the leading crop having area share of 33% followed by Wheat, Barley, Teff, and Bean, respectively, in wet season (Table3).

**Table 3 Existing crop pattern and production of Gibgedel Kebele, 2015/2016 (Rainfed).**

S/ N	Crop type	Area		Productivity (qt/ha)	Production (qt)
		(ha)	%		
1	Wheat	244	17	32	7808
2	Barley	185	13	32	5920
3	Teff	120	8	24***	2880
4	Beans	95	6.5	25***	2375
5	Field peas	35	2.4	20	700

6	Linseed	5	0.34	4	20
8	Maize	475	33	45	21375
9	Pepper	54	3.7	9	486
10	Potato	170	11.7	200***	34000
11	Cabbage	18	1.24	120	2160
13	Carrot	5	0.34	120	600
14	Onion	45	3	85	3825
	<b>Total</b>	<b>1450</b>	<b>100</b>		<b>82149</b>

Source: Gibgedle Kebele Agriculture Development Office

\*\*\* = Crops productivity is exaggerated

#### *1.1.1.1. Cropping system*

As other parts of the region crop production of the project area is totally dependent on the availability, amount and distributions of rainfall.

**Following:**

Fallowing is not practiced in the project area as a result of population number increment and the rising demand and sharing of agricultural lands for the young rural youths.

### **Crop Rotation:**

The usual cropping system being practiced, in the project area in particular, is crop rotation. Farmers of the project area usually rotate cereals with pulses (Table 4). Farmers also sometimes rotate shallow rooted crops with deep-rooted crops and cereals with horticultural crops too.

**Table 4 The existing crop rotation patterns of the project area**

<b>Meher /Wet Season (1<sup>st</sup>)</b>	<b>Meher /Wet Season (2<sup>nd</sup>)</b>
Teff	Wheat, bean, Maize,
Wheat	Teff, barley, bean, field pea, maize, linseed, onion, potato, cabbage, beet root.
Barley	Bean, field pea, maize, millet, linseed, onion, potato, cabbage, beet root.
Maize	Wheat, teff, faba bean, onion, potato, cabbage, pea
bean/Field pea	Wheat, barley, teff,
Linseed (flax)	Teff, wheat
Tomato	Carrot

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Potato	Onion, potato, cabbage, chick pea
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**Source:** Agronomy survey made in the project area, in 2016

### **Intercropping:**

In the project area, farmers are practicing intercropping system by mixing Maize with potato, rapseed, and Bean, faba bean with field pea, pepper with garlic these all are adopted practices.

### **Shifting cultivation:**

Such type of cropping system is an old fashioned practice and not exercised in the project area so long as there is no extra free land in the area.

#### ***1.1.1.2. Agronomic practices***

In simple terms, agronomic practices of crops include pre- and post-harvest operations (See Table 5 & 6).

A. Pre-harvest practices: Land preparation, sowing and weeding/cultivation operations.

In the project area land preparation start from land clearing if some weeds and crop residues are there, especially maize fields, which otherwise directly starts plowing since many of the pieces of lands are cultivated year after year. The highest frequency of plowing is done for Maize and Teff on average six times (Table 11).

Sowing for major crops is done by broadcasting. Row planting is practiced mostly for horticultural crops Bean and Maize`. For teff, farmers sow the seed after the final plough and stepping the field with animals to make the land surface leveled or smooth. All other crops such as wheat, barley, field pea, , and linseed are broadcasted and then under plowed. Maize and vegetables are sown in rows.

The farmers' seeding rates of different crops vary depending on the fertility level of the farmland, the seed quality, etc. Farmers of the project area are also using oxen-drawn traditional ploughing tools, such as big or small '*Beam*' or '*Moffer*', wider or narrow '*Boards*' or '*Diggir*', long or short '*Share*' or '*Maresha*', and '*Kember*'(localy)during land preparation and seeding times, depending up on the moisture condition and the frequency of plough of the field.

Weeds are one of the well known causes for yield reduction in the project area. If crop fields are totally un-weeded 100% damage could be occurred in the area. Hand weeding is, therefore, the common practice carried out in the project area to control weed infestation (Table 5). Hoeing is carried out for some crops like maize, onion , potato, etc. with

the help of digging hoe. Moreover, oxen mounted cultivation, locally called “*Shilshallo*”, is practiced for maize. Weeding is done by all families, including children who have reached for work. Weeding frequencies/number of weeding activities vary from 0 to 4 for different crops. Use of herbicide (like 2, 4-D Amine), to control broad leaved weeds, is also adopted in the project area. In general, farmers practice weeding for all crops except Lin seed, though weeding practices are not commenced at the right time of weeding and provide enough number of weed

Table 5 Existing land preparation and weeding frequencies

No.	Crop type	Plowing frequencies	Weeding and/or cultivation
<b>I</b>	<b>Rainfed crops</b>		
1	Teff	5	1
2	Wheat	5	1
3	Barley	4	1
4	Bean	3	2
5	Field pea	3	1
6	Maize	6	3 (1 shilshalo & 1 hoeing)
8	Linseed	1	1
9	Potato	5	3hoeing & weeding
<b>III</b>	<b>Irrigated</b>		

	<b>crops</b>		
1	Onion	4	3 hoeing & weeding
2	Tomato	4	3 hoeing & weeding
3	Potato	4	3 hoeing & weeding
4	Pepper	5	3 hoeing & weeding
4	Vegetables (others)	3	3 hoeing & weeding

**Source:** Agronomy survey made in the project area, in 2016.

### **B. Harvest and post-harvest practices (harvesting, threshing, transporting, and storage).**

Harvesting and threshing are the most labour intensive and time consuming operations and are done in a traditional manner in the project area. Harvesting is practiced after the crop has got its physiological maturity and the leaf, stem, etc parts changed from green to straw, brown, and the like colors. Regarding the harvesting methods and tools, for most cereals harvesting is done with hand by using sickles; chick pea with hand pulling; onion with the help of digging hoe, and for tomato, cabbage, beet root and carrot by hand picking.

Cereal and pulse crops are left on the ground for some time to dry after harvest and then piled up for short duration. For horticultural crops they are taken soon to the market for sale after harvest and before it gets perished. Field pea are harvested before they get complete drying to avoid yield losses due to shattering. As to maize, the cobs are mostly

hand-picked and used as a roasted-food (as fruit-crop) after grain filling and before the cobs get drying. The stalks of maize are collected to be used for livestock feeds and other purposes.

Threshing is done after a threshing ground site has selected, scarped, cleaned, watered, straw is sprinkled, stepped and get compacted, and cleaned. In addition to this, the threshing ground is also plastered with cow dung for all crops. Threshing is carried out by using oxen, cows, horse, and donkeys by trampling on it and farmers continuously turn the straw with a forked stick locally called “*Mensh*”, while for teff using hands to get the panicles exposed to the oxen hooves and the grain to get loosen and separated. For majority of the crops, the mixture of chaff and grain are separated by wind when it is thrown up ward with a winnow, a scarped wooden tool. For teff they use piece of animal leather, locally called “*Margebia*”, to separate the chaff with the grain. For chaff separation, they also use other local materials, locally called “*Sevez*”, “*Godir*”, “*kesse*” and “*Chefeka*” for all crops.

After separation and cleaning of the grain from chaffs the produces are mostly packed by plastic bags (*Madaberia*) and transported to home for storage by loading on donkeys’ or horses’ back or by human labour. In the project area the produces are stored in different traditional storage structures; and most produces are commonly stored in local granary, locally called “*Gottera*” and “*Gota*” and area mostly placed indoor. Few farmers are also using “*Gushgush*” which is made of fermented

mud. The size and capacity of the different storage structures varies from farmer to farmer depending up on the amount of their crop produces.

Regardless of the types of structures used for storage and the precautionary measures taken by farmers, the overall annual losses of stored grains (by rodents, birds and insect pests like *weevils*) are high. As studies suggested, by FAO and others, the losses due to poor storage is estimated to be as high as 15–20% of the stored grain.

**Table 6 Existing crop production schedule/crop calendar for the different farming activates**

<b>S N</b>	<b>Crop type</b>	<b>Land preparati on</b>	<b>Sowing</b>	<b>Weeding /cultivati on</b>	<b>Harvesting</b>	<b>Thresh ing</b>
<b>I</b>	<b>Rainfe d</b>					
1	Teff	feb- Jun	Jul	Aug- Sept	Oct-Dec	Dec- Jan

2	Wheat	Dec-May	Late Jun-Earl Jul	Jul-Sept	Nov-Dec	Dec- Jan
3	Barley	Dec-Apr	Late May- Earl Jun	Jul	Oct-Nov	Oct- Nov
5	Bean	Feb-Mar	Earl-Late Jun	Jul-Sept	End Seot-End Nov	Nov
6	Field pea	Feb-May	Earl-Late Jun	Jul	Mid Oct-End Nov	Nov
7	Linseed	Apr	Earl May	End Jun	Dec	Dec- Jan
8	Maize	Jan-Mar	End Mar-End May	Jun-Jul	Nov	Dec- Jun
9	Potato	Dce-Feb	May	Jul-Aug	EndAug-Sept	-
<b>I</b>	<b>Irrigat</b>					
<b>I</b>	<b>ed</b>					
1	Onion	Sept	End Oct-Nov	Nov-Dec	End Jan-Earl Feb	-
2	Pepper	Sept-Dec	End Jan-Feb	Feb-Apr	End May-Earl Jun	-

**Source:** Agronomy survey made in the project area, in 2016.

#### **1.1.1.3. Input use**

Even if not much satisfactory, farmers in the project area are on the way of adopting with modern technologies, inputs and improved agronomic

practices. Regarding the use level of traditional and/or improved soil fertility improvement practices, compost was prepared and used in farmland. In general, compost preparation and utilization is now being scaled up by the local farmers with the recommendation application rate of 80-120 quintals per hectare. Use of crop residue as fertilizer is, however, almost none.

Some of the modern inputs distributed and utilized in the project area are fertilizers, improved seeds, agro-chemicals, and farm tools. The 2013/14 cropping year inputs' distribution data, in Gibgedle kebele and Burie woreda has presented on Table 7. Based on information obtained from farmers and DAs, artificial fertilizers (DAP & UREA) are used for wheat, maize, bean, and Teff. The application rate of these fertilizers also varies mostly depending up on the crop and soil types.

**Table 7 Inputs supplied and used in the project area in 2015/16 cropping year**

Types of Inputs	Unit	Kebele	
		Supplied	Utilized
<b>Soil fertilizers</b>			
DAP	Qt	1600	1600
UREA	"	1700	1700
LIME	"	25	25

Bio-fertilizer	Sachet		
<b>Improved seeds</b>			
Wheat	Qt	86	86
Teff	"	4	4
Maize	"	320	60
<b>Agro-chemicals</b>			
Insecticides	Kg/Lt		Na
Herbicides	Lt		Na
Fungicides	"		
<b>Farm tools</b>			<b>8</b>
Water pump	No		14
Drippers	No		-

Na= Data

is not available

**Source;** Gibigedle Kebele Agricultural Development Offices

Secondary data collected from the project kebele has showed that farmers of the project area are using artificial fertilizers in an increasing situation; whereas improved seeds demand and utilization is not indicating encouraging situation. Based on interviewed local farmers and

DAs of Gibigedele kebele explanation, the major problem for the low level of crop productivity, especially the lack of improved seeds, is that farmers are using their own local seeds, except wheat, Teff and maize even if that is low.

Untimely supply of inputs, supply of poor quality improved seed (i.e., sprouted and spoiled seeds), as well as the yearly increasing of inputs price (especially that of artificial fertilizers prices) are some of the reasons stated for the low level of inputs utilization (based on interviewed farmers explanation). In the project area herbicides and insecticides are distributed by private traders.

#### ***1.1.1.4. Crop protection***

Every year a significant amount of crop yield is lost due to crop pest infestation. In the project area, there are economically important insect pests, weeds and diseases of crops. Stalk borer, boll worm, cut worm, aphids, and weevils (in storage) are some of the most important field and insect pests causing extensive damages to different crops (Table 8).

**Table 8 Common insect pests and crops infested in the project area**

S/ N	Insect pests		Crops infested
	Common name	Scientific name	

1	Stalk borer	Buseola fusca	maize
2	Ball worm	Heliothis armigera	Faba bean, field pea
3	Aphids	Different spp.	Cabbage, field pea,
4	Termites	Different spp.	All crops (wheat, faba bean)
6	Cut worm	Agrotis segetum	bean, potato, onion, Pepper
	Weevils	Sitophilus spp.	Cereal and pulse crops when stored

Source: Agronomy survey made in the project area, in 2016.

Weed floras are also known to cause great crop yield reduction. The name of major weeds of the project area and crops infested are shown below in (Table 9).

**Table 9 Major weed species and crops infested**

S/N	Common Name	Scientific Name	Craps infested
-----	-------------	-----------------	----------------

1	Muja	Snowdnia polystachy	Maize ,pepper
2	Mech (Amharic)	Gizotia scabra	All crops
3	Adyo	Bidens pachyloma	All crops
4	Striga	-	Maize and sorghum
5	Asendabo (Amharic)	Phalaris paradoxa	All crops
6	Purple nutsedge (Engicha)	Cyprus spp	All crops
7	Star grass (Serd-Amharic)	Cynodon nlemfuensis	All crops
8	Blue coach grass (Wariat)	Digitaria abyssinica	All crops
9	Gorteb (Amhara)	Plantago lanceolata	Teff, wheat, barley ,Millet
10	Dodder	-	Nug

Source: Agronomy survey in the project area in 2016

Some of the common crop diseases identified in the project area are presented on Table 10. The common crop diseases listed out on table 10 do cause crop yield reduction in the project area. Local farmers of the project kebele do not have know how about crop diseases, rather they relate it as a weather or insect pest effect and commonly they do not practice control measures.

**Table 10 Major diseases and crops infested**

S/	Common Name	Scientific Name	Crops infested
----	-------------	-----------------	----------------

N			
1	Strip or yellow rust	Puccinia striformis	Wheat
2	Loose & covered smut	Ustilago spp.	Barley,Wheat
3	Chocolate spot	Botrytis fabae	Faba bean
4	Late blight	Phytophthora infestans	Potato
6	Root rot, Damping-off, pink rot	Fusarium spp.	Onion, Pepper,Potato

Source: Agronomy survey in the project area in 2016

There are also domestic and wild lives that cause crop yield reduction in the area. Some of the common wild lives and crops attacked are: Porcupine (potatoes), Apes (maize and faba bean). Moreover, there are also bird pests (on barley, maize, sorghum,) and rodents (in field and storages on most crops) that cause crop yield reduction in the area. Dog is also domestic animal that attacks maize crop at the back yards.

#### ***1.1.1.5. Supporting Services***

##### **Agricultural Extension**

Like other kebeles of the region, agriculture development office has already established in the project kebele too. Fife development agents (DAs) with different professions (Office head,Natural resource, Animal Sciences, Plant Sciences and irrigation expert) are assigned in the kebele to provide agricultural extension services and trainings to farmers.

The DAs have close and day to day contacts with farmers found in the kebele and are responsible to implement the different agricultural programs and technology packages at the grass root level. Furthermore, the kebele has divided into 3 sub-kebeles and each DA has assigned to work extension activities in his/her sub-kebele. Of the three DAs only one of them are assigned to act as manager for 2 consecutive years at kebele level. The managerial position is transferable to another DA after 2 consecutive years of services in a round style.

The woreda agricultural development office also providing technical assistances to DAs, supervisors and other experts who are assigned at kebele level to work with the farmers.

Zonal and Regional agricultural developments are also providing agricultural development and extension services working directions to the woreda agricultural and rural development office and others who are working at the grass root levels. Besides to this, the zonal and regional SMS team at both levels supports the woreda agricultural development and others too.

The current and flourishing approach for the dissemination of agricultural technologies to farmers, within the region in general and the project area in particular, is scaling up. This approach is mainly focused on the addressing of best agricultural practices that were tested and/or exercised by few farmers before. Thus, the previous minimum and family packages approach are now dropped and scaling up type of

approaches and strategies are now being practiced at all levels (Region to kebele level).

## **Research**

Though the project site is located under the working areas of Adet Agricultural Research Center; its branch is located in Finote Selam the capital of the woreda the dissemination levels of new technologies to the project area is not satisfactory. In general, there are no strong Research-Extension-Farmers linkages in the area; thus, needs to be strengthened.

## **Credit**

Credit supply to farmers is essential to purchase different inputs as a result of this maximize crop yields. The only credit supplier institutions found in the project kebele are Farmers Service Cooperative (FSC) and Amhara Credit and Saving Institution (ACSI). In general, these credit supplier institutions are not quit enough to satisfy the credit demands' of local farmers.

### ***1.1.1.6. Constraints to the growth of crop production***

Based on interviewed local farmers and group discussions made with the respective woreda agriculture staffs and DAs of the project kebele, the major constraints for the growth of crop production and productivity are pointed out here below. Hence, the major yield limiting factors, in the project area, are:

- Occurrence of moisture stress due to late start and early withdrawal of meher rain.
- Low level demand of inputs to farmers' (i.e., fertilizer, improved seeds, agro-chemicals, farm tools, etc).
- Lack of awareness among farmers about new technology utilization.
- Insufficient crop protection measures in crop field and at post harvest stage (storages).
- Unavailability of efficient pest controlling chemicals (including storage pests-like weevils)
- Lack or low level of credit supply to purchase agricultural inputs (e.g., fertilizers, improved seeds, agro-chemicals, etc).
- Crop diseases problems (i.e., onion bulb rot, late blight of potatoes, checholate spot on bean, smut on barley, rust on wheat, etc).
- Slow development of agricultural research and existence of poor linkages among research-extension-farmers.
- No strong and sustained agricultural extension services are provided to farmers. It is loose type.
- Soil erosion hazards as the soil and water conservation measures/practices are not well developed in the kebel and the worda too.
- Shortage of farm lands and traditional farming practices of farmers.

### 1.1.2. Existing irrigation practices in the project area

The pressure of survival and the need for additional food supplies to meet the demands of the increasing population is necessitating a rapid expansion of irrigation scheme throughout the world. Thus, irrigation is becoming a basic part of well-developed agriculture throughout the world.

Generally, a total of 425 ha of land was covered by irrigated crops and 427100 qt of yield was estimated to be produced in the kebele, in 2016 (Table 12). Farmers of the project kebele have strong demand on the transformation of Silala river to modern diversion/irrigation scheme. The major crops grown under traditional irrigation practices, in the project

Table 11 Existing crop pattern & production in the kebele traditional irrigation, 2016.

S/ N	Crop type	Area covered		Productivity	Production
		Ha	%	(qt/ha)	(qt)
1	Onion	20	25	84	1080
2	Potato	30	37.5	121	3630
3	Garlic	3	3.75	125	375
4	Tomato	8	10	124	1240
5	Cabbage	6	7.5	111	666
7	<b>maize</b>	<b>15</b>	18.75	40	600
11	carrot	3	3.75	89	267
12	sugarcane	12	15	265	3180
15	avocado	2	2.5	260	520
16	mango	5	6.25	180	900
22	pepper	21	25	12	252
	<b>Total</b>	<b>125</b>	100		12710

**Source:** Kebele Agriculture Development Office.

### **3 THE IRRIGATION PROJECT**

#### ***3.1 Project Rationale and Back Ground***

Due to unreliable nature of rainfall (uneven distribution and erratic nature), population growth, low level inputs utilization, etc, farmers of the project area are suffering from low income, poor standard of living and subsistence food supply. The importance of reversing the current situation is appreciated by all levels of the concerned regional government bodies and by the farmers of project area too. Hence, the development of Silala modern irrigation project integrated with improved agronomic practices is vital.

The proposed irrigation project would contribute towards increased production in the project area with small size farmland holding and high population growth as well as very low standard of living. It can secure the use of double cropping (i.e., harvesting twice a year). With the utilization of modern farm inputs and integration of improved management practices the proposed crops productivity/yield would be highly increased both per unit area and per unit time. As a result of this, food self-sufficiency could be assured and household incomes also would be improved and risen up.

Thus, implementation of Silala small-scale irrigation project aimed at increasing crop yields through a wider application of agricultural inputs and use of irrigation water from Silala diversion weir in both dry and wet season on a net command area of 51 hectares.

Development of modern diversion irrigation scheme is expected to solve the shortage of farmlands and the problem of unreliable rainfall in the area. The proposed water harvesting structure for this irrigation scheme is construction of modern diversion weir and canal outlet on the right side from the natural flow direction of the spring to irrigate the proposed command area.

***The main objectives of Silala Small-Scale Irrigation Project are:***

- To increase crop yields in a sustainable farming system among the beneficiary households in the project area through double cropping and better use of agricultural inputs.
- To bring about sustainable development of the farm families in the area as a result of increasing their farm incomes from food and cash crops.
- To reduce the risk of crop production and productivity by minimizing moisture stress and crop pests problem through the use of modern crop protection technique in the area of irrigation.

## ***3.2 .Proposed Crop Development Plan***

### **3.2.1. Crop selection**

The project area that comprises mainly Clay loam textured soils and annual mean minimum & maximum air temperature of 10 and 25.2 °C, respectively, is suitable for wider range of crops production. Hence, crops for Silala diversion weir irrigation project are selected based on soils and agro-climatic suitability, food habit of the population, the woreda in general and the project kebele in particular, the intrinsic ability of the surrounding farmers to grow the crops in conjunction with the existing management, the technical skills available at present, marketability and productivity of the crops as well as the national and regional priorities and other socio-economic and environmental consideration with the preference of farmers.

In the selection of crops the following additional considerations were also made, i.e., inclusion of leguminous crops, which shall fix free atmospheric nitrogen for the command area soil thereby help in maintaining soil fertility and the crops which are already growing in small patches in and around the command area are also considered.

On the basis of the above criteria and the peculiar situation of the area, the following cereals, pulses, root and vegetable crops are selected.

**Wet season** –Maize, Wheat, Pepper and bean

**Dry season** – Onion, cabbage, Wheat, Potato

### **3.2.2 Proposed cropping pattern and crop calendar**

The cropping pattern that has been plotted has to be used to calculate the irrigation water requirements during the cropping year. The major criteria to recommend the new cropping patterns are:

- Inclusion of a leguminous crop in the crop rotation system with cereals, vegetables and root crops to maintain soil nitrogen status for nitrogen fixation by the legumes.
- Contribution of crop rotation practices in breaking the life cycle of crop diseases, insect pests and parasitic weeds causing yield loss in mono-cropping practices.
- Targeting an efficient water use for full irrigation and supplementation to the available rainfall as well as the length of growing for these crops.
- Aiming at efficient and more productive occupation of the available labour force during the year.

In determining of proposed crops' sowing and harvesting, care has been taken in that there is no too much of over lapping of various pre-sowing and post-harvesting operations, heavy rainfall does not coincide with flowering and maturation, beginning and ending of *Meher* rain season, temperature suitability and harvesting during dry and warm periods as far as possible.

The proposed cropping pattern and calendar presented on Table14 have many advantages:

- It minimizes the risk of monoculture in irrigation.
- It improves the intake of balanced diet by the people.
- Guarantees annual incomes to a certain level.
- Allows a good employment and occupation for the available labour forces throughout the year.
- Reduce soil erosion through effective and continuous soil cover
- Production of animal feeds from crop residues (straw, etc).

**Table 12 Proposed cropping pattern and calendar for wet and dry seasons**

Crop	Area (ha)	Area (%)	Land preparation	Planting	Weeding & pest control	Harvesting
<b>Wet season</b>	<b>51</b>	<b>100</b>				
Maize	15.3	30	Mar-Apr	May	Jun-Aug	Octo
Wheat	15.3	30	End Apr-May	Jun	Late Jun-Aug	November
Barly	7.7	15	May-Jun	June	Aug-Sept	Septe
Bean	12.7	25	May-Mid Jun	Jun	Jul-Earl Aug	October
<b>Dry season</b>		<b>100</b>				
Onion	12.75	25	Nov-Dec	07- Jan	Feb-Apr	Lat Apr-Earl May
Cabbage	10.2	20	Nov-Dec	07-Jan	Feb-Apr	Late April
Potato	10.2	20	Oct- Nov	20-Dec	Jan-Mar	Lat Apr-Earl May
Wheat	17.85	35	Oct- Nov	07-Dec	Jan-Feb	Lat Apr

**Irrigation Duty:**

Irrigation duty is the volume of water required per hectare for the full flange of the crops. It is also the relationship between the volume of

water and the area of the crop matures. Moreover, it helps in designing an efficient irrigation canal system. The area, which will be irrigated, can be calculated by knowing the total available water at the source and the overall duty for all crops required to be irrigated in Silala

The proposed cropping pattern of Silala irrigation project has showed a maximum Net Irrigation Water Requirement (NIWR) in the month of March with the amount of 3.1 mm/day for 24 working hours.

The gross irrigation water requirement (GIWR) is calculated from NIWR and irrigation efficiency as follows:

$$\mathbf{GIWR = NIWR \times IE}$$

Where; GIWR – Gross irrigation water requirement [mm/day]

NIWR – Net irrigation water requirement [mm/day]

IE – Irrigation Efficiency [%]

For Silala small scale irrigation project, it has estimated to adopt 60% field application efficiency (for furrow irrigation system) and 70% conveyance efficiency as the soil is clay loam textured and some part of the canal systems are estimated to be non-lined. Therefore, the overall efficiency for the selected surface irrigation method is 0.42 % ( $60/100 \times 70/100$ ).

The GIWR, for the design of the project, is given for the selected irrigation method (i.e., surface irrigation) as follows:

$$\mathbf{GIWR = 3.1/0.42 = 7.38[mm/day]}$$

The GIWR, 7.38mm /day, represents the daily quantity of water that is required to be applied. This water quantity is also used for determination of the canal discharge in consideration of the time of flow and is defined as the duty, expressed as l/s/ha. The duty is calculated by:

$$\mathbf{Duty (D) = GIWR \times 1000 \times 10 / (t \times 60 \times 60)}$$

Where; Duty – the duty [l/s/ha]

GIWR – Gross Irrigation Requirement [mm/day]

t – Daily irrigation or flow hours [hrs]

The duty for the GIWR 7.38 mm/day and 18 hours of daily irrigation time (t = 18) is supported to be used with furrow irrigation method. Hence, Duty for 16ha working hours is computed as follows:

$$\mathbf{D = 7.38 \times 1000 \times 10 / (18 \times 3600) = 1.13 \text{ l/s/ha}}$$

### *3.2.2.1 Irrigation methods and systems*

Among the different irrigation systems perennial irrigation system will be used for the project area. The irrigation water will be obtained from Silala river by diverting and conveying through the main canal and then lead to the command area.

Among the various irrigation methods surface irrigation method has selected for this project. Of the surface irrigation methods furrow, border and basin irrigation methods can be used to supply irrigation water to the plants/crops. However, each method has its own advantages and disadvantages. Care should be taken into account when choosing the method which is best suited to the local circumstances, i.e., mainly depending on the command area slopes, soil types, types of crops, and the amount of water available.

In this irrigation scheme, furrow irrigation method has proposed for the dry season proposed crops. Furrow irrigation method allows applying light irrigation and can be laid out in sloping fields along the contour. Furrow irrigation method is also best suited to the proposed row planted crops. In general, furrow irrigation method is simple, manageable and widely practiced irrigation method. This method is suitable for row crops that cannot stand in water for long periods. The only thing required to use this method is row planting of crops. Besides, basin and border irrigation method would be used for the non-row planted crops. Rotational flow water distribution is also recommended for the project area.

### ***3.2.2.2 Irrigation scheduling***

Irrigation scheduling is one of the managerial activities that aim at effective and efficient utilization of water. Irrigation scheduling is a means of conserving water which helps in making decisions on allocation of quantity and timing of water supply commensurate with crop needs.

Irrigation schedules are expressed in terms of frequency rate and duration of how water is delivered to a farm unit. The number and intervals (timing) of irrigation vary widely for different crops. That is because of the function of crops, soils and climate factors.

Field irrigation scheduling is based on the field water balance, expressed in depth (d in mm), and interval of irrigation (I). Hence, the following relationship is used to determine the irrigation schedules of the proposed crops in the irrigation scheme.

#### **Depth of irrigation application (d):**

$$d = \frac{(P \times S_a) \times D}{E_a}$$

E<sub>a</sub>

Where; d = Depth of irrigation application

SA = Total available soil moisture (water) mm/m soil depth.

P = Fraction of available water

(p.sa) = readily available soil water (mm/m)

D = Rooting depth (m)

Ea = Application efficiency factor, (Ea = 60%).

Since ETc will vary over the growing seasons, the depth in mm and interval of irrigation in days will vary as well.

### **Irrigation interval (I):**

$$I = \frac{P \times S_a \times D}{ET_c}$$

ETc

Where; I = Irrigation interval (days)

ETc = Maximum crop evapotranspiration per day (mm/day)

In this project study it has tried to determine the irrigation intervals of the proposed dry season crops (see Table 15). For the wet season crops supplementary irrigation will be provided when irrigation is needed. Generally, it can be supplemented depending on the distribution of the ‘Meher’ or ‘kiremt’ rainfall.

The irrigation schedule was determined for the period of peak water demand (mid-season stage). In the early crops growth stages, when the

plants are small, the crop water need is less than the mid-season stage. This is because of the low evapotranspiration of the young plants and their shallow root depths. Hence, during the early stages of crops growth, it is possible to irrigate with smaller amount of irrigation water application and frequently.

Generally, timing of irrigation should conform to soil water depletion requirements of the crop, which are shown to vary considerably with evaporative demand, rooting depth and soil type as well as with stages of crop growth.

**Table 13 Irrigation Intervals of dry season proposed crops**

<b>Crop</b>	<b>Root Depth (m)</b>	<b>P</b>	<b>PxSaxD, (mm/m)</b>	<b>ETc, (mm/day)</b>	<b><math>I = \frac{PxSaxD}{ETc}</math>, (days)</b>
<b>Onion</b>	<b>0.3</b>	<b>0.35</b>	<b>14.7</b>	<b>3.9</b>	<b>10</b>
<b>Cabbage</b>	<b>0.5</b>	<b>0.45</b>	<b>31.5</b>	<b>4.43</b>	<b>7</b>
<b>Potato</b>	<b>0.6</b>	<b>0.35</b>	<b>29.4</b>	<b>3.79</b>	<b>8</b>
<b>Wheat</b>	<b>0.5</b>	<b>0.55</b>	<b>38.5</b>	<b>3.88</b>	<b>10</b>

**Note:** The irrigation intervals have been determined for silt Clay loam textured soils ( $S_a = 140$  mm/m) throughout the profile.

D = root depth      P = Depletion fraction      I = Interval of irrigation

Critical stages of crops at which moisture stress adversely affects the growth, flowering, seeds formation and development, and ultimately the yield. Care has to be taken that crops are adequately irrigated at these stages. Proposed crops critical stages are presented on Table 16.

**Table 14**The most critical moisture sensitive crop growth stages for proposed crops

Crop	Growth stages	Season
Maize	Tasseling ,silkingand grain formation	Wet
Wheat	Flowering ,panicle initiation, grain and tiller formation	
Teff	Booting to heading stage	
Bean	Flowering, pod and seed setting.	
Onion	Throughout but particularly during bulb formation and enlargement	Dry
Cabbage	During head formation and Development	
Pepper	Throughout but particularly just prior and at early stage of flowering	
Beet root	Tuber initiation, yield formation, early vegetative period	
Tomato	Throughout but particularly just prior and at early stage of flowering.	

### 3.2.3Organizational aspects of irrigation scheme

Administrative and technical problems, in irrigated agriculture, cause great failure of crop yields and in irrigation extension, unless they are solved as quickly as possible. Hence, water users association (WUA) has to be established and should be given due attention by the woreda administrative councils and development sectors in solving both social and technical problems.

- The project beneficiaries (farmers), who are organized under the WUA, would have the following advantages:
- Problems of local administration will be solved.
- Damaged irrigation weir and canal structures could be maintained easily and sooner after close supervisions are made by the members of the association and irrigation water managing bodies of the project.
- The organization could construct common storage facilities so that they could store their surplus and low costly productions and can sell when the price rises up.
- When the association get the by-Laws can take credits of agricultural inputs, farm tools and equipments for its members.
- The association controls the whole irrigation structures, irrigation water distribution and management operations and maintenance of the weir and canals.

Therefore, the woreda agriculture development office and the cooperative promotion agency work process, at woreda level, should

have to take the lion-share to carry out the organization of the water users association and its structural set.

### **3.2.3 Recommended Crop production Management Practices**

Recommendations are described as information to be used by farmers to improve the productivity of their resources, i.e., farmlands, labour, and then outputs (yields).

#### **3.2.3.1 *Cropping system***

Different cropping systems are being practiced in different regions of the country. However, there are different features of cropping system to be considered. Andrew and Kassam (1977) have put the following important characteristics:

**Availability of water:** in rain fed agriculture, crop growth is dependent on the availability and duration of moisture during the cropping season.

**Utilization of space and time:** crops can be grown sequentially one after another so that time is used to obtain more production. Crops may be mixed and grown together simultaneously intercropped.

**Yield advantages in crop mixtures:** the yield advantage results from better total crop water use efficiency of mixture, nitrogen use efficiency in cereal – legume cropping patterns, utilization of space, weed control and use of total available labour.

Security factors: The significant feature of multiple cropping is a greater dependability of return compared with sole cropping.

Thus, crop rotation is being practiced in the project area and also proposed to be used during project implementation. Crop rotation is one means to maintain soil fertility as well as to control weeds and other pests, and thus gives better grain yield. In the project area cereal/oil crops with legume/vegetable crops rotation system should be followed in order to maintain the soil fertility and to protect crop pests attack. On top of this, the proposed crops rotation pattern of the project area is arranged as follow:

**Wet season**

**Dry season**

Maize (30%) -----Onion 20 % + Wheat 10 %

Wheat (30%) ----- Cabegge 10 % + Potato 20%

Barely (15%) ----- + Cabbage 10 + Onion 20%

bean (25%) ----- Wheat 25 %

***Improved crop management/agronomic practices***

The existing crop management practices lack skill full and technical knowhow. Thus, to improve the existing back ward management and promote specifically the irrigated farming and make economically feasible, use of improved agronomic practices are crucial. High level of production can be attained after farmers of the project area are adopted improved agronomic practices/technologies. Agricultural technologies

are also too broad and may need specification and modification based on local tangible conditions or test on actual fields. Based on these facts, some commonly understood practices are suggested for proposed project. Some of these practices are very common to the area except it lacks skill full treatment, while others are not well under stood to the area because of lack training and sufficient extension services.

During the project implementation time the following general improved agronomic practices should be implemented. The details and individual crops packages and improved management practices are presented on annex 6.

### **Field sanitation and land preparation:**

Crop residues that harbor insect pests, plant diseases and weed seeds should have to be removed out before land preparation on the project field. Deep tillage is required to improve the aeration and water retention conditions of the soil. It also helps the root of the crops to penetrate easily into the soil to extract moisture and nutrients from the lower layers of the soil. Hence, depending up on the types of crops to be planted and the farmland history and conditions, proper number of ploughing, 2-4 times, should be practiced before sowing/planting operations is done in the project area.

Plowing is also necessary to destruct the roots of weeds and exposing eggs of crop pests that buried in the soil to heavy sun hit. .

**Planting method and planting materials:**

In order to have vigorous growth and obtain optimum yields, recommendations of seeding rates (plant populations), spacing between plants and rows should be followed and adopted for the proposed crops. Planting/sowing has proposed on rows, except teff (Table 24). Standardized and quality planting materials/seeds that are free from insect pest, disease and weed seeds, unbroken seeds and healthy seedling materials should be used. Uses of improved seeds (crop varieties) have paramount importance to ensure increased crop production and productivity.

**Fertilizer application:** fertilizers are used to increase crop production by adding nutrients to the soil and to restore and to maintain the soil fertility. Furthermore, it is important to use the proper type, placement and application rate at the right time so as to ensure increased crop production and productivity. Apart from applying artificial fertilizers (like DAP, UREA, etc), organic manures are useful to improve the physical structure of the soil, water holding capacity, drainage, workability, etc. of the soil. Although, the use of manures by local farmers in the project area, is encouraging, strong measures on the application of organic fertilizers (compost, farm yard manure, crop residues, green manures, etc) is very important since it improves soils physical, chemical as well as biological conditions (Annex 6).

**Irrigation:** during irrigation season sufficient amount of water should be provided to the irrigated crops and also supplement wet season crops when rain shortage occurs. According to the recommended schedule, consideration has to be taken particularly during the crucial moisture sensitive crop growth stages.

**Harvesting:** harvesting of grain crops should be practiced when the crops attains full physiological maturity and optimum moisture content. Harvesting of vegetable crops depends on the purpose to be used, availability of storage facility and maturity. The proposed crops improved management.

**Threshing:** after harvesting grain crops should be sun dried, for a certain period (days) in the field, to reduce the moisture content, for threshing. Threshing should be done on clean, well-compacted threshing ground; and if possible on canvasses or concrete grounds.

**Storage:** the crop product to be stored should be clean, dry and free from field pest infestation as well as cross-infestations of storage structures. Therefore, the storage structures should be cleaned, aerated, rodent and termite proof before storage of the new produces. To control storage pests attack different botanicals, cultural methods and chemicals could be used.

### **3.2.3.2      *Recommended crop varieties***

In the project area, almost all the seeds used as planting materials are local seeds carried over by farmers from their previous year harvest; and these seeds include local land races. Farmers' produced seeds are no seed dressing measures are undertaken, leaving the seeds vulnerable to soil pests and seed borne diseases. The source of vegetables seeds (onion, tomato, and cabbage), grown in the area, is from Burie town. Thus, different variety with basket of options has recommended, on table 15, to be used in this project implementation.

Table 15 List of improved and recommended crop varieties

<b>Crop type</b>	<b>Improved crop verities</b>	<b>Season</b>
Maize	BH-660, BH- 540, PHB-3253,BH-543,Shonne	Wet
Wheat	HAR-1685, HAR-604, HAR-1522, HAR-1868, HAR-3646 (Senkegna),Gasagn	
Bean	Degaga, Dagim, Wayu, Selale Kasim, CS-20DK, Bulga 70, Holeta-2	
Onion	Red creol, Adama red, Melkasa red, Melkam, Mermiru brown, Mermiru white	Dry
Cabbage	Copen hagin, Early drum head	
Potato	Tolcha,wechecha	
Wheat	HAR-1685, HAR-604, HAR-1522, HAR-1868, HAR-3646 (Senkegna),Gasagn	

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### **3.2.4 Supporting services**

#### **Extension**

Strong agricultural extension services, trainings, demonstrations and experience exchange tours should have to be arranged. Demonstrations on new technologies and improved working practices would have to be carried out to the project beneficiaries on the field of FTC (farmers training center). Training of farmers on different techniques and crop management practices is essential. Seasonally scheduled trainings should be provided for extension staff of irrigation process including DAs and related woreda experts.

Irrigation development agent, who is qualified in plant sciences/general agriculture and well experienced in irrigated agronomy, has to be assigned in order to deliver irrigation aspect extension service for the project beneficiaries.

#### **Research and demonstration**

Specific applied research and development for selecting new superior varieties suited to the proposed project and extension activities in dissemination will become instrumental in increasing awareness among

growers concerning the values of good varieties and superior seed quality.

Issues that need prompt research include: Develop improved crop management practices specifically in irrigated agronomy, integrated pest management practices (IPM) and post harvest technology. This includes:

- Varieties development for irrigated cropping.
- Demonstration works such as farm verification and adaptive field trial should be carried out to demonstrate for farmers practically.
- Irrigation method and irrigation scheduling
- Cropping intensity and input utilization rates, etc.

### Inputs supply

The poor performance of inputs supply systems contributes a lot for the low input-output subsistence farming system. Fertilizers (DAP, UREA and others) should be made available to growers by Cooperatives/Unions/WUA and other suppliers established in the region. Prices should be competitive or set by officials to prevent over-pricing by suppliers.

Quality agricultural inputs supply are imperative for successful crop production. These include planting seeds, fertilizers and agro-chemicals mainly for pest control. Proper application rate of inputs is also needed. In this study, the type and amount of inputs that are thought to be required during the project implementation period are recommended.

The required types and quantity of inputs needed in a hectare basis has presented on table 16.

**Table 16 Input Requirement per hectare and planting methods of the proposed crops**

Maize	200	200	25
f/bean	100	0	175
Barely	100	100	125
Wheat	100	100	125
<b>Dry season</b>			
Onion	200	100	4
Cabbage	100	100	0.6
Wheat	100	100	125
Potato	100	100	200

BC = Broad casting      BBF = Broad bed furrow

#### Labour and draft power

In the region in general and in the project area in particular, human labour and draught power is the main source of power for any agricultural development. No development is expected without the direct involvement of these power sources. Especially human labour is a driving force to facilitate and organize any farm operation. Based on interviewed farmers data and literature findings total human and oxen

power requirements for the selected crops production is proposed per hectare basis

### **Agricultural credit and financial services**

Credit supply mechanisms are imperative for sound agricultural development. The project beneficiaries' can get credit services from their water users association (WUA). Credit arrangements are common in agricultural communities worldwide. So that government intervention could be essential in the facilitation of credit and financial sources/services. Arrangement and provision of credit facilities to the beneficiaries is one step for the successful implementation of the project.

#### **3.2.5 Crop protection**

Crop protection is one of the essential farming activities used to control crops from pest damages. The best method proposed to manage the existing pest population of the project area includes cultural operation including crop rotation, crop sanitation, routine use of resistant or tolerant crop varieties, good tillage practices, timely planting and harvesting, thinning, fertilizer application, water management, mechanical method including hand destruction of pests and their exclusion by screens and other types of barrier and chemical methods.

In the project area, the following crop protection activities should be executed for an effective and efficient control of problematic crop pests:

- Training of farmers, development agents (DA) and woreda, zonal and regional experts on pest assessment and different control measures should be practical.
- Design and implement an appropriate credit system on revolving fund basis through water users association on the purchase of pesticides.
- Supply the required and the right type of agro-chemicals on time
- Identify valuable traditional pest control inputs on time and promote the use of those practices as part of integrated pest management (IPM) measures.
- Conduct regular crop pests assessments/survey on the farm fields
- Spray the recommended type and rate of chemicals (Table18).
- Use of disease resistant/tolerant crop varieties and field sanitations.

- Conduct timely hand weeding and/or cultivations.

**Table 18 Major pests and recommended control measures.**

<b>Crop Pests</b>	<b>Crop Attacked</b>	<b>Cultural control method</b>	<b>Chemical recommended</b>
Ball worm	Bean	Hand collecting	Spray Endosulfan 35% EC 2 l/ha
Cut worm	Onion, Bean	Hoeing and hand collecting	Seed dressing with Apronstar
Army worm	Maize	Stepping with animals attracting birds to the farm.	Spray diazinon 45% Ec
Aphid	Cabbage	Use fermented cow urine	Spray Dimatoate 40% EC 2 l/ha
Degezza	Teff	Cultural measures, biting the pest early morning time, etc	Spray Sevein 85% W.P at a rate of 1.5 kg/ha
Termites	All crops	Distracting	-

		mounds and remove crop or any residues.	
Weevils	Maize ,Wheat	Clean storages and crop left-over's.	Actelic 2% dust 50 gram/quintal seed dressing

### 3.2.6 Yield projections

Yield projections are normally required in order to determine the feasibility of irrigation projects. In the successive years of project implementation the productivity of the proposed crops is expected to be increased to the optimum levels through adoption of improved farming practices, efficient input and water utilization (Table19).

For the estimation of yield build-up, reference was made mainly to the following factors:

- Use of modern inputs (Fertilizers, improved seeds, agro-chemicals, etc.)
- Present average yields obtained by research institutes.
- Existing and proposed yield build-up data of previous studies made around the project area.
- With the utilization of improved agronomic practices/crop management.

- With the provision of better credit and strong agricultural extension services.
- Yield potential of the area
- Agro-ecological suitability and yield potential of proposed crops and other environmental factors.
- Traditional experience of farmers.

**Table 19 Yield projections of proposed crops (qt/ha) for the improved irrigation scheme**

Seasons	Crops	Years					
		1	2	3	4	5	6
Wet	Maize	52	67	73	88	93	97
	Barely	20	22	25	27	29	30
	Bean	16	17	20	22	23	26
	Wheat	32	36	39	41	42	45
Dry	Onion	108	136	170	185	190	201
	Cabbage	130	165	175	190	205	225
	Wheat	32	36	39	41	42	45
	Potato	130	150	175	195	210	240

**Table 20:- Small farm tools and equipments for project**

No	Small farm tools and equipments	Number of required	Remark
1	Knapsack sprayer	1 for ten hectare	

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2	Spade	1 for five farmer	
3	Improved plough	1 for each farmer	
4	Rake	1 for each farmer	
5	Shovels	1 for each farmer	
6	Sickle	1 for each farmer	
7	Hoe	1 for each farmer	
8	Wheel borrow	1 for 20 farmers	

## ***4. CONCLUSION AND RECOMMENDATIONS***

### ***4.1 Conclusion***

The study has showed that the command area is moderately suitable for irrigated crop production though different soil and water conservation

measures are needed to be carried out. Therefore, it is hoped that, in the subsequent years of the project implementation, crop yields and income would be obtained through the adoption of double cropping system, adequate and proper inputs utilization, growing high value and productive crops, provision of strong extension and credit services and application of efficient crop protection measures.

Generally, agricultural production will be more confidential as irrigation water supply will be available throughout the year and dependency on rainfall would be minimized. Irrigation development project also will create an employment opportunity of labour in the project area. Moreover, food self-sufficiency would be assured specifically in the project kebele and surplus for sale would also be produced.

#### ***4.1 Recommendations***

For the success full implementation of this project the following points are recommended:

The project Water Users Association (WUA) should be established soon.

Assigning irrigation agronomy expert for the project site is crucial.

Training on irrigation agronomy and management should be provided to DAs and beneficiary framers to equip them with sufficient techniques

and skills of irrigation methods, soil and water management, utilization of agricultural inputs, improved crop management practices, etc.

It is also quite important to implement the project in accordance with the proposed cropping pattern and calendar so as to avoid irrigation water management related problems.

Establish and strengthen inputs and credits supplier institutions in the area.

Regular and timely inputs supply, credit facilities and marketing channels should be arranged.

Appropriate SWC measures/management practices should be used (different terrace structures, biological treatments, gully treatments, cut-off drains, artificial water ways, etc.).

Different demonstration and adaptation trials should be adopted on farmers' fields.

**Note:** The proposed cropping pattern for this irrigation scheme is based on the existing knowledge of the farmers, market accesses, environmental adaptability, productivity, etc. conditions. However, the proposed pattern is flexible and can be revised according to the prevailing market demand and changes in production objectives of the farmers.

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## 6. ANNEXES

### **Annex 1. Meteorological and ETo data of the study area (Tilili Station)**

country

Ethiopian

Altitude

2406m

station Tilili



## Annex 2. Rainfall data of the study area

Months	Rain	Eff. Rain
	mm	Mm
January	0.9	0.9
February	1.4	1.4
March	13.2	12.9
April	35.6	33.6
May	140	108.6
June	283.8	153.4
July	358.4	160.8
August	348.9	159.9
September	245.1	149
October	142.4	110
November	32.9	31.2
December	1.9	1.9

### Annex 3 Net monthly Irrigation Demands for both Wet and Dry Seasons crops proposed

Scheme supply											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Precipitation deficit											
1. Maize	0	0	0	0	3	0	0	0	0	0	0
2. Wheat	0	0	0	0	0	0	0	0	0	0	0
3. Barely	0	0	0	0	0	0	0	0	0	0	0
4. Bean	0	0	0	0	0	0	0	0	0	0	0
5. Wheat	42.8	76.5	99.8	33.7	0	0	0	0	0	0	0
6. onion	20.6	52.9	84.3	80.7	12	0	0	0	0	0	0
7. cabbage	18.6	56.8	94.2	94.3	9.3	0	0	0	0	0	0
8. potato	29	69.9	102.8	48.1	0	0	0	0	0	0	0
Net scheme irr.req.											
in mm/day	1	2.3	3.1	2	0.2	0	0	0	0	0	0







Dec	1	Init	0.3	0.41	1.7	0.8	0.7
Dec	2	Init	0.3	0.38	3.8	0	3.8
Dec	3	Deve	0.34	0.46	5.1	0.1	5
Jan	1	Deve	0.57	0.85	8.5	0.4	8.1
Jan	2	Deve	0.84	1.32	13.2	0.2	12.9
Jan	3	Mid	1.11	2.01	22.1	0.3	21.8
Feb	1	Mid	1.22	2.49	24.9	0.1	24.8
Feb	2	Mid	1.22	2.78	27.8	0	27.8
Feb	3	Mid	1.22	3.17	25.4	1.4	24
Mar	1	Mid	1.22	3.56	35.6	2.8	32.9
Mar	2	Late	1.19	3.88	38.8	3.9	34.9
Mar	3	Late	0.98	3.5	38.5	6.3	32.1
Apr	1	Late	0.74	2.85	28.5	7.2	21.3
Apr	2	Late	0.5	2.11	21.1	8.6	12.4
					294.8	32.1	262.4

potato

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Dec	2	Init	0.45	0.57	0.6	0	0.6
Dec	3	Init	0.45	0.62	6.8	0.1	6.7
Jan	1	Init	0.45	0.66	6.6	0.4	6.3
Jan	2	Deve	0.52	0.81	8.1	0.2	7.9
Jan	3	Deve	0.76	1.38	15.1	0.3	14.8
Feb	1	Deve	1.01	2.07	20.7	0.1	20.6
Feb	2	Mid	1.16	2.65	26.5	0	26.5
Feb	3	Mid	1.16	3.04	24.3	1.4	22.9
Mar	1	Mid	1.16	3.41	34.1	2.8	31.4
Mar	2	Mid	1.16	3.79	37.9	3.9	34
Mar	3	Late	1.12	4	44	6.3	37.6
Apr	1	Late	0.96	3.72	37.2	7.2	30
Apr	2	Late	0.82	3.4	27.2	6.9	18.6
					289.1	29.6	257.7

## onion

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Jan	1	Init	0.5	0.74	2.9	0.2	2.8
Jan	2	Init	0.5	0.79	7.9	0.2	7.6
Jan	3	Deve	0.53	0.95	10.5	0.3	10.2
Feb	1	Deve	0.69	1.42	14.2	0.1	14.1
Feb	2	Deve	0.88	2.01	20.1	0	20.1
Feb	3	Mid	0.96	2.51	20.1	1.4	18.7
Mar	1	Mid	0.96	2.82	28.2	2.8	25.5
Mar	2	Mid	0.96	3.13	31.3	3.9	27.4
Mar	3	Mid	0.96	3.43	37.7	6.3	31.4
Apr	1	Late	0.96	3.71	37.1	7.2	29.9
Apr	2	Late	0.94	3.9	39	8.6	30.4
Apr	3	Late	0.91	3.83	38.3	17.8	20.4
May	1	Late	0.88	3.75	37.5	28.8	8.7
May	2	Late	0.85	3.69	22.1	22.6	3.3
					347	100.3	250.4

## cabbage

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Jan	1	Init	0.45	0.66	2.7	0.2	2.5
Jan	2	Init	0.45	0.71	7.1	0.2	6.8
Jan	3	Deve	0.48	0.88	9.6	0.3	9.3
Feb	1	Deve	0.71	1.45	14.5	0.1	14.4
Feb	2	Deve	0.95	2.17	21.7	0	21.7
Feb	3	Mid	1.06	2.77	22.1	1.4	20.7
Mar	1	Mid	1.06	3.11	31.1	2.8	28.3
Mar	2	Mid	1.06	3.45	34.5	3.9	30.6
Mar	3	Mid	1.06	3.78	41.6	6.3	35.2
Apr	1	Mid	1.06	4.1	41	7.2	33.8
Apr	2	Mid	1.06	4.43	44.3	8.6	35.6

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Apr	3	Late	1.01	4.27	42.7	17.8	24.9
May	1	Late	0.92	3.95	23.7	17.3	9.3
					336.6	66.2	273.3