ANNEX E

IRRIGATION AGRONOMY

THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

OROMIYA NATIONAL REGIONAL STATE

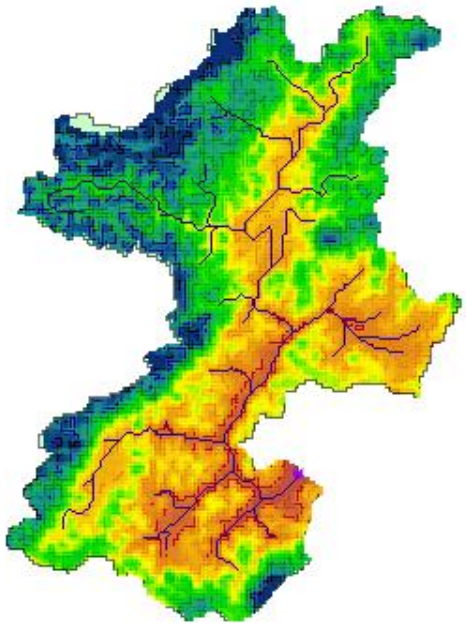
OROMIA IRRIGATION DEVELOPMENT AGENCY (OIDA)

SORIA SMALL-SCALE IRRIGATION PROJECT

FINAL FEASIBILITY STUDY AND DETAIL DESIGN REPORT

ANNEX E:

IRRIGATION AGRONOMY (FINAL)



November, 2016
AWE Consultant Plc

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EXECUTIVE SUMMARY

It is recognized that there is a need to increase food production in this Soriya command through improved irrigation and water resources management. However a number of problems encountered in the area that prevent from achieving better crops yield. Some of the major issues constraining development are reflected in this study. To utilize the command potential and implement fully mechanized crops farm, the command area land has been under crop production and also virgin lands as well. Since its establishment it has been producing cereals, pulses, vegetables and pasture crops. However, mono cropping is the dominant cropping system in this environment under only rain fed condition.

Livestock production is traditional and subsistence. Livestock production is the second major agricultural production activity in the highland after crop production. In smallholder mixed farming system, livestock produce food such as meat, milk, honey, egg, cheese and butter besides fiber. Livestock management is similar in all kebeles of the project area; however, assessment has been carried out in this wereda on population, nutrition / feed aspect and pests of live stocks.

The main objective is to examine and recommend improved surface irrigated crop and livestock production by determining the crop water requirement and develop suitable cropping pattern and calendar along with improved crop and livestock management and input requirements determination. To accomplish the study appropriate scope of the study and methodology have been drown.

The crop water requirement computation has been worked out.The main component of crop water requirement determination is reference evapotranspiration determination. This mainly depends on climatic parameters. Based on the hydrology report climatic data the duty obtained is 0.76 l/sec/ha in the month of January and this is for 12 hour.

Livestock sector is an important component of growth of agricultural economy and will continue to contribute in years to come mainly due to sustained growth in per caput income, urbanization and awareness about nutritionally rich animal based-food and ,rural household with little or no land, look for opportunity in non-land based and/or less land intensive enterprises and trade is expected to play a crucial role in the growth of livestock sector in favor of developing and transitional economies owing to comparatively lower input costs and cheap labor.

Yield Projections for the command area has been estimated based on available data/information obtained during field assessment carried out in the command area. Also cost of cultivation and benefit cost ratio has been analyzed for the selected crops considering the established irrigation system.

Based on the irrigation agronomy study the following important points of recommendations have emerged for consideration in view of existing agronomic situation of the command, soils and climatic conditions. Such as , better to start awareness creation and to popularize the use of already established irrigation for both the crop production and animal rearing purpose in the whole command areas and the surrounding of the project wereda, and with the involvement of research and local experts of the command area, introducing and ensuring the supply of quality seeds of improved varieties of high yielding, photo-insensitive which are resistant to abiotic and biotic stresses and responsive to irrigation water and other production inputs recommended for the Project Command. Livestock production in the project impact area is traditional and subsistence. Commercial production for milk and meat is limited and in most areas non-existent. Animal feed and water shortages, poor market infrastructure, poor access to livestock extension services, poor veterinary infrastructure and high mortality rates are the most limiting factors for commercialization of livestock in the project impact area. Therefore, improved practices with the established irrigation system would be the best solution to overcome the challenges.

1. INTRODUCTION

1.1 Background

In Ethiopia agriculture and allied activities have been described as the main sources of many of the raw materials, investment capital, foreign exchange and labor needed for economic growth. Improving the performance of agriculture sector is, therefore, of critical importance for fast development of countries economy. In spite of its importance, the agriculture in this country is characterized by its low productivity mainly due to limited use of improved agro-techniques, production inputs and continuous degradation of natural resources like soil. This has affected the food security and environmental stability of the country adversely at the face of prevailing rapid and uncontrolled growth of population. Due to increase in population most of lands available for crop production have exhausted. Therefore, the only option left with the society is to enhance the crop productivity per unit area to feed the growing population. According to the census report, 90% of the total cropped area is occupied by grain crops. The other crops like vegetables, root crops and perennial or permanent crops are occupying only limited hectares.

These command areas are some of the revealing examples as a potential area for several crops cultivation. To utilize its potential and implement fully mechanized crops farm, the command area land has been under crop production and also virgin lands as well. Since its establishment it has been producing cereals, pulses, vegetables, fruit crops and pasture crops. However, mono cropping is the dominant cropping system in this environment under only rain fed condition.

Livestock production is traditional and subsistence. Livestock production is the second major agricultural production activity in the highland after crop production. The highlanders generally rear livestock along with the crop production for their livelihood whereas the low Landers or pastoralists subsistence is based mainly on livestock and livestock products. In smallholder mixed farming system, livestock produce food such as meat, milk, honey, egg, cheese and butter besides fiber. At national level, livestock plays an important role in providing export commodities like live animals, hides and skins to earn foreign exchange to the country. Livestock management is similar in all kebeles of the project area; however, assessment has been carried out in all the woredas on population, nutrition / feed aspect and pests of live stocks.

Cognizant of the immense crop production potential exist in command and with the intent of this project to establish reliable crop production the project has launched SSI study fully commercialized crop development plan in the near future. Accordingly, the client has contracted AWE consultant to undertake

feasibility study of the Soriya SSI Project and hence this irrigation agronomy study was conducted as an integral part of the overall study to design fully mechanized surface irrigated crop farm.

1.2 Objectives

1.2.1 General objectives of irrigation study

To examine and recommend improved surface irrigated crop production by determining the crop water requirement and develop suitable cropping pattern and calendar along with improved crop management and input requirements determination.

1.2.2. Specific objective

- To review and update previous studies concerning to the command areas;
- To select of most suitable crops, fruits, vegetables, livestock, apiculture etc. and their most appropriate integration with suitable economic return for different size of irrigated farm holdings.
- To evaluate the available potentials as well as the prevailing constraints and possible limitations that may block the crop production in the areas and impede improvement in the existing farming system;
- To propose improved varieties which are adaptable, high yielding, input responsive and pest tolerant in the command area;
- Renovation of existing grasslands and their rejuvenation for economic production of livestock and sustainability of environment.
- To evaluate availability of post-harvest facility for the crops produced and storage to fulfill the gap.

1.3 Scope of Study

The overall program of the Project in the Project command area is to integrate the agricultural production with various facets of agriculture production namely crops, livestock, horticulture, etc. keeping in view the climatic and soil parameters in the existing socioeconomic conditions both under rain fed and irrigated agro-ecosystem. While making the appropriate agricultural plan for project command and water shed, the overarching concerns would be of nutritional and livelihood security, Poverty alleviation, profitability, gender equity, ecology and environment, and competitiveness in terms of cost and quality. This will include the following broad aspects:

- Study of existing farming systems and agricultural development pattern of project command and watershed area in association with socio-economic situations.
- Selection of most suitable crops, fruits, vegetables, livestock, apiculture etc. and their most appropriate integration with suitable economic return for different size of irrigated farm holdings.
- System approach having economically dynamic and efficient cropping patterns involving selected food and cash crops and other enterprises suitable under the prevailing climate, soils and added irrigation conditions.
- Identification of most appropriate agro-techniques and input support services for the farmers for increased farm productivity.
- Renovation of existing grasslands and their rejuvenation for economic production of livestock and sustainability of environment.
- Need assessment and introduction of improved post-harvest technologies and value addition.

2. APPROACH AND METHODOLOGY

The following three major procedural stages were employed to conduct irrigation agronomy study namely, pre-fieldwork, fieldwork and post-fieldwork. The field survey methodologies and data collection formats have been designed to fulfill the different but complementary objectives and targets of the project feasibility study. The study also included the type and number of livestock being reared, their socio-economic importance and marketability to decide on the future livestock to be included in the selected production plans.

2.1. Pre-field Work

The pre-field work stage refers to all necessary preparatory tasks for irrigation agronomy and livestock feasibility studies which mainly encompasses the collection and review of previous studies and existing documents related to the project, and preparation of data collection formats / questionnaires. Checklists were used to undertake focus group discussion, key informant interviews, and stakeholder consultation.

2.2 Field Work

The field survey work was carried out to collect primary and secondary data regarding existing crop and livestock production activities including practices, productivity, production constraints, and irrigation water management practices.

2.3 Post-Fieldwork

The post fieldwork activities included data organization, data encoding and analysis and feasibility study report writing. The major activities accomplished under this include:

(a) Review of previous studies in and around the project area ;

(b) Analysis of existing crop and livestock production practices and identification of problems and constraints with respect to: moisture availability; production practices; important diseases and pests; and availability of improved production technologies.

(c) Determination of suitable crop varieties and rotational crops for the improved surface irrigated cultivation project.

(d) Determination of improved crop calendar and cropping pattern for the selected dominant crops also rotational crops.

(e) Determination of Crop Water Requirement (CWR): Reference Evapotranspiration (ETo) and Crop Water Requirement (CWR) was calculated using FAO CropWat version 8 software. Irrigation interval, depth of water application and duty were determined

3. NATIONAL AND REGIONAL AGRICULTURAL POLICIES

3.1 National Agricultural Policies

The Federal government of Ethiopia have initiated and introduced a number of reforms aimed at transforming the previously centralized economic policy to new and free marketing economy. The agricultural strategy currently in use was formulated based on characterizing of agricultural sectors and outlining the major issues and constraints hindering production and productivity of the sector in the country. The strategy formulated is called "Agricultural Development Led Industrialization (ADLI)." The main objectives of the strategy are:

- Improving quality of life of rural people,

- Increasing production of food supply in order to feed not only the population of the sector but also the population of other sectors,
- Increase and diversify the production of raw materials for industry,
- Increase and diversify the production of export and
- To make agriculture the driving force for economic development.

The objectives have been aimed to be met through improvement of productivity of small holders farming and commercial extensive and intensive agricultural development.

Because livestock contributes to direct food supply or cash income generation it plays a significant role in fulfilling the objectives set in the five-year plan of Plan for Accelerated and Sustained Development to End Poverty (PASDEP). For this reason, to bring about changes major fields of intervention are livestock development and animal health services.

In the former, the goal is to improve the overall livestock production, where special attention will be given to the sedentary production system. In areas characterized by high human population pressure, fragmented land holding, land degradation and arid climate, the attention is on small ruminants and poultry production also an important strategy.

3.2 Regional Agricultural Programs

Oromia National Regional State (ONRS) has also adopted the federal agricultural development strategy and formulated the same depending on the resource, social and political conditions of the region for a period of five years. The region has divided the development sectors as surplus producing areas and drought prone areas, and has formulated development programs which can be addressed according to the specific problems and need of the areas. In this context, the following activities have been undertaken in crop production aspect:

- Improving the use of improved seeds and fertilizers,
- Introduction and improvement of availability of seed of drought resistant Varieties,
- Strengthening of credit service,
- Construction of irrigation schemes through the sustainable Agriculture and Environmental Rehabilitation Program in the Oromia region.
- Creation of income generating activities,

- Fill up the positions of Development Agents (DAs) wherever they are deficient and
- Strengthen the social institutions

The regional livestock development strategy is designed based on the national livestock development policy and strategy. The regional livestock development strategy focuses on:

- Forage Development
- Breed Improvement
- Veterinary Service improvement and,
- Marketing

In addition to the above strategies, the regional agricultural strategy also indicates the livestock productivity improvement from the existing level to a better level. The strategy also shows main objectives of the strategy example, improve communal grazing lands, establish veterinary clinics and staff with trained personnel, etc.

4. REVIEW OF PREVIOUS STUDIES

4.1 Study of Land and Water Resources of Blue Nile Basin (1964)

The U.S. Departments of the Interior Bureau of Reclamation (USBR) conducted a reconnaissance level study of land and water resource of Blue Nile Basin in 1964. The report gives detailed accounts of the development plan of land and water resources of the above basin for enhancement of area under irrigation and introduction of improved production technologies to replace the existing farming practices. According to this study the farming in this Project command is at rudimentary stage and at subsistence level. Heavy rain and day time temperature, insect-pests, malaria and other human and animal diseases and other factors have adverse effect on farming in this area. This report has generally not provided in depth details of land potentiality and water potential for agriculture specifically for the proposed command area, but attempted to give the description of crops and their suitability. Although according to the above study farming in Sota, Doma and Soriya projects are practically non-existent. Under such circumstances the study could not provide specific details for the development of agriculture in the command except that the soil appears to be fertile and suitable for cultivation.

4.2 Preliminary water Resources Development Master Plan for Ethiopia (1990)

Water and power consultancy services (India) limited (WAPCOS), during 1988-1990 in collaboration with Ethiopia Valleys Development studies Authority carried out the studies of all 14 river basins of Ethiopia based on the secondary data without collection of the actual field level data. On the basis of reconnaissance level study, they prepared the preliminary water Resources development Master Plan for the country. This plan indicated water resources potential and utilization for the next 50years covering various aspects of agriculture under irrigated and rain fed agro-ecosystems and other water use areas. They also made efforts to delineate the agro-eco-regions of the country, land use pattern, soil characteristics, land use capabilities and discussed their significance for agricultural production and land use planning. The study also highlighted the cropping plans and crop calendar for the project command as a general guideline. The study related to agronomy discussed the characteristics of traditional agro-climatic zones and ecological zones on the basis of interrelated physical, abiotic and biotic parameters and indicated the length of crop growing period, the cropping systems at various altitudes and temperature regimes. The details of major vegetation types for different soils have also been mentioned but they are not specific to the command area. The study has also divided the country into 7 thermal zones from the crop production point of view particularly under irrigated production systems. These are based on the altitudes and temperature regimes for particular altitudes along with the crops as per their adaptability for the entire country. The general guidelines for crop selection criteria pertaining to the climate and soils have been discussed along with crop production practices in the country as a whole with a brief review of livestock management under mixed farming system.

4.3 Abay River Basin Integrated Development Master Plan Project (1999)

BCEOM- French Engineering Consultant in association with ISL and BRGM provided consultancy to Ministry of water Resources, GOE. Since 1994 in 3 phases which was completed in 1999. They prepared integrated Development Master Plan for Abay River Basin based on several previous studies, which generally focused on irrigation and use of extensive resources of the basin. This also included the above studies of USBR (1964), and WAPCOS (1988-90). The study also aimed at the exploitation of existing water potential of the above basins for the overall improvement in agricultural economy through enhancement of agricultural and livestock productivity. These reports reviewed the overall situation of

markets for food crops and livestock products, role of livestock in farming system, poverty and socio-economic condition of farmers of the basin. The study found the climatic unreliability, particularly insufficient rainfall and absence of irrigation as one of the important reasons for low production and poor productivity. The report also discussed the agricultural system existing in the region and zone in which the present project command falls. The report related to agricultural plans described various production constraints of the above basin and suggested strategies for enhancement of production and productivity under the existing potentials of soils and climate both under rain fed and irrigated production systems. It also discussed the status of agricultural research, technology innovations, their dissemination in relation to research-extension and farmer's linkages, their weakness and strength in the light of the present agricultural policies of the Federal Government and the Oromia Regional State government for food and nutritional security.

5. AGRO-ECOLOGY, LAND USE, SOIL AND CLIMATE

5.1 Agro-Ecology, existing Land Use and Soil

Agro-Ecology deals on the land characteristics such as Physiography, soils, climate, present land use/cover type and farming systems of each of the sub-zone, also information regarding crops, livestock wildlife and forestry and above all the agricultural potentials and constraints of each sub-zone. Therefore, the present command classified as "Temperate to cool sub humid mid highlands" .This is based on Physiography, altitude, climate, soils, present land use/cover, crop and livestock. Thus, utmost efforts should be made to manage the existing land resource as efficiently as possible.

In Soriya of Didessaa district Project Command area, the major part of the area is not cultivated and is virgin land. Most of the command kebeles are covered by forest with different species of trees. The cropping intensity, within the cultivated existing farmland is 58% at Didessaa. On an average, the estimated present cropping intensity is nil at Soriya command. Since the farmland is part of land cover, therefore, large area of land has a good potential for cultivation. The low cropping intensity reflects the role of livestock and biomass energy in farming system and the associated requirement to assign land to these uses. Land use in hectare; it is essential to wisely utilize land for development purposes. Wise use means to employ the appropriate conservation methods while consuming the products.

According to the year 2007 E.C data from Didessaa wereda agricultural office has been collected and summarized accordingly. At Didessaa more than 50 % is covered by crops. The natural and the man-made forests are in a very good condition with 13.22 % with natural and 5.8% with man-made forests in the year 2007EC (Table 5.1).

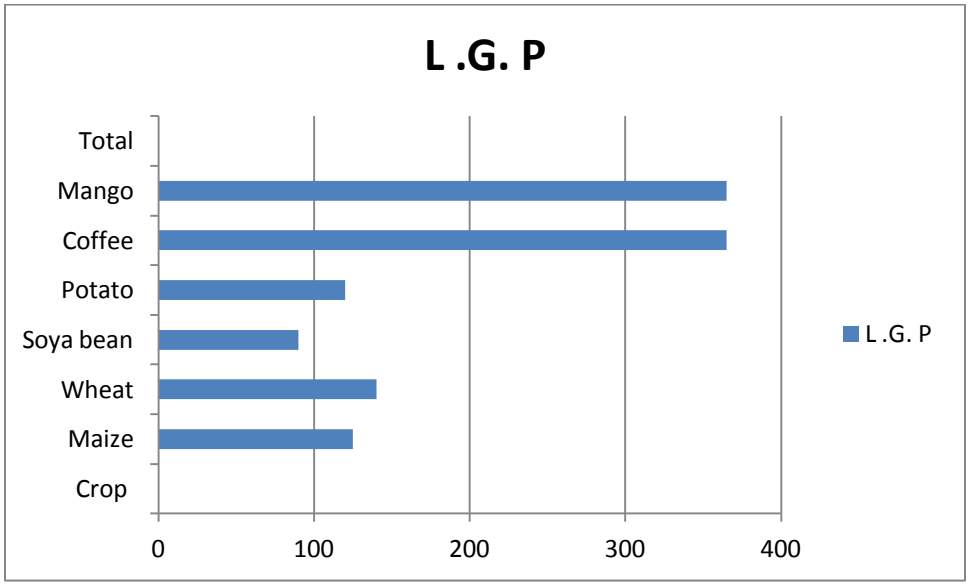


Table 5.1 Land Use in Bedele wereda (in Hectares)

No	Land Use	2006 E.C		2007 E.C	
		Area	Percent	Area	Percent
1	Land under annual crops	20107	35.17	21,628	29.69
2	Land under perennial crops	11615	20.32	20,811	28.57
3	Pasture land (Grazing land)	12116	21.19	6000	8.24
4	Natural forest	9751	17.06	9632	13.22
5	Wood Land	--	--	706.5	0.97
6	Man-made forests	3577	6.26	4227	5.80
7	Others (Specify) settlement	--	--	9843	13.51
	Total Area	57,166	100.00	72,848	100.00

Source of Data:-Didessaa wereda Agricultural Development Office

Soil types of the respective woredas of Didessaa and their physical, chemical and biological properties greatly influence the crops and their performances have been analyzed. Some of the physical properties, which affect the crop growth, are soil depth, organic matter content, texture, structure, infiltration rate,

hydraulic conductivity and available soil moisture and soil strength. The chemical and biological properties are equally or sometimes more important to determine the quality and sources of nutrients to be used for high yields. The bulk of the project command soil is dark grey, fine textured heavy clay. Details of the analysis are available in AWE Soils survey study report.

5.3 Climate

Distribution of crops, their production and seasons of cropping are influenced by climatic factors such as temperature and rainfall to a much greater degree than other environmental factors. The crops differ in their response to day and night temperatures and humidity etc. and react differently to the change of level of these factors. Soil factors such as texture, structure, depth and topography affect the moisture storage capacity of soil influencing the crop growth and crop productivity. Thus, the crop production in command will be largely controlled by climate and soil interaction.

The summary of the meteorological observations (data) obtained from –hydrology report of AWE consultant are given in table 5.4, for mean temperature, relative humidity, wind speed, sunshine hours, estimated ETo and rainfall monthly wise. As per the altitude, sunshine duration or expected radiation and temperature, the Bedele, Gechi and Didessaa Irrigation Project command area falls under Dega cool and semi-humid traditional climatic zone. According to the recent classification and characteristics of agro-ecological zones in Ethiopia, the Project command falls under Tepid to cool sub-humid mid highland zone.

5.3.1 Temperature

The maximum mean temperature of the project command area varies from 22.4^0c in July to 28.9^0c in February and March while the minimum mean temperature ranges from 11.4^0c in December to 14.3^0c in April. The growth of many crops ceases below and high critical temperature and adversely affects the crop growth and yield.

Temperature influences include cold and frost and scorching effects on crops. The temperature of the project command area suits cereals like wheat, maize under irrigated conditions due to their best response to irrigation. The temperature variation also suits to high value oil seeds, pulses, vegetables, fruits.

5.3.2 Sunshine

The mean sunshine hours/day vary from 3.5 in July to 8.4 hours in November and December. This is also expressed or calculated in terms of radiation. The radiation and temperature affect the photosynthesis of

crops, consequently the dry matter accumulation and yield. In general the sunshine hours are favorable for crop production, mainly the cereals.

5.3.3 Relative Humidity

The average relative humidity varies from 57% in February to 84% in July. The relative humidity influences the evaporation, disease prevalence, ripening and maturity of crops.

5.3.4 Wind Speed

The average wind speed (m/sec) varies from 0.2 in December to 1.2 in July, the maximum being 1.2 in July. This, in general, will be influencing the crop-water requirements.

5.3.5 Estimated Reference Evapotranspiration (ETo)

The estimated Reference Evapotranspiration (ETo) in mm/day on an average varies from 2.8in July to 4.2 mm in April. The maximum ETo of 4.2 mm/day was calculated in April and minimum of July. This parameter would determine the selection of crops for rain fed and irrigated production system. This will also influence the water requirement for the crops.

5.3.6 Rainfall

The average rainfall in mm/month varies from 0 mm in January to 104.7 mm in April. The low precipitation (between 0 to 18.3 mm) is received from December to February as is shown on Table5.2. This pattern of rainfall would not allow the possibility of a good agricultural production during the above period without irrigation.

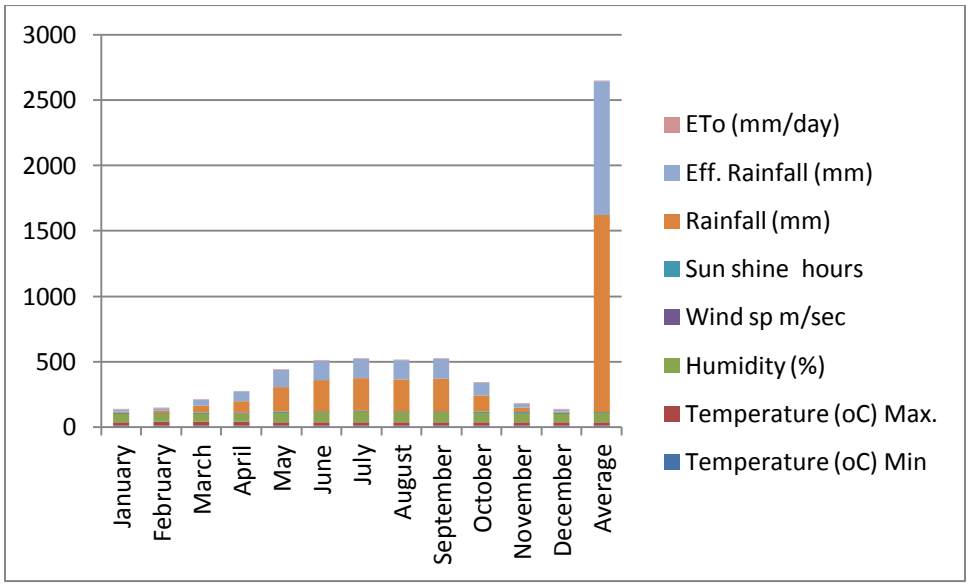
Table 5. 22 Summary of Climatic Data and ETo for the Project Command Area

Country: Ethiopia Station: Bedele
Altitude: 2011 m. Latitude: 36.38 E Longitude: 8.47 ^{o} N

Month	Temperature (^{o}C)		Humidity (%)	Wind sp m/sec	Sun shine hours	Rainfall (mm)	Eff. Rainfall (mm)	ETo (mm/day)
	Min	Max.						
January	11.9	27.3	61.0	0.4	8.2	13.4	13.1	3.49
February	13.0	28.9	57.0	0.4	7.9	17.8	17.3	3.82
March	14.0	28.9	59.0	0.6	7.5	52.1	47.8	4.15
April	14.3	28.3	62.0	0.6	7.4	84.7	73.2	4.20
May	13.6	25.8	72.0	0.6	7.4	188.4	131.6	3.94
June	12.7	23.7	79.0	0.6	5.9	238.7	147.5	3.35
July	12.6	22.4	84.0	1.2	3.5	249.1	149.8	2.80
August	12.6	22.5	80.0	0.9	3.9	243.8	148.7	2.95
September	12.6	23.9	77.0	0.4	5.9	250.6	150.7	3.37

Month	Temperature (°C)		Humidity (%)	Wind sp m/sec	Sun shine hours	Rainfall (mm)	Eff. Rainfall (mm)	ETo (mm/day)
	Min	Max.						
October	12.4	25.1	73.0	0.5	8.1	121.5	97.9	3.77
November	12.1	25.5	69.0	0.4	8.4	33.7	31.9	3.54
December	11.4	25.6	64.0	0.2	8.4	11.9	11.7	3.28
Average	**12.8**	**25.7**	**70.0**	**0.6**	**6.9**	**1505.7**	**1020.5**	**3.55**

Source: AWE, 2016. Hydrology Report



6. EXISTING AGRICULTURAL STATUS

6.1 Crop Production

6.1.1 Introduction

The existing status of crop production, cropping system and farming system scenario Soriya of Didessaa irrigation commands was studied through a comprehensive questionnaire consisting of all production parameters. These questionnaires were completed by personal contact and through kebeles of the selected woredas for collection of primary data. The secondary data on land use, area and production of crops along with inputs distribution were also collected from agricultural and rural development offices of kebeles also Illuababora Zone of the three woredas under which the present irrigation project falls.

6.2 Production and productivity of crops

6.2.1 National status

The national status of crop productivity has been studied for the year 2012 and given in table 61. During this period, the total production of cereal was estimated at 198,952,002 quintals with average yield of 20.28 q/ha, pulses **22,745,025** quintals and oilseeds **7,371,520** quintals with mean yields of 14.14 and 8.65 q/ha respectively. The total yield of the above three groups of crops was estimated to 229,068,547 quintals.

Table 6.1: Forecast of 2012/13, Area (ha), Production (quintal) and Yield (qt/ha) of major crops at National Level for private peasant house holding during the Meher season.

Major crops	Area forecasted	Production forecasted	Yield forecasted
Total Grain	12,270,472	229,070,553	------
Cereals	9,808,958	198,953,002	------
Teff	2,781,186	37,690,984	13.55
Barley	1,047,281	17,867,703	17.06
Wheat	1,595,724	33,119,728	20.76
Maize	2,185,382	65,030,048	29.76
Sorghum	1,685,729	36,028,732	21.37
Finger millet	444,908	7,527,339	16.92
Pulses	**1,609,053**	**22,747,021**	------
Faba bean	583,821	9,394,740	16.09
Field pea	259,095	3,250,165	12.54
Haricot bean	359,235	4,127,345	11.49
Fenugreek	30,697	282,742	9.21
Oil seed	**852,460**	**7,370,529**	-------
Neug	304,7351	954,218	6.41
Linseed	128,497	1,296,998	10.09
Sesame	271,717	1,982,460	7.30
Rapeseed	43,374	764,935	17.64
Root crops	**462,064**	**20,101,667**	------
Potato	73,683	6,230,355	84.56
Taro	35,902	3,071,561	85.55
Sweet potato	35,605	3,340,631	93.82
Crop/ Enset	**35,580,785**	**Prod,qt**	**Yield qt/plant**
Enset		Amicho 2,248,720 Kocho 20,146,947 Bulla 370,882	Amicho 0.23 Kocho 0.29 Bulla 0.01

6.1.2 Illuababora Zone Status

According to the Ethiopian agricultural sample enumeration result for Illuababora Zone (CSA 2012) the total area under various cereals crops in Oromia region of Illuababora Zone is 218,199.31 hectares producing 5,247,574.30 thousand quintal with average productivity of 24.05 q/ha. The area under pulses is estimated to be **30,103.29** hectares producing **344,811.99** quintal with average yield of 11.45 q/ha. The production under oilseeds is estimated to be **110,041.10** quintals the productivity of 8.63 q/ha.

Table 6.2: Forecast of 2012/13, Area (ha), Production (quintal) and Yield (qt/ha) of major crops at Illuababora Zone for private peasant house holding during the Meher season

Major crops	Area forecasted	Production forecasted	Yield forecasted
Total Grain	257,282.35	5,050,427.39	----
Cereals	218,199.31	5,247,574.30	----
Teff	70,696.41	754,308.58	9.95
Barley	7,493.13	17,016.61	10.26
Wheat	5,146.01	113,431.35	13.08
Maize	88,034.65	3,212,274.41	32.09
Sorghum	38,731.33	965,629.87	23.09
Finger millet	6,245.61	126,827.87	18.24
Pulses	**30,103.29**	**344,811.99**	-----
Faba bean	9,630.75	103,946.44	10.79
Field pea	8,019.51	56,799.33	7.08
Haricot bean	5,315.28	58,950.04	11.09
Fenugreek	160.82	-----	----
Oil seed	**12,743.72**	**110,041.10**	----
Neug	7,661.28	----	----
Linseed	----	-----	-----
Sesame	----	-----	------
Rapeseed	426.64	10,545..70	16.00
Root crops	**3,43.21**	**136,915.81**	----
Potato	----	-----	----
Taro	534.55	48,195.30	90.16
Sweet potato	716.18	70,758.24	98.80
Crop/ Enset	**701,672.00**	**Prod (t**	**Yield qt/plant**
Enset	701,672.00	Amicho 78,489.0 Kocho 282,476.0 Bulla 8,476.0	Amicho 0.11 Kocho 0.40 Bulla 0.01

6.1.3 Production Status in Project Command Woredas

The crops being grown and their area, production and productivity have been given in table 6.2. From the table it is quite evident that the yield of maize per hectare is higher than the average yield recorded at both

the national level regional level. The total hectares under teff is the highest followed by maize and sorghum. The area and production for some of the crops and commodities under project command are not available, though they are being grown; hence the table contains the list of some crops only.

Table 6.2: Area, Productivity and Production of different crops for Soriya

Soriya							
Details of Project Command Woreda & Kebeles	**Cereals**						**Pulse**
	Wheat	**Barley**	**Teff**	**Maize**	**Sorghum**	**Total**	**Haricot-bean**
Jamiyaa							
Area (ha)	498.0	395.0	5755.0	5894.0	5270.0		579.0
Yield (qt/ha	28.3	12.6	14.2	40.2	31.8		21.7
Total Yield (qt)	141185.0	49675.0	81789.2	236909.0	167412.0		10422.0

Soriya							
Details of Project Command Woreda & Kebeles	**Oil-seed**	**Vegetables**					
	Sesame	**Tomato**	**Cabbage**	**Sweet-potato**	**Onion**	**Pepper**	**Total**
Jamiyaa							
Area (ha)	10.0	1319.0	------	------	------	------	
Yield (qt/ha	4.8	75.9	------	------	------	------	
Total Yield (qt	48.0	24240.0	------	------	------	------	

Soriya					
Details of Project Command Woreda & Kebeles	**Fruits**				
	Citrus	**Papaya**	**Banana**	**Avocado**	**Total**
Jamiyaa					
Area (ha)	------	------	------	------	
Yield (qt/ha	------	------	------	------	
Total Yield (qt	------	------	------	------	

6.3 Existing Status of Farming System

Several natural factors influence the farming system of the project command area. Among these the altitude, soil and climatic parameters are the major factors. The rain fed crop cultivation integrated with livestock rearing is the principal farming system in most part of the project command. The project command is sparsely populated with a few small holders; hence major portion of land is yet to be cultivated. However, on the basis of the statistics available from wereda office, at Didessaa mixed farming with crops dominating especially cereals, pulses, oilseeds, vegetables including Enset.

Being a Mixed Farming System in all the three woredas, the farmers are generally rearing livestock mainly cattle along with the crop cultivation. Some of the farmers have sheep and apiculture. The cattle are being reared mainly for fattening for sale and draught power for land preparation, sowing and threshing. The land preparation is carried out by bullock drawn local plough (maresha) and manually operated hand tools. The frequency of plowing depends on the type of crop to be grown, its seed size and intensity of weed infestation.

Generally farmers are growing crops only during wet season; hence the mono-cropping is predominant in the project command. The cropping intensity is very low.

6.3.1 Crop yields

The average crop yields for project commands are given in Table 6.3. The yield of cereals varies from 40 to 11 q/ha, the lowest being in teff and the highest in maize. The yields of pulses range from 12 to 25 q/ha and oilseeds 4.8 to 6.0 q/ha. The yields of vegetables and root crops are between 90 to 200 quintals per hectare, which is very low. Such status of low yields indicates the poor levels of input use and application of farm technologies.

6.3.2 Size of holdings

On the basis of data collected from office experts in the project command, the size of holdings varies from 0.5 to above 1.5 ha. The details have been indicated in Table 6.4.

Table 6. 3: Holding size of the farmers in project area

Holding size in ha	No. of farmers	Percentage
0.0 - 0.5	2249	21.1
0.5 – 1.0	2542	23.8
1.0 – 1.5	2102	11.3
1.5 and above	3784	35.4
Total	10677	

Source: Woreda office survey, 2008EC.

6.4 Cultural practices

6.4.1 Land preparation

Land preparation is accomplished by using local wooden plough drawn by a pair of bullock or by digging with the help of indigenous tools. The plough is locally called “maresha”. The number of poughing depends on the intensity of weed infestation, crops to be sown and size of the seed of the crops. Small seeds like teff require good soil tilth for proper germination.

6.4.2 Planting

The planting involves the time, date and methods. Most of existing crops are planted during wet season starting from May in all the irrigation command woredas under rain fed production system. Potato is planted as rain fed as well as irrigated crop twice in a year. Common method of planting for field crops is broadcasting of seed followed by light mixing.

6.4.3 Seed Rate

The project area farmers are mostly using the seed from their own previous year crop produced, hence, germination remains poor. This is required to be compensated by using high seed rate to get near optimum plant population. As per the information received from woreda a small number of farmers even no farmers of the zone used improved seed.

6.4.4 Fertilizer application

The farmers are using only Urea and Diammonium phosphate (DAP) as a source of nitrogen and phosphorus respectively. No specific data is available on the quantity of fertilizers being used by the farmers of the project command. However, the information available from Didessaa office indicated that 11 quintal DAP and 20 quintal urea were supplied to the farmers. To maintain the soil fertility, the farmers are generally using the cow dung, crop rotation and system of intercropping. A few farmers growing vegetables are using small quantity (50-100 kg/ha) urea and DAP with irrigation through local waterways.

6.4.5 Crop protection

General information on the incidence of insect-pests and diseases for the zone is available for different crops along with plant protection measures. The extent of losses crop-wise and their thresholds values are important for planning the control measures at economic level. Similar is the status of weed infestation both in rainfed and irrigated crops and grazing lands. The present status of common insect-pests, disease and weeds are given in table 3.5. Farmers do not follow any chemical control measures but they do uproot the weeds from the crops like maize, sorghum, teff etc.

Table 6. 1: present status of weeds, insect pests and diseases

Type of crop	Weeds	Insect-pests	Diseases
Maize, sorghum and teff	*Sorhum helpense ,Lantana camara Cynodon dactylon, Cyperus spp , Amaranthus spp. Digitaria spp. Striga & Plantago*	Stock borer Termites, Grass-hoppers, Weevils	Leaf blight, Root rot, Rust, Covered smut
Sesame and pepper	Same as above	Bollworms	Root rot, Rust Powdery mildew

Source: MOA, Woreda offices (2008 EC)

6.4.6 Cropping Pattern and Crop Rotation

In project command, there is common practice of mono cropping and intercropping under rain fed production system. Under irrigated production system, vegetable crops are growing dominantly on a small part of their holdings.

6.4.7 Harvesting, Threshing and Cleaning

The crops are harvested at maturity by family labors on small farm holdings and by employing laborer at larger holdings. The crops are harvested between December to October depending on their duration and varieties. The main tool being used for harvesting is locally made sickles. Threshing floors are specifically prepared for threshing the crops either by beating with the sticks or taking the help of oxen for trampling to separate the grain from straw or stalk depending on the crop type. After removal of straw or the grains are being separated from chaff and dust by winnowing with the help of wind.

6.5 Agricultural Extension

The crop yields have remained low due to several problems, among which the low level to technologies utilized by the farmers as a result of poor agriculture support services is the major. Currently existing support services are inadequate to alleviate the problem of small holders. The agricultural extension services are one of them. The number of Development Centers, Development Agents and the centers having no Development Agents are of greater importance. The statuses of development centers having development agents are still poor in the command zones namely Illuababora. DAs are the main extension workers to carry the technological messages to the farmers if regular programs of capacity building at zonal and wereda levels adequately equip them.

7. STORAGE

The common types of storage facility available for the farmers in the project command areas is made of wood and grass "Gotera" and constructed both in and outdoors while in highlands, it is made of mud and grass. The structure is cylindrical in shape and its height ranges from 1.5 to 2 meters. The capacity of these varies from 5-8 quintals. As per the report received from the farmers, there is considerable loss of grain due to rodents, weevil infestation and theft from these stores. There is no improved storage facility available even at retailer and whole sellers' level due to short period storage needs. The total post-harvest losses including storage vary from 30 to 35%. Thus, the traditional storage being used by farmers and traders have made significant contribution towards the loss of produce. This may also be due to lack of extension towards construction of proper and scientific storage and lack of credit facility for their construction.

8 SORIYA SMALL-SCALE IRRIGATION PROJECT

8.1 Proposed Crops, Cropping Pattern and Crop Calendar

8.1.1 Criteria for Crop Selection

The climatic parameters determining the choice of a crop are temperature, sunshine or radiation, frost, wind speed, relative humidity, precipitation and Evapo-transpiration. Like climatic factors, the physical, chemical and biological characters of soil and soil depth also, have direct influence on the performance of a crop. The choice of a crop for a particular area under irrigated agro-eco-system is dependent on its potential response to irrigation, location specific environmental conditions, socio-economic situation, marketability and expected profitability. The crops widely vary in their response to irrigation. Therefore, under the irrigated agro-ecosystem, with assured availability of water, the efforts are made to select the most economical, high yielding and highly irrigation responsive crops which fit well in the production system with high degree of input- use- efficiency, eco-friendly and helping in sustainable agricultural production. The crops like vegetables, fruits, wheat and maize are highly responsive to irrigation while some of the legumes/pulses and oilseeds respond moderately. On the other hand crops like teff and barley have ability to tolerate drought but show only marginal response to irrigation and other inputs. Besides, the above factors, the present land use, social considerations, liking of the farms, their attitude and ability to successfully cultivate a particular crop also determine the choice of a crop. In this particular case for this particular project a wide arrays of crops are included to be further verified in the future.

8.1.2 Cropping Pattern and Crop Calendar

For Soriya Irrigation project, the proposed improved cropping pattern for the suggested few crops for wet and dry seasons are given in (Table 8.1 and 8.2).

The available high yielding varieties of maize, wheat, pulses, vegetables and perennials are recommended to be used for this project. However, the suitability of the varieties of crops should be verified for the area suitability and yield performance prior to large scale application in the command area. Upon observation of the crops there could be changes of crops and patterns after the project.

A total area of 104 ha, with a surface irrigation system will be employed under the condition studied.

Table 8. 1: Cropping patterns for Soriya irrigation project during wet season

Sr. No	Crop	Area (ha)	Area (%)	L .G. P (days)	Growing period (days)	
					Planting	
1	Maize	20.0	25	125	15/04	17/08
2	Wheat	20.0	25	140	20/04	27/08
3	Soya bean	20.0	25	90	25/04	18/07
6	Potato	8.0	10	120	22/04	29/08
8	Coffee	4.0	5	365	10/04	09/04
9	Mango	8.0	10	365	10/04	09/04
	Total	**80.0**	**100**			

Table 8.2: Cropping patterns for Soriya irrigation project during dry season.

Sr. No	Crop	Area (ha)	Area (%)	L .G. P (days)	Growing period (days)	
					Planting	
1	Maize	7.4	30	125	05/11	09/03
2	Wheat	4.8	20	140	10/11	19/03
3	Soya bean	6	25	90	15/11	07/02
4	Onion	2.4	10	120	25/11	27/03
5	Mango	2.4	10	365	10/04	09/04
6	Coffee	1.2	5	365	10/04	09/04
	Total	**24**	**100**			

9. CROP WATER REQUIREMENT

The total amount of water that is required for a specific crop in an environment from planting up to harvesting defined as crop water requirement. The computation of Crop Water Requirement (CWR) constitutes / contains an important component of irrigation Projects for planning planting systems. A good number of methods and procedures are available for determinations of CWR. The Food and Agriculture Organization of the United Nations (FAO/ UN) has also brought out several publications dealing with various aspects of estimation of CWR including issues related to this.

9.1 Crop Water Requirement (CWR)

9.1.1 Computation of Reference Evapo-transpiration (ETO)

The main component of crop water requirement determination is reference evapotranspiration determination. This mainly depends on climatic parameters. The climatic factors determining evapotranspiration are parameters, which provide energy for vaporization and remove water vapor from the evaporating surface. The principal climatic parameters considered were temperature, humidity, wind

speed, sunshine and solar radiation. Accordingly, the reference evapotranspiration (ETo) was calculated following the modified Penman Monteith Method (FAO, 1984) using FAO CropWat version 8 software.

9.1.2 Selection of values of Crop Coefficient (Kc)

The Crop Coefficient (Kc) for each corresponding crop and growth stages were extracted and computed from FAO CropWat version 8 databases.

9.1.3 Determination of CWR and Net Irrigation Requirement (NIR)

The water requirements as a whole were determined using a computer software program (FAO CropWat 8.0), used for irrigation planning. The software consider the crop water requirement (ETc) =ETo X Kc. It was taken 80% dependable rainfall to compute the effective rainfall which eventually used to calculate the net irrigation requirement (NIR).The details of the crop water requirement for the proposed crops is already included in this report

Irrigation Duty: Irrigation duty is the volume of water required per hectare. The peak crop irrigation water requirement for surface furrow irrigation system is 0.44 lit/sec/ha flow in the month of February for 24 hours a day assuming 70%efficiency.

SORIYA SSI Project Crop Water Requirement

CROP WATER REQUIREMENTS

ETo station: Soriya Crop: MAIZE (Grain)
Rain station: Soria Rainfall Planting date: 15/04

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Apr	2	Init	0.30	1.26	7.6	13.7	0.0
Apr	3	Init	0.30	1.23	12.3	29.9	0.0
May	1	Deve	0.35	1.41	14.1	38.7	0.0
May	2	Deve	0.57	2.26	22.6	45.9	0.0
May	3	Deve	0.83	3.09	33.9	47.0	0.0
Jun	1	Mid	1.07	3.79	37.9	47.8	0.0
Jun	2	Mid	1.14	3.80	38.0	49.8	0.0
Jun	3	Mid	1.14	3.60	36.0	49.8	0.0
Jul	1	Mid	1.14	3.39	33.9	49.8	0.0
Jul	2	Late	1.13	3.16	31.6	50.0	0.0
Jul	3	Late	0.93	2.64	29.0	49.9	0.0
Aug	1	Late	0.65	1.89	18.9	49.6	0.0
Aug	2	Late	0.43	1.26	8.8	34.6	0.0
					324.7	556.5	0.0

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: MAIZE (Grain)
Rain station: Soria Rainfall Planting date: 05/11

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Nov	1	Init	0.30	1.08	6.5	9.9	0.0
Nov	2	Init	0.30	1.06	10.6	8.5	2.1
Nov	3	Deve	0.35	1.22	12.2	6.9	5.2
Dec	1	Deve	0.58	1.97	19.7	5.5	14.2
Dec	2	Deve	0.83	2.73	27.3	2.9	24.4
Dec	3	Mid	1.09	3.64	40.0	3.4	36.6
Jan	1	Mid	1.17	3.99	39.9	4.1	35.7
Jan	2	Mid	1.17	4.07	40.7	4.3	36.4
Jan	3	Mid	1.17	4.20	46.2	4.8	41.4
Feb	1	Late	1.15	4.27	42.7	4.5	38.2
Feb	2	Late	0.94	3.58	35.8	4.6	31.2
Feb	3	Late	0.69	2.72	21.7	8.3	13.4
Mar	1	Late	0.46	1.86	16.7	11.4	4.0
					359.9	79.1	283.0

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: Spring Wheat
Rain station: Soria Rainfall Planting date: 20/04

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Apr	2	Init	0.30	1.26	1.3	2.3	1.3
Apr	3	Init	0.30	1.23	12.3	29.9	0.0
May	1	Init	0.30	1.21	12.1	38.7	0.0
May	2	Deve	0.30	1.19	11.9	45.9	0.0
May	3	Deve	0.49	1.82	20.0	47.0	0.0
Jun	1	Deve	0.77	2.72	27.2	47.8	0.0
Jun	2	Mid	1.02	3.43	34.3	49.8	0.0
Jun	3	Mid	1.10	3.48	34.8	49.8	0.0
Jul	1	Mid	1.10	3.28	32.8	49.8	0.0
Jul	2	Mid	1.10	3.08	30.8	50.0	0.0
Jul	3	Late	1.08	3.09	34.0	49.9	0.0
Aug	1	Late	0.87	2.53	25.3	49.6	0.0
Aug	2	Late	0.61	1.79	17.9	49.5	0.0
Aug	3	Late	0.38	1.17	8.2	31.6	0.0
					302.9	591.5	1.3

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: Spring Wheat
Rain station: Soria Rainfall Planting date: 10/11

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Nov	1	Init	0.30	1.08	1.1	1.7	1.1
Nov	2	Init	0.30	1.06	10.6	8.5	2.1
Nov	3	Init	0.30	1.04	10.4	6.9	3.4
Dec	1	Deve	0.30	1.02	10.2	5.5	4.7
Dec	2	Deve	0.48	1.57	15.7	2.9	12.8
Dec	3	Deve	0.77	2.57	28.2	3.4	24.9
Jan	1	Mid	1.05	3.58	35.8	4.1	31.6
Jan	2	Mid	1.12	3.92	39.2	4.3	34.9
Jan	3	Mid	1.12	4.05	44.5	4.8	39.7
Feb	1	Mid	1.12	4.17	41.7	4.5	37.2
Feb	2	Late	1.11	4.24	42.4	4.6	37.8
Feb	3	Late	0.92	3.61	28.9	8.3	20.5
Mar	1	Late	0.67	2.71	27.1	12.7	14.5
Mar	2	Late	0.41	1.70	15.3	14.5	0.0
					351.1	86.6	265.3

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: Soybean
Rain station: Soria Rainfall Planting date: 25/04

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Apr	3	Init	0.40	1.64	9.9	17.9	0.0
May	1	Deve	0.40	1.63	16.3	38.7	0.0
May	2	Deve	0.71	2.78	27.8	45.9	0.0
May	3	Mid	1.08	4.04	44.4	47.0	0.0
Jun	1	Mid	1.10	3.92	39.2	47.8	0.0
Jun	2	Mid	1.10	3.70	37.0	49.8	0.0
Jun	3	Mid	1.10	3.50	35.0	49.8	0.0
Jul	1	Late	0.98	2.94	29.4	49.8	0.0
Jul	2	Late	0.61	1.71	13.7	40.0	0.0
					252.5	386.7	0.0

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: Soybean
Rain station: Soria Rainfall Planting date: 10/11

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Nov	1	Init	0.40	1.45	1.4	1.7	1.4
Nov	2	Init	0.40	1.42	14.2	8.5	5.7
Nov	3	Deve	0.50	1.73	17.3	6.9	10.4
Dec	1	Mid	0.95	3.19	31.9	5.5	26.5
Dec	2	Mid	1.12	3.68	36.8	2.9	33.9
Dec	3	Mid	1.12	3.76	41.3	3.4	38.0
Jan	1	Mid	1.12	3.84	38.4	4.1	34.2
Jan	2	Late	1.11	3.87	38.7	4.3	34.4
Jan	3	Late	0.78	2.80	30.8	4.8	26.0
Feb	1	Late	0.50	1.85	3.7	0.9	3.7
					254.6	42.9	214.2

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: Potato
Rain station: Soria Rainfall Planting date: 22/04

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Apr	3	Init	0.50	2.06	18.5	26.9	0.0
May	1	Init	0.50	2.01	20.1	38.7	0.0
May	2	Deve	0.52	2.05	20.5	45.9	0.0
May	3	Deve	0.70	2.63	28.9	47.0	0.0
Jun	1	Deve	0.91	3.24	32.4	47.8	0.0
Jun	2	Mid	1.09	3.64	36.4	49.8	0.0
Jun	3	Mid	1.11	3.50	35.0	49.8	0.0
Jul	1	Mid	1.11	3.30	33.0	49.8	0.0
Jul	2	Mid	1.11	3.10	31.0	50.0	0.0
Jul	3	Late	1.10	3.15	34.7	49.9	0.0
Aug	1	Late	1.02	2.95	29.5	49.6	0.0
Aug	2	Late	0.88	2.60	26.0	49.5	0.0
Aug	3	Late	0.76	2.33	21.0	40.6	0.0
					367.1	595.2	0.0

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: Onion
Rain station: Soria Rainfall Planting date: 25/11

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Nov	3	Init	0.40	1.38	8.3	4.2	4.8
Dec	1	Deve	0.40	1.36	13.6	5.5	8.2
Dec	2	Deve	0.71	2.34	23.4	2.9	20.5
Dec	3	Mid	1.10	3.68	40.5	3.4	37.1
Jan	1	Mid	1.13	3.85	38.5	4.1	34.3
Jan	2	Mid	1.13	3.93	39.3	4.3	35.0
Jan	3	Mid	1.13	4.05	44.6	4.8	39.8
Feb	1	Late	0.97	3.60	36.0	4.5	31.5
Feb	2	Late	0.61	2.32	16.3	3.2	11.7
					260.4	36.8	222.9

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: MANGO
Rain station: Soria Rainfall Planting date: 10/04

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Apr	1	Init	0.86	3.60	3.6	2.1	11.9
Apr	2	Init	0.90	3.78	37.8	22.9	14.9
Apr	3	Init	0.90	3.70	37.0	29.9	7.1
May	1	Init	0.90	3.62	36.2	38.7	0.0
May	2	Init	0.90	3.54	35.4	45.9	0.0
May	3	Init	0.90	3.37	37.0	47.0	0.0
Jun	1	Init	0.90	3.19	31.9	47.8	0.0
Jun	2	Init	0.90	3.02	30.2	49.8	0.0
Jun	3	Init	0.90	2.85	28.5	49.8	0.0
Jul	1	Deve	0.90	2.69	26.9	49.8	0.0
Jul	2	Deve	0.91	2.56	25.6	50.0	0.0
Jul	3	Deve	0.93	2.64	29.1	49.9	0.0
Aug	1	Deve	0.94	2.73	27.3	49.6	0.0
Aug	2	Deve	0.96	2.82	28.2	49.5	0.0
Aug	3	Deve	0.97	3.00	33.0	49.7	0.0
Sep	1	Deve	0.99	3.19	31.9	51.5	0.0
Sep	2	Deve	1.00	3.38	33.8	52.5	0.0
Sep	3	Deve	1.02	3.56	35.6	45.9	0.0
Oct	1	Mid	1.03	3.75	37.5	38.8	0.0
Oct	2	Mid	1.03	3.89	38.9	33.2	5.7
Oct	3	Mid	1.03	3.81	41.9	25.7	16.2
Nov	1	Mid	1.03	3.73	37.3	16.5	20.8
Nov	2	Mid	1.03	3.65	36.5	8.5	28.1
Nov	3	Mid	1.03	3.56	35.6	6.9	28.7
Dec	1	Mid	1.03	3.48	34.8	5.5	29.3
Dec	2	Mid	1.03	3.39	33.9	2.9	31.0
Dec	3	Mid	1.03	3.46	38.0	3.4	34.6
Jan	1	Late	1.03	3.52	35.2	4.1	31.0
Jan	2	Late	1.01	3.52	35.2	4.3	31.0
Jan	3	Late	0.99	3.57	39.2	4.8	34.5
Feb	1	Late	0.97	3.61	36.1	4.5	31.6
Feb	2	Late	0.95	3.64	36.4	4.6	31.9
Feb	3	Late	0.94	3.68	29.5	8.3	21.1
Mar	1	Late	0.92	3.72	37.2	12.7	24.5
Mar	2	Late	0.90	3.74	37.4	16.1	21.3
Mar	3	Late	0.88	3.67	40.4	18.9	21.5
Apr	1	Late	0.86	3.60	32.4	18.5	11.9
					1242.4	1020.3	488.5

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CROP WATER REQUIREMENTS

ETo station: Soriya Crop: Coffee
Rain station: Soria Rainfall Planting date: 10/04

Month	Decade	Stage	Kc coeff	ETc mm/day	ETc mm/dec	Eff rain mm/dec	Irr. Req. mm/dec
Apr	1	Init	0.66	2.76	2.8	2.1	4.3
Apr	2	Init	0.70	2.94	29.4	22.9	6.5
Apr	3	Init	0.70	2.88	28.8	29.9	0.0
May	1	Init	0.70	2.82	28.2	38.7	0.0
May	2	Init	0.70	2.76	27.6	45.9	0.0
May	3	Init	0.70	2.62	28.8	47.0	0.0
Jun	1	Deve	0.70	2.48	24.8	47.8	0.0
Jun	2	Deve	0.69	2.31	23.1	49.8	0.0
Jun	3	Deve	0.68	2.15	21.5	49.8	0.0
Jul	1	Deve	0.66	1.98	19.8	49.8	0.0
Jul	2	Deve	0.65	1.83	18.3	50.0	0.0
Jul	3	Deve	0.64	1.82	20.0	49.9	0.0
Aug	1	Deve	0.62	1.81	18.1	49.6	0.0
Aug	2	Deve	0.61	1.80	18.0	49.5	0.0
Aug	3	Deve	0.60	1.85	20.3	49.7	0.0
Sep	1	Mid	0.59	1.89	18.9	51.5	0.0
Sep	2	Mid	0.58	1.97	19.7	52.5	0.0
Sep	3	Mid	0.58	2.05	20.5	45.9	0.0
Oct	1	Mid	0.58	2.12	21.2	38.8	0.0
Oct	2	Mid	0.58	2.20	22.0	33.2	0.0
Oct	3	Mid	0.58	2.16	23.7	25.7	0.0
Nov	1	Mid	0.58	2.11	21.1	16.5	4.6
Nov	2	Mid	0.58	2.07	20.7	8.5	12.2
Nov	3	Mid	0.58	2.02	20.2	6.9	13.2
Dec	1	Mid	0.58	1.97	19.7	5.5	14.2
Dec	2	Mid	0.58	1.92	19.2	2.9	16.3
Dec	3	Mid	0.58	1.96	21.5	3.4	18.1
Jan	1	Late	0.63	2.15	21.5	4.1	17.4
Jan	2	Late	0.66	2.30	23.0	4.3	18.7
Jan	3	Late	0.66	2.37	26.1	4.8	21.3
Feb	1	Late	0.66	2.45	24.5	4.5	20.0
Feb	2	Late	0.66	2.52	25.2	4.6	20.7
Feb	3	Late	0.66	2.59	20.8	8.3	12.4
Mar	1	Late	0.66	2.67	26.7	12.7	14.0
Mar	2	Late	0.66	2.74	27.4	16.1	11.3
Mar	3	Late	0.66	2.75	30.2	18.9	11.4
Apr	1	Late	0.66	2.76	24.8	18.5	4.3
					828.0	1020.3	240.8

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SCHEME SUPPLY

ETo station: Soriya Soriya: Crop Scheme
Rain station: Soria Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
1. MAIZE (Grain)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Spring Wheat	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Soybean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Potato	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5. MANGO	93.8	81.4	62.9	32.6	0.0	0.0	0.0	0.0	0.0	20.2	75.2	92.6
6. Coffee	54.1	49.5	32.4	9.6	0.0	0.0	0.0	0.0	0.0	0.0	29.0	47.6
7. MAIZE (Grain)	113.7	82.9	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	75.3
8. Spring Wheat	106.3	95.6	14.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	42.4
9. Soybean	103.5	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.3	89.7
10.Onion	96.0	85.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	66.2
Net scheme irr.req												
in mm/day	3.3	2.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.2
in mm/month	101.0	64.4	10.5	2.9	0.0	0.0	0.0	0.0	0.0	1.0	14.1	69.5
in l/s/h	0.38	0.27	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.26
Irrigated area (% of total area)	100.0	100.0	65.0	40.0	0.0	0.0	0.0	0.0	0.0	5.0	100.0	100.0
Irr.req. for actual area (L/s/h)	**0.38**	0.27	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.08	0.05	0.26

Based on the hydrology report climatic data the duty obtained is 0.76 l/sec/ha in the month of January and this is for 12 hours.

10. LIVESTOCK PRODUCTION

10.1 Status of Livestock

Man and animal association is since time immemorial and man used animals both for food and food production. The indigenous knowledge and improved animal husbandry practices, particularly selection and breeding led to domestication and development of breeds and breed types, which have contributed substantially to food and nutritional security through milk, meat and eggs, and also provided the much needed draft animal power, manure and fuel, especially for small farm production system and rural households. Globally about 70% of world's poor are associated with livestock enterprises in one way or the other. Growth in livestock is considered to be poverty reducing. Optimum management of animal biodiversity, therefore, while increasing its contribution to food and nutritional security, shall substantially reduce poverty, increase house hold income and empower women which accounts for more than 70% labor force in livestock production.

Livestock sector is an important component of growth of agricultural economy and will continue to contribute in years to come mainly due to:

- Sustained growth in per caput income, urbanization and awareness about nutritionally rich animal based-food,
- Rural household with little or no land, look for opportunity in non-land based and/or less land intensive enterprises and
- Trade is expected to play a crucial role in the growth of livestock sector in favour of developing and transitional economies owing to comparatively lower input costs and cheap labour.

Livestock production systems are likely to change largely influenced by socio-economic condition and environment, resource availability and greater demand for animal proteins. Livestock sector is expected to move from subsistence farming to commercial production for increased profitability and income. High producing strains or breeds are to find larger use to support the increased needs of milk, meat and eggs. Locally adopted breeds will slowly get replaced. The present and future use of breeds across production systems is to be examined and short term and long term strategies have to be suggested for their improvements to meet the present and future food needs, while maintaining animal biodiversity and

addressing concerns of environment. Appropriate technological support to enhance productivity both in small and commercial production system need to be ensured.

Traditionally draught animals are being used for field operations in the country but their traction power is very low, hence, the introduction of modern tools and equipment for farm operation is not feasible due to more power requirement for traction. Since, the farmers with small landings would continue to rely on draught animals and human power for farm operation, there is genuine need to design the animal breeding strategy to produce upgraded oxen.

10.2 Status of livestock in Oromia Region

The Oromia national Regional state accounts for almost 50 % of the national livestock population in the country. The estimated livestock population in the region is 18,035,685 cattle, 469101636 sheep, 4174968 goats, 2679107 equines, 161060 camels, 14784303 poultry and 2270166 beehives (CSA 2002). Out of three project command and catchment zones, Jima has 9.5% of the cattle while East Welega and Illuababora have 4.00 to 8.5%. More than 90% cattle are of local breeds with low productivity and long calving interval. The major problems are:-

- Poor availability of quality adequate feed and fodder,
- Low genetic potential of livestock and lack of improved breeds,
- Incidence of diseases and parasites like protozoal disease causing trypanosomiasis and high mortality,
- Lack of proper livestock extension service,
- Poor livestock marketing infrastructure and absence of credit facilities for livestock development.

10.3 Project command area

There is fairly distribution of livestock population. The livestock population in project woredas is given in Table 10.1.

Table 10. 1: Livestock Population in Project command and catchment

Livestock Species	Soriya
1. Cattle	114308
2. Sheep	35175
3. Goats	6709
4. Horse	5332
5. Mule	8951
6. Donkey	5230
7. Poultry	69001
8. Beehives	-------
Total	

Source: Socio-Economy Profile (2007)

The average livestock numbers per household are variable for command area. The number of ox varies from 0.7 (Sota) to 1.97 (Doma) while cows from 0.065 (Sota) to 0.8 (Soriya). The number of goats ranges from 0.6 (Soria) to 4 (Doma). There is negligible population of sheep and donkey but the beehives varies from 0.14 (Sota) to 1.6 (Soriya). Cattle breeding system is uncontrolled and indigenous due to limited practices and remoteness of villages to reach with liquid nitrogen. Some efforts have also been made to develop improved poultry birds for high egg production.

10.4 Status of feed resources

The major source of feed and forages are grazing of natural pasture and crop stubbles and feeding of crop residues. Grazing lands are dominated by poor quality grasses, weeds and other vegetation. The process of continuous grazing leads to various nutritional deficiencies in livestock and making them susceptible to diseases with poor production efficiency. The practice of forage conservation is also absent in the area due to lack of surplus fodder. Not much has been done to introduce improved grass and cultivated fodder crops in the project command and catchment. It does not make a part of cropping system of the farmers so far. There is also dearth of legumes in natural grazing land. Therefore the entire livestock production system requires scientific planning supported by adequate supply of nutritious feed and fodder year round for economic production at farmer holdings.

The factors which are affecting livestock rearing, poultry and bee keeping in the command area:
According to the Agricultural Development office of the wereda is.

- Shortage of animal feed (quality and quantity)
- Animal disease is a common problem
- Absence of food Management, Housing, Feeding Watering etc
- Un balanced livestock population with grazing land ratio
- Poultry disease specially un roll disease
- Lack of Improved Breed
- Pest and predators in cases of bee keeping honey budget ant and wax moth.

11. PRODUCTION CONSTRAINTS AND POTENTIALS DEVELOPMENT

11.1 Major Production Constraints

In general, in the projects' irrigation command areas of Sota, Doma and Soriya, the system of production technology is mainly traditional with very limited use of modern inputs like high yielding varieties, fertilizers, quality seeds etc. Moreover, different natural hazards like soil degradation as a result of erosion and rapid deforestation, flood and drainage problem etc, have resulted in low productivity in project command. There is high density of population and land is being intensively used for rain fed farming. The major production constraints as identified during socio-economic survey vary depending on the exposure of farmers to improved technology, his farm resources and farming system. Among the several production constraints identified during the survey, the major ones are described below:

11.1.1 Inadequate Input supply

This mainly includes the Quality seed, high yielding varieties, fertilizers, and agro-chemicals, improved farm tools and implements.

11.1.2 Quality seed

Seed is a basic input for crop production. It has a high contribution in yield enhancement. The farmers of the project command have been using their own produce saved from previous crop as seed without having any knowledge of their germination, viability and overall quality. Thus, the field germination seedling vigor and plant population are affected adversely, resulting in poor yield.

11.1.3 Varieties

Most of the farmers are still using the local varieties due to their ignorance or non-availability of seed of high yielding varieties of crops. Since the local varieties are being used for a very long period, they have

gone through mutation process over a time and lost their genetic yield potential. Moreover, they have also become susceptible to a number of biotic factors resulting in low productivity.

11.1. 4 Fertilizers

The fertility status of the soil in the project command is low due to long period of unprotected cultivation and soil erosion. The traditional soil fertility management practices like keeping the land fallow is not adequate to maintain the soil fertility. The use of fertilizers by the farmers is either negligible or very low. The low use of fertilizers by small holders is due to a number of factors as mentioned below:

- Lack of proper knowledge about the benefit of fertilizers,
- Unfavorable prices of crop produce as compared to the cost of fertilizer nutrients;
- Unfavorable weather condition for crop production and fertilizer cost
- Inadequate distribution system causing untimely and insufficient supply.
- Shortage of agricultural credit and poor farm resources.
- Poor research-extension and training support.

11.1.5 Agro-chemical

One of the production constraints as mentioned by the farmers is the high incidence of pest and diseases of crops for which the control measures are not taken mainly due to following reasons.

- Unable to identify the insect-pests and diseases,
- Lack of knowledge regarding control measures,
- Lack of availability of desired agro-chemicals locally or in nearby markets and their high cost.

The losses due to insect-pests and diseases are very high due to lack of resistant varieties.

11.1 .6 Farm implements and tools

Lack of proper farm implements and tools have also contributed to low crop productivity. They are using only oxen-drawn small wooden plough for land preparation. It has a very poor capacity to plough the land properly and on time.

The farmers have not been able to get proper support in obtaining suitable bullock drawn farm implement and improved tools to maximize the pre and post-harvest crop losses. Though the research on agricultural machinery and farm implements has resulted in a number of recommended animal drawn implements for tillage and transportation but these have not been adopted by the farmers due to higher traction power

requirement than are available at the farm. Also the high cost of such implements and lack of technology dissemination has resulted in very poor adoption.

11.1.7 Shortage of Draft Power

Many farmers in project command do not have bullocks to plough the land. Some farmers have only one bullock and share with others for ploughing which delays the timely and proper field preparation resulting in delayed planting and low yield.

11.1.8 Drainage Problem

Major soil type of the project command has Vertisol, which is poorly drained. They have the tendency of water logging problem which affects the growth and development of crops if not managed properly and reduces the crop productivity.

11.1 .9 Poor Research-Extension Linkage

A strengthened and well-coordinated dissemination of research based and well assessed technologies from research centers to farmers will be able to accelerate production by alleviating the problems of farmers. But such types of generated technologies from research are not reaching to farmers due to weak research-extension linkages resulting in poor productivity.

11.1.10 inadequate extension service

The extension services have been very limited in the project area. The system of technology dissemination has been quite weak so far. It has affected the productivity adversely. The existing agricultural extension service lacks the services of subject matter specialists for dissemination of technology appropriately.

11.1.11 Lack of Proper Land use Plan

There is no proper national and regional land use plan supported by regulation to permit the proper land uses as per their gradation. This has been resulted the use of the area otherwise not useful for cultivation for crop production resulting land degradation mainly due to serious soil erosion. The high population of livestock and human beings has worsened the condition and rendered such areas difficult to rehabilitate. This has reduced the crop productivity.

11.2 Production Potentials

Despite of a number of agricultural production constraints, the Sota, Doma and Soria Irrigation projects have a considerably good potential that can be exploited through a comprehensive agricultural

development program, as the areas owe well developed infrastructure etc. despite the existing farming systems being practiced in the projects' command are very traditional and lead to low level of output.

There is very good scope for development of agriculture under irrigated production system as there exists reasonable irrigation potential in the project command. There is already indication of enhancement of productivity with the help of small scale irrigation. However, the yield of crops, in general, are not very high, perhaps due to lack of know-how of the farmers, lack of staff of relevant supporting institutions, inadequate number of extension agents, low supply or absence of agricultural inputs (seeds, fertilizers, agro-chemical etc), lack of under developed or absence of infrastructures etc.

Therefore, it is relevant and important that the irrigated agriculture should appropriately be supported by back up services with their adequate strengthening particularly the extension.

Diversification of cropping pattern has a great scope in the area under irrigated production system to enhance the income of the farms. This will also bring the commercialization in agriculture. This will also open the way of need based mechanized farming in farms fields.

12. DEVELOPMENT STRATEGY

The development strategy will include the following

- Strengthening of research and extension service to bridge yield gaps between average yield from farms fields and potential good yields obtained with improved technology. Extension system should be capable of properly understanding and addressing the problems of the farms.
- Provision of adequate input supply: The supply of critical inputs like crop variety, seed, fertilizers and agro-chemicals and farm implements in adequate quantity and on time.
- Buildings of a sustainable utilize the critical inputs for increasing production. Strengthening of the existing farm management and establishing new once will help in promotion of farms.
- Improving-pre and post-harvest implements like land preparation equipment, weeding, harvesting, and threshing and storage materials. The agricultural research institution and rural technology centers have to work in collaboration in improving the farm implements used by the farms.
- Enhancement of conservation based agriculture like improvement of degraded soil for increased crop and livestock production.

- Improving management of crop production practices of the farms based on the improved agro-techniques developed by research systems.
- Enhancement of organics to improve the soil physical and chemical properties. This should be done by the use of animal dung manure (farmyard manure), crop residues, and green manure and vegetable wastes.
- Strengthening of irrigation development and improving water management practices at the holdings of the farms.
- Introduction and popularization of new crops and their high yielding, adaptive and insect-pest resistant varieties. This may include field crops; horticultural crops etc to increase the income of the farms.
- Conservation and utilization of crop genetic resources. This involves the existing biodiversity and introduced germplasms for their proper utilization in various crop improvement programs. Conservation of crop genetic resources will help for future research work in development of varieties resistant to different production limiting factors such as disease, insect-pests, moisture stress etc.(biotic and abiotic)
- Enhancement of Integrated pest management (IPM) system with multi-disciplinary approach as an alternative to chemical method of control. This may involve various cultural and biological methods also.

12.1 Agronomic Measures for Increasing Production

There are several factors that influence crop yields independently as well as in combination with others. These may be climates, soils, suitable agro-techniques etc. The simple and main steps and features of technology for attaining high level of production are as mentioned below:

- Prepare the field as per the crop need with suitable implements,
- Use of improved high yielding variety and quality seeds suitable to the prevailing agro-climatic condition,
- Crops to be sown at optimum period as delayed sowing gives low yields,
- Treating seeds and soil with recommended fungicides or pesticides for controlling diseases and insect-pests,

- Treating leguminous crop seed with appropriate *Rhiyzobium* culture to enable them to fix atmospheric N,
- Planting to be done by drill method rather than broadcast for obtaining uniform and optimum plant population and also to ease in inter-cultural operations,
- The key factor for attaining yield besides others is to have optimum plant population per unit area (without any gap) by using proper seed rate, spacing, depth of seeding and appropriate moisture conditions,
- Application of NPK and other nutrients as per the soil test and crop requirements with assured irrigation,
- Timely and proper weeding or weed control,
- Irrigating crop judiciously as per needs, particularly at the critical stages of growth,
- Depth of irrigation according to crop stages and soil texture. Light and frequent irrigations in case of soils with high and very low infiltration rates. Over-irrigation to be avoided in all types of soil,
- Cropping system to include sequential and inter cropping with suitable crops,
- Harvesting the crop at appropriate time avoiding losses due to shattering etc,
- Proper method of threshing, winnowing and storage to reduce losses,
- Appropriate plant protection measures to be adopted to control insect-pests and diseases,
- Introduction of suitable farming implements,
- Cleaning and grading the produce before marketing.

13. POST-HARVEST TECHNOLOGY AND STORAGE

Agriculture comprises the sole source of producing food materials like cereals, pulses, oilseeds, fruits, vegetables, milk, meat, eggs etc. A host of physical and chemical factors greatly affect the food materials after production and before consumption. Microbes and parasites also adversely influence through spoilage or causes diseases on consumption. The existing systems of harvesting, threshing and storage in the Project Command and the Woredas as a whole are too traditional and as a result crop losses are immense. Crops produce is severely spoiled at the time of harvesting and threshing. The foremost problem being poor field & crop management practice, climate variability, archaic harvesting and threshing implements and shortage of labor force. Post-harvest technology entails multi-disciplinary approach to

provide food security. It comprises various facets of processing after harvesting including rural-level agro-processing. Rural agro-processing is, in fact, based on experience through ages plus science as known to the rural masses to reduce post-harvest losses.

13.1 Post- Harvest Losses

There is non-availability of suitable processing and preservation technologies coupled with inadequate facilities for handling, transportation and storage causes of losses. The estimates evince that approximately 12-15% or even more of food grains (cereals, pulses and oilseeds), 20-30% of horticultural produce (fruits and vegetables) and 15-29% of animal and fishery production are lost annually. These losses can be minimized by adopting appropriate processing, preservation and storage technologies of food and other farm products. The technology helps a great deal in conservation, value addition, income, and employment generation to benefit the farms, producers and processors. Value addition is very important and critical due to socio-economic and industrial factors as it makes the production highly lucrative on one hand, and on the other generates interest among large section of rural population in agricultural, animal husbandry and horticultural activities.

13.2 Post- Harvest Operations and Value Addition

The operations viz., cutting, threshing, cleaning and grading (separation) drying/dehydration, storage, extraction, milling, fortification, packaging, transportation and handling of biomass from harvesting to consumption constitute the components of post-harvest operations. Post-harvest management also leads to establishment/creation of agro-processing industries at the rural thresholds to produce value added products assuring greater financial returns and generation of employment opportunities at rural level as well. This is expected to possess a great potential to revive the farm and guarantee to reduce losses, and better benefits for the farm.

Post-harvest operations to be carried out vary from one to other crop on account of varied physico-chemical nature of the products. The unit operations will be different for poultry products, fish and others. The value addition to food itself can be of different types viz., isolation of constituents that provide avenues for broad-basing food uses (essential oils, vitamins, minerals etc.). The processing for transformation into products with precisely specified and precise utilization, health-oriented formulations with multiple ingredients to promote over-all well-being, augment nutritional quality through enrichment

with essential nutrients found otherwise deficient. There is a brief account of crop-wise post-harvest technology.

Table 13. 1: Unit Operations for Food, Fruits, Vegetables and Animal Products for Processing and Preservation

Food Crops	Fruits and Vegetables	Animal Products (meat & milk)
Cleaning	Washing	slaughtering
Grading	Cleaning	dressing
Curing	Grading	cutting
Shelling	Packaging	packaging
Decortications	dehydration	refrigerated storage
Parboiling	bottling & canning	cooking or curing
Dehusking	refrigeration	smoking
Polishing	Pickling	handling
Size reduction	transportation	transportation
Expelling or extraction	Storage	marketing
Mixing by product or		
Residue utilization mgnt	residue utilization	abattoir management and waste
Blending		tanning of skin and hides
Fortification	-	collection
Packaging quality control	-	processing and utilization of by products (horns, hooves, bone, blood)
Storage	-	milk and milk product processing
Transportation	-	-
Marketing	-	by products or residue utilization

14. YIELD PROJECTIONS FOR THE COMMAND AREA

As the exact cultivable area in the targeted 80 ha area could not be obtained, therefore, the following assumptions were made in the process of determining yield projections for the command area. The yield projections for different crops were made based on available data/information obtained during field assessment carried out in the command area. Taking in to account the land use pattern and considering the fact that agricultural land in this particular woredas context is equal to cultivated land +Forest land +grazing land which will add up to the total area, the cultivated land will constitute over 95 % of the agricultural land of the command area.

On top of the above-mentioned considerations, the productivity of the proposed crops is expected to increase to the optimum level, in the successive years of project implementation, through quick adoption of improved fully mechanized irrigated farming practices, efficient input and water utilizations (Table 14.1).

Table 14. 1 : Yield (Qt/Ha) Projections for Different Crops in the Command Area

S NO.	Crop Type	Yield level(Qt/Ha) before the project	Yield Projection				
			Yr-1	Yr-2	Yr-3	Yr-4	Yr-5
1	Maize	42	50	54	60	65	70
2	Wheat	26	32	34	37	40	42
3	Soya bean	15	20	24	25	27	30
4	Oil seeds	6	8	9	10	12	15
5	Onion	80	150	160	170	175	180
6	Potato	84	180	200	215	220	225
7	Coffee	-----	-----	-----	-----	-----	-----
8	Mango	------	------	------	------	------	------

15. COST OF CULTIVATION OF PRINCIPAL CROPS

A number of crops which are carefully selected have been included in the proposed cropping system under the Sota, Doma and Soriya irrigated production, but the cost of cultivation of only five crops namely maize ,wheat, haricot bean , potato and onion are given from Table 15.1 to 15.6. The cost of various inputs such as seeds, fertilizers, agro-chemicals and labor used for the analysis is based on the information collected from woreda offices of the project command. The costs of cultivation of these crops are only for surface irrigation production system are given with net benefit cost ratios based on the input costs and the yield estimated relationship.

The real benefit in terms of agricultural production after the irrigation establishment covering at-least 90% of the total command area is based on the produce's price of the CSA estimate suggested in the previous publication is many folds higher as compared to the area traditional production indicated earlier.

Table 15. 1: Cost of cultivation of Maize

Items	**Material and labour inputs (per hectare)**	**Cost (ETB) per unit**	**Total cost (ETB)**
I. Operational cost			8468.00
Human Labour	40 man days	70.00	2800.00
Machine	1500.00	1500.00	1500.00
Seed	25 kg	65.00	1650.00
Fertilizers	150 kg	-----	-----
	DAP - 150 kg	15.12	2268.00
	Urea - ----		
Pesticides	-		
II. Fixed cost			50.00
Rental value of owned land	-		
Rent paid for leased land	-		
Land tax paid	For one ha yearly	50.00	50.00
Total I + II (Total cost of cultivation).....			**8518.00**
III. Yield and production per Hectare & Gross value	(Gross income)		51200.00
1. Yield per ha & value	50 quintal	1000.00	50000.00
2. Value of by product & yield	100 quintals	12.00	1200.00
Net income			42682.00
Benefit cost ratio 5.01 : 1			

Table 15. 2 : Cost of cultivation of Wheat

Items	**Material and labour inputs (per hectare)**	**Cost (ETB) per unit**	**Total cost (ETB)**
I. Operational cost			9228.00
Human Labour	40 man days	70.00	2800.00
Machine	-----	1500.00	1500.00
Seed	125 kg	20.00	2500.00
Fertilizers	150 kg		
	DAP - 150 kg	15.12	2268.00
	Urea - ----		
Pesticides	-		
Miscellaneous	Gunny bags & others	5 * 32	160.00
II. Fixed cost			50.00
Rental value of owned land	-		
Rent paid for leased land	-		
Land tax paid	For one ha yearly	50.00	50.00
Total I + II (Total cost of cultivation).....			**9278.00**
III. Yield and production per Hectare & Gross value	(Gross income)		46800.00
1. Yield per ha & value	32 quintal	1400.00	44800.00
2. Value of by product & yield	100 quintals	20.00	2000.00
Net income			37522.00
Benefit cost ratio 4.04 : 1			

Table 15. 3 : Cost of cultivation of Soya bean

Items	**Material and labour inputs (per hectare)**	**Cost (ETB) per unit**	**Total cost (ETB)**
I. Operational cost			8712.00
Human Labour	30 man days	70.00	2100.00
Machine	-----	1500.00	1500.00
Seed	90 kg	40.00	3600.00
Fertilizers	100 kg		
	DAP - 100 kg	15.12	1512.00
	Urea - ----		
Pesticides	-		
Miscellaneous	Gunny bags & others		
II. Fixed cost		50.00	50.00
Rental value of owned land	-		
Rent paid for leased land	-		
Land tax paid	For one ha yearly	50.00	50.00
Total I + II (Total cost of cultivation)			**8762.00**
III. Yield and production per Hectare & Gross value	(Gross income)		26000.00
1. Yield per ha & value	20 quintal	1300.00	26000.00
2. Value of by product & yield	-----	-----	------
Net income			17238.00
Benefit cost ratio 2.0 : 1			

Table 15. 4 : Cost of cultivation of Potato

Items	**Material and labour inputs (per hectare)**	**Cost (ETB) per unit**	**Total cost (ETB)**
I. Operational cost			8968.00
Human Labour	50 man days	70.00	3500.00
Machine	-----	1500.00	1500.00
Seed	200 kg	4.00	800.00
Fertilizers	150 kg		
	DAP - 150 kg	15.12	2268.00
	Urea - ----		
Pesticides	-		
Miscellaneous	Gunny bags & others	5.00 * 180	900.00
II. Fixed cost			50.00
Rental value of owned land	-		
Rent paid for leased land	-		
Land tax paid	For one ha yearly	50.00	50.00
Total I + II (Total cost of cultivation).....			**9018.00**
III. Yield and production per Hectare & Gross value	(Gross income)		72000.00
1. Yield per ha & value	180 quintals	400.00	72000.00
2. Value of by product & yield	-----	-----	-------
Net income			62982.00
Benefit cost ratio 7.0 : 1			

Table 15. 5: Cost of cultivation of Onion

Items	**Material and labour inputs (per hectare)**	**Cost (ETB) per unit**	**Total cost (ETB)**
I. Operational cost			12518
Human Labour	50 man days	70.00	3500.00
Machine	-----	1500.00	1500.00
Seed	750 kg	6.00	4500.00
Fertilizers	150 kg		
	DAP - 150 kg	15.12	2268.00
	Urea - ----		
Pesticides	-		
Miscellaneous	Gunny bags & others	5.00 * 150	750.00
II. Fixed cost			50.00
Rental value of owned land	-		
Rent paid for leased land	-		
Land tax paid	For one ha yearly		50.00
Total I + II (Total cost of cultivation).....			**12568.00**
III. Yield and production per Hectare & Gross value	(Gross income)		75000.00
1. Yield per ha & value	150 quintal	500.00	75000.00
2. Value of by product & yield	-----	-------	-------
Net income			62432.00
Benefit cost ratio 5.0 : 1			

16. CONCLUSION AND RECOMMENDATIONS

16.1 Conclusion

According the project irrigation study carried out in all the command areas the topographic feature of the selected areas are more suitable for surface furrow irrigations as compared with the others. And still, all the areas have been found suitable for an irrigated land development. However, on the basis of the feasibility study conducted in the Sota and others Command Projects the current observed and collected information from the area have a very good crop adaptation across the wereda and kebeles. This again implies excellent agronomic practices are possible in the area. Therefore, the maximum effort should focus and geared towards changing the farms to modern irrigated crop producing farms by the available rivers water potential of the area, to accomplish this, some indications have been already identified by the irrigation agronomy feasibility study already carried out in the area.

16.2 Recommendations

Based on the irrigation agronomy study the following important points of recommendations have emerged for consideration in view of existing agronomic situation of the farms, soils and climatic conditions.

- Better to start awareness creation and to popularize the use of already established irrigation for both the crop production and animal rearing purpose in the whole command areas and the surrounding of the project woredas.
- With the involvement of research and local experts of the command area, introducing and ensuring the supply of quality seeds of improved varieties of high yielding, photo-insensitive which are resistant to abiotic and biotic stresses and responsive to irrigation water and other production inputs recommended for the Project Command.
- Intensification of capacity building program of the farm managements specially by giving more emphasis on skill oriented program to increase the self-employment and village-based agronomic management practices.
- Strengthening the applied research for rapid technology generation in irrigated system to increase the crop production. Increase in the number of research findings and qualified research staff with more funding support.
- The proper guidance and training should be given to the farm operators for soil and water conservation practices along with the crop production management.

- It is also recommended to manage the grazing land scientifically and follow the practice of cut and carry and stall feeding, if possible or the practice of deferred rotational grazing. This could be done by them or advised to be practice for the future as part of livestock's management.
- For the livestock water points also should be established taking into consideration traditional system. Otherwise, they can sometimes be the cause of land degradation in the surrounding lands. Increases in livestock populations were perceived to be related to increasing water sources which will allow larger populations to be supported, decreased mortality from epidemic diseases. Thus equitable access to land, water resources and secure land-use systems, including protection of pastures from encroachment and strengthening of local and/or customary systems so that they are better able to negotiate dry-season access to key feed resources.
- Livestock production in the project impact area is traditional and subsistence. Commercial production for milk and meat is limited and in most areas non-existent. Animal feed and water shortages, poor market infrastructure, poor access to livestock extension services, poor veterinary infrastructure and high mortality rates are the most limiting factors for commercialization of livestock in the project impact area.

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