

**Oromia Regional State**

**Water and Irrigation Development Authority**

**Wataba SSIP**

**Irrigation Agronomy Final Feasibility Report**



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**Arsi Zone Shirka Wereda**

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**HM Development Consulting PLC**

P.O. Box 1281, 2<sup>nd</sup> floor, Seblewengel Building,

Tiruffat to Alamura Avenue, Hawassa, ETHIOPIA

Phone: +251 46 212 4401/+251 916 451 962/ Email:

[hm.development.consult@gmail.com](mailto:hm.development.consult@gmail.com)



<b>TABLE OF CONTENTS</b>	<b>PAGE</b>
LIST OF TABLES .....	4
1. Introduction.....	5
1.1 General.....	5
1.2 Background.....	6
3. Objectives.....	7
3.1. General.....	7
3.2. Specific.....	7
4. Methodology .....	7
4.1. Pre-field work.....	7
4.2. Field observation and data/information collection.....	7
5. Location.....	8
6. Cropping practices.....	8
6.1. Land Clearing.....	8
6.2. Land preparation.....	8
Sowing and planting .....	9
Weeding and hand hoeing .....	9
6.3. Harvesting and post harvest handling .....	9
6.4. Major crop and yield.....	10
6.5. Crop Rotation.....	11
6.6. Intercropping.....	11
6.7. <i>Inputs provision and extension support</i> .....	12
6.8. Crop protection .....	13
6.9. Harvesting and storage system .....	15
6.10. Keeping of seeds.....	15
6.11. Backward crop production system .....	15
7.1. Traditional irrigation practices.....	16
7.2. Lack of proper cropping system.....	16
8. Soil of the project area .....	16
9. Challenges of crop production .....	17
10. The Project Development.....	18
10.1. Climate .....	18
10.2. Potential crops and crop selection .....	21
10.2.1. Crop selection .....	21
10.2.2. Climatic suitability of the area .....	21
10.2.3. Soil .....	21
10.2.4. Fulfilling the dietary need of the farming community.....	22
10.2.5. Marketing condition and market value of the crops.....	22

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10.2.6.	Crop production per unit of area and length of growing period .....	22
10.2.7.	Existing cropping pattern farmers experience and their preference .....	22
10.2.8.	Soil fertility improvement .....	22
10.2.9.	Availability of labor.....	22
10.2.10.	Irrigation Method and crop water demand.....	23
10.2.11.	Credit facilities.....	23
10.3.	Crops selected and their growing period .....	24
10.4.	Cropping seasons and crops .....	24
10.5.	Proposed cropping area and cropping intensity .....	25
10.6.	Input requirement .....	25
9.8.	PRODUCTION PACKAGES FOR SELECTED CROPS.....	27
9.8.2.	Maize (Zea mays) .....	27
9.8.3.	Haricot Bean (Phaseolus vulgaris L.) .....	33
9.8.4.	Onion (Allium Spp) .....	39
9.8.6.	SUGARCANE .....	42
8.9.	Yield build-up .....	45
8.10.	Proposed crop management.....	47
8.10.1.	Land preparation.....	47
8.10.2.	Intercropping .....	47
8.10.3.	Irrigation.....	47
8.10.4.	Proposed crop rotation.....	48
8.10.5.	Harvesting.....	50
8.11.	Agro-industry development and Marketing .....	50
9.	Conclusion and Recommendation .....	51
10.	References .....	52

<b>LIST OF TABLES</b>	<b>PAGE</b>
Table 1: Existing crops types, area and productivity .....	11
Table 2: Climate data interpolated from Kuyera metrology station for Wataba ssip .....	19
Table 3: scheme supply calculated for wataba project.....	20
Table 4: wataba Irrigation Project Cropping Pattern .....	24
Table 5: Input Requirements per Hectare for Selected Crops Wataba project.....	25
Table 6: labor requirements for proposed crops, mandays and oxen days for Wataba project.....	26
Table 7: Improved Maize Varieties Suitable for Low land Areas and their Characteristics.....	29
Table 8: Export Type Improved Haricot Bean Varieties.....	34
Table 9 : Some Food Type Improved Haricot Bean Varieties.....	35
Table 10: Improved Onion Varieties.....	40
Table 11: Crop yield-build calculated for the project life period (qt/ha) for Wataba project.....	46
Table 12 Proposed crop rotation .....	48

## **1. Introduction**

### **1.1 General**

Climate, soil and water are the three basic natural resources that decide the nature, scope and extent of successful crop growing. Climates decide the availability of water and the type of crops to be grown in a region, while soil serves as a storehouse of water and nutrients for crops. Water is a vital for any life process and there can be no substitute for it. Inadequacies, erratic and unreliable rainfall in most places of the country as a whole and in the project area specifically make irrigation water the most important. The effectiveness of rainfall, even in high rainfall areas, is again influenced by its erratic nature and uneven distribution.

The main concern of productive agriculture is the effective and efficient supply of irrigation water to crop fields either as supplementary or complementary irrigation. Moreover, Irrigation provides a powerful management tool against the vagaries of rainfall and makes it economically attractive to grow high-yield seed varieties and to apply adequate plant nutrition as well as pest control and other inputs, thus giving room for a boost in yields.

Irrigation may lead to poverty reduction via increased yields, increased cropping areas and higher value crops (all favoring initially farmers, including poor small deficit and surplus farmers). By these means raises employment (directly of farm workers, indirectly of other workers if wages are bid up) and may be cuts prices in an imperfectly open economy or if there are high transport costs. Increased mean yields can indicate increased food supplies, higher calorie intakes and better nutrition levels. There are also stability effects because of reduced reliance on rainfall – hence irrigation lowers the variance of production, employment and yields, and helps to reduce adverse consequences of drought.

## 1.2 Background

Ethiopia is endowed with vast water resources including twelve major river basins, twenty two natural and artificial lakes. Regardless of these resources, the agricultural system is dependent on the availability of rainfall. Due to the dependency on rain resulted in low crop productivity. However, agricultural sector contributes about 52.3 % of the total country's GDP and agricultural labor force accounts 89.3 % and 87.6 % male and female respectively.

In spite of its endowment with sufficient natural resources in project area and in the country at large it is challenging to achieve a reasonable economic development and the farming community in the project area is food insecure. The society live in the project area are engaged in subsistence agriculture with very poor traditional methods of cultivation. Even though the gain from the agriculture is limited, agriculture is the main stay of the farming community in the project area. The absence of developed irrigation system in order to practice double cropping system back warded farming system for rain fed agriculture and natural hazards have contributed a lot to low crop production in the region.

To alleviate this problem, the Oromia regional Government has undertaken a strategy that addresses the study of irrigation development projects, which includes *Wataba irrigation project, 250 ha*. Therefore, the development of this irrigation project will play vital role in alleviating food insecurity problem in the project area and surroundings. Moreover, the irrigation project is of paramount importance to enable the agricultural sector of the region to contribute its share in achieving the goals of the five years development plan and creating sustainable agricultural growth.

### 3. Objectives

#### 3.1. General

- To study and/or make detail evaluation of the present situation of crop production and climate of the project area in order to develop the irrigated crop production potential of the command area.

#### 3.2. Specific

- To assess the existing crop production system, agronomic practices of the project area and updating the previous study documents in order to determine the most suitable and economical cropping patterns which are suitable for the prevailing climate and soil type.
- To determine the crop water and inputs requirements of the crops productivity per hectare in subsequent years due to introduction of the project, and recommend appropriate irrigated crop production methods.

### 4. Methodology

#### 4.1. Pre-field work

- ✚ Major relevant studied documents were reviewed.
- ✚ Checklists were prepared to collect information from Region, zone, woreda and PA levels.
- ✚ Field visit program to project area to observe existing crop production situation was designed.

#### 4.2. Field observation and data/information collection

- ✚ Field observation was performed in order to know the existing cropping pattern and agronomic as well as cultural practices of the project area.
- ✚ Interview of the farmers and agricultural extension workers in the project area is done.
- ✚ Useful data/information is collected from Arsi zones and Shireka woreda of agriculture and rural development office and Elilewalena peasant association

- Literature review of similar studies was performed.

## **5. Location**

The command area is entirely located in Arsi zone, Oromia region, Arsi Zone, Shireka Woreda, specifically Elilewalena Kebele. It is situated 60 km away from Shireka of the woreda town. The command area elevation ranges from 1715-2000masl.

## **6. Cropping practices**

### **6.1. Land Clearing**

Land clearing is the pre-land preparation process that cleans up the land for land preparation or planting. Before the beginning of the rain in a season, the clearing of land takes place, i.e., at the end of dry and wet seasons. The burning of grasses and bushes/shrubs carried out in dry season before the onset of the rain in the project area. Then after, clearing of leftovers will take place using hand tools like machete.

### **6.2. Land preparation**

Land preparation is important agricultural practices and carried out after harvesting the crops when the soil is at good moisture condition to simplify the Land preparation. Land preparation using oxen drawn plow or hand tools are experienced and the frequency of land preparation is three to four times to get good seed bed. According to focus group discussions the soil types in the project kebele is 26.7% dark brown, 40 black and 33.3% stony which is less fertile and difficult to operate. The vertisols is hard to plough in wet and dry seasons and required intensive oxen and human days to pulverize the soil for good seed bed preparation.

Land preparation for dry season crops starts on January to February to prepared one month before sowing and planting to create compact soil and good root anchorage to minimize the falling of crops. Wet season land preparation starts on May and June with 4-5 times of plough to create fine seedbed and prepare drainage structure to remove

excess water in rainy season. Minimum frequency of land preparation is required for dry crops to create firm stand for the plant roots hence the soil type is vertisols expands when wet and crack when dry that lodge crops.

### **Sowing and planting**

Sowing and planting are crucial in agricultural activities and it is highly dependent in the rainfall pattern. Based on available and reliable rainfall planting and sowing time is divided in to their times such as early, medium and late planting. March and August is the sowing time for dry crops and wet seasons and it is performed at the end of last plough. In the project area and the farming community is sowing seeds in the rows for maize and millet, haricot bean.

### **Weeding and hand hoeing**

Weeding should performed at the critical and right time of growing stage of the plant in order to minimize the yield loss by fierce weeds computation. Two and three times of weeding are practiced in the project area and first and second weeding is carried out after one month and two months after planting or sowing. Weeding performed with oxen plough and hand hoeing and weeding; however, more than 10% of the maize plant is damaged. Farmers apply 2-4-D for wheat and barley to control broad leaves weeds and followed by hand weeding for other grass weeds. Sometimes farmers apply round up to eradicate Cyprus species weed before sowing seeds.

### **6.3. Harvesting and post harvest handling**

Harvesting of crops at right time with recommended seed moisture is a prerequisite to manage yield loss due to poor harvest and post harvest handling practice. Threshing of sorghum and maize is done by beating head and cob with stick is practiced. Threshing

of the crops can be done whenever the crops are needed for consumption. In the project area farmers harvest dry and wet season's crops on May-June and October-November respectively. Farmers harvest the crops using the traditional farm tools and trash and transport to house and store in the wooden made storage. Sugarcane, mung bean, barley are some of the crops sold in the market. As farmers respondents' described the area is high productive and potentials to supply sugarcane to the nearby markets, however poor infrastructures and absence of bridge hindered the farmers to transport the ripe sugarcane on time to the market and resulted spoiled of sugarcane in the fields because farmers transport small amount of sugarcane by hoarse, mule and donkey.

Storage structures are poor and needs improvement in to manage damaged by weevil and other storage pests. Farmers required training and sanitation of well ventilated storage structures, store pure seed and demonstrate model storage structures made from local materials with appropriate height raised from ground. Millet grain is stored under the ground, which well cemented to water linkage, and consumed when need arise.

#### **6.4. Major crop and yield**

Major crops grown in the project area are maize, millet, haricot bean, Sugarcane and teff, mung bean, wheat, barley, chick pea, garlic, coffee, onion, fruits such as banana, papaya, avocado, orange, lemon, mango, however Farmers' Training Center (FTC) adaptation trial was conducted for wheat. In the project area average land holding size is estimated to be 2.5h hectares .The performance was very good, according to the Shireka woreda agricultural office and farming community of the project area see table 1 below.

**Table 1:** Existing crops types, area and productivity

Crop type	Elilewalena Peasant association		Remark
	Area (%)	Productivity(qt/ha)	
Maize	8	20-25	Belg season
wheat	13	12-14	Meher season
Haricot bean	5	5-7	Belg season
Barely	5	10-12	Meher season
Teff	15	7-9	Meher season
Mung bean	20	8-10	Belg season
Sugarcane	20	900	perennial
Millet	5	5-6	Meher season
Onion	5	60-70	Belg seson
Garlic	4	50-60	Belg season

Source: Meher season comprise 70% and belg season 30% Shireka woreda agricultural office and Elilewalena PA 2018 G.C.

### 6.5. Crop Rotation

Crop rotation is a cropping strategy in which a set of crops are cultivated in a predetermined sequence, avoiding the same crop being cultivated continuously at the same location or field. In organic farming, the importance of crop rotation is in the management of soil fertility, diseases and pests. Continuous cropping of the same piece of land leads to nutrient deficiency and nutritional imbalance. Crop rotation is a primary strategy for controlling pests in an organic farming. Crop rotation of cereals with beans is experienced in the project area. Such as rotating mung and haricot beans with wheat, and maize, tef, kale, onion is practiced in 'belg' and 'meher' seasons.

### 6.6. Intercropping

Intercropping is the crop production practice in which one crop is planted in the open areas of another in the same piece of land to grow together. Intercropping system sometimes produce greater yields than an equal area of land devoted to single stands of the same crops because the mixing of crops favors a better utilization of space, time and the resources of sunshine, water and soil nutrients.

The ways the crops are arranged when they are grown together can be such as to minimize competition for these resources, as when tall crops are mixed with shorter, shed tolerant ones, or when root system of the crops are such that to some extent they exploit different soil layers. It is also used for risk avoidance because some crops are more tolerant to unfavorable climatic conditions where as the others sensitive and in this way the more resistant one can give yield when the sensitive ones die in unfavorable situation.

Even though intercropping has good advantage as mentioned above; intercropping is not practiced in the project area. However, intercropping of maize with haricot bean and is experienced to some extent. Inter planting kale, pepper and onion in the coffee field are practiced in small area.

### **6.7. *Inputs provision and extension support***

Agricultural extension system is well designed in the structural frame work of zonal as well as woreda agriculture and rural development offices. The extension worker is assigned in the kebele of the project area and their efficiency in guiding and supporting farming community is not satisfactory. But, famers lack efficient agricultural extension workers that guide them to practice crop production properly.

Food and fiber are fundamental to the survival of all civilizations. Agriculture is the major source of both and agriculture depends on productive soils to support the plant life that captures the sun's energy to produce the products that become our food, fiber and, more recently, a growing portion of our fuel. For soils to be productive, they must be fertile. Therefore, the fertility of our soils is a critical indicator of the health of our agriculture and of our food, fiber, and fuel production capacity.

Improved varieties like dedefa, pachal for maize, calamg, molowalecho dendea(sus for rust) for wheat, and baleen for barley farmers purchase improved varieties from local market.

Fertilization of land using artificial fertilizer is well known to boost up crop production in areas where there is low soil fertility. In the project area, farmers apply 50kg/ha NPS and sometimes Urea 50kg/ha may be because of natural existing soil fertility is sufficient, Urea lost by leaching or weak extension services according to farmers respondents and woreda agricultural and rural development office. Farmers apply pesticides to control highly devastating damage by rust on wheat and barley crops. Informal markets are the main sources of pesticides to purchase and very weak support is provide to link farmers with reliable suppliers, technical advice buy the right product and teach them how to use safely and disposal measures.

Farmers randomly apply the chemical without proper recommendation and dilution rate and store, and dispose the chemicals in the house carelessly and it is very dangerous for humans and animals and environment contamination and hence urgent measures should be taken teach the farmers to correct the wrong actions.

## 6.8. Crop protection

The major weed types in the area include: *Cyprus spp*, *Partinium spp*, *grass spp*, *Cynadon dactylone*, *Amarantus spp.*, and *Solanium nigrum*. *Bidens pilosa*, *Tagetes minula*, *Datura stramonium*, *Cyperus rotundas*, *Sonchus oleraceus*, *Gallinsoga parviflora*

Among insect pests, stalk borer is the major pest that attacks maize. It feeds on leaves of maize in the early stage and later on bore into the stem and cobs. Cutworm (all crops), Aphids (bean crops), and ants are common field insect pests that attack both maize and wheat, barley. There was no control measure and inefficient control measures to protect the crops from the insect pests.

Rat, monkey, wild pig, monkey, baboon, kerkerero, porcupine, mole rats and are the vertebrate pests that attack cereal and beans crops. Guarding is well practiced controlling method to protect the crops from these wild animals the project area is located around the protected area for wild life.

Weevil is the most common storage insect pest that attacks maize and sorghum in the store. Smoking under the store and ventilation is very well known traditional controlling measure to prevent storage pest attack. The local store is constructed at the height of about 1.5 meter above the ground and under it cooking of foods intentionally done in order control weevil.

### **6.9. Harvesting and storage system**

Harvesting of maize and sorghum is done using sickle and/ or machete. Cutting of maize with its stalk at approximate height of 80cm from the ground and piling it in the field is well practiced. The important part or the head of sorghum is cut by the same tool that used for maize and heaped/piled in the field is also usual process. Before the onset of rain, the important part of maize and sorghum taken in to resident area and stored in the store. Threshing of sorghum and maize is done by beating head and cob with stick is practiced. Threshing of the crops can be done whenever the crops are needed for consumption.

### **6.10. Keeping of seeds**

Farmers of the project area are sowing their own seed that is land races and second third generation of hybrid. Farmers keep the selected better seeds from maize and sorghum and hang on the roof in the house and exposed to smokes. At the time of the onset of the rain in next year, the seeds will be used as seed material

### **6.11. Backward crop production system**

For correct and timely seed bed preparation is important for early sowing of seeds but farmers practice late planting and use traditional farm tools. The farming communities in project area have no access for improved varieties and its' packages in their crops fields. Farmers' apply random application of NPS, which is below the recommendation rate. They practiced intercropping and crop rotation system to enhance crop productivity by improving soil fertility and reducing pest damage. Instead of incorporating in the soil farmers' complete remove crop residues from the field and

burning of crop residues is mining and loss of soil nutrients. Poor practices of harvesting and post management.

### **7.1. Traditional irrigation practices**

Traditional irrigation practice started since last 20 years irrigated 40-60 hectares of land to grow sugarcane, banana, avocado, lemon, tomato, tomato, onion and pepper. Uneven distribution of rain fall, unreliable and erratic nature causes moisture shortage resulted in either crop failure due to attacked by crop pests or reduced productivity. Furthermore, floods damage on the irrigation structures and inundate farmlands, which can lead to food shortages.

### **7.2. Lack of proper cropping system**

Double cropping is possible in the project area using the existing rainfall in normal years. The contribution of crop production in dry and wet seasons is 30% and 70% respectively the farmers provide supplement irrigation for the 'belg' season which unreliable and low rainfall.

## **8. Soil of the project area**

Soil serves as a storehouse of water, irrigation water and particularly the whole of rainwater becomes available to crops through the soil. Only a small part of rain intercepted by aerial parts is absorbed directly by crops. Therefore, understanding the soil characteristics of the command area is crucial.

According to focus group discussions the soil types in the project kebele is 26.7% dark brown, 40 black and 33.3% stony which is less fertile and difficult to operate. For balck color soil efficient drainage system is required in order to reduce water logging effect on crop yields in rainy season. The detail characteristics the soil of the area is included in

the soil report. It should be noted that the crop selection and agronomic practices of the project area is proposed based on the visual soil characteristics of the command area.

## **9. Challenges of crop production**

The major challenges of crop production system in the project area is weak extension support, lack inputs, poor farming practices, lack of skill in soil and water management practices, poor handling of chemicals purchased from local markets which is high risk on human, animal, and environment, crop pests, damage of traditional irrigation structures in rainy season and recurrent draught. According to participatory rural appraisal (PRA) tools we identified that draught contributes 50%, vertebrate pest 22.3% and 27.2 insect pests and diseases for low productions.

In general famers highly emphasis those 52.3% infrastructures no bridge and poor roads network to transport agriculture products to the markets. 36.8 flood damage of infrastructures of irrigation and 10.5 weak extension supports (only one development agent is assigned rarely visit them).

## **10. The Project Development**

Crop response to irrigation varies with soil, type of crops, crop growth stage, and local climate. Knowledge of how crops respond to, and use, soil water throughout their growing season is essential to successfully design and manage an irrigation system. The purpose of irrigation is to supplement natural precipitation so that moisture requirement of crops being grown is met in rainy season and to grow crops in dry season in order to increase crop production through double or triple cropping in a year in sustainable way of production. Crops that are climatically suitable and fits to soil type need to provide farmers with good profits in order to develop their purchasing power of agricultural inputs and to fulfill their economic need in general in addition to their food requirement.

### **10.1. Climate**

Climate determines crop adaptation; cultivars that are not adapted to the local climate grow and perform poorly. Field crop production is subjected to the short term variations in climate factors, frequently referred to as the vagaries of the weather. Climate and weather are two critical factors in crop production that are not within the control of the producer. Photosynthesis is the single most important plant process that is responsible for crop productivity. Rain fall, wind speed, radations Evapotranspiration (ET<sub>o</sub>), Solar radiation, Humidity and sunshine (hours) 10 years data are used to calculate crop water requirements from Kuyera metrological station indicated below in Table 2 and 3 .

**Table 2:** Climate data interpolated from Kuyera metrology station for Wataba ssip

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo	Rain	Effrain
	°C	°C	%	km/day	hours	MJ/m <sup>2</sup> /day	mm/day	mm	mm
January	8.1	25	57	112	8.2	20	3.84	32	30.4
February	10.2	25	54	112	8	20.9	4.11	79	69
March	11.4	25.8	59	130	7.6	21.1	4.35	72	63.7
April	12.8	25.6	63	112	6.6	19.6	4.08	101	84.7
May	11.8	25.1	74	112	7	19.7	3.86	91	77.8
June	11.2	23.9	75	138	6.6	18.6	3.65	96	81.3
July	11.5	21.9	78	112	4.7	16	3.07	152	115
August	11.3	23.1	77	104	5.5	17.6	3.35	126	100.6
September	11.8	22.7	77	78	5.5	17.8	3.32	137	107
October	10.4	24	71	69	6.8	19.2	3.55	63	56.6
November	8.2	24.2	58	86	8.6	20.8	3.78	31	29.5
December	6.9	24.9	53	95	8.7	20.3	3.75	3	3
Average	10.5	24.3	66	105	7	19.3	3.73	81.9	68.2

Maximum monthly gross irrigation requirements are on the month of January which is calculated and indicated below see scheme supply calculated for the project throughout the year table 3 below.

GIR for January = NIR/Ep

$$= \text{NIR} / \text{s/ha/Ep}$$

$$= 0.48 \text{ l/s/ha} = \mathbf{0.95 \text{ l/s/h}} \text{ for 24 hrs irrigations and } \mathbf{1.9 \text{ lsh}} \text{ for 12 hrs irrigations}$$

0.48

**Table 3: scheme supply calculated for wataba project**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
1. MAIZE (Grain)	0	0	1.3	13.4	65.4	34.2	2.2	0	0	0	0	0
2. Pulses	0	0	0	0	6.4	39.6	0	0	0	0	0	0
3. Mung bean	0	0	0	2	8.8	31.6	0	0	0	0	0	0
4. Tomato	0	0	0	0	0	0	0	0	0	61.9	43	0
5. Peppers	0	0	0	0	0	0	0	0	2.8	60	14.8	0
6. Onion	0	0	0	0	0	0	0	0	0	51.6	89.5	27.4
7. Sugarcane (Ratoon)	116.6	54.9	57.6	9	1.2	20.3	4.2	27.6	16.2	86.9	115.7	143.3
Net scheme irr.req.												
in mm/day	0.4	0.2	0.2	0.1	0.3	0.4	0	0.1	0.1	1.4	1.4	0.7
in mm/month	11.7	5.5	5.9	2.4	7.9	10.6	0.6	2.8	2.2	42.9	43.3	21.2
in l/s/h	0.04	0.02	0.02	0.01	0.03	0.04	0	0.01	0.01	0.16	0.17	0.08
Irrigated area	10	10	20	30	35	35	20	10	30	70	70	35
(% of total area)												
Irr.req. for actual area (l/s/h)	0.44	0.23	0.11	0.03	0.08	0.12	0.01	0.1	0.03	0.23	0.24	0.23
Pro. efficiency (Ep)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
GIR (irr act% / Ep)	<b>0.92</b>	0.48	0.23	0.06	0.17	0.25	0.02	0.20	0.06	0.48	0.50	0.48

Maximum monthly gross irrigation requirements is on the month of January which is

GIR for January = NIR/Ep

$$= \text{NIR} / \text{l/s/ha} / \text{Ep}$$

$$= 0.44 \text{ l/s/ha} / 0.48 = \mathbf{0.92 \text{ l/s/h}}$$

$$0.48$$

1.84lsh for 12 hrs irrigation on the month of January.

## **10.2. Potential crops and crop selection**

Based on climatic and soil factors several crops can be grown in the area since these two basic parameters are suitable for crop growth. Potential crops include sorghum, maize, sesame, haricot bean, mango, banana, sesame, onion, sugar cane.

### **10.2.1. Crop selection**

Based on different factors, the cropping patterns of the Elilewalena irrigation project that is crop selection, crop rotation, cropping intensity, cropping seasons and cropping calendar are determined. The crop selection for the project area is determined based on the following criteria.

### **10.2.2. Climatic suitability of the area**

Weather is essentially the day-to-day interplay of temperature, humidity, wind velocity, atmospheric pressure, sunshine duration, rainfall, and all the other components that combine to produce it. The climatic factors that determine the crop production are thoroughly examined to decide the crops to be grown in the project area.

### **10.2.3. Soil**

Plant response to irrigation is influenced by the physical condition, fertility, and biological status of the soil. Soil conditions, texture, structure, consistency, biological activity, organic matter content, depth, effective soil depth, organic matter, bulk density, permanent wilting point, field capacity, salinity, sodicity, acidity, drainage, topography, land use pattern, fertility, and chemical characteristics all determine the extent to which a plant root system grows into and uses available moisture and nutrients in the soil. Many of these factors directly influence the soil's ability to store, infiltrate, or up flux water delivered by precipitation or irrigation (including water table control). Therefore, these characteristics of the soil have given due attention when crop selection concerned.

**10.2.4. Fulfilling the dietary need of the farming community**

The common food of the farming community and largely cultivated crops in the area are taken in to consideration. In addition, the nutritional value of the crops and farmers preference is also taken into account.

**10.2.5. Marketing condition and market value of the crops**

To have economically developed society and to get maximum economic return from the project, market value and marketing situation are given due attention. Infrastructure facilities (roads, transport and storage) to markets are considered for crop selection.

**10.2.6. Crop production per unit of area and length of growing period**

Crops vary in their production per unit area. A small area of vegetables brings better returns and their growing period is shorter than that of grain crops. Length of growing period is very crucial for planning of double or triple cropping system.

**10.2.7. Existing cropping pattern farmers experience and their preference**

Farming community in the project area has no experience in irrigated crop production. The existing cropping pattern and farmers experience as well as their interest is taken in account for the proposing of crops to be produced.

**10.2.8. Soil fertility improvement**

Crops that can improve soil fertility, leguminous, are included in crop rotation to maintain soil nitrogen status and to break the life cycle of crop pests that affect crop yield in mono cropping system.

**10.2.9. Availability of labor**

The availability of labor during land preparation, planting, crop management and harvesting time is considered to design cropping pattern for the project.

**10.2.10. Irrigation Method and crop water demand**

Irrigation method may determine the crops to be grown. For example furrow irrigation method is suitable for most cereal crops. Crops that are suitable for furrow irrigation methods are proposed. Crops vary in their water demand and it is also considered for the determination crops to be grown.

**10.2.11. Credit facilities**

Cropping pattern involving high value cash crops need more investment. Poor farmers are usually inclined to grow crops like cereals, pulses and some cash crops (for example, sesame) of land races that require a low investment. So, the availability of credit facilities from banks and other sources is assumed for the selection of crops and varieties in the projects areas (it is true in farmers' case).

### 10.3. Crops selected and their growing period

Based on considerations and assumptions mentioned above, the selected crops for the project are indicated in the table 4 below.

Table 4: wataba Irrigation Project Cropping Pattern

No.	Crop Type	Area in Percent.		Date of Planting	Date of Harvesting
		Wet	Dry		
1	Maize	35		February	May
2	Haricot bean	15		April	June
3	Mung bean	30		March	June
4	Pepper		25	August	December
6	Onion		35	August	December
7	Tomato		20	August	December
9	Sugarcane	20		March	
	Total	<b>100</b>	<b>100</b>		

The proposed gross command area is estimated to 250ha with cropping intensity 200%

Maize, mung bean and haricot bean are proposed to be grown once in a year that is both in wet season. Onion, tomato, pepper is planned once in a year that is in dry. This to reduce diseases, especially fungal which can occur in rainy season as high moisture is favorable for the fungal disease and these crops are sensitive for this condition at some stage in their growth period. Moreover, heavy rainfall during the flowering period causes flower shedding and poor fruit setting. Sugar cane will exist throughout the year since they are perennial crops.

### 10.4. Cropping seasons and crops

One of the advantages of irrigated agriculture is the increasing of cropping intensity by double or triple cropping with controlled water supply whenever moisture stress occurs and the possibility of growing high yielding and profitable crops. To use these advantages efficiently, the crop-growing periods or seasons are planned in to two. These are rainy season, from April to June, and the second season is from End of August to half of December. The first season is planned in accordance with the farmers planting time in the area, i.e., in the onset of rain in April and the second season is designed to grow from September. The driest period is from January to March.

### 10.5. Proposed cropping area and cropping intensity

Existing cropping pattern, farmers' preference, growing period, soil favorability and water consumption are taken in to consideration for the decision of cropping area by each crop. Growing period is the major factor that affect cropping intensity and for this reason due attention is given for it. Increasing the area of long growing crops will decreases the cropping intensity by affecting double cropping this in turn will reduce the total return from the project. For this project, the cropping intensity is proposed to be 200% at the end of 4-5 project years.

### 10.6. Input requirement

Fast growth in irrigated agriculture can be achieved with the use of appropriate agricultural inputs such as improved seeds, fertilizers, agricultural chemicals, machinery and implements/ tools. The increasing of crop production is obvious with the use of high yielding Crop varieties, when they are used together with other required inputs and appropriate agronomic practices. The correct use of fertilizer in time and amount in specific area of land and the use of crop protecting agro-chemicals or pesticides are of a paramount importance to increase crop yield. In addition, appropriate use of farm machinery and tools have a vital role in increasing yield see Table 5 and 6.

Table 5: Input Requirements per Hectare for Selected Crops Wataba project

Crop type	Variety	Seed (kg/ha)	NPS	Urea	Pesticides
Maize	BH-661/ shone/Jibat	25	150	200	Dimethoale 4% 0.25 kg/ha, Ampligo 250ml/ha
Haricot bean	Red wolaita	80-100	100	50	Perimiphos methyl 50% w.P 1 kg/ ha by mixing with water.
Onion	Bombie red /Melkam (Pusa Red)/	3	100	250	Endosulfan35% EC 2lit/ha and Dimethoale 4% 1lit/ha
Pepper	Mareko fana	750 gm -1kg	100	200	3 kg/ha rate of ridomyl (0.23%)
Mung bean	Rasa/MH-97- 6	0.15	100	60	Tilet 0.5 kg/ha
Tomato	Rainbow/ Galilea	0.15	70	220	3 kg/ha rate of ridomyl (0.23%), Tilet 0.5 kg/ha, 50- 70 g per hectare of cypermetrin 10 % E.c mixing with 500 lit. of water
Sugarcane	Local	17,000 seedlings	100	100	Endosulfan35% EC 2lit/ha

**Table 6: labor requirements for proposed crops, mandays and oxen days for Wataba project**

Activities	Unit	Maize	Haricot bean	Mung bean	Tomato	Pepper	Onion	Sugarcane
Nursery					50	40	60	
Sowing	Man-days	0.5	0.5	2	13	12	14	16
Fertilizing	Man-days	0.5	0.5	0.5	3	3	0.5	0.6
Spraying	Man-days	0.2	0.2	0.2	1	0.2	2	2.5
Thinning	Man-days	3	3		3	3	3	
Weeding 1	Man-days	12	12	8	10	12	10	8
Weeding 2	Man-days	8	8	8	9	12	10	8
Harvesting	Man-days	12	12	12	22	12	20	18
Bagging and	Man-days	2	2	2	2	2	2	
Loading and	Man-days	2	2	2	2	2	2	3
Guarding	Man-days	10	10	6	8	10	10	7
Irrigation	Man-days	12	12	6	49	12	48	46
Sub-total		62.2	62.2	46.7	122	120.2	181.5	109.1
Land preparation								
	Oxen-days	16	12	12	12	12	20	12
	Man-days	16	12	12	12	12	20	12

## 9.8. PRODUCTION PACKAGES FOR SELECTED CROPS

### 9.8.2. Maize (*Zea mays*)

#### General Growth Requirements

**Altitude:** Maize is generally a warm season crop and it can grow from sea level up to 2800 meters. However optimum result can be obtained when it is grown from 0-2200 meters above sea level.

**Annual Rainfall:** When Maize is produced under rain fed condition, a mean annual rain fall of 500-800 mm will suffice provided that the rain fall is uniformly distributed throughout the growing season. When Maize is grown under full-fledged irrigation, a medium maturing maize variety requires 5000-8000 cubic meter of irrigation water per hectare depending on local climatic condition. Maize is tolerant to mild water stress during its vegetative growth provided that the stress lasts only for a short period. However, it is very sensitive to water deficit during tasseling and silking stages. Water stress during this stage resulted insignificant yield reduction or even total failure because of the dying out of the silk. Moisture stress during ripening has minor effect on yield.

**Soil Condition:** Maize can grow on a range of soil types. However, for optimum production, it requires fertile, well drained medium textured soils having a PH of 6.0-7.2.

#### Requirements when Maize is grown for Seed Production Purpose.

**Choice of Area:** For the purpose of seed production suitable area should be carefully selected. In general, the area must have suitable agro-climatic conditions for the production of Maize crop. It has to be free from natural hazards such as frost, flood, prolonged drought condition etc. The area must be completely free from noxious weed species and has the possibility of securing the required isolation distance between adjacent Maize fields to maintain genetic purity.

**Land Requirement:** The necessary attention must be given to know the previous cropping history of the land to be used for Maize seed multiplication purpose before starting any farm operation. This is done in order to avoid contamination by volunteer plants of same crop type grown during previous years.

**Isolation Distance:** Maize is a highly cross pollinated crop and it is normally cross pollinated by wind. Sometimes (less than 5 %) self pollination in Maize could occur due to pollen shading. For pure seed production, different varieties of hybrid and open pollinated Maize varieties must be isolated at least 200 meters apart. Isolation distance for Maize depends on wind velocity and in a situation where wind velocity is very high, a minimum isolation distance of 350 to 700 meters is recommended.

**Rotation Year:** For the purpose of seed production, Maize should not follow Maize and a minimum of 2-3 years rotation years must be maintained.

**Source of seed for planting:** The most important factor which affects the quality of seed is the quality and genetic purity of the initial seed stock used for planting purpose. For the purpose of seed production it is necessary to use certified seed from authorized sources.

**Rouging:** In seed multiplication programme, frequent rouging is necessary for quality seed production. In this case, off-types, diseased and insect damaged plants, should be removed from the seed field. Rouging is done at different stages of crop growth that is, at vegetative stage, flowering stage and maturity stage in general

**Improved Maize Varieties:** Many improved Maize Varieties have been developed and released for large scale production. Some of the improved Maize varieties which are under production and which are suitable for the project area indicated in Table 23.

**Table 7: Improved Maize Varieties Suitable for Low land Areas and their Characteristics**

S.N.	Name variety	Altitude (m)	Rainfall (mm)	Days To Maturity	Seed color	Yield qt/ha	
						Research	Farmer's
1	BH-140(ACV-3)	<1800	400-1000	105-120	White	30-50	20-30
2	Tesffa (ACV-6)	<1800	400-1000	105-120	White	30-50	20-30
3	Melkassa-1	<1600	450-1000	85-105	Yellow	30-50	20-30

**Source:-EIAR**

### **Cultural Practices**

**Land Preparation:** For maximum production Maize requires a fine and well prepared seedbed that is free from weeds and other crop residues. This can be achieved through repeated plowing the land for about two to three times when oxen drawn traditional plough is used. If tractors are used one plowing and two harrowing are recommended. Weeds and crop residue left on the field from the previous year harvest should be ploughed under and incorporated with the soil well ahead of sowing time in order to minimize the occurrence of different pests and also to improve soil fertility. In moisture stress areas, tied ridges must be constructed at appropriate interval in order to conserve soil moisture.

**Planting Time:** Planting time may vary from place to place depending upon the onset time of rainfall. In a situation where Maize is grown under rain fed condition, and/or if supplemental irrigation is used sowing must be accomplished as soon as the first effective shower is received. This will enable the crop to exploit the full rainy season. On the other hand where a full-fledged irrigation is used planting time could be arranged as appropriate. However, other factors like time of frost occurrence and availability of sufficient irrigation water must be taken in to consideration.

**Planting Method:** Broadcast or row planting method can be used in the production of Maize. However, row planting method is recommended to obtain optimum yield. When

row planting method is used a spacing of 75 cm between rows and 25 cm between plants is recommended.

**Planting Depth:** Proper seed germination and crop establishment will be greatly affected if appropriate planting depth is not maintained. For Maize crop a planting depth of 5-10 cm is recommended based on soil type. Use deeper planting depth for light soils and shallower depth for heavy soil types in general.

**Seed Rates:** Seed rate can be influenced by different factors such as variety, seed size, seed health, germination capacity, planting method, soil moisture content, and fertility status of the soil and the likes. In general a seed rate of 25-30 kg/ha is recommended for Maize crop.

**Fertilizer Application:** In general soil test based fertilizer application is advisable. In a condition where specific soil test based fertilizer recommendation is not available application of 100 kg DAP and 100 kg Urea per hectare is recommended for Maize crop. Considering Urea, split application that is half at planting time and the remaining half at knee-high stage is recommended to enhance fertilizer use efficiency.

### **Crop Protection**

**Weed Control:** Maize is sensitive to competition from weeds particularly in its early stage of growth. Therefore, it is important to keep Maize field free of weeds. Regarding hand weeding a minimum of two hand weeding are recommended. The first hand weeding must be accomplished when the crop is at four leaf stage and the second one at Knee-high. In addition to hand weeding, other cultural control methods such as proper seed bed preparation, inter row cultivation, use of weed free clean seed. Crop rotation and field sanitation can also help to minimize weed problem. Where and when the level of weed infestation is too high, different pre and post emergence chemical herbicides can be used to control both broad leaved and grass weeds.

**Insect Control:** Major insects of economic importance on Maize include stalk borer (*Buscallo fusca*) which is a major pest above 1200 m.a.s.l. and spotted stalk borer

(Chillo partellus) which is serious insect below 1200 m.a.s.l. In addition to these two major insects, army worm, African boll worm and Aphids also attack Maize crop.

### **To control Stalk borer**

- + Cut the maize stalk close to the ground level at harvest time.
- + Spread the harvested stalk thinly in the field for about one month in order to expose the hibernating pupa in the stalk to sun's heat.
- + Apply field sanitation and destroy alternative host plants well ahead of sowing time.
- + Remove and destroy infected plants with dead hearts within six weeks after emergence.
- + Apply Simbush (Cypermethrin) 1.0 % granule at the rate of 3.5 kg/ha.

### **To control Armyworm**

- + Dig a shallow trench around the field to retard its entrance of Army worm into the field
- + Spray different insecticides such as Malathion, Sumathion, Diazinon and Sevin.

### **To control African boll worm**

- + Plow the field deep in order to expose the hibernating pupa to sun's heat and different natural predators.
- + Apply proper field sanitation.
- + Spray Thiodan (Endosulphan) 35 % EC at the rate of 2.0 liter per hectare mixed with 200-300 liters of water or Thiodan 25% ULV at the rate of 3.0 liters per hectare.

### **To control Aphids**

- + Avoid planting when there is no rain.
- + Use resistant varieties.
- + Spray Premophosmethel at the rate of 0.5 liters per hectare mixed with 200-300 liters of water.

### **Disease control**

Major diseases on Maize are:- Rust (*Puccinia sorghi*), Leaf blight (*Helminthosporium tursicum*) and Head smut (*Sphacelothecia reiliane*).

**To control Rust and Leaf blight** use resistant variety.

**To control Head smut use** crop rotation, treat the seed with appropriate chemical, apply proper field sanitation and destroy crop residue and other plant debris.

**Harvesting and Threshing:** Maize is physiologically mature and ready for harvest when a black abscission layer develops at the tip of the kernel at its point of attachment to the cob. Maturity after this period is just a matter of losing moisture. Harvesting can be accomplished by cutting the entire plant at the ground level or by removing only the cob. Once the harvested cobs are properly dry, they can either be shelled manually or by modern Maize shellers. To store the grain,

- ✦ Clean all storage facilities properly before storing the grain.
- ✦ Make sure that the moisture content of the grain is reduced to about 12% before storing it.
- ✦ To control storage pests use Actelic 2 % powder at the rate of 200-500 gm per 10 quintals of grain.
- ✦ Fumigants like Fostoxin can also be used to control storage insects.

### **9.8.3. Haricot Bean (*Phaseolus vulgaris* L.)**

Haricot Bean has got many uses which include:-improvement of soil fertility by fixing atmospheric nitrogen, cheap source of protein for humans, high quality and protein rich livestock feed and an important precursor crop in rotation programme with cereals in general.

#### **General Growth Requirements**

##### **Altitude**

Haricot Bean is a warm season crop and its climatic requirements are the same as that of Maize. Haricot Bean can be successfully grown from 900-2100 m.a.s.l.

##### **Annual Rainfall**

For proper growth and development Haricot Bean requires about 600 mm of rain provided that the distribution is uniform through out the growing season. In general Haricot Bean is produced in areas receiving annual rain fall ranging from 400-700 mm. In areas where the amount of rainfall is very low, the crop should receive supplemental irrigation in order to ensure successful production. The crop requires sufficient amount of soil moisture particularly during flowering and pod setting stages. Water stress during these stages cause excessive shading of flowers and pods resulting in reduced yield. Haricot Bean grows well and produce high yield under irrigated condition.

##### **Temperature**

Optimum growing temperature for Haricot Bean production is 24-25 ° for better performance Haricot Bean should be produced in areas with minimum risk of frost occurrence.

##### **Soil Condition**

Haricot Bean can grow on a wide range of soil types. However, for better performance it requires fertile, well drained light clay loam, sandy loam and alluvial soils with a PH range of 6.5-7.0.

### Improved Haricot Bean Varieties

Improved Haricot Bean Varieties which have been released from different research centers are shown in table 24 and 25 below.

**Table 8: Export Type Improved Haricot Bean Varieties**

SN	Variety Name	Days to Maturity	Seed Colour	Protein Content (%)	Yield Qt/Ha.	
					Res.	Farmers
1	Mexican -142	95-100	White	22	20-22	8-10
2	Awash-1	95-100	White	22	22-25	8-10
3	Awash-Melka	95-100	White	22	22-25	8-10
4	Argene	85-90	White	22	20-22	8-10
5	ACOS- Red	70-75	Red	22	18-20	8-10

Source:-EIAR.

**Table 9 : Some Food Type Improved Haricot Bean Varieties**

S/No	Variety Name	Days to Maturity	Seed Colour	Protein Content (%)	Yield Qt/Ha.	
					Research.	Farmers
1	Red Wolaita	95	Red	22	15	8-10
2	Roba-1	95	Cream	22	24	8-10
3	Atendaba	92	Speckled	22	26	8-10
4	Brown Speckle	92	Speckled	22	17	8-10
5	Dinknesh	95	Red	22	25	8-10
6	Melka-Dima	93	Red	22	23	8-10
7	Ayengew	91	Speckled	22	25	8-10
8	Gofta	92	Gray	22	26	8-10
9	Zebra	93	Speckled	22	32	8-10
10	Gobe Rasha	95	Red Spec	22	32	8-10
11	Beshbesh	83	Cream	22	32	8-10
12	Melkie	82	Red	22	25	8-10

Source:-EIAR

## **Cultural Practices**

### **Land Preparation**

For maximum production Haricot Bean requires a fine and properly prepared seed bed. Poorly prepared seed bed will adversely affect germination thereby resulting in reduced yield. In this case 2-3 plowings/harrowing should be done using oxen drawn plough or tractors.

### **Planting Time**

Planting time can vary from place to place. Under rain fed condition Haricot Bean can be planted from the last week of May until the last week of June. Under irrigated condition planting can be adjusted as required, however consideration should be made regarding time of frost occurrence and availability of irrigation water.

### **Planting Method**

Either row or broadcast planting method can be used to produce Haricot but for maximum production row planting method is recommended. When Haricot Bean is planted in rows, depending upon the growth habit of the varieties (Erect, Semi-erect and Trailing or climbing types) spacing of 60-75 cm between rows and 5 cm between plants are recommended.

### **Planting Depth**

Improper planting depth adversely affects germination and crop establishment. The recommended planting depth for Haricot Bean is 3-5 cm. usually, 5 cm is considered to be optimum.

### **Seed Rate**

Seed rate can be influenced by different factors such as variety, seed size, seed health, germination capacity planting method, moisture and fertility status of the soil, etc. For Haricot Bean 80-100 kg/ha seed is recommended.

### **Fertilizer Application**

Haricot Bean produce good yield when grown on fertile soils and it is important and preferable if soil test based fertilizer application is adopted. However, in the absence of soil test based specific fertilizer recommendations, use 50 kg/Ha DAP for moisture stress areas and 100 kg/Ha for high rainfall areas in general.

### **Crop Protection**

#### **Weed Control**

At an early stage, Haricot is very sensitive to heavy weed infestation. Two hand weeding are recommended. The first 25-30 days after emergence, and the second 50-60 days after emergence. In addition to hand weeding using clean and weed free seeds, proper seed bed preparation, inter row cultivation can reduce weed problem.

#### **Insect Control**

Major insects on Haricot Bean include African boll worm, Leaf hoppers, Flower beetle, Aphids and Bean weevil. If the infestation level is beyond the economic threshold level appropriate insecticides should be used to control them.

**To control African boll Worm and Flower Beetles use:** Endosulphan 35 % E.C.at the rate of 2.0lts/Ha mixed with 200-300 liters of water and Dimethoate 40 % E.C. at the rate of 1.0lts/Ha mixed with 200-300 liters of water.

**To Control Aphids:-** Thimethone 15 % ULV at the rate of 1.5 lt/Ha.

**To Control Bean Weevil use:-** Actelic 2 % powder at the rate of 40 gm for one quintal of seed.

## **Disease control**

In humid areas the crop is attacked by many diseases most of which are not very severe in drier areas. The major diseases on Haricot Bean include:-Anthracnose, common Bacterial Blight (CBB), Root Rot and Rust. Anthracnose is one of the most destructive Haricot Bean disease world wide. Sunken spots with pink centers and darker borders appear on the pods. The disease is seed born and transmitted through infected seeds. Therefore, it is important to use clean and disease free seed. Haricot Bean is also attacked by several bacteria that cause foliar blight.

Effective control measure is to use disease free seed and use resistant varieties. Root rot is caused by *Fusarium oxysporium*. The pathogen persists in the soil for a long time and only a long term rotation is effective to control it. Rust is a common disease worldwide. Reddish spores which turn in to dark brown colour later on are observed on the leaves and stem. The best method to control the disease is to use resistant variety.

## **Harvesting and Threshing**

Haricot Bean is physiologically mature and ready for harvest when the color of the leaves turn from green to yellow and start dropping. Since shattering is a major problem, Haricot Bean should be harvested at the right time and should not be left in the field to over mature. Dry weather condition is required for harvesting and threshing. Once the harvested crop is properly dry it can be threshed on clear threshing ground and safely stored when the moisture content of the seed drops to 10 % or below.

#### **9.8.4. Onion (*Allium Spp*)**

##### **General growth requirements**

###### **Altitude**

The optimum altitude ranges for Onion production is between 700 and 2200 meters above sea levels.

###### **Rain fall**

For optimum yield, Onion requires 350 - 550 m.m. of rain fall during the growing period. Onion can be grown during the rainy season, but the latter part of growing period should be dry. When grown under irrigated condition Onion should be irrigated at 5 – 7 days interval. However, a longer interval may be necessary when it is grown on heavy soils. Irrigation should be stopped before full size development stage of the bulbs.

###### **Temperature**

The optimum growing temperature for Onion lies between 15<sup>0</sup> C and 23<sup>0</sup> C.

###### **Soil Condition**

Onion needs well-drained sandy loam soils with a high content of organic matter and PH of 6.0 –7.0.

###### **Improved Onion Varieties**

Onion is strongly influenced by day length to produce bulbs and only short- day varieties (approximately 12 hours) are well adapted to Ethiopian conditions. Varieties that are either long or intermediate are not adapted to Ethiopian condition, since they do not produce bulb when grown in region having less than 12 hours day length. Varieties adapted to specific areas must be resistant to diseases, and have good size and yielding capacity, long storage properties and the pungency or flavor desired of the onions. The recommended varieties under irrigation are, therefore, Adama Red, Red Creole, Bombay Red and Melkam Red. However, Red Creole is not widely adapted and usually imported seeds of this variety have low quality standards. However, it has some

resistance to leaf diseases such as powdery mildew and purple blotch. Experience of some farmers, in some parts of the country revealed that Bombay Red is more preferred by farmers, mainly due to better market demand and high productivity. However, this variety produces split bulbs and stores poorly. Adama Red has better pungency property than the other varieties and keeps well under storage condition. These improved varieties of Onion have low resistant to diseases, and they are particularly susceptible to Purple Blotch disease and Onion thrips attack see table 26.

**Table 10: Improved Onion Varieties**

<b>Variety</b>	<b>Bulb colour</b>	<b>Average weight of the bulb (gm).</b>	<b>LGP (days)</b>	<b>Average yield (qt/ha)</b>
<b>Adama red</b>	Deep red	65- 80	120- 135	350
<b>Melkam red</b>	Red	85- 100	130- 142	400
<b>Red Creole</b>	Deep red	60- 70	130- 140	300
<b>Bombay red</b>	Deep red	70- 80	135- 145	300

Source:-EIAR.

### **Cultural practices**

**Land Preparation:** The land to be used for Onion production should be plowed 3-4 times in order to have fine seed bed to properly grow seeds and transplanting seedlings.

**Nursery Managements:** For transplanted Onion, seeds are generally sown on raised nursery beds of 15—22 c.m. height. To cover one hectare Onion production 560 m<sup>2</sup> nursery beds is needed.

**Planting methods:** When Onion is transplanted in the field, the height of the seedlings should be 12 – 15 c.m. Seedlings of Onion are usually transplanted in flat bed or flat top ridges with furrows between ridges and making double rows on the flat ridges 20 c.m

apart. The spacing between double rows is 40 c.m. and between plants is 10 c.m. (40c.m× 20c.m × 10c.m).

**Seed rate:** 4 k.g of Onion seed per hectare is the optimum seeding rate for transplanted Onion.

**Fertilizer Application:** For successful Onion production, 200 Kg. DAP and 100 Kg Urea is recommended as the optimum rate. The whole quantity of Phosphorous and half of Nitrogen should be added to the soil before transplanting. The remaining half Nitrogen should be applied as top dressing at 30- 45 days after transplanting.

### **Crop Protection**

**Weed control:** Onion does not properly compete with weeds particularly at an early stage of growth. Therefore, proper and timely weeding and cultivations are needed to destroy weeds at an early stage of crop development.

**Insect control:** Thrips (Thrips tabaci), a small, yellowish sucking insect which attacks the leaves of Onion are the most injurious insects usually during dry weather conditions.

**To control Thrips:** Spray Sypermethrin 10 % at the rate of 500 ml per hectare mixed with 200-300 liters of water.

**Diseases control:** Among major diseases attacking Onion plant, Purple Blotch (*Alternaria porri*) is the major one. Purple Blotch attacks leaves, seed, stem and bulbs. In the end, darkened mass of spots develop in the centers of the lesions. The infected leaves turn yellow and within three to four weeks. Then, the fungus grows down ward into the bulbs if control measures are not taken in time. Downy mildew (*Peronospora destructor*) is also another distractive fungal disease that attacks onion plant. To control these diseases: Use long rotation cropping system; For both fungal diseases apply 3.5 Kg Ridomil per hectare mixed with 600 liters of water and spray it at one week interval and mankozeb 2.5 kg with 600 liters of water in every 10 days interval.

**Harvesting:** Onion should be harvested when 50 to 80 of the top leaves have fallen over. Every harvest results in sprouting of the bulbs and late harvest gives also rise to

formation of roots during storage. After harvest, spread the onions in the row in the field and let them dry in the field for about 5 days. The top part should not be removed until the necks are dry. After the onion is properly dry or cured, the top part of the bulb should be trimmed to a length of about 2.5 cm.

### **9.8.6. SUGARCANE**

**Scientific name:** *Saccharum arundinaceum*

**Local name:** *Shenkora-ageda*

#### **Climatic Requirement**

Sugarcane is a tropical plant but it grows successfully in subtropical regions as well. It grows best at an average temperature range of 26-32<sup>0</sup>c with an annual rainfall of 750-1200 mm having fairly high humidity alternating with hot dry weather and bright sunshine during the growing period of the cane.

**Soil requirements:** Sugar Cane can grow on a range of soil types. However, for maximum production, it requires fertile well drained, clay loam and sandy loam. Saline and alkaline or acid soils are not suitable for this crop.

**Land Preparation:** Sugarcane requires a well prepared seedbed for better production. For this the field has to be ploughed and harrowed until it's free of weeds and clods and well pulverized.

**Planting:** Sugarcane is planted by opening furrows trenches in a well prepared seedbed. Stripped stalks are placed in the furrows lengthwise. Healthy planting material taken from well matured, erect and healthy sugarcane crop of not more than 10-12 months age should be selected for planting purpose. It is better to utilize only the upper half of the cane for planting to ensure better germination. Canes of ratoon crop are not suitable for planting purpose. After removing the dry leaves of the cane stalks by hand to avoid buds damage, the cane is cut into pieces of three budded sets of usually 30-45 cm long. About 35000-40,000 sets are needed to plant-one hectare of land.

**Fertilization:** Sugarcane needs a fertile soil to give profitable yield and fertilizer requirements of sugarcane depend upon the soil and climatic conditions. Sugarcane, being a long duration crop, it needs plenty of organic manure for a long term and continuous supply of plant nutrients. Therefore, well decomposed Farm Yard manure (FYM) at the rate of 30-40 t/ha should be applied. In addition in organic manure, nitrogen and phosphorus fertilizers based on soil tests should be applied through chemical fertilizers. The chemical fertilizers may be so applied as to meet the requirement of the crop depending on the soil test. However, N, P and K is generally applied @ 150 – 250 kg N, 80-100kg P<sub>2</sub>O<sub>5</sub>, and to kg k<sub>2</sub>o per ha. If need arises as per soil test micro-nutrients should also be applied.

**Water management:** Judicious supply of water is one of the main factors governing the cane yield and sugar recovery. The water requirement of the crop varies greatly with the climatic factors, types and growth phases of the crop. The growth phases of sugar cane are germination phase (planting to 60 days), formative phase (from 60-130 days), grand growth phase (130 to 250 days) and maturity phase (250 – 360 days). Water requirement of sugarcane is maximum in formative and ground growth phases.

### **Plant protection**

**Weed Management:** The most critical period for weed competition in sugarcane is upto 4 months after planting beyond which the crop smothers the weed flora. The cultural method of weed control includes hand weeding, hoeing especially after irrigation, mulching which retards surface evaporation and saves water. However, these practices sometimes become cumbersome, time consuming, labour intensive and expensive. In such conditions, chemical control of weeds offers a good substitute. To control broad leaved weeds, apply 2, 4-D at the rate of 1 kg a.i/ha in 500-600 liters of water 25-30 days after planting or before the weeds attain 3-4 leaf stage. Application of atrazine at the rate of 2.0 Kg/ha in 500-600 liters of water after planting is also very effective in controlling weeds.

**Diseases:** Sugarcane is attacked by a number of diseases. Some of the major ones include: Red Rot caused by a fungus *colletotrichum falcatum*, Wilt caused by *cephalosporium sacchari*, Smut it is caused by *ustilago scitaminea*, Red Stripe caused by *xanthomonas rubnilineas*, Albino or Grassy Shoot caused by a virus and Ratoon Stunting which is also a viral disease. Control measures include:-- select cane sets from completely healthy fields for planting ; use disease resistant variety; remove affected plants and burn them; field Sanitation, i.e. remove all debris after harvesting of the crop and select well drained fields for the production of sugarcane. **Insects:** Some of the important insect pests on sugarcane include shoot and root borer, black bug, and sugarcane white fly. To control these insects, cultural methods such as use of proper irrigation, field sanitation and destruction of affected plants can be used. In addition use of different chemicals such as Gamma BHC, Endosulfan, Thiodane etc. can also help in controlling pests.

**Harvesting:** Maturity in sugarcane is generally recognized by the gradual withering up or drying of the lower leaves leaving only a few green leaves at the top. It is always better to use a hand refractometer for testing the maturity of the canes. If the juice of the cane taken from the middle portion of the cane gives a reading of refractometer between 17 to 18, the crop is then ready for harvest. If refractometer is not available, the maturity is determined on the basis of sweetness of the canes. The cane is cut from the ground level. Leaves are stripped, the top is cut. And the canes are bundled and transported to the factory to be processed. The yield of 11-12 months old sugarcane plant ranges from 1000-1500Q/ha, under good management and suitable soil and climatic conditions.

## 8.9. Yield build-up

The yearly crop yield is proposed to increase. The yearly increment of crop yield is due to anticipated input and more awareness of farmers in irrigated agriculture through time with close supervision of agricultural extension workers. The yield of the second season crop of the same type is a little bit higher than that of first season. This is based on the assumption that higher natural calamity (flooding and water logging) in first season than second season that may affect crop production to some extent. The yield buildup for the project life is estimated based on the following assumptions.

- Current crop yield in the project area: The existing crop yield in the project area both at farmers' level and mechanized farms are assessed and used to estimate rain fed crop productivity.
- Regional and national average crop yield: The crop yield data at woreda, Zonal, regional and country level are used to predict/ estimate the yield buildup for the proposed crops.
- The anticipated input and management level: The important inputs like fertilizers or the existing fertility of the soil, improved seeds, pesticides and irrigation water are assumed to be applied correctly. Moreover, correct agronomic practices such as time of planting, weeding, and other practices, which are proposed in this document, are assumed to be applied correctly.
- Yields obtained in research stations and demonstration centers: the potential yield obtained in research stations and demonstration centers is considered for the yield estimation. Yield estimation for the project is indicated below in table 11.

**Table 11: Crop yield-build calculated for the project life period (qt/ha) for Wataba project**

Crop	Projection Year						Existing yield, qt/ha
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 5-25	
Maize grain	30	35	40	50	55	60	20-25
Haricot bean	13	17	21	25	25	25	10
Pepper	5	6	7	8	9	10	3-4
Onion	160	197	234	271	271	271	70
Tomato	170	200	230	300	350	350	120
Mung bean	6	7	7.5	8	9	10	4
Sugarcane		750	800	1000	1200	1200	250

## **8.10. Proposed crop management**

### **8.10.1. Land preparation**

Before the seed is planted, the land must be prepared in some fashion to provide an adequate seedbed. Land preparation entails removing weeds and loosening the soil, facilitate seed germination and root penetration. Tractor based land preparation not only does reduce the tedium in field production, but machinery and field equipment also allow the cultivation of large area and increase the efficiency with which producers conduct their operations. Moreover, stubble left after crop harvesting can be well mixed in the soil to improve its physical characteristics by the use of machinery. The land should be ploughed 1-2 times based on the situation of the specific field during the operation, then disking/ harrowing follows.

### **8.10.2. Intercropping**

Intercropping is the crop production practice in which one crop is planted in the open areas of another in the same piece of land to grow together. In the first 3-4 growth years' period of mango and in the first year of banana, intercropping of haricot bean with them is important for effective utilization of space, time and the resources of sunshine, water, and soil nutrients. This in turn will increase the land productivity and crop production per unit area.

### **8.10.3. Irrigation**

The cost of water for irrigation is often high. Therefore, farmers in the area should use water more efficiently to increase crop profitability. To maintain farm profitability, it is imperative that producers need to increase water-use efficiency through proper farm water management. Water management pertains to optimum and efficient use of water for best possible crop production keeping water losses to the minimum. Serious water loss can occur unless it is properly monitored and controlled while irrigating the fields. Irrigation water management involves the management of water allocation and related inputs in irrigated crop production for enhanced economic returns.

Over and under irrigation should be avoided. Wastage of irrigation water in the field through furrows must be avoided. Furrow irrigation method proposed to be applied for all crops in order to manage and it is the appropriate method for the current development situation of the region. The length of furrow varies mainly depending on soil type, and the slope of the specific farm, which determines the slope of the furrow. In coarse soils, the length of furrow is shorter and longer in heavy soils. The higher the field slope, the longer will be the furrow length. For efficient use of irrigation water, it is better if the furrow length for this project is not more than 100 meters.

**8.10.4. Proposed crop rotation**

Shallow Crop rotation is the growing of multiple crops on the same piece of land, one after the other. Here, different crops do not interact but separated temporally. Crops that can be attacked by the same pest should not follow each other in order to avoid pest buildup. Moreover, crops that are heavy feeder of nutrients should not follow each other. Deep-rooted crops need to be rotated with shallow rooted crops to improve soil structure. The proposed crop rotation for the project is indicated below table 28.

**Table 12 Proposed crop rotation**

Plot	Year 1		Year 2		Year 3	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
2	Maize	Haricot bean, onion	Maize	sesame	sorghum	onion
3	Sorghum	Haricot bean, pepper	Sorghum	Haricot bean	Maize	sesame
4	sesame	onion	Cotton	sesame	Haricot bean	maize
5	Haricot bean	Sorghum	sesame	Haricot bean	onion	sesame
6	Banana	intercropping	-----	-----	-----	-----
7	Sugar cane	intercropping	-----	-----	-----	-----
8	Mango	intercropping	intercropping	intercropping	intercropping	intercropping



### **8.10.5. Harvesting**

Appropriate time of harvesting is important and recommended for good result as it has implications in its yield use, quality and storage. Delaying harvesting or harvesting prematurely often adversely affects product quality. If the crop is left in the field for too long after maturity, it becomes predisposed to pest attack and deterioration from the vagaries of the weather. Moreover, delayed harvesting affect double cropping system since the first crop stays longer time in the field; the second season crop will not have enough time to grow. Manual harvesting is proposed for crops proposed for this irrigation project.

### **8.11. Agro-industry development and Marketing**

Like most of the areas of the country, the main problem of the project area is lack agro-industry for the processing of vegetable, fruit crops and oil crops at important area. For sustainable supply of the produce of these crops for the non producers or even for export purpose, they should be available as raw form as well as in the processed form depending on the crop type and the market demand. For the feasibility of the important agro-industries, the detail study needs to be undertaken by economists.

Crops proposed are basically food crops and high market value crops; therefore, a crop producer should have a marketing plan. Market plan entails developing a strategy to deal with alternative situations that may arise during a short-term period of about one to two years during which the crop would be produced and marketed. Marketing planning should be part of production planning. Generally, there is no need to produce what the producer can't sell or can't be used as food crop. The plan should include strategies to adopt in relation to specific pricing and risk goals. It should be emphasized that situations may change during the crop production period and soon thereafter that may warrant modifications of the plan. A sound plan does not guarantee the highest return on risk, but increases the chances of higher returns and reduces the risk. The proposed crops may or may not be profitable for ever, therefore, looking for the market situation during the production period especially for a high value crop is essential to avoid the risk that may happen due to fall in market price.

## **9. Conclusion and Recommendation**

The existing crop yield of the command area is low owing to inefficient use of irrigation water, traditional farming system, lack, and/or insufficient supply of improved crop seeds and other agricultural inputs. Therefore, the upgrading of irrigation system together with modern crop production system is a fundamental issue to make the farming community food self-sufficient. It is not only useful for the community but also important for the society living nearby the project area because they can purchase the produce from the beneficiaries. Moreover, it creates employment opportunity for the community other than the beneficiaries of the project.

The right application of improved agronomic practices is of paramount importance to gain the benefit from improved crop varieties. Moreover, the efficient use of irrigation water and its timely application is essential to get the profit from the project. Effective and sufficient agricultural extension service is needed to support farmers in irrigated agriculture in order to produce the required amount of production. The recommended inputs like improved seed, fertilizers and others should be available before the time of planting in both seasons. The delay of inputs will delay planting time, which adversely affects the double cropping system, but the basic importance of irrigation is to grow crops twice or three times in a year in the same piece of land.

It is advisable if the seed multiplication is done in project area to reduce the cost of crop seeds. Farmers can do the seed multiplication themselves with close monitoring and supervision of agronomists. The necessary support need to be given to farmers from both Governmental and non-Governmental organizations (which are involving in agricultural and rural development) during the project development period.

To be perfect and for optimum utilization of our resources: water and land, irrigated crop production trial need to be carried out in the area. The trial should include irrigation frequency, furrow length, and different agronomic practices. This trial need to be carried out by bureau of agriculture at Woreda and PA levels and in collaboration with other concerned sectors.

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