EASTERN NILE IRRIGATION AND DRAINAGE STUDY/FEASIBILITY STUDY
DINGER BEREHA IRRIGATION PROJECT

ANNEX 6: AGRICULTURE AND LIVESTOCK

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1. AGRICULTURE

1.1 INTRODUCTION

The agricultural study of Dinger Bereha Irrigation Project (Ethiopia), which is part of the Eastern Nile Irrigation and Drainage Study Project (ENIDS), has been conducted to investigate the present state of farming practices and to make an assessment of the prospect for irrigated agriculture in the project area. ENIDS aims at contributing to the enhancement of food security, reduction of rural poverty, and reduction of population pressures in the Eastern Nile sub-basin countries of Egypt, Ethiopia and Sudan. The project in Ethiopia, therefore, identified, among the proposed potential sites in the country, an area of about 7,500 ha to undertake feasibility study for irrigation development.

This report, therefore, deals with the Terms of Reference's specific requirements, which includes (i) description of the project area in terms of location, climate, soils and topography; (ii) current agriculture situation of the scheme providing baseline data and background information on farming practices, where available; (iii) rationale for the development of irrigated agriculture and (iv) irrigated agriculture focusing on crop production, the crops to be grown, crop water needs, practices to be introduced and the problems of irrigated crop production.

1.1.1 Study Objectives

The objective of the envisaged project is to increase agricultural production through the introduction of irrigated agriculture over an area of about 7,500ha and thereby attain food self-sufficiency and food security for the population of the area. The specific objectives of the agricultural/agronomic study are:

- Evaluation of the existing agricultural situation of the area including crops grown, the cropping pattern, and farming practices;
- Investigation on the suitability of soils, climate and water to irrigated agriculture;
- Identification of most appropriate crops and their cultural practices;
- Estimation of crop water requirements; and
- Determination of input requirements for irrigated crops and estimation of crop and farm budgets.

1.1.2 Study Methodology

The methodology used is mainly collecting and checking existing agricultural data, if any, from the Woreda Agricultural Office and own observation from site visits. Prior to the field visit that was conducted by the socio-economic and agricultural group, a checklist that guides the agricultural data need was prepared and incorporated in the overall study approach and methodology.

Available primary information of the project area was collected during the field visit. The information was gathered through various focus group discussions and individual interactions with farmers' association leaders and other farmers in the project site. In these discussions, the primary focus was on the farming environment of the area as related to the farming system, land use, food availability, crops preferred, attitudes towards irrigation development, constraints in farming practices, etc.

Collection of secondary data was mainly from Woreda institutions including Woreda Administration, Agricultural and other pertinent offices. Various types of documented data were sought and collected from these institutions. However, it is worth mentioning here that the Woreda is a newly established settlement project and as such, there is a general lack of organized and well documented data and information. Nevertheless, the few information collected include the general land use of the project Woreda, currently employed agricultural practices, types and varieties of crops grown, crop pests of the area (diseases, insects, weeds and others), use of agricultural inputs (fertilizers, improved seeds, and agro-chemicals), production performance and crop yields, and off-farm activities of the farmers.

1.2 DESCRIPTION OF THE PROJECT AREA

The project area is located in Chewaka Woreda of Illuababora zone, Oromia National Regional State (ONRS). The Woreda is bounded by Didessa and Dabana rivers, and is located upstream of the confluence of the two rivers (see Map 1). Neighbouring Zones and Woredas include Dabo Hanna in the south, West Wollega Zone in the north, East Wollega Zone in the east, and Meko Woreda in the west.

The Woreda is a newly established settlement scheme (2004) where by people from drought stricken Eastern and Western Hararge Zones of ONRS were resettled in the area on free will basis. In the beginning, the number of households resettled was estimated at 12,390. However, the current households are estimated at 14,026, with a total population of 92,027 (Woreda population census, 2008). Agriculture is the main occupation of the settlers and various crops are grown under rainfed and traditional irrigation during the rainy and dry seasons, respectively. Livestock rearing is also part of the agricultural activities.

The total area of the Woreda is about 55,400 ha. The potentially irrigable land, estimated at about +7,500ha, is located between UTM 98669m-998979m North and 19098-195294 East. The number of Kebeles in the Woreda is 28. Eleven of these Kebeles benefit from the implementation of the irrigation scheme. While four of the Kebeles are fully covered by the command area, the remaining seven Kebeles have partial coverage, ranging from 25 to 75%.

1.2.1 Topography

The altitude variations, which range from less than 1,100masl in the low lying valley bottoms to about 1,800masl in the nearby mountain ranges, have little effect on variation in temperature and rainfall patterns in the Woreda. According to the engineering study, the command area would be bounded by contours +1240 and +1260. However, these areas are characterized by undulating plains and strongly slopping terrains, with slopes ranging from 0 to 8%. A large portion of this area is currently under rainfed cultivation.

1.2.2 Climate

The various climatic parameters of the project area are described in detail in Annex 1. According to the hydrology study, Didessa State Farm Meteorological Station is the nearest station from which the climatic data were inferred. The information is briefly reviewed here in relation to agricultural production, in general and crop selection, in particular.

1.2.2.1 Rainfall

According to the Woreda report, the rainfall pattern in the project area is uni-modal and the amount ranges between 900 to 1,100 mm, annually. However, the long-term records at Didessa indicate a much higher amount, averaging 1,500 mm over a twenty years period. The onset of the rainy season begins around mid-May and lasts for approximately 4 to 5 months. The highest rainfall occurs during July and the dry spell stretches from November to April. The amount of rainfall in the area does not constrain rainfed cropping although abnormal on set and cessation of the rains can impact on crop yields.

On the basis of Agro-Ecological Zones of Ethiopia (MoRAD, 2005), the project Woreda is basically classified as moist sub-humid indicating a fair distribution and adequacy of moisture in the area. There would be very little or no need for supplementary irrigation for any rainfed cropping so long planting takes place at the correct time. Irrigation development would only be necessary for the provision of water during the dry season cropping. A summary of the average monthly rainfall at Dedessa station is presented in the following table.

Table 1.1: Monthly Rainfall Characteristics at Didessa (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rf (mm)	12.0	14.5	44.8	58.5	172.6	264.8	293.1	249.0	227.0	126.2	30.8	11.8	1505.1

Source: Annex 1

1.2.2.2 Other Climatological Characteristics

Long-term records of temperature, relative humidity, wind speed, sunshine hour and potential evapotranspiration (Table 1.2) have also been analyzed by the hydrology study. The monthly mean temperature data at the station shows relatively small fluctuations; the range being from 22.1°C in August to 26.6°C in March. Temperature regime is generally suitable for normal growth of major crops adapted to low to medium altitudes. Relative humidity values are highest during the rainy season (88%, August & September) and lowest during March (46%).

Table 1.2: Other Climate Factors

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temp $_{mean}$(°C)	23.1	24.4	26.6	26.3	24.8	23.3	22.2	22.1	22.9	23.5	23.1	22.3	23.7
RH (%)	64.8	59.0	56.6	68.0	75.7	81.1	87.5	88.5	88.6	84.6	79.4	72.4	75.5
W.S(m/s)	0.62	0.8	1.0	1.08	1.04	0.86	0.62	0.51	0.5	0.51	0.48	0.51	0.71
Sun (hrs)	8.2	7.6	7.5	7.3	7.6	6.1	3.7	4.1	6.2	7.9	8.3	8.3	6.9
PET (mm)	114	114	142	134	133	107	92	96	113	124	114	107	1,390

Source: Hydrological Study, ENIDS, 2009

The mean monthly wind speed varies from 0.5 m/sec in September to 1.08 m/sec in April. The relatively higher wind speed values stretch from February to June. On the other hand, mean sunshine hour per day ranges from 3.7hrs in July to 8.3hrs in November and December. The annual potential evapotranspiration is about 1,390mm. The peak monthly potential evapotranspiration occurs in March and the lowest in July.

1.2.3 Soils and Land Suitability

Information on the soils of the project area is based on the findings of the feasibility level soil study in which 104 pits were opened, the profiles studied and samples taken for laboratory analysis. Both the soils and land suitability studies have been performed in accordance with the project's Terms of Reference, the objective being the selection and confirmation of sites best suited to the development of irrigated agriculture. The full documents of the soils and land suitability studies of the project area are presented in the Soils & Land Suitability Annex, and the original soil survey report made as part of the Complementary Surveys. The highlights of the basic characteristics of the soils of the area are briefly indicated hereafter.

The total surveyed area of the project is about 10,546ha. On the basis of the soil classification undertaken, only 64% of the total area is considered suitable for irrigated agriculture, in terms of soil type and slope gradient. Major units identified include Nitisols, covering 4,303ha (41%); Vertisols with an area of 1,053ha (10%); Leptosols cover 788 ha; Acrisols, which occupy 1,062ha (10%); and Cambisols and Gleysols with a combined area of 1340 ha. The remaining area is classified as non-irrigable area due to several constraints, chiefly shallow soils and steep slopes.

The textural characteristics of the soils vary from sandy clays and heavy clay for Vertisols and from clay loam to clay for Nitisols and Acrisols. The Vertisols are dark brown in the surface and grayish brown in the sub-surface. The other soil types show dark reddish on surface and red to yellowish colour in the sub-surface. The well-drained soils generally occur on the higher grounds. Infiltration rates are high ranging from 6.8 to 10.0cm/hr. The major constraints in the Vertisols and Gleysols are poor drainage, infiltration rate being between 6.3 to 6.8cm/hr, which hinder pre-planting activities.

The study has identified nutrient deficiencies and low pH (4.5 to 7.1) that generally impact on crop productivity. Micronutrient deficiencies and possibly aluminum toxicity would be the major crop production constraints of the Nitsols and Acrisols: trace elements are moderate but zinc was found to be low. Exchangeable aluminium was also assessed and indicated that aluminium toxicity is not widespread in the area. Organic carbon is rated low indicating a positive response to organic fertilizer applications. Salinity and sodium hazards of the soils are all low.

Cation Exchange Capacity (CEC) and Base Saturation Percentage, which generally indicate fertility status of soils are very low. In the Vertisols that occur in receiving sites, the levels are higher. In general, fertility status of most soils in the project area is poor in major nutrients including phosphorus, nitrogen and organic carbon.

Land Suitability: The land evaluation assessed the fourteen soil mapping units for four main groups of land utilisation types: wetland rice, cereals and sesame, vegetables and pulses, citrus and fruit crops. The evaluation concludes that out of the total survey area, a maximum total area of about 2,668 ha of moderate to marginally suitable land could be used for wetland rice, whilst 9,476 ha was available for the other groups, all on marginal land. This latter total includes some 787 ha of land that was rated currently not suitable for citrus and fruit crops; the remaining land, mainly hills, rocky surfaces and very steep slopes was permanently not suitable for any of the proposed LUTs.

The evaluation has been carried out for various crop types (cereals, pulses, oil crops, vegetables and fruits). Accordingly, many of the crops proposed have been rated to grow sustainably provided appropriate soil management and agronomic practices are in place.

1.3 CURRENT AGRICULTURAL PRACTICES

1.3.1 Farming System

The farming system of the project Woreda is cereal dominant, single cropping and mixed farming, where livestock production, though at a smaller scale, is undertaken complementary to crop production. The farming system, accounting for the bulk of the food produced in the area, is characterized by subsistence farming with its typical feature of low input–low output productivity. Crop production is predominantly carried out under rainfed condition though irrigation, using small stream diversion, is being practised in few areas.

1.3.2 Land Use of the Woreda

The Woreda covers a much larger area than the proposed irrigation project, and comprises about 54,400 hectares of land. According to the Woreda Agriculture Office, almost 50% of the total area is classified as arable land. The current annually cropped area is in the range of 18,500 to 19,500ha. The remaining area is covered by natural forest, bushes, and shrubs.

The land use pattern of the Woreda is shown in Table-3.1, below. The land use data for the project area is also shown, in parallel, as estimated by the detailed soil survey work. It has to be noted here that the estimate for cultivated area increases, annually, as new settlers clear forest and shrub lands for agricultural use.

Table 1.3: Woreda Land Use

No.	Category	*Area (ha)	**Project Area (ha)
1	Cultivated land	19,400	4,942
2	Grassland	3,500[1]	1,053
3	Natural Forest	24,900	1,721
4	Shrubs & Marshs	5,500[1]	2,577
5	Towns & farmsteads	1,100[1]	253
6	Total	54,400	10,546

Source: *Woreda Agriculture & Rural Development Office
** Soil Survey Report, MCE, 2009
[1]Estimate

1.3.3 Farm Size and Land Tenure

When the settlement scheme was first initiated, allocation of land was determined to be 2ha per household. Currently, the program has been, more or less, implemented as planned and cultivated land per household ranges from 1.5 to 2.0ha, averaging about 1.75ha. The tenure system is based on the Country's policy that farmers have the right for long-term usufruct rights to their holdings. Compared to the national average holding, which is less than 1ha, farmers in the project area are relatively better off than their contemporaries else where in the country.

1.3.4 Crops and Cropping Patterns

The major crops of the Woreda include cereals (sorghum and maize,); pulses (soybean); oil crops (sesame); fruits (mango); and vegetables (onion, tomato and pepper); almost all are grown during the rainy season.

Rice is a new addition to the cropping pattern, since the last two years. As depicted in the table below, sorghum commands the largest area coverage, which signifies its importance as staple crop for the population of the Woreda. There are few locally selected crop varieties currently cultivated by the farmers. Most crops grown are registered varieties and distributed through the Woreda Agriculture Office or through cooperatives and NGOs.

Irrigated crops are mostly vegetables (tomatoes, carrots) and fruits (mango, banana and papaya). Banana and papaya are newly introduced fruit crops and seem to be readily taken by the farmers. Last cropping season, rice was grown under irrigation on 12ha for seed multiplication purposes. Information gathered from the Woreda Agriculture records indicate that the yield performance was more than satisfactory, averaging 54q/ha.

According to the Woreda Agricultural Office, crop yields are satisfactory by national standards. In fact, present cropping pattern and production levels are reported to produce more than enough to cover the basic food requirements of the Woreda population. Although well compiled and documented data are hardly available, a two year trend of area, production and yield of the Woreda is shown in the following table.

Table 1.4: Area, Production and Yield/ha

Crop Type	1999/00			2000/01		
	Area (ha)	Prod. (qt)	Yield (qt/ha)	Area (ha)	Prod. (qt)	Yield (qt/ha
Sorghum	6,800	173,400	25.5	5,356	183,006	34
Maize	2,788	66,277	24.0	3469	77,578	22
Tef	-	-	-	12	63	5.5
Barley	-	-	-	9	70	8
Millet	10	70	7	19	152	8
Rice	623	23,695	38	1,528	67,516	44
H. Beans	580	7,540	13	430	3,472	8
Soybean	3,074	58,481	19	4,082	79,089	19
Sesame	3,400	20,440	6	3,827	18,775	5
G.Nut	240	4,080	17	180	1,584	9
Total	17,515	353,983	20.1	18,912	431,305	22.8

Source: Chewaka Woreda Agricultural Office

The two-year trend shown above indicates that there is a marked improvement in crop performance in the given time frame. The increment in production may be attributed to expansion of cultivated land. But, the productivity per unit area has also been greatly improved by about 15%, over a one-year period. This fact indicates that there is room for improving the performance of crop production through improved support services.

Moreover, communication made with Woreda Agricultural experts reveals that at times of good rains, yields are far better than indicated above. In fact, they estimate yields to range between 50 to 60qt/ha for sorghum, 40 to 50qt/ha for maize, and more than 50qt/ha for rice.

Table 1.5: Cropping Calendar of Major Crops

Crop Type	Land preparation	Planting	Harvesting
Sorghum	Feb-Mar	Mar-Apr	Oct-Nov
Maize	Mar-Apr	Apr-May	Oct-Nov
Rice	Mar-Apr	Jun-Jul	Oct
Pulses	Apr-May	Jun-Jul	Oct

Source: Chewaka Woreda Agricultural Office

Data on crop production are presented in table 1.6.

Table 1.6: Crop production 2006-2008

Crop Type	2006/2007			2007/2008		
	Area (ha)	Prod. (qt)	Yield (qt/ha)	Area (ha)	Prod. (qt)	Yield (qt/ha
Sorghum	6,800	173,400	25.5	5,356	183,006	34
Maize	2,788	66,277	24.0	3469	77,578	22
Tef	-	-	-	12	63	5.5
Barley	-	-	-	9	70	8
Millet	10	70	7	19	152	8
Rice	623	23,695	38	1,528	67,516	44
H. Beans	580	7,540	13	430	3,472	8
Soybean	3,074	58,481	19	4,082	79,089	19
Sesame	3,400	20,440	6	3,827	18,775	5
G.Nut	240	4,080	17	180	1,584	9
Total	17,515	353,983	20.1	18,912	431,305	22.8

Source: Chewaka Woreda Agricultural Office

The cropping calendar for major crops of the area and the main operations are presented in the table below. These calendars of farm operations follow normal rainfall regime and in cases of abnormality (late set of rains) adverse conditions prevail, which affect the cropping pattern, crop production and the level of food availability in the area.

Table 1.7: Cropping Practices

Crop Type	Land preparation	Planting	Harvesting
Sorghum	February-March	March-April	October-November
Maize	March-April	April-May	October-November
Rice	March-April	June-July	October
Pulses	April-May	June-July	October

Source: Chewaka Woreda Agricultural Office

1.3.5 Cropping Practices

1.3.5.1 Land Preparation

As the settlers come from a different culture, hoes are predominantly used for land preparation. Nevertheless, the use of animal traction is now being used for ploughing purposes. Apart from the cultural aspect, there is a limited supply of draft oxen due to the prevalence of the livestock disease, trypanosomiasis. However, the Woreda Agriculture Office is strongly promoting the use of animal power to ease the burdensome operation of land preparation. All farm activities are undertaken by family labour with few instances of hired labour. The frequency of hoeing/ploughing, however, depends on the soil type and the type of crop grown. In most cases, two to three passes suffice for most types of crops. Land preparation begins as early as February and extends up to end of May depending on crops to be grown (Table 1.7 above).

1.3.5.2 Planting Time

Planting period is governed by the occurrence and availability of sufficient rainfall. Many of the crops are, therefore, sown from March to early July. During the earlier period of the planting season, relatively long maturing crops like sorghum are sown. As per the Woreda's information, the rainfall pattern observed in the last three to four seasons had little variation as to affect the planting season, significantly.

1.3.5.3 Maintenance of Soil Fertility

Prior to the implementation of the settlement program, almost all parts of the project area have been under various types of vegetation including forests, bushes and shrubs. The population was very sparse and, as such, farming practices were virtually absent. Apparently, during the first two seasons, soil fertility was not a problem. However, farmers reported that they are now observing a marked difference in crop growth and yield compared to earlier performances. This has also been confirmed by the soil study that nutrient deficiencies and acidity could be constraints on crop production in most parts of the project area. Consequently, the Woreda Agricultural Office is now endeavoring to introduce improved production practices such as inclusion of leguminous crops, crop rotation, application of commercial fertilizers and the use of compost to maintain soil fertility. Evidently, the level of fertilizer utilization in the area is getting importance though application is limited to a number of crops, which mainly includes maize, rice and soybean. However, as it is indicated in the soils study, there would be a need for cautious selection of appropriate types of fertilizers that would not exacerbate the inherent acidity of soils in the area.

1.3.5.4 Input Use

As indicated above, agricultural inputs notably fertilizers, improved seeds and agro-chemicals are being introduced and used as soil fertility declines and crop pests prevail. There is no compiled data in the Woreda that indicates the type and quantity of inputs distributed in the past years. Nevertheless, information gathered from the Woreda Agriculture Office as well as from the socio-economic focus group discussions indicates that few farmers use fertilizers on cereals and some vegetables and some benefit from using improved seeds of maize, pulses and oil crops. However, though there is a general awareness of the usefulness of these inputs (fertilizers, improved seeds and agro-chemicals), high prices and inadequate supply deter farmers from taking advantage of the benefits. According to the Woreda Agriculture Office, inputs distributed to farmers include fertilizers (DAP and Urea) improved maize varieties (4 in number), sorghum (1), rice (4), and soybean (2). The following table summarizes distributed inputs in three consecutive years.

Table 1.8: Inputs distributed

Inputs Distributed (2006-08)

Year	Input	Type/Variety	Amount (in qt)
2006	Fertilizer	DAP	4,956
	Seed	-----	--------
2007	Fertilizer	DAP	4,843
		Urea	4,936
	Seed	Maize BH140	253
		Maize 30H83	202
2008	Fertilizer	DAP	237
		Urea	491
	Seed	Maize 30H83	50
		Maize BH140	137

1.3.5.5 Crop Protection Practices

As in all parts of the country, farmers of the project area face considerable problems associated with various forms of crop pests both in the field and storage structures. The level of crop protection practices exercised by farmers is not that much satisfactory and as a result crop loss could be quite substantial.

There is no documented data on the types and degree of prevalence of insect, disease and weed pests in the Woreda. However, according to the Woreda Agriculture Office, these pests are among the major treats that cause low crop yields and poor quality produces. Weeding is a labor-intensive operation and some crops, depending on the infestation level, require one to four hand weedings and one to two hoe cultivations.

Among insect pests, termites, stalk borer, cut worms and aphids inflict substantial damage to sorghum, rice and maize. Ball worm and locusts are also occasional insect pests. Rats/rodents are damaging pests both in the field and storage. Crop diseases include smut, rust and other diseases that mainly affect sorghum fields.

Systematic pest control measures are not yet established. Certain broad spectrum pesticides are used for general control purposes. Appropriate cultural practices could play a bigger role in controlling certain pests. For the control of termites, for instance, farmers are minimizing damage by pouring water into the hole and hunting down the queen. In extreme cases, chemicals (Methasystox) are used but, to a limited extent.

1.3.5.6 Harvesting and Threshing

For early maturing crops, harvesting begins in the months of October/November. However, most crops are harvested in the months of November and December, sometimes extended to early weeks of January. Usually, threshing is follows immediately, December to January. Both harvesting and threshing are manually operated.

1.3.5.7 Storage

Common storage types used in the area include underground pits and above ground structures made of local materials. The underground pits are mostly used for sorghum. An improved version of this underground pit is being promoted by the extension people. The improvement is basically on lining of the floor and walls of the pit.

The above ground structures have inlets and outlets and are equipped with rat guard mounted on the four stands of the structure. However, this structure has got little acceptance as farmers see it as being sophisticated. The traditional version has only one opening to serve as inlet and outlet.

Magnitude of post-harvest losses has not been specifically determined for the area. However, studies made in other parts of the country indicate that losses range from 10 to 70% at altitudes ranging from 2,500 to 1,700masl, respectively. Obliviously, as the project area's altitudinal range is between 1,100 and 1,800masl, the loss would be in the higher range. Most frequent storage pests are lesser grain borer (maize), saw-toothed grain beetle (sorghum and maize) and grain moth (sorghum and maize).

1.3.6 Agricultural Support Institutions

Agricultural extension services are provided by the Woreda Agricultural Development Office. The system, which is based on participatory approach, is envisaged to enhance better adoption rate of technological packages, provide proper feedback mechanism and ensure successful implementation of programs and projects. The Woreda has 28 Kebeles and according to the extension program, each Kebele will have three specialists that deal with natural resources, crop production and livestock development. Farmers Training Centres (FTCs) are being established in the area and these centres provide training to farmers on all cultural practices including on irrigated agriculture. The extension workers will work in close contact with the farmers and the main task of the centres is to provide new technologies, advice farmers and serve as bridge between technology providers and farmers. They are expected to play important role in the adoption and implementation of various agricultural practices including irrigation and irrigated crops.

Non-governmental organizations (NGOs) play some role in providing specific extension services in the Woreda. Sasakawa Global 2000 (SG2000) has been active in the last two years and is credited for the introduction of adoptable rice varieties to the area. Rice is now multiplied in selected farmers' fields with support provided by SG2000. It has also distributed seeds and fertilizers to more than 250 farmers. United Nations Development Program (UNDP) is also involved in providing assistance in equipping basic needs to FTCs. It also provides seeds with watering cans for farmers including women to grow horticultural crops.

The Ethiopian Institute of Agricultural Research has two main centers at Jimma and Bako, which are relatively nearer to the project area. The Jimma Research Center, in addition to its main task as coffee center, works on various cereals, horticultural and spice crops. Bako is the center for National Maize Research Project. It also deals with other crops including sorghum, rice, soybean, haricots, groundnut and sesame. The project would benefit much from these two research centers for cereals, pulses, oil seeds and horticultural crops. On farm testing and application of new techniques would be readily adapted to the conditions in the area.

1.3.7 Constraints of Current Farming System

Deforestation: Due to the relative success of the settlement program, there is an influx of people coming into the Woreda. Almost ninety percent of these migrants are farmers whose basic need is to access land for their livelihood. As a result large tracts of forest land are being burned down for cultivation of crops. The Woreda Administration seems powerless to control the influx and the destruction of the dwindling forest resources. As indicated in the report, the current land holding size per household is on the average 1.75ha. This is more than adequate for a family size of 4 to 6 members. However, if the current influx of migrants continues, land redistribution may be inevitable. The result would a diminishing crop area and this will have a catastrophic effect on the livelihood of the settlers.

Poor farming practices: Farming operations are generally labour intensive and animal power is rarely employed for farming purposes. Current use of production inputs (fertilizers, improved seeds and agro-chemicals) is encouraging. Nevertheless, the ever escalating prices of these inputs and the limited access to credit facilities are important factors that determine the productivity of the Woreda in general and the project in particular.

Crop pest problems: Termites, rats and other wild animals are reported to inflict heavy losses to agricultural production. Measures, so far, taken are not satisfactory. For the control of termites, there is a need for a concerted effort among all stakeholders including researchers, NGOs, extension people and authorities. As the project cropping program is intensified, termite infestation might be exacerbated.

Soil Acidity: Fertility status is poor mainly due to strong acidity of most parts of the project area. The soils study confirmed that major cations like calcium, magnesium, potassium and sodium have been leached down and the sizable portion of the soil colloid is covered by Aluminium cation. The effect of acidity on crop yield may be enormous and there is a need for cautious application of fertilizers as currently used types may further exacerbate the problem of acidity.

1.4 AGRICULTURAL DEVELOPMENT

1.4.1 Objective and Rationale

The objective of the irrigation development would be to:

- Develop 7,500 hectares of land for irrigation and irrigate dry season crops as well as supplement wet season crops during times of late set or early withdrawal of the rains;
- Recommend realistic and profitable cropping pattern for irrigated farming;
- Determine input requirements for the proposed scheme; and
- Realize higher crop yields and raise household incomes of the beneficiaries.

The rationale will be to establish a cropping system that will change gradually so that subsistence cropping will be dominant, during the wet season in the first few years, but will decrease steadily with increasing yields of the staple crops and increasing revenues of cash crops. The cropping intensities during the dry season will increase depending on the development of marketing opportunities and better returns.

The adaption and implementation of improved farming practices will be on gradual basis. Farm mechanization and use of very high-yielding varieties requiring substantial amounts of high priced inputs are assumed to be feasible in the long term. For the immediate future, improvements have to be found in the introduction of improved, locally adapted varieties, introduction of crop rotation systems, improved land preparation and harvesting technologies and use of environmentally friendly crop protection methods. Moreover, improved transport, and better market outlets are equally important for the sustainability of the project.

The requirements of improved, locally adapted and environmentally sound agricultural systems shall be the responsibility of agricultural research in close collaboration with the extension service. Outputs generated from research need to be translated into extension messages that would address the needs of the farmers.

1.4.2 Choice of Crops

Crop selection for the project is based on the following important factors:

- Suitability of the soils (physical and chemical characteristics);
- Adaptability to the prevailing climate (rainfall, temperature, altitude and other climatic factors);
- Food and economic value;
- Farmers' preference and experience in the production of the crop in question;
- Suitability of the crop for the envisaged irrigation system; and
- Marketability and potentiality for agro-processing.

On the basis of the above mentioned factors, suitable crops were selected for both seasons (wet and dry). Farmers of the area are well acquainted with most of these crops. This was confirmed during the focus group discussions where farmers' preferences include almost all of these crops. The following are the main crop types recommended for the scheme.

- Cereals: Maize, Sorghum & Rice
- Pulses: Haricot beans & Soybean
- Oil-crops: Groundnuts, Sunflower & Sesame
- Vegetables: Onion, Pepper, Sweet-potato & Potatoes
- Fruits: Citrus & Mango

The table below shows possible cropping systems that could be adapted for the irrigation project at Dinger Bereha.

Table 1.9: Cropping System (Wet and Dry Season Cropping)

Crop Type	Total Coverage- %	Wet Season May/June - October	% of area coverage	Dry season November – April/May	% of area coverage	Remarks
Grain crops	40	Maize	25	Maize	25	Food value & Maize & Rice respond better to Irrigation
		Sorghum	15	Rice	15	
Root Crops	5	S. Potatoes	5	Potatoes	5	Food value
Pulses	25	Groundnuts	10	H. Beans	25	Food & cash value and for crop rotation purposes
		Soybeans	15	----------	---	
Oil seeds	15	Sunflower	3	Sunflower	3	
		Sesame	12	Groundnuts	12	Mainly as cash crops
Vegetables	10	Peppers	7	Onion	8	
		Cabbages	2	Tomatoes	2	
		Lettuce	1			Food & market prospect
Fruits	5	Mango	4	Mango	4	
		Citrus	1	Citrus	1	Market prospect

*Note that the pattern is based on farmers' current practices
*The total suitable area identified by the soils study is about 7,500ha
*The pattern is tentative and would be adjusted in due course
* The choice of irrigated crops is based on food and cash value mix

1.4.3 Cropping Pattern (Annual Cropping Program)

As indicated above, the change in the present cropping pattern would be gradual until most prerequisites are fulfilled. The prerequisites include availability of suitable crop varieties, farmer's knowledge on cultural practices of the various crops and access to market information develops to a satisfactory level.

On the basis of crop mix and area coverage, three options of cropping patterns are proposed. Various crop types have been considered to establish the crop mix and area coverage. The introduction of various crops into the cropping pattern is assumed to provide a wider economic base of the project that would minimize the risks associated with the growing of a single or a few crops. The pattern shall be kept under continuous review so as to include new crops that serve the rotational requirements as well as alternative crops under certain circumstances.

As food security is the main objective of the project, the cropping pattern will be dominated by food crops. At full project development, the annual cropping intensity would be close to 200%. Cereals (Sorghum, maize and rice) will command the major part of the area followed by pulses (haricot beans, soybean) and vegetables (onion, pepper and sweet potato). Generally, the cropping pattern is based on the needs of the population of the area and will have the following main features:

- It increases the volume of production (through successful cropping in the two seasons) and there by improving food security of the area;
- The production of high value crops, especially pulses, oil crops and vegetables improves cash income and dietary requirements of the households;

- It employs household labour throughout the year; and
- Increases availability of livestock feed (crop residue) all year round.

In the final analysis, it is the choice of the individual farmer that prevails. The cropping pattern presented here below only serves as a guide that eventually aids the project's cost/benefit analysis. Area and percentage of coverage of the crops to be grown, annually, in wet and dry seasons, is shown in the tables below.

Table 1.10: Cropping Pattern for the Proposed Project (Option I)

Crop	Percent Coverage	Area (ha)	Planting Date	Harvesting Date	Remarks
Season - I (Wet Season)					
Sorghum	25.0%	1,750	15/04-30/04	15/08-30/09	
Maize	15.0%	1,050	07/5-28/05	21/09-07/10	
soybeans	15.0%	1,050	15/06-30/06	15/10-30/10	
G.Nuts	10.0%	700	15/06-30/06	01/10-15/10	
Sesame	12.0%	840	15/06-30/06	21/09-30/09	
Sunflower	3.0%	210	15/06-30/06	30/09-15/10	
Pepper	7.50%	525	15/06-30/06	15-10-30/10	
Sweet Potato	7.50%	525	15/06-30/06	15-10-30/10	
Citrus	5.00%	350	-		
Total	100%	7,000			
Season - II (Dry Season)					
Maize	35.0%	2,450	15/11-30/11	30/03-07/04	
Rice	10.0%	700	21/11-30/11	21/03-30/03	
H.Beans	25.0%	1,750	15/12-30/12	15/04-30/04	
Sunflower	7.5%	525	21/11-30/11	15/04-30/04	
G.Nuts	7.5%	525	15/12-30/12	15/04-30/04	
Onion	7.0%	490	15/11-15/12	30/03-30/04	
Tomato	3.0%	210	15/11-15/12	30/03-30/04	
Citrus	5.0%	350			All Year round
Total	100%	7,000			
Total Annual	200%	14,000			

Table 1.11: Cropping Pattern for the Proposed Project (Option II)

Crop	Percent Coverage	Area (ha)	Planting Date	Harvesting Date	Remarks
Season - I (Wet Season)					
Sorghum	40.0%	2,800	15/04-30/04	15/08-30/09	
Soybean	25.0%	1,750	15/06-30/06	15/10-30/10	
Sesame	15.0%	1,050	15/06-30/06	21/09-30/09	
Pepper	7.5%	525	15/06-30/06	15-10-30/10	
Sweet Potato	7.5%	525	15/06-30/06	15-10-30/10	
Citrus	5.0%	350			
Total	100.0%	7,000			
Season -II (Dry Season)					
Maize	25.0%	1,750	15/11-30/11	30/03-07/04	
Rice	20.0%	1,400	21/11-30/11	21/03-30/03	
H.Beans	25.0%	1,750	15/12-30/12	15/04-30/04	
Sunflower	15.0%	1,050	15/12-30/12	15/04-30/04	
Onion	8.0%	560	15/11-15/12	30/03-30/04	
Tomato	2.0%	140	15/11-15/12	30/03-30/04	
Citrus	5.0%	350			All year round
Total	100.0%	7,000			
Total Annual	200.0%	14,000			

Table 1.12: Cropping Pattern for the Proposed Project (Option III)

Crop	Percent Coverage	Area (ha)	Planting Date	Harvesting Date	Remarks
Season - I (Wet Season)					
Sorghum	20.0%	1,400	15/04-30/04	15/08-30/09	
Maize	10.0%	700	07/5-28/05	21/09-07/10	
Rice	10.0%	700	15/06-30/06	15/10-30/10	
Soybean	12.5%	875	15/06-30/06	15/10-30/10	
H.Beans	12.5%	875	15/06-30/06	30/09-15/10	
Sesame	15.0%	1,050	15/06-30/06	21/09-30/09	
Pepper	10.0%	700	15/06-30/06	15/10-30/10	
Sweet Potato	5.0%	350	15/06-30/06	15/10-30/10	
Citrus	5.0%	350			
Total	100.0%	7,000			
Season -II (Dry Season)					
Maize	15.0%	1,050	15/11-30/11	30/03-07/04	
Rice	25.0%	1,750	21/11-30/11	21/03-30/03	
Groundnut	10.0%	700	15/12-30/12	15/04-30/04	
H.Beans	15.0%	1,050	15/12-30/12	15/04-30/04	
sunflower	15.0%	1,050	15/12-30/12	15/04-30/04	
Potato	5.0%	350	15/11-30/11	15/03-30/03	
Onion	8.0%	560	15/11-15/12	30/03-30/04	
Tomato	2.0%	140	15/11-15/12	30/03-30/04	
Citrus	5.0%	350			
Total	100.0%	7,000			
Total Annual	200%	14,000			

1.4.4 Crop Water Requirement

The estimation of crop water requirements needs the analysis of climatic data and recommended agronomic practice of each irrigation scheme. The effect of climate on crop water requirement is given by the reference crop evapotranspiration (ET_o) that is analyzed using the modified penman method. The actual amount of water used by a crop, or crop evapotranspiration (ET_c), is related to ET_o by crop coefficient k_c so that

$ET_c = k_c * ET_o$

Crops characteristics (k_c) values were obtained from FAO Irrigation and Drainage Paper No. 24. Dry season crop water requirements (Et_c) are given in Appendix 1. Climatic data and reference crop evapotranspiration for the project area is analyzed in detail in the Hydrology Annex.

1.4.5 Agronomic Planning

1.4.5.1 Area Development

The envisaged cropping area of the project would be about 7,500 ha, comprising 6,800 ha suitable land surveyed and 700 ha out of 1,500 ha, originally reserved for reforestation along river and streambanks. The cropping pattern described above, is based on this assumption. However, as described in section 1.2.1, above, the project area is topographically undulating with slopes greater than 8%. It is further assumed that this area would further be subjected to availability of suitable land for the intended type of irrigation as well as for the construction of the various infrastructures the system requires. Consequently, the net available area for irrigated agriculture would not be known until the full design work is completed.

1.4.5.2 Crop Diversification

Though new crops have just begun to be grown, production of cereals, notably sorghum and maize, has been the primary crops of the project area. New inclusions of other crops in the cropping pattern, both for use in rotation with cereals or as an alternative crop under certain circumstances, would be necessary. Crops like pulses, oil seeds, and horticultural crops have been considered as alternative crops with cereals. These crops, apart from their agronomic benefits, most have readily available market, locally as well as for export.

The envisaged crop mix should, therefore, create the opportunity for diversification. The objective of diversification is basically to maximize marketing opportunities and production economics. In addition, production factors including land, oxen/equipment and labor will be profitably employed thereby widening the economic base of the project as well as the farm community.

1.4.5.3 Crop Intensification

The prospect for crop intensification, through double or more cropping per year is highly appreciable. The crops for irrigation should, in as much as possible, be high value crops both for local and export markets. The types and extent of high value crops that will be grown under irrigation will depend on further studies and applicable, gradually. However, for the short-term period, certain types of pulses, oil seeds, fruits, and vegetables are identified for a cropping intensity of 200%, which may be attainable through time as farmers gain knowledge and experience in irrigation practices.

1.4.5.4 Yield Projections

Yield estimates for individual crops are based on current performance of the project area, yield potentials of the crops, recorded yields of trials and demonstrations, improved cultural practices and efficient management. Current farm yields of the various crops have been taken as base yields and research outputs from the Ethiopian Institute of Agriculture, EIAR, have been considered to serve future projections. Yields are indicated to increase steadily during the first few years as a result of improvements in husbandry techniques as well as through the introduction of improved and adoptable crop varieties.

At full development, the envisaged irrigated crop yield levels in quintals/ha are 56 for maize, 25 for haricots and sunflower, 28 for groundnut, 148 for various types of fruits and 220 for onion. Yield projections for both wet and dry seasons and for the three cropping pattern options are shown in the following tables. Moreover, it has to be noted here that production of fruits will not be realized until the fifth year after plant establishment.

1.4.6 Schedule of Production Costs

For the three options, cost of production and operational expenses for the subsequent years are presented in the following tables. Production inputs in terms of materials, machinery/draft power and labour have been estimated for individual crops (cost estimation tables annexed). In general, for the majority of crops, the proportion of costs is higher for labour and materials. However, this does not hold true for other crops like that of fruits and vegetables, where costs for labour tend to be relatively higher. It should also be assumed that the level of inputs, notably fertilizers chemicals and handling materials, estimated in this schedule will eventually increase as the farm develops its husbandry and management techniques. For practical purposes and appropriate for current practices in the area, the cost for land preparation is based on oxen/draft power although estimation for machinery operation has also been indicated (see Appendix 3). The indication may be useful for references when the need arises.

1.4.7 Cropping Pattern adopted after preliminary economic and financial Analysis at Household and Project level

The following table presents the cropping pattern that has been adopted for further calculations after preliminary economic and financial analyses at household and project levels showed that the presented mix would be the most suitable and profitable one.

Details on the economic and financial feasibility are shown in the Main Report and Annex 9.

Table 1.13: Cropping pattern adopted for final financial and economic calculations

DINGER BEREHA IRRIGATION PROJECT				
Global Cropping Pattern		Main crops	" The Basket"	
		%		%
Rainy season	Cereals	65%	Maize	10%
			Sorghum	35%
			Rice	20%
	Pulses	20%	Har.bean *	5%
			Soya bean *	15%
	Oil seeds	10%	Sesame *	10%
	Fruits	5%	Mango	1%
			Citrus	4%
Dry season	Cereals	20%	Maize irrig.	30%
	Pulses	20%	Har.bean irrig.	15%
			Soya bean irrig.	10%
	Oil seeds	17%	Sesame irrig.	25%
	Vegetables	13%	Potato irrig.	5%
			Cabbage irrig.	3%
			Pepper irrig.	3%
			Onion irrig.	4%
	Fruits	5%	Mango	1%
			Citrus	4%
	Total	175%		200%

Table 1.14: Estimated Crop Yields and Production Program (Option I)

Crop	Unit	Area, Yields and Production by Year					
		1	2	3	4	5	6-15
SEASON I (WET SEASON)							
Sorghum							
Area	Ha	1,750	1,750	1,750	1,750	1,750	1,750
Yield	qt/ha	24	28	34	43	43	43
Total Prod.	Qt	42,000	49,000	59,500	75,250	75,250	75,250
Maize							
Area	Ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	28	34	41	49	49	49
Total prod.	Qt	29,400	35,700	43,050	51,450	51,450	51,450
Soybeans							
Area	Ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	19	22	25	31	31	31
Total prod.	Qt	19,950	23,100	26,250	32,550	32,550	32,550
G. Nuts							
Area	Ha	700	700	700	700	700	700
Yield	qt/ha	13	15	17	21	21	21
Total prod.	Qt	9,100	10,500	11,900	14,700	14,700	14,700
Sesame							
Area	Ha	840	840	840	840	840	840
Yield	qt/ha	6	8	10	10	10	10
Total prod.	Qt	5,040	6,720	8,400	8,400	8,400	8,400
Sunflower							
Area	ha	210	210	210	210	210	210
Yield	qt/ha	13	15	17	21	21	21
Total prod.	qt	2,730	3,150	3,570	4,410	4,410	4,410
Pepper							
Area	ha	525	525	525	525	525	525
Yield	qt/ha	10	12	14	18	18	18
Total prod.	qt	5,250	6,300	7,350	9,450	9,450	9,450
Sweet Potato							
Area	ha	525	525	525	525	525	525
Yield	qt/ha	120	138	173	225	225	225
Total prod.	qt	63,000	72,450	90,825	118,125	118,125	118,125

Table 1.15: Estimated Crop Yields and Production Program (Option I)

Crop	Unit	Area, Yields and Production by Year					
		1	2	3	4	5	6-15
SEASON II (DRY SEASON)							
Maize							
Area	ha	2,100	2,100	2,100	2,100	2,100	2,100
Yield	qt/ha	30	36	43	56	56	56
Total prod.	qt	63000	75600	90300	117600	117600	117600
Rice							
Area	ha	700	700	700	700	700	700
Yield	qt/ha	30	35	42	50	50	50
Total prod	qt	21000	24500	29400	35000	35000	35000
H. Beans							
Area	ha	1,750	1,750	1,750	1,750	1,750	1,750
Yield	qt/ha	14	16	19	25	25	25
Total Prod	qt	24500	28000	33250	43750	43750	43750
Sunflower							
Area	ha	525	525	525	525	525	525
Yield	qt/ha	14	16	19	25	25	25
Total Prod.	qt	7350	8400	9975	13125	13125	13125
G,Nut							
Area	ha	525	525	525	525	525	525
Yield	qt/ha	16	18	22	28	28	28
Total Prod.	qt	8400	9450	11550	14700	14700	14700
Onion							
Area	ha	490	490	490	490	490	490
Yield	qt/ha	120	138	170	220	220	220
Total Prod.	qt	58800	67620	83300	107800	107800	107800
Tomato							
Area	ha	210	210	210	210	210	210
Yield	qt/ha	120	138	170	220	220	220
Total prod.	qt	25200	28980	35700	46200	46200	46200
Citrus*							
Year		5	6	7	8	9	10-15
Area	ha	350	350	350	350	350	350
Yield	qt/ha	85	98	118	148	148	148
Total prod.	qt	29750	34300	41300	51800	51800	51800

*****Fruits begin production starting 5th year after transplanting

Table 1.16: Estimated Crop Yields and Production Program (Option II)

Crop	Unit	Area, Yields and Production by Year					
		1	2	3	4	5	6-15
SEASON I (WET SEASON)							
Sorghum							
Area	ha	2,800	2,800	2,800	2,800	2,800	2,800
Yield	qt/ha	24	28	34	43	43	43
Total Prod.	qt	67200	78400	95200	120400	120400	120400
Soybean							
Area	ha	1,750	1,750	1,750	1,750	1,750	1,750
Yield	Qt/ha	19	22	25	31	31	31
Total prod.	qt	33250	38500	43750	54250	54250	54250
Sesame							
Area	ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	6	8	10	10	10	10
Total prod.	qt	6300	8400	10500	10500	10500	10500
Pepper							
Area	ha	525	525	525	525	525	525
Yield	qt/ha	10	12	14	18	18	18
Total prod.	qt	5250	6300	7350	9450	9450	9450
Sweet Potato							
Area	ha	525	525	525	525	525	525
Yield	qt/ha	120	138	173	225	225	225
Total prod.	qt	63000	72450	90825	118125	118125	118125

Table 1.17: Estimated Crop Yields and Production Program (Option II)

Crop	Unit	Area, Yields and Production by Year					
		1	2	3	4	5	6-15
SEASON II (DRY SEASON)							
Maize							
Area	ha	1,400	1,400	1,400	1,400	1,400	1,400
Yield	qt/ha	30	36	43	56	56	56
Total prod.	qt	42000	50400	60200	78400	78400	78400
Rice							
Area	ha	1,400	1,400	1,400	1,400	1,400	1,400
Yield	qt/ha	30	35	42	50	50	50
Total prod.	qt	42000	49000	58800	70000	70000	70000
H. Beans							
Area	ha	1,750	1,750	1,750	1,750	1,750	1,750
Yield	qt/ha	14	16	19	25	25	25
Total Prod	qt	24500	28000	33250	43750	43750	43750
Sunflower							
Area	ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	14	16	19	25	25	25
Total Prod.	qt	14700	16800	19950	26250	26250	26250
Onion							
Area	ha	560	560	560	560	560	560
Yield	qt/ha	120	138	170	220	220	220
Total Prod.	qt	67200	77280	95200	123200	123200	123200
Tomato							
Area	ha	140	140	140	140	140	140
Yield	qt/ha	120	138	170	220	220	220
Total prod.	qt	16800	19320	23800	30800	30800	30800
Citrus*							
Year		5	6	7	8	9	10-15
Area	ha	350	350	350	350	350	350
Yield	qt/ha	85	98	118	148	148	148
Total prod.	qt	29750	34300	41300	51800	51800	51800

*****Fruits begin production starting 5th year after transplanting

Table 1.18: Estimated Crop Yields and Production Program (Option III)

Crop	Unit	Area, Yields and Production by Year					
		1	2	3	4	5	6-15
SEASON I (WET SEASON)							
Sorghum							
Area	ha	1,400	1,400	1,400	1,400	1,400	1,400
Yield	qt/ha	24	28	34	43	43	43
Total Prod.	qt	33600	39200	47600	60200	60200	60200
Maize							
Area	ha	700	700	700	700	700	700
Yield	qt/ha	28	34	41	45	45	45
Total prod.	qt	19600	23800	28700	31500	31500	31500
Rice							
Area	ha	700	700	700	700	700	700
Yield	qt/ha	28	32	38	45	45	45
Total prod.	qt	19600	22400	26600	31,500	31,500	31,500
Soybean							
Area	ha	875	875	875	875	875	875
Yield	qt/ha	19	22	25	31	31	31
Total prod.	qt	16625	19250	21875	27125	27125	27125
H. Beans							
Area	ha	875	875	875	875	875	875
Yield	qt/ha	12	14	17	22	22	22
Total prod.	qt	10500	12250	14875	19250	19250	19250
Sesame							
Area	ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	6	8	10	10	10	10
Total prod.	qt	6300	8400	10500	10500	10500	10500
Pepper							
Area	ha	700	700	700	700	700	700
Yield	qt/ha	10	12	14	18	18	18
Total prod.	qt	7000	8400	9800	12600	12600	12600
Sweet Potato							
Area	ha	350	350	350	350	350	350
Yield	qt/ha	120	138	173	225	225	225
Total prod.	qt	42000	48300	60550	78750	78750	78750

Table 1.19: Estimated Crop Yields and Production Program (Option III)

Crop	Unit	Area, Yields and Production by Year					
		1	2	3	4	5	6-15
SEASON II (DRY SEASON)							
Maize							
Area	ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	30	36	43	56	56	56
Total prod.	qt	31500	37800	45150	58800	58800	58800
Rice							
Area	ha	1,750	1,750	1,750	1,750	1,750	1,750
Yield	qt/ha	30	35	42	50	50	50
Total prod.	qt	73500	87500	113750	113750	113750	113750
Groundnut							
Area	ha	700	700	700	700	700	700
Yield	qt/ha	16	18	22	28	28	28
Total Prod	qt	8400	10500	11900	14700	14700	14700
H. Beans							
Area	ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	14	16	19	25	25	25
Total Prod.	qt	12600	14700	17850	23100	23100	23100
Sunflower							
Area	ha	1,050	1,050	1,050	1,050	1,050	1,050
Yield	qt/ha	14	16	19	25	25	25
Total Prod.	qt	12600	15750	17850	22050	22050	22050
Potato							
Area	ha	350	350	350	350	350	350
Yield	qt/ha	90	105	125	156	156	156
Total Prod.	qt	31500	36750	43750	54600	54600	54600
Onion							
Area	ha	560	560	560	560	560	560
Yield	qt/ha	120	138	170	220	220	220
Total Prod.	qt	67200	77280	95200	123200	123200	123200
Tomato							
Area	ha	140	140	140	140	140	140
Yield	qt/ha	120	138	170	220	220	220
Total prod.	qt	16800	19320	23800	30800	30800	30800
Citrus*							
Year	5	6	7	8	9	10	11-15
Area	ha	350	350	350	350	350	350
Yield	qt/ha	85	98	118	148	148	148
Total prod.	qt	29750	34300	41300	51800	51800	51800

*****Fruits begin production starting 5th year after transplanting

1.5 TECHNICAL CONSTRAINTS & IMPROVEMENTS

1.5.1 Planting & Harvesting Period

Crops planted during the rainy season are mainly harvested in the months of October to December. These months are also periods when land preparation and planting of irrigated crops overlaps. Conversely, many of the irrigated crops are also scheduled for harvest during the months of March, April and May. Again, this period overlaps with the preparation of the wet season crops. These overlaps, inevitably, create shortages of labour and farm power, which in turn affects the timely execution of the various farm operations. Although, at a smaller scale, farmers' experience in irrigated agriculture is not negligible, the change to growing a large area of crops during the dry and wet seasons will be a constraint to the sustainability of the project. This situation, therefore, calls for a gradual introduction of partial mechanization of certain farm operations.

1.5.2 Fertilizer Application

Fertilizer requirement depends upon fertility/nutrient level of the soils of the project areas. As mentioned in the soils section above, the fertility status of the project area has been rated as low, especially considering the levels of nitrogen, phosphorus and organic carbon. Moreover, soils are also highly acidic with pH values ranging from 4.5 to 7. As most of the crops under consideration favour a pH range of 6 to 7, raising the range to optimal level requires a close follow up on determining the type and amount of fertilizer application. Repeated application of Di-Ammonium Phosphate (DAP) aggravates acidity, which requires the need for judicious application of fertilizers. The trend of using compost and natural fertilizers would be highly appreciated.

1.5.3 Crop Varieties

Production of commercial and high value crops entails quality cultivars that meet the requirements of the area and market preferences. At the moment, there are very few seed suppliers in the country and the locally available research stations are not capable to fully cater for the needs of the farmers. In view of this, the issue needs to be addressed through Regional Bureau of Agriculture and the various research centres. Some crop varieties recommended by the Ethiopian Institute of Agricultural Research (EIAR) are tabulated hereunder but access is limited due to shortage of supply. V

1.5.4 Crop Protection

There is a need for establish a system that prevents or reduces crop losses to an acceptable minimum by keeping pests in check while, at the same time, being economic and friendly to the environment. Integrated Pest Management (IPM) has been implemented, to a limited extent, in some parts of the country. It is high time now to revisit the program in view of the envisaged intensive and diversified cropping system.

IPM is said to be an ideal approach for farmers to keep in check the pest problems of the area. Components of an IPM programme are practical and less costly that include appropriate cultural practices (planting time, methods of seedbed preparation, crop rotation, field sanitation, etc.), physical control (mechanical removal of pests), use of resistant cultivars, biological and chemical control. The program has to be promoted in the project area by selecting specific techniques based on their suitability to the specific pest problems involved

Table 1.20: Recommended Crop Varieties

NO.	CROPS	VARIETIES	REMARKS
1	Maize	*BHQP-542; BH-540; PHB-304183; BH-660*	BHQP-542 is a newly released variety (2001) and has higher protein content.
3	Soybean	*Clark 63K; Coker240; YET-80*	
4	Haricots	*Awash-1; Mexican-142; Awash Melka*	All varieties are white colored with high potential for export market. There are also varieties supplied by ACOS Eth
6	Groundnut	*Roba; Shulamit; Manipinter*	Care should be taken in selecting suitable plots – lighter and well drained soils.
7	Sesame	*Adi; Mehado, Argane*	Export market is favorable.
10	Pepper	*Mareko Fana; Paprica King; Paprica Queen*	The two varieties, Paprica King & Queen have potentials for export market.
11	Mango	*Alfonce; Peal Melgoso*	
12	Avocado	*Freta, Has*	
14	Onion	*Adama Red; Red Croel; Bombay Red*	
15	Tomato	*Melka Sholla/Red Pear; Melka Salsa/Serio*	

Note: Some crops that are not included in the cropping pattern are indicated here in anticipation of future inclusion

1.5.5 Crop Rotation

Systematic crop rotation should be a basic component of the project. The system is basically designed to prevent anticipated problems that might arise from continuous cropping of single or similar crops, season after season. These problems may include loss of soil structure and fertility, prevalence of crop diseases, weeds and insect pests. However, maize and other cereals may be grown continuously, provided soil fertility is maintained. But, crops like beans and some of the vegetables are sensitive to soil borne diseases and crop rotation would be essential when cultivating these crops.

The cropping patterns that are proposed have considered the rotational needs of the project. The envisaged cropping patterns include cereals, pulses, oil crops and vegetables. Nevertheless, in order to recommend definite and reliable sequence of cropping, a well-planned research work that best suits the project's conditions, need to be conducted.

This research work will take some time. In the mean time, any of the following cycles may temporarily serve the purpose. But, with regard to the irrigated agriculture, care shall be taken not to plant crops of the same family in sequence. Wet season cereals may follow dry season vegetable production or pulses as deemed necessary.

- a) Cereals (Maize/Sorghum/Rice) ➢ Pulses (Soybean/Haricots) ➢ Oil crops (Groundnut) ➢ Vegetables (Onion/Tomato)
- b) Oil crops (Sunflower/Sesame) ➢ Cereals (Maize/Sorghum/rice) ➢ Pulses (Soybean/Chickpeas) ➢ Vegetables (Onion/Tomato)
- c) Cereals (Maize/Sorghum/Rice) ➢ Spices (pepper) ➢ Oil crops (Sesame, sunflower) ➢ Pulses (Haricots) ➢ Vegetables (Onion/Tomato)

1.5.6 Pilot Scheme - Research and Trial Programs

With the objective of developing the full potential of the scheme, an area of 10 to 20ha of land is proposed to be allotted for a) establishing adaptive trials; b) generating new cropping systems for both irrigated and rainfed farming; and c) maximizing crop yields and incomes. A research and trial program could be coordinated between the project and the near by Agricultural Research Centres, Jima and Bako. In view of these aspects, a research unit, under the project or the Woreda Agricultural Office may be considered for such tasks to coordinate activities with the center.

The research program should not be restricted to the usual adaptive trials but shall also broadly include other programs such as tillage practices, sequential cropping, irrigation water management, soil erosion control methods, etc.

1.6 LABOUR REQUIREMENTS

The labour requirements, adopted for the calculations are presented in the following table.

Table 1.21: Labour requirements

	LABOUR REQUIREMENTS			
DINGER BEREHA IRRIGATION PROJECT				
Labor requirement / ha		Labor days/ha	Financial value birr/ha	Economic value birr/ha
R S	Maize *	66	1,320	660
	Sorghum *	66	1,320	660
	Rice *.	76	1,520	760
	Har.beans *	78	1,560	780
	Soya bean	75	1,500	750
	Sesame *	68	1,360	680
				0
Dry S	Maize irrig.	83	1,660	830
	Har.bean irrig.	98	1,960	980
	Soya bean irrig.	95	1,900	950
	Sesame irrig.	88	1,760	880
	Potato irrig.	197	3,940	1,970
	Cabbage irrig.	190	3,800	1,900
	Pepper irrig.	180	3,600	1,800
	Onion irrig.	220	4,400	2,200
	Mango	92 *	1,840	920
	Citrus	92 *	1,840	920
* For Mango and Citrus in full regime: after the 7th year				

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APPENDIX 1

DRY SEASON CROP WATER REQUIREMENTS, GROWING STAGES AND K_C VALUES

SUMMARIZED DRY SEASON WATER REQUIREMENT

Overall Irrigation Efficiency: 60% | Cropped Ara(ha) | **7,500**

25% **CROP: MAIZE** | **AREA CROPPED:** | **1875** | **PLANTING DATE: 15TH NOV.**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	0.95	1.1	0.9								0.4	0.67	
ETo (mm)	115	115	143								114	107	
ETc (mm)	109.0	126.6	128.9								45.5	71.1	
Mean Montly Rainfall	3.0	6.0	26.0								28.0	8.0	
Effective Rainfall	0.0	0.0	5.6								6.8	0.0	
Net Irrigation Requirement	109.0	126.6	123.3								38.7	71.1	
Field Irrigation Requirement	181.6	211.0	205.5								86.0	158.0	
Field Irrigation Requirement (mm/day)	**5.9**	**7.5**	**6.6**								**2.9**	**5.1**	
Crop Water Needs(l/s/ha)	**0.7**	**0.9**	**0.8**								**0.3**	**0.6**	
Flow (l/s)	**1,274.19**	**1,638.86**	**1,441.79**								**623.18**	**1,108.44**	

10% **CROP:RICE** | **AREA CROPPED:** | **750** | **PLANTING DATE: 21ST NOV.**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	1.1	1.15	1.00								1.00	1.0	
ETo (mm)	115	115	143								114	107	
ETc (mm)	126.2	132.3	143.2								113.7	106.6	
Mean Montly Rainfall	3.0	6.0	26.0								28.0	8.0	
Effective Rainfall	0.0	0.0	5.6								6.8	0.0	
Net Irrigation Requirement	126.2	132.3	137.6								106.9	106.6	
Field Irrigation Requirement	210.3	220.6	229.4								237.6	237.0	
Field Irrigation Requirement (mm/day)	**6.8**	**7.9**	**7.4**								**7.9**	**7.6**	
Crop Water Needs(l/s/ha)	**0.8**	**0.9**	**0.9**								**0.9**	**0.9**	
Flow (l/s)	**590.15**	**685.34**	**643.71**								**688.91**	**665.07**	

20% **CROP: HARICOTS** | **AREA CROPPED:** | **1500** | **PLANTING DATE: 15TH DEC.**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	0.68	1.04	0.9	0.7								0.35	
ETo (mm)	115	115	143	135								107	
ETc (mm)	78.4	119.9	128.9	94.7								37.3	
Mean Montly Rainfall	3.0	6.0	26.0	49.0								8.0	
Effective Rainfall	0.0	0.0	5.6	19.4								0.0	
Net Irrigation Requirement	78.4	119.9	123.3	75.3								37.3	
Field Irrigation Requirement	130.6	199.8	205.5	125.5								82.9	
Field Irrigation Requirement (mm/day)	**4.2**	**7.1**	**6.6**	**4.2**								**2.7**	
Crop Water Needs(l/s/ha)	**0.49**	**0.83**	**0.77**	**0.49**								**0.31**	
Flow (l/s)	**733.22**	**1,241.56**	**1,153.43**	**728.00**								**465.55**	

6% **CROP: SUNFLOWER** | **AREA CROPPED:** | **450** | **PLANTING DATE: 15TH NOV.**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	1.00	1.1	0.75								0.35	0.72	
ETo (mm)	115	115	143								114	107	
ETc (mm)	114.7	126.6	107.4								39.8	76.4	
Mean Montly Rainfall	3.0	6.0	26.0								28.0	8.0	
Effective Rainfall	0.0	0.0	5.6								6.8	0.0	
Net Irrigation Requirement	114.7	126.6	101.8								33.0	76.4	
Field Irrigation Requirement	191.2	211.0	169.7								73.3	169.8	
Field Irrigation Requirement (mm/day)	**6.2**	**7.5**	**5.5**								**2.4**	**5.5**	
Crop Water Needs(l/s/ha)	**0.7**	**0.9**	**0.6**								**0.3**	**0.6**	
Flow (l/s)	**321.90**	**393.33**	**285.74**								**127.58**	**285.98**	

25% **CROP: GROUNDNUT** | **AREA CROPPED:** | **1875** | **PLANTING DATE: 15TH DEC.**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	0.65	0.88	1.0	0.8								0.45	
ETo (mm)	115	115	143	135								107	
ETc (mm)	74.6	100.7	143.2	108.2								48.0	
Mean Montly Rainfall	3.0	6.0	26.0	49.0								8.0	
Effective Rainfall	0.0	0.0	5.6	19.4								0.0	
Net Irrigation Requirement	74.6	100.7	137.6	88.8								48.0	
Field Irrigation Requirement	124.3	167.8	229.4	148.1								106.6	
Field Irrigation Requirement (mm/day)	**4.0**	**6.0**	**7.4**	**4.9**								**3.4**	
Crop Water Needs(l/s/ha)	**0.5**	**0.7**	**0.9**	**0.6**								**0.4**	
Flow (l/s)	**871.81**	**1,303.64**	**1,609.27**	**1,073.48**								**748.20**	

6% **CROP: ONION** | **AREA CROPPED:** | **450** | **PLANTING DATE: 15TH NOV.**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	1.0	1.0	0.92	0.9							0.5	0.79	
ETo (mm)	115	115	143	135							114	107	
ETc (mm)	114.7	115.1	131.3	121.8							56.9	84.4	
Mean Montly Rainfall	3.0	6.0	26.0	49.0							28.0	8.0	
Effective Rainfall	0.0	0.0	5.6	19.4							6.8	0.0	
Net Irrigation Requirement	114.7	115.1	125.7	102.4							50.1	84.4	
Field Irrigation Requirement	191.2	191.8	209.5	170.6							111.2	187.6	
Field Irrigation Requirement (mm/day)	**6.2**	**6.9**	**6.8**	**5.7**							**3.7**	**6.1**	
Crop Water Needs(l/s/ha)	**0.1**	**0.1**	**0.1**	**0.1**							**0.0**	**0.1**	
Flow (l/s)	**32.19**	**35.76**	**35.27**	**29.69**							**19.35**	**31.59**	

3% **CROP: TOMATO** | **AREA CROPPED:** | **225** | **PLANTING DATE: 15TH NOV.**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	0.82	1.15	0.90								0.45	0.60	
ETo (mm)	115	115	143								114	107	
ETc (mm)	93.7	132.3	128.9								51.2	64.0	
Mean Montly Rainfall	3.0	6.0	26.0								28.0	8.0	
Effective Rainfall	0.0	0.0	5.6								6.8	0.0	
Net Irrigation Requirement	93.7	132.3	123.3								44.4	64.0	
Field Irrigation Requirement	156.1	220.6	205.5								98.6	142.2	
Field Irrigation Requirement (mm/day)	**5.0**	**7.9**	**6.6**								**3.3**	**4.6**	
Crop Water Needs(l/s/ha)	**0.6**	**0.9**	**0.8**								**0.4**	**0.5**	
Flow (l/s)	**131.44**	**205.60**	**173.01**								**85.77**	**119.71**	

5% **CROP: CITRUS** | **AREA CROPPED:** | **375** | **PLANTING DATE:1ST JUNE**

MONTHS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Crop factor	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.75	0.75	
ETo (mm)	115	115	143	135	134	107	92	96	114	125	114	107	
ETc (mm)	86.0	86.3	107.4	101.5	100.7	80.6	68.8	67.5	80.0	87.5	85.3	80.0	
Mean Montly Rainfall	3.0	6.0	26.0	49.0	158.0	274.0	312.0	277.0	209.0	104.0	28.0	8.0	
Effective Rainfall	0.0	0.0	5.6	19.4	101.4	194.2	224.6	196.6	142.2	58.2	6.8	0.0	
Net Irrigation Requirement	86.0	86.3	101.8	82.1	0.0	0.0	0.0	0.0	0.0	29.3	78.5	80.0	
Field Irrigation Requirement	143.4	143.9	169.7	136.8	0.0	0.0	0.0	0.0	0.0	48.8	130.8	133.3	
Field Irrigation Requirement (mm/day)	**4.6**	**5.1**	**5.5**	**4.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.6**	**4.4**	**4.3**	
Crop Water Needs(l/s/ha)	**0.5**	**0.6**	**0.6**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	**0.5**	**0.5**	
Flow (l/s)	**201.19**	**223.48**	**238.12**	**198.35**	-	-	-	-	-	**68.41**	**189.65**	**187.05**	

TOTAL MONTHLY FLOW (l/s)	**4,156.09**	**5,727.58**	**5,580.34**	**2,029.52**	-	-	-	-	-	**68.41**	**1,734.44**	**3,611.59**	
MAX. MONTHLY FLOW (l/s)	**5,727.58**												
SCHEME DESIGN FLOW (l/s)	**5,727.58**	(Assuming 24 hours of daily irrigation)											
SCHEME DESIGN FLOW (l/s)	**11,455.15**	(Assuming 12 hours of daily irrigation)											
DUTY(l/s/ha)	**1.53**	(Assuming 12 hours of daily irrigation)			Taken 1.6 l/s for safety								
total													
DUTY(l/s/ha)	**0.76**				Taken 0.8 for safety								

ETc (mm) = ETo*Kc
Effective Rainfall = 0.8*P-25 If P>75; =0.6*P-10 If P <75
Net Irrigation Requirement = ETc - Effective Rainfall
Field Irrigation Requirement = (Net Irrigation Requirement)/(Application Efficiency 80%)

GROWING STAGES AND KC VALUES					
Maize					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	25	35	45	30	135
Kc per stage	0.4	0.8	1.1	0.9	
Rice					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	50	20	30	20	120
Kc per stage	1.0	1.15	1.15	1.0	
Haricots					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	20	30	40	20	110
Kc per stage	0.35	0.75	1.1	0.7	
Sunflower					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	25	35	45	25	130
Kc per stage	0.35	0.9	1.1	0.75	
Groundnut					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	25	35	45	25	130
Kc per stage	0.45	0.75	1.0	0.8	
Onion					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	15	25	70	40	150
Kc per stage	0.5	0.75	1.0	0.9	
Tomato					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	30	40	40	25	135
Kc per stage	0.45	0.75	1.15	0.85	
Citrus					
Stage growth	**Initial**	**Crop dev.**	**Mid season**	**Late season**	**Total Growing Period**
No. of days	60	90	120	95	365
Kc per stage	0.75	0.7	0.75	0.75	

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ETo(mm/day)	3.7	4.11	4.62	4.51	4.33	3.58	2.96	3.11	3.81	4.03	3.79	3.44
No. of Days	31	28	31	30	31	30	31	31	30	31	30	31
ETo(mm)	115	115	143	135	134	107	92	96	114	125	114	107

APPENDIX 2

COST OF PRODUCTION

COST OF PRODUCTION – MAIZE/RICE

A. MACHINERY & OXEN OPERATIONS							
No.	Operation	Requirement		Cost (Birr)		Total cost (Birr/ha)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	14	300	27	750	380
2	Other operations	--	6	--	27	--	160
	Total	2.5	20	----	---	750	540

B. LABOR OPERATIONS				
No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Land preparation	16	20	320
2	Planting	6	20	120
3	Weeding	20	20	400
4	Irrigation	7	20	140
5	Miscellaneous	4	20	80
6	Harvest & handling	20	20	400
	Total	---	---	1,460

C. MATERIAL INPUT				
No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	30kg	750/qt	225
2	Fertilizers			
	DAP	100kg	410/qt	410
	Urea	100kg	360/qt	360
3	Agrochemicals	5kg	85/kg	425
4	Others (LS)	---	----	250
	Total	-----	------	1,670

Cost of Production----- A+B+C = Birr 3,880 /ha (Macinery/Irrigated)
= Birr 3,740/ha (Machinery/Rainfed)
= Birr 3,670/ha (Oxen/Irrigated)
= Birr 3,530/ha (Oxen/Rainfed)

COST OF PRODUCTION - SORGHUM

A. MACHINERY & OXEN OPERATIONS							
No.	Operation	Requirement		Cost (Birr)		Total cost (Birr)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	14	300	27	750	380
2	Other operations	--	6	--	27	--	160
	Total	2.5	20	----	---	750	540
B. LABOR OPERATIONS							
No.	Operations	Md/ha		Unit cost (Birr)		Total cost (Birr)	
1	Land preparation	14		20		320	
2	Planting	6		20		120	
3	Weeding	15		20		400	
4	Irrigation	--		--		--	
5	Miscellaneous	4		20		80	
6	Harvest & handling	20		20		400	
	Total	----		----		1,320	
C. MATERIAL INPUT							
No.	Input	Req./ha		Unit Cost (Birr)		Total cost (Birr)	
1	Seed	10kg		350/qt		35	
2	Fertilizers						
	DAP	100kg		410/qt		410	
	Urea	100kg		360/qt		360	
3	Agrochemicals	3kg		85/kg		255	
4	Others	---		----		150	
	Total	-----		------		1,210	

Cost of Production----- A+B+C = Birr 3,280/ha (Machinery/Rainfed)
= Birr 3,070/ha (Oxen/Rainfed)

COST OF PRODUCTION - SOYBEAN

A. MACHINERY & OXEN OPERATIONS							
No.	Operation	Requirement		Cost (Birr)		Total cost (Birr)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	14	300	27	750	380
2	Other operations	--	5	--	27	--	135
	Total	2.5	19	----	---	750	515

B. LABOR OPERATIONS				
No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Land preparation	20	20	400
2	Planting	6	20	120
3	Weeding	20	20	400
4	Irrigation	--	--	--
5	Miscellaneous	4	20	80
6	Harvest & handling	25	20	500
	Total	----	----	1,500

C. MATERIAL INPUT				
No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	70kg	850/qt	595
2	Fertilizers			
	DAP	100kg	410/qt	410
	Urea	50kg	360/qt	180
3	Agrochemicals	3kg	85/kg	255
4	Other materials	---	----	100
	Total	-----	------	1,540

Cost of Production----- A+B+C = Birr 3,790/ha (Machinery/Rainfed)
= Birr 3,555/ha (Oxen/Rainfed)

COST OF PRODUCTION - SESAME

A. MACHINERY & OXEN OPERATIONS

No.	Operation	Requirement		Cost (Birr)		Total cost (Birr)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	10	300	27	750	270
2	Other operations	--	2	--	27	--	54
	Total	2.5	12	----	---	750	324

B. LABOR OPERATIONS

No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Land preparation	16	20	320
2	Planting	6	20	120
3	Weeding	15	20	300
4	Irrigation	--	--	--
5	Miscellaneous	6	20	120
6	Harvest & handling	25	20	500
	Total	----	----	1,360

C. MATERIAL INPUT

No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	7kg	600/qt	42
2	Fertilizers			
	DAP	100kg	410/qt	410
	Urea	50kg	360/qt	180
3	Agrochemicals	2kg	85/kg	170
4	Other materials	---	----	100
	Total	-----	------	902

Cost of Production----- A+B+C = Birr 3,012/ha (Machinery/Rainfed)
= Birr 2,586/ha (Oxen/Rainfed)

COST OF PRODUCTION – PEPPER

A. MACHINERY & OXEN OPERATIONS							
No.	Operation	Requirement		Cost (Birr)		Total cost (Birr)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	10	300	27	750	270
2	Other operations	--	2	--	27	--	54
	Total	2.5	12	----	---	750	324
B. LABOR OPERATIONS							
No.	Operations	Md/ha		Unit cost (Birr)		Total cost (Birr)	
1	Nursery	60		20		1,200	
2	Land preparation	50		20		320	
3	Planting	30		20		120	
4	Weeding	40		20		300	
5	Irrigation	--		--		--	
6	Miscellaneous	12		20		120	
7	Harvest & handling	60		20		1,200	
	Total	----		----		3,260	
C. MATERIAL INPUT							
No.	Input	Req./ha		Unit Cost (Birr)		Total cost (Birr)	
1	Seed	6kg		600/qt		36	
2	Fertilizers DAP Urea	 150kg 150kg		 410/qt 360/qt		 615 540	
3	Agrochemicals	8kg		85/kg		680	
4	Other materials	---		----		100	
	Total	-----		------		1,971	

Cost of Production----- A+B+C = Birr 5,981/ha (Machinery/Rainfed)
= Birr 5,555/ha (Oxen/Rainfed)

COST OF PRODUCTION – SWEET POTATO/POTATO

A. MACHINERY & OXEN OPERATIONS

No.	Operation	Requirement		Cost (Birr)		Total cost (Birr)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	10	300	27	750	270
2	Other operations	--	2	--	27	--	54
	Total	2.5	12	----	---	750	324

B. LABOR OPERATIONS

No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Land preparation	50	20	1,000
2	Planting	20	20	400
3	Weeding	40	20	800
4	Irrigation	--	--	--
5	Others	12	20	240
6	Harvest & handling	50	20	1,000
7	Total	----	----	3,440

C. MATERIAL INPUT

No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	------	----	250
2	Fertilizers DAP Urea	 100kg ----	 410/qt ----	 410 ----
3	Agrochemicals	3kg	85/kg	255
4	Other materials	---	----	100
	Total	-----	------	1,015

Cost of Production----- A+B+C = Birr5, 205 /ha (Machinery/Rainfed)
= Birr 4,779/ha (Oxen/Rainfed)

COST OF PRODUCTION - FRUITS

A. MACHINERY & OXEN OPERATIONS

No.	Operation	Requirement		Cost (Birr)		Total cost (Birr)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	10	300	27	750	270
2	Other operations	--	2	--	27	--	54
	Total	2.5	12	----	---	750	324

B. LABOR OPERATIONS

No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Nursery	60	20	1,200
2	Land preparation	10	20	200
3	Planting	30	20	600
4	Weeding	20	20	400
5	Irrigation(power &manpower)	--	--	1,400
6	Others	12	20	240
7	Harvest & handling	60	20	1,200
	Total	----	----	5,240

C. MATERIAL INPUT

No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seedling	250	5	1,250
2	Fertilizers DAP Urea	 80kg 100kg	 410/qt 360/qt	 328 360
3	Agrochemicals	3kg	85/kg	255
4	Other materials	---	----	100
	Total	-----	------	2,293

Cost of Production----- A+B+C = Birr 8283 /ha (Machinery/Irrigated)
= Birr 7857/ha (Oxen/Irrigated)

COST OF PRODUCTION – H.BEANS

A. MACHINERY & OXEN OPERATIONS							
No.	Operation	Requirement		Cost (Birr)		Total cost (Birr/ha)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	12	300	27	750	324
2	Other operations	--	4	--	27	--	108
	Total	2.5	16	----	---	750	432

B. LABOR OPERATIONS				
No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Land preparation	16	20	320
2	Planting	6	20	120
3	Weeding	20	20	400
4	Irrigation (power & labor)	----	---	1,400
5	Miscellaneous	6	20	120
6	Harvest & handling	30	20	600
	Total	---	---	2,560

C. MATERIAL INPUT				
No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	60kg	400/qt	240
2	Fertilizers DAP Urea	 100kg ----	 410/qt ---	 410 ---
3	Agrochemicals	2kg	85/kg	170
4	Others (LS)	---	----	100
5	Total	-----	------	920

Cost of Production----- A+B+C = Birr 4,230 /ha (Macinery/Irrigated)
= Birr 3,912/ha (Oxen/Irrigated)

COST OF PRODUCTION – G.NUT

A. MACHINERY & OXEN OPERATIONS

No.	Operation	Requirement		Cost (Birr)		Total cost (Birr/ha)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	12	300	27	750	324
2	Other operations	--	4	--	27	--	108
	Total	2.5	16	----	---	750	432

B. LABOR OPERATIONS

No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Land preparation	16	20	320
2	Planting	6	20	120
3	Weeding	20	20	400
4	Irrigation (power & labor)	----	---	1,400
5	Miscellaneous	6	20	120
6	Harvest & handling	30	20	600
	Total	---	---	2,960

C. MATERIAL INPUT

No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	60kg	400/qt	240
2	Fertilizers DAP Urea	 100kg ----	 410/qt ---	 410 ---
3	Agrochemicals	2kg	85/kg	170
4	Others (LS)	---	----	100
	Total	-----	------	920

Cost of Production----- A+B+C = Birr 4,630 /ha (Macinery/Irrigated)
= Birr 4,312/ha (Oxen/Irrigated)

COST OF PRODUCTION – S.FLOWER

A. MACHINERY & OXEN OPERATIONS

No.	Operation	Requirement		Cost (Birr)		Total cost (Birr/ha)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	12	300	27	750	324
2	Other operations	--	4	--	27	--	108
	Total	2.5	16	----	---	750	432

B. LABOR OPERATIONS

No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Land preparation	16	20	320
2	Planting	6	20	120
3	Weeding	20	20	400
4	Irrigation (power & labor)	----	---	1,400
5	Miscellaneous	6	20	120
6	Harvest & handling	30	20	600
	Total	---	---	2,960

C. MATERIAL INPUT

No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	10kg	4000/qt	400
2	Fertilizers DAP Urea	 100kg ----	 410/qt ---	 410 ---
3	Agrochemicals	2kg	85/kg	170
4	Others (LS)	---	----	100
	Total	-----	------	1080

Cost of Production----- A+B+C = Birr 4,790/ha (Macinery/Irrigated)
= Birr 4,472/ha (Oxen/Irrigated)

COST OF PRODUCTION - ONION

A. MACHINERY & OXEN OPERATIONS

No.	Operation	Requirement		Cost (Birr)		Total cost (Birr/ha)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	14	300	27	750	378
2	Other operations	--	4	--	27	--	108
	Total	2.5	18	----	---	750	486

B. LABOR OPERATIONS

No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Nursery	60	20	1,200
2	Land preparation	50	20	320
3	Planting	30	20	120
4	Weeding	60	20	400
5	Irrigation (power and labor)	----	---	1,400
6	Miscellaneous	12	20	240
7	Harvest & handling	60	20	1,200
	Total	---	---	4,880

C. MATERIAL INPUT

No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	30kg	750/qt	225
2	Fertilizers			
	DAP	100kg	410/qt	410
	Urea	100kg	360/qt	360
3	Agrochemicals	5kg	85/kg	425
4	Others (LS)	---	----	250
	Total	-----	------	1,670

Cost of Production----- A+B+C = Birr 7,300/ha (Macinery/Irrigated)
= Birr 7,036/ha (Oxen/Irrigated)

COST OF PRODUCTION - TOMATO

A. MACHINERY & OXEN OPERATIONS

No.	Operation	Requirement		Cost (Birr)		Total cost (Birr/ha)	
		Tractor (hr)	Oxen (pair)	Tr/hr	Ox/ha	Tr	Ox
1	Land preparation	2.5	14	300	27	750	378
2	Other operations	--	4	--	27	--	108
	Total	2.5	18	----	---	750	486

B. LABOR OPERATIONS

No.	Operations	Md/ha	Unit cost (Birr)	Total cost (Birr)
1	Nursery	60	20	1200
2	Land preparation	50	20	1000
3	Planting	30	20	600
4	Weeding	50	20	1000
5	Irrigation (power & labor)	---	----	1400
6	Miscellaneous	12	20	240
7	Harvest & handling	60	20	1200
	Total	---	---	6,560

C. MATERIAL INPUT

No.	Input	Req./ha	Unit Cost (Birr)	Total cost (Birr)
1	Seed	30kg	750/qt	225
2	Fertilizers			
	DAP	100kg	410/qt	410
	Urea	100kg	360/qt	360
3	Agrochemicals	5kg	85/kg	425
4	Others (LS)	---	----	250
	Total	-----	------	1,670

Cost of Production----- A+B+C = Birr 8,980 /ha (Macinery/Irrigated)
= Birr 8,716/ha (Oxen/Irrigated)

APPENDIX 3

AGRONOMIC REQUIREMENTS OF SELECTED CROPS

AGRONOMIC REQUIREMENTS OF SELECTED CROPS

1. Onion

Onion grows well between altitude ranges of 1800-2500 m.a.s.l. It can be grown on many soils but well drained loamy or sandy loam soils are preferred. High level of organic matter is required for the optimum growth of the crop. A pH 0f 5.8-6.8 is most favorable.

Field Preparation: Seeds are normally sown in seedbeds and transplanted to prepared fields after about 45-60 days when seedlings are 8-12cm in height. As onions are shallow rooted, meticulous watering and mulching with straw is advisable to minimize evaporation losses and suppress weed growth.

Seed Rate: The seed rate for direct planting may go up to 12-15kg/ha. But, for transplanting, the normal seed rate is between 5-8kg. Recommended spacing is 40cm between rows and 20cm between plants. Onion can also be directly sown to the field and latter thinned to the given spacing.

Fertilizer: For optimum yields, applications of 150-200kg DAP and 100-150kg Urea per hectare is very appropriate.

Weed Control: A minimum of two hand weedings are required.

Disease: Purple blotch, downy mildew and anthracnose are major diseases of onion. Control measures include crop rotation, plant hygiene and removal and burning of onion stubble after harvest.

Insect Pests: Onion trips are the major insect pests of the crop. Other pests include cut worms, onion fly and armyworm. Endosulfan 35% E.C. at the rate of 1.5lt/ha controls these pests.

Irrigation: Onion requires 350-550mm water during its growth period. It is sensitive to water stress and the crop requires frequent, light irrigation, which are scheduled when about 25% of available water in the first 30cm soil depth has been depleted by the crop.

Irrigation applications of every 5-7 days are commonly practiced. The most common methods used are furrow and basin.

2. Pepper

Pepper grows best in areas where seasonal temperatures range from 18-27^{0}c during the day and 15-18^{0}c during the night. The crop is well adapted to altitudes ranging from 1000-2000 m.a.s.l. Light textured soil with an adequate water holding capacity and good drainage properties are preferred. The crop is moderately sensitive to soil salinity. It is more sensitive to salinity in the seedling stage. Optimum pH ranges from 5 to7.

Field Preparation: Seeds are normally sown in seedbeds and transplanted when the seedlings reach 10-15cm in height. Seedlings are transplanted to well prepared fields in rows of 60-80cm apart and 35-45cm between plants. Pepper can also be directly sown, but needs to be thinned to standard or preferred plant population level. In some cases plants are established in double rows 1-1.5m apart, 30cm between the double rows and 25-30cm between plants in the row.

Seed Rate: The seed requirement for pepper is in the order of 750-1,500g/ha. This depends on the variety and method of plantation.

Fertilizer: Pepper requires application of 150kg DAP and 140kg Urea per hectare during the growth period.

Weed Control: Two hand weedings are normally required during the growing period.

Diseases: Most commonly occurring diseases of pepper are anthracnose, fruit rot, powdery mildew, bacterial leaf spot and leaf curl virus. Recommended control measures are avoiding planting during times of heavy rains, destroying crop residues and use of resistant varieties. Seed treatment with copper based fungicides at the rate of 1 to 2 tablespoonful in 4 liters of water is also recommended.

Insect Pests: Trips, whitefly and African bollworm are important pests of pepper. Spraying of Endosulfan 35% E.C. at the rate of 1.5 lit/ha and Dimethoate 40% E.C. at the rate of 1lt/ha controls these pests.

Irrigation: Water requirement of pepper ranges from 600-1250mm, depending on the agro climatic condition of the area. Irrigation should be applied regularly to avoid soil water deficit. Excessive irrigation can be harmful since the crop is very sensitive to water logged conditions. Irrigation frequencies of 4-7 days are common. Peppers are preferably grown under furrow irrigation.

3. Potato

Optimum altitude for the production of potatoes ranges from 1800-2900 m.a.s.l. But, it also grows in altitudes as low as 1,500m.a.s.l. The crop requires a well drained, well aerated, porous soil with a pH of 5 to 6.

Field Preparation: Deep cultivation to a depth of 25cm is essential, with organic material and fertilizer incorporated in the soil before planting. Under irrigation, the crop is mainly grown on ridges. The growing depth is generally 10-15cm, while plant spacing is 20-25cm between plants and 75-100cm between rows.

Seed Rate: Tuber planting rate varies with the size of the tuber and about 15-20qt/ha may be required.

Fertilizer: In addition to organic material, 200kg DAP and 100kg Urea per hectare would be required for satisfactory production of potato. Urea is normally given as dressing when ridging or earthing up begins.

Weed Control: Depending on weed flora one to two hand weedings are normally recommended.

Diseases: Early blight, black leg, soft rot, late blight common scab and viruses are commonly occurring diseases in potato. Use of resistant varieties and strict crop rotation is recommended.

Insect Pests: Potato aphids and potato tuber moth can cause damage. Application of Endosulfan at the rate of 1-2lt/ha is effective against these pests.

Irrigation: The crop water requirement of potato ranges from 500-700mm depending on agro-climatic conditions. A seven day interval of irrigation application is beneficial. The most commonly used irrigation method is furrow irrigation.

4. Sweet Potato

Sweet potato is grown over a wide range of climatic conditions, at elevations of up to 2,500m.a.s.l. It requires fairly high average temperatures ranging between 25 and 30^0c, with plenty of sunshine and a well distributed rainfall during the growing season. Well drained, deep but light loams and high organic matter content with a pH range of 5.6-6.6 are suitable for better production.

Field Preparation: The crop is susceptible to water logging and should be planted on ridges or on mounds to facilitate drainage. Ridges are constructed about 45cm high, 75cm between rows and 15-20cm between plants in the rows.

Seeding: Direct planting of cuttings is the most convenient method under irrigated conditions. The cuttings are taken from the vines of a mature plant and cut into pieces, some 15-20cm in length. They are directly planted with about half the cutting covered with moist soil. Under rainfed conditions the best method is to pre-root all the cuttings in a nursery, prior to planting out in the field, which should be done at the on set of the rains. The recommended plant population is in the range of 40,000 to 100,000 plants /ha.

Fertilizer: The crop responds well to nitrogenous fertilizers, but high levels may encourage excessive vegetative growth. About 250-300kg/ha of DAP, half applied prior to planting and the other half applied as side dressing two to three weeks after planting/transplanting, is recommended.

Weed Control: The crop is very susceptible to weed competition and the field has to be kept weed free during the crop establishment period. About one to two hand weedings are required the growing period.

Diseases: Viral leaf diseases, causing stunting and yellowing of the leaves have been reported. The use of resistant varieties, removing and burning of infected plants prevents spread of the disease.

Insect Pests: Sweet potato weevil is the most important pests attacking sweet potato. Leaf miner is also getting importance in some areas. Time of harvesting, earthing up and crop rotation are important practices to control the pest.

Irrigation: If irrigation is considered, water should be supplied at weekly intervals during the first three weeks. Thereafter, the interval shall be extended to 21 to 30 days interval and shall be stopped three weeks before harvesting to discourage sprouting of tubers.

5. Tomato

Tomato grows well at elevations of up to 2000 m.a.s.l. It can be grown on a wide range of soils but slightly acid conditions with pH of 5.8 to 6.8 are considered very suitable. Day temperatures within the range of 21-27^{o}C and night temperatures between 16 and 20^{o}C are necessary for optimum growth and fruit production. High temperatures and low relative humidity affect fruit setting. Excessive rainfall and high relative humidity are harmful to tomato production.

Field Preparation: Seeds are generally sown in nursery beds and transplanted to well prepared fields when seedlings reach about 8-10cm height. Plants may be established in single rows of 70-90cm apart, 30cm between plants or in double rows 45-60cm apart, 45cm between plants in the row and 75-90cm between the double rows.

Seed Rate: The seed requirement is 0.5kg/ha for a plant population of about 20,000-30,000 plants per hectare.

Fertilizer: The crop demands higher fertilizer application and about 200kg DAP and 100kg Urea/ha is the normal recommendation.

Weed Control: Two hand-weeding through out the growing period of tomato control most of the weed infestation.

Diseases: Early and late blights, septoria leaf spot, wilt and fruit rot are important diseases of tomato. Use of resistant varieties, crop sanitation and crop rotation are the principal control measures of these diseases.

Insect Pests: Insects like White fly, bollworms, flea beetle and cut worms attack tomatoes. Very selective application of insecticides based on established thresholds is recommended.

Irrigation: Tomato has a high water requirement throughout the growing period until fruiting occurs. Water requirement is between 400-600mm depending on the climate. Water application needs to be adjusted according to the use of the product. The highest yield of salad tomatoes are obtained by frequent, light irrigation. For mechanical harvesting heavy and infrequent irrigation is more appropriate with the last irrigation applied well before the harvesting date. For satisfactory yield, light and frequent irrigation of 7-14 days intervals, well distributed water application is required.

6. Haricot Beans

Haricot beans grow well in regions where there is a mean annual rainfall of some 700-1,500mm and at altitudes ranging from 1,400 to 1,800m.a.s.l. Daily temperature requirements range between 15 and 20^{o}C. A wide range of soils, from light sandy to heavy clay, are suitable for the growth of the crop. Optimum pH range is between 5.5 and 6. Haricot beans are sensitive to soil salinity.

Field Preparation: Two to three plowings are adequate but the field has to be free from big clods and weeds.

Time of Planting & Seed Rate: Wet season planting is June to July after the rains began. Dry season (irrigated) plantings are done during December to January. Seeding rate for row cropping varies from 40 to 60kg/ha depending on agro-climate and variety. Row spacing is between 40 and 60cm and spacing between plants is 5-10cm for erect types and 10-15cm for climbing types.

Fertilizer: Current recommendations are between 100 and 150 kg DAP/ha.

Weed Control: One to two hand weedings are required. Early weeding is essential, most appropriately between 25-35 days after planting.

Diseases: Haricot beans are subjected to a wide range of plant diseases. Bean rot, bacterial blight and leaf spot are commonly occurring diseases. Major control measures include growing resistant varieties, crop rotation and use of disease free seed.

Insect Pests: Aphids, jassids and African boll worm are important insect pests of haricot beans. Aphids and jassids can be controlled by spraying Marshal 25% E.C. at the rate of 2lt/ha. Boll worms are controlled by the application of Endosulfan 35% E.C. at 1.5lt/ha.

Irrigation: Water requirement varies between 350-500mm per season. Frequent irrigation (7-14 days interval) at flowering and yield formation stage is recommended. Furrow irrigation method is best suited for the crop.

7. Groundnut

Groundnut is a warm season crop and grows well at altitudes of less than 1,600 m.a.s.l. Optimum daily temperature ranges between 22 and 28°C. It can be grown in a wide variety of soil types but does best on deep sandy loam and loamy soils. In black soils, drainage shall be very adequate.

Field Preparation: Two to three plowings are necessary for good tilth. Ridges and furrows shall also be made for bunch types. The field shall be completely free from weeds.

Time of Planting & Seed Rate: It is planted in June after the rains start. Planting for irrigation would be during the months of December and January. Spacing of 45 x 15cm for spreading types and 30 x 15 for bunch types are recommended. Seed rate varies from 60 to 80kg/ha based on variety and agro climatic conditions.

Fertilizer: The recommendation is 100kg/ha of DAP.

Weed Control: One or two hand weddings ate necessary to reduce competition from weeds. The crop should not, however, be damaged during weeding or cultivation when the crop is forming pegs as this practice will affect the yield of the crop.

Insect Pests: African bollworm, aphids and the lesser Army worm can cause damage particularly to the younger plants. Endosulphan 35% E.C. at a rate of 1.5lt/ha is recommended for African bollworm and the lesser army worm. For aphids, application of Dimethoate 40% E.C. at 1lt/ha would be effective.

Diseases: Rust, bacterial wilt and 'Rosette viruses' are major diseases. The use of resistant varieties and early planting are the recommended controlling measures.

Irrigation: Depending on the prevailing climate, the crop water requirements range between 500-700 mm. Furrow irrigation is the most appropriate method of irrigation. The ridge should be flat topped and not too deep. Irrigation interval of between 14-21 days is recommended depending on the soil type and climatic conditions.

8. Maize

Maize grows well over a wide range of climates ranging from lowlands of less than 1,000 to about 2,000 m.a.s.l. But its performance is poor in altitudes of more than 2,000 m.a.s.l. It grows well on most soils, but it does better on medium textured and well drained soils. It is sensitive to water logging conditions.

Field Preparation: On the average, maize fields require three plowings to ensure fine, compact and weed free seedbed.

Time of Planting & Seed Rate: Planting season is from early April to late May, depending on the start of the rains or availability of irrigation water. Maize is usually row planted at a spacing of 30cm between plants and 75cm between rows. Seeding rate is 25-30kg/ha.

Fertilizer: Maize is a heavy feeder of nitrogen, phosphorous and potassium. Where manure is available, heavy manuring is required. Fertilizer recommendation for maize varies with the type of the soil. However, the general recommendation is to apply 100kg DAP and 100kg Urea/ha. Urea should be applied in split applications.

Weed Control: Maize is sensitive to weed competition in the early stages of its growth. Two hand weedings are recommended, the first at four leaf stage and the second at knee high stage. In between, however, inter row cultivation ensures good growth and higher yields. Herbicides like atrazine can control leafy weeds if applied at a rate of 4 lit/ha before emergence.

Diseases: Maize rust, leaf blight and head smut are commonly found diseases of the crop. Seed dressing, crop rotation and the use of resistant varieties are recommended.

Insect Pests: Stalk borer, African bollworm, maize aphids and army worm are the major insect pests of maize. Destroying the previous crop residues controls stalk borer infestation. Application (inside each leaf funnel of the plant) of Cypermetrin 1% granular or Endosulfan 3% granular or Diazinon 5% granular at the rate of 2.5-5kg/ha controls stalk borer. For the other pests, Endosulfan 35% E.C. can be applied.

Irrigation: Maize is an efficient user of water in terms of total dry matter production. Depending on the local climate and soil type, the crop requires between 500-800mm of water. It is very sensitive to water deficit during flowering period including silking, tasselling and pollination. Application of pre-plant irrigation encourages root development and reduces weed infestation. An immediate post-planting irrigation may be required depending on prevailing climatic conditions.

9. Sorghum

Sorghum grows well at altitudes ranging from 500 to 2,000 m.a.s.l. but the optimum altitude level is between 1,000 and 1,600m.a.s.l. It grows well on moist, light to medium textured, well drained and aerated soils of pH 6-8. The crop survives and grows successfully under inadequate and erratic rainfall conditions.

Field Preparation: Two to three plowings are required to prepare the seedbed reasonably well. The field should be free of clods and weeds.

Time of Planting & Seed Rate: Depending on the start of the rains, sorghum should be planted between April and May in Woina Dega agro-climates and between May and June in Kolla agro-climates. The crop is either broadcasted or row planted (spacing of 20x75cm) at the rate of 5-10 kg/ha.

Fertilizer: Recommended rates of fertilizers vary with different soil types and agro-ecological conditions. However, the general recommendation is 100kg DAP and 100kg Urea per hectare. With regard to disease and pest control the same practices used for maize can be applied.

Weed Control: Sorghum should be weeded twice; the first 20-25 days after germination and the second 45-50 days after planting. Striga spp. is the most noxious weed in sorghum fields and control of this weed is through crop rotation (with pulse crops) and pulling out the weed after flowering, just before fruiting.

Insect Pests: See Maize, above

Diseases: Smut, grain moulds and foliar diseases are common in sorghum. For the control of smuts, seed treatment using Fernesan D at the rate of 300 g/quintal is recommended. Cultural practices including use of resistant varieties, crop rotation and removal of smut infested heads controls foliar diseases and grain moulds.

Irrigation: Crop water requirement for sorghum varies between 450-650mm depending on the climate. Because of its extensive root system the crop is more drought resistant than most other crops. Irrigation could be used as supplementary to minimize moisture deficit during establishment, flowering and early yield formation.

2. LIVESTOCK

2.1 PREAMBLE

This draft report presents the initial findings of the Livestock Production/Animal Health Specialist who worked in Ethiopia during the period 16-20 November and 26 November - 5 December 2009. During this period, time was spent in Addis Ababa in discussions and in reading project and related documentation. A field visit was made to the Dinger Bereha Project Area during which discussions were held in Chewaka with wereda staff. Discussions were held in the project area with regard to their problems and aspirations.

2.2 LIVESTOCK SECTOR BACKGROUND

The agricultural sector plays a central role in the economic and social life of Ethiopia. It is the cornerstone of the Ethiopian economy and about 80-85 per cent of the population are employed in the sector. At the beginning of the 21st century the sector contributes about 40 per cent of total GDP. Within agriculture some 60 per cent of the output derives from crop production.

Livestock and their products (excluding draught power and manure that contribute perhaps almost 60 per cent of the real gross value of livestock output) account for 30 per cent of agricultural GDP. Forestry contributes about 7 per cent to agricultural GDP.

Growth in the economy as a whole remains largely dependent on agriculture despite massive efforts by the Derg regime of 1974-1991 and the current regime since 1991 to increase industrial production. Weakness in agricultural performance is reflected in that of other economic sectors. In the 10 years following the overthrow of Emperor Haile Selassie the overall economy grew slowly at 2.5 per cent per year. A drought in 1984 followed by a more severe drought in 1985 caused a massive decline in agricultural output and a dip in the economy as a whole. The subsequent recovery was again interrupted by drought in 1988. As the Ethiopian Peoples Revolutionary Democratic Front (EPRDF) took over power in 1991 GDP actually fell by 5 per cent due to the effects of war and yet another drought. There was a sharp increase in GDP of 12.3 per cent in fiscal year 1992/1993 but further dry conditions in 1993 reduced the 1993/1994 growth rate to 1.7 per cent. Growth rates of 4.9 per cent and 7.6 per cent were achieved in the two succeeding years with agriculture performing well as a result of adequate and temporally and spatially well distributed rainfall accompanied by moves toward more favourable agricultural and economic policies. Since the mid 1990s agricultural production has again fluctuated due in large part to climatic factors and especially to variable but generally low rainfall.

Smallholder or peasant farmers are the backbone of the sector. They cultivate 96 per cent of the cropped area and produce 90-94 per cent of all cereals, pulses and oilseeds. Subsistence sector technology is largely traditional and depends almost entirely on the rains for water and to a large extent on draught animals and human labour for energy inputs. Crop yields are generally low. Five cereals dominate the cultivated area. T'ef (28 per cent of the area under cereals, average yield 0.7-0.9 tonnes/ha, 1.4-2.0 million tonnes total production) occupies the largest area, but has the lowest yields per hectare and is third in total cereal production. Wheat (18 per cent of area, 1.0-1.5 t/ha, 1.0-2.1 million tonnes production) is the next most important cereal in area and is also second in production.

Maize (18 per cent of area, 1.5-1.8 tonnes/ha, 1.7-2.5 million tonnes production) is grown on about the same area as wheat but output is somewhat higher. Sorghum (16 per cent of area, 0.9-1.4 t/ha, 1.0-1.7 million tonnes production) is the fourth most important cereal followed by barley (14 per cent of area, 0.9-1.2 t/ha, 0.7-1.3 million tonnes production) as the fifth although this crop is the most important one at higher altitudes. Finger millet and oats occupy less important positions among the cereals. Cereals occupy 78 per cent of the annual cropped area with pulses (faba beans, field peas and haricot beans predominating) accounting for a further 14 per cent and oil seeds (mainly neug, linseed and sesame) bringing up the rear with 8 per cent of the area. In "normal" years it is probable that one quarter to one third of peasant output of the primary product is marketed.

By-products from these crops -- straw, haulm, pods, oil seed cakes -- are a very important source of livestock feed. There is an estimated 160,000 ha under irrigation which is a very small proportion of the estimated 3 million ha of potentially irrigable land. Some 64,000 ha of that currently irrigated is small scale which is a considerable percentage of the 165,000-187,000 ha considered suitable for this type of development.

The livestock subsector has expanded recently at a faster rate than agriculture in general. In the early 1970s livestock contributed about 25 per cent to agricultural GDP but in the 1990s the contribution had risen to about 33 per cent. Livestock are a major repository of national wealth but in relation to potential they make a disproportionately small and disappointing addition to national income and to national food security. It has been estimated that livestock provide only 6 per cent of daily calories -- less than 100 Kcals -- in the human diet. Poor performance is attributable, *inter alia*, to most native livestock resources being adapted to survival rather than to high production, a high disease challenge, inferior nutrition, inadequate support services and mediocre management.

Livestock are a strategic element in livelihoods, income generation, food security and in agricultural development. They contribute to the national economy and to human welfare via four principal pillars:

In poverty alleviation

- they are the only assets of many of the landless poor
- their products (milk, meat, eggs, wool) provide a direct or indirect source of income throughout the year
- they are a means of capital accumulation (livestock always appreciate but rarely depreciate) and provide a cash buffer in times of need

In food security

- they are a buffer against low crop yields and crop failure and are thus an important element in risk management
- milk and eggs are the only agricultural products that can be harvested every day throughout the year
- they can be productive throughout the year where crop production is difficult or impossible
- they provide draught power without which crop production in many areas would be severely compromised
- they make use of crop and agro-industrial by-products and waste and convert them to high quality human food

In environmental conservation

- they produce manure that contributes to sustainable nutrient cycling and maintenance of soil fertility and structure
- they contribute to bush and weed control in many areas

In matters of gender equality

- livestock, especially small animals are often owned by women who are denied access to land
- women (and children) often have priority access to livestock products for consumption or sale
- they reduce much of the drudgery of women's and children's work when used for transport

2.3 PRODUCTION SYSTEMS

2.3.1 General context

Livestock are an important component of most local production systems. Smallholder farmers consider animals an integral part of crop production and an essential component in their contribution to household food security, to agricultural operations, to raising capital and providing cash in times of need and to improving the quality of life in other ways. Production systems are determined by climate, the types of crop grown, the livestock species reared and their economic importance to the producer. In the highlands livestock are subordinate but complementary to crop production which is the main agricultural activity. Livestock provide almost all of the agricultural power which is a vital contribution to the overall farm economy. Provision of draught power, although rarely accounted for in financial or economic terms, is the most important function of livestock in the mixed farming systems of the highlands.

The use of draught animals is an ancient tradition in Ethiopia whereas in the remainder of sub Saharan Africa it is a relatively new introduction Ethiopia has a greater proportion of cattle in its livestock mix than most other countries which underlines the need for more feed resources.

In the highlands, demand for draught outweighs all other considerations in cattle herd structure. Perhaps 40 per cent of highland herds are oxen and in some cases, as in central Tigray, up to 70 per cent of cattle are oxen. These herds are not self-sustaining and need to draw on outside sources for draught animals. More than 90 per cent of crop production is dependent on draught power and early land preparation -- if it can be achieved -- using animal traction is virtually a guarantee of higher crop yields. In return crop residues contribute to animal nutrition and are eaten *in situ* or conserved and fed to animals in times of natural feed scarcity with this often being cited as an example of integration of crops and livestock. The relations between draught and crops are, however, very complex. Different crops have often very different requirements for land preparation. Cereals, for example, are more demanding of fine seedbed conditions than are oil seeds so households with more draught power cultivate greater proportions of cereals. The situation is even more refined in Ethiopia because of the extremely fine seedbeds required by the very small seeds of t'ef for which a very large proportion of the draught power is used where the ecology is conducive to this crop. Further inequality is introduced into the highland systems as farmers with more draught power can cultivate larger areas and do not have labour constraints of the same magnitude as those without. Since livestock are vulnerable to disease and poor nutrition -- and bear a heavy disease burden and are often severely under- and mal-nourished or even starving -- the loss of animals from disease or drought can bring even greater devastation to a household than if they were merely crop farmers. In principle the dung from draught (and other) animals should return to the soil at least a proportion of the nutrients extracted. In this way it should increase the nutrient content of the soil and improve its structure and water holding capacity which in turn helps to boost crop yields further. Because dung is also in demand as a household fuel much of its potential benefit to the cropping system is lost and although never stated this might be considered an example of disintegration.

In some highland areas fattening of cattle and of sheep is also an important and lucrative activity. Farmers often see this as a profitable means of investing surplus cash from crop sales for short term gain. Young or old oxen are fattened depending on the source of supply. In areas close to the pastoral zones it is more likely that younger stock will be purchased for feeding on but in the heartland of the highlands older oxen are fattened at the end of their productive life.

2.3.2 The production system in Chewaka wereda

Agriculture is the main if not the sole contributor to the economy of the wereda. The area was sparsely populated with a few scattered smallholdings prior to 2004. Since then the population of the wereda, which covers an area of about 32,000 ha, has been expanded to about 14,000 people under a planned resettlement programme. Families were allocated 1.5 ha or 2.0 ha depending on the number of people in the household. Rainfed crops are produced during the long 7-month rainy season. Traditional long-season and very tall varieties of sorghum are overwhelmingly predominant under rainfed conditions. Maize, finger millet, upland rice, sweet potato, soya bean and sesame are subsidiary crops. Some small scale dry season irrigation has already developed. Irrigated crops include maize, rice chilli peppers and a wide variety of vegetables. Coffee, banana and sugar cane are rapidly expanding in area and the wereda administration is encouraging the planting of fruit trees (mango, citrus, guava). All crops are subject to attack by insects, termites, rodents and baboons.

According to the wereda records about 50 per cent of the area is cropped (Table 1).

Table 2.1: Land use in Chewaka wereda

Land use	Area	
	ha	per cent
Cultivable area	24,900	48.5
Forests and grass	23,314	43.0
Hills and stony areas	1,950	3.5
Marsh and water bodies	1,750	3.2

Source: wereda records

Livestock are a small but possibly not unimportant component of the overall system. Oxen have been provided to settlers by the administration in order to complement the crop component in the provision of draught power. Most cattle are "stall fed" (but actually tied loosely by the neck in the shade of trees, Figure 1) using a primitive and low input system which, in the main does not include an element of concentrate feeding. Cattle of about 1-year old are bought at a value of about Birr 1200 and fed for two or more years until they are sold fat two or more years later at a value of Birr 3000-4000. Other cattle are herded in small units as are sheep and goats although the small ruminant species are often allowed to roam freely. Poultry provide a subsidiary source of food and income. Bees are "farmed" in the traditional way and their honey gathered by the simple expedient of setting fire to the tree in which they have built their nest and then robbing them of their honey. Some modern hives have been introduced and distributed by the administration.

Figure 2.1: "Stall- fed" cattle under the shade of a tree

2.4 LIVESTOCK RESOURCES

2.4.1 Numbers and Ownership Patterns

Information on livestock numbers in the wereda have been obtained on at least two occasions. They do not bear a great deal of resemblance to each other (Table 2). What needs to be noted between the two dates is that in little over a year there is:

- a doubling of oxen numbers;
- a 5-fold increase in small ruminant (sheep and goat) numbers; and
- a 3.5-fold increase in poultry numbers.

It should further be noted with respect to the November 2009 data that:

1. the numbers of small ruminants per owning household is high in the national context;

2. the percentage of households owning poultry (12.6) is much lower than households owning nationally (about 60); and

3. the numbers of poultry kept by owning families (25) is much higher than the national average (6-10).

Additional data from September 2008 indicate that 5935 farmers had no oxen, 6578 had one ox and two 695 farmers had two oxen to give a wereda total 7274 oxen.

Table 2.2: Livestock numbers in Chewaka wereda

Livestock species/class	September 2008			November 2009			
	Number of animals	Average number all households/a		Number of animals	Number of households owning	Average number per owning household	Average number all households/b
Oxen	5,168	0.37		11,382	7,802	1.46	0.86
Cow	203	0.01		799	511	1.56	0.04
Heifer	2,021	0.14		??	??	??	??
Sheep	1,341	0.1		41,380	2,113	19.58	2.92
Goat	7,490	0.53					
Donkey	1,481	0.11		??	??	??	??
Poultry	12,154	0.87		41,724	1,662	24.83	3.19
Modern hive	2,240	0.16		??	??	??	??

Notes: *a) 14,026 households*

b) 13,209 households

Sources: *wereda administration for basic numbers*

2.4.2 Genetic Resources

For thousands of years Ethiopian farmers have consciously and unconsciously selected locally adapted animals from the pool of their domestic livestock. Their characteristics now are more often relevant to survival and to minimizing the risk of total loss than to high levels of production. These traditional species and breeds still dominate the livestock subsector in Ethiopia and representatives of them are the ones found in the Project Area.

2.4.3 Cattle

The main cattle breed in the area, the Horro type, is well known as a milk producer and is the commonest type in the west of Oromiya State. Horro cattle belong to the Intermediate Sanga/Zebu group, are generally a rich brown colour, have medium-long horns (Figure 2) and are reported to be extremely docile The mean lactation length is 314 +/- 91 days. The total lactation milk yield is 587 litres, 37 per cent of which is suckled by the calf. Average yearly household butter production is 31.5 +/- 8.9 kg. Mean body weight one week after birth is 15.2 +/- 3.0 kg and daily weight gain from birth to 6 months is 110 +/- 41 g. Oxen are worked seasonally for about 101.7 days per year with ploughing (89 per cent of work time) being the major activity.

Low production performance is explained by inappropriate calf management, a probably inadequate diet, widespread disease and presumed low genetic potential.

2.4.4 Sheep

The common sheep of the area is the Horro. This type is found in the western and south western parts of the country and is widely distributed from Shoa to East and West Wollega, Illubabor and Jimma in Oromiya Regional State. These are among the largest Ethiopian sheep with adult males standing about 73 cm at the withers and females about 68 cm. Birth weights are 2.8-2.9 kg, weaning (90 day) weights are 13-15 kg and yearling weights are 25-33 kg. Ewe mature weights average about 30 kg. The predominant colour is a solid rich dark tan although other colours do occur. The hair is short and shiny. Rams often had longer coarser hair down the underside of the neck and a mane overt the neck and shoulders. The face profile is usually straight although it may be slightly convex in males. The Horro has a relatively long neck without a pronounced dewlap. There are fat deposits under the jaw and in the brisket in animals in good condition. The tail is large and fat, pendulant, sometimes with a slight twist and descending below the hocks. The Horro is a somewhat prolific sheep with up to 60 per cent of older ewes giving birth to twins.

2.4.5 Goats

The Western Highland goat is the most common type in the Project Area. It is related to both the Central Highland and Keffa types. These goats are found widely in the Highlands of South Gondar, Gojam, Wollega and West Shoa. The Western Highland is a relatively tall goat standing 81 cm at the withers and weighing 48 kg in adult males and 71 cm at the withers and weighing 33 kg in adult females. It has a concave facial profile. The body is covered in long coarse hair. Colours are variable, either whole or in patches and spots (Figure 3). Both males and females usually have straight, short, backward oriented horns although some animals are polled. Males sport beards and ruffs and some animals have wattles. They are of medium to high prolificity.

2.4.6 Poultry

All poultry in the area are "indigenous" types. Local fowl show great variation in body size and shape, feather contours, plumage colours and combinations of plumage colours and comb type. Mature weights are in the range 1.3-1.7 kg for cocks and 1.0-1.2 kg for hens.

Figure 2.3: Western Highland goats on free range management system

2.5 FEED RESOURCES

The natural vegetation of the area between 35 and 38 degrees east longitude and 7 and 10 degrees north latitude in the altitudinal range of 14-200 metres above sea level with an annual precipitation of 1000-1400 mm is generally more or less broad-leaved savanna woodland ranging into open wooded grassland. The Project Area is typical of this ecotype and due to the fact that it has only recently been settled much of the area that has not been taken into cultivation is in near pristine condition.

The tree layer comprised mainly deciduous trees and deciduous and evergreen shrubs. The main genera are *Acacia*, *Millettia*, *Cordia* and *Ficus* with occasional *Podocarpus*. Many of these are "multipurpose" trees, stabilizing the soil, shading the environment, providing local medicines, producing firewood and charcoal and being browsed by livestock. The understorey comprises mainly tall coarse grasses including *Pennisetum*, *Hyparrhaenia* and *Setaria*: shorter finer grasses include *Chloris virgata* and *Rhynchelytrum repens*. Some of these grasses provide valuable animal feed but others become unpalatable very quickly as they grow through the rainy season. There have already been some limited attempts to plant forages as Guinea grass (*Panicum naximum*) was seen growing in the wereda administrative compound.

In relation to current livestock numbers there is an abundance of crop residues and by-products. Sorghum stover is not preferred by livestock but finger millet and maize residues provide adequate quantities – even if low in quality – of feed. Other crop by-products include the tops of sweet potatoes (and occasionally the tubers), sorghum leaves.

Unusually for Ethiopia there is no animal feed problem in the area at the present time.

2.6 SERVICES

2.6.1 Extension

The wereda Bureau of Agriculture and Rural Development is responsible for agricultural development activities. Under this large umbrella it is responsible for providing extension and development advice for livestock. As is often the case the Bureau has little access to transport and equipment and is constantly short of recurrent funding with which to carry out its duties.

2.6.2 Animal health

The wereda has eight veterinary assistants/animal health assistants who have been trained at Alage Agricultural TVET College. Two of these are posted in the wereda capital and the four others out in the villages. The wereda has one Class C clinic and two Class D clinics either operational or under construction. These clinics have only very limited capability in disease diagnosis. In discussions with farmers they expressed limited satisfaction with the field services provided. They occasionally had visits from the veterinary personnel but more often had to go themselves (often taking their animals with them) to the clinic location to obtain treatment or veterinary pharmaceuticals.

Trypanosomosis transmitted by the tsetse fly was signalled as the main cattle disease by both wereda personnel and farmers themselves. Sick animals are treated either by injection or by oral administration of appropriate drugs. Peste des Petits Ruminants is the main disease of small ruminants: it can be controlled by vaccination but is not. Other diseases of cattle include contagious bovine pleuropneumonia, pasteurellosis, lumpy skin disease, anthrax and blackquarter. Most animal health services and pharmaceuticals are provided free of charge to livestock owners. The latter, however, are prepared to pay for the cost of some treatments.

2.6.3 Marketing

Livestock marketing in the area is informal. Most animals are taken to the regular weekly market where they are sold directly by the farmer to a final consumer, to a local butcher or to traders who then move the animals on to a larger market for resale or to the regional centres for slaughter.

2.7 LIVESTOCK PRODUCTIVITY

2.7.1 Overview

The most common judgement on Ethiopian livestock is that they are of poor genetic potential and that productivity is low. What is meant, however, is that "production" (= output) is low as "productivity" implies an output in relation to inputs. Ethiopian livestock hardly benefit from the latter. There are certainly considerable opportunities for increasing both production and productivity if the necessary inputs can be made available in sufficient quantities and farmers can be persuaded to improve their management standards.

Offtake from the national herds and flocks is estimated at 8 per cent for cattle, 19 per cent for sheep and 25 per cent for goats. Most offtake -- about 82 per cent of cattle, 93 per cent of sheep and 95 per cent of goats -- is "unofficial" (private or household) slaughter with only very small amounts entering the market. Livestock exports in the late 1980s were made up of hides and skins (83 per cent), live animals (11 per cent and canned and frozen meat (6 per cent). Per caput consumption of milk is estimated to be 16 kg and of meat 10 kg (down from an estimated 13 kg in the mid 1980s): these consumption rates put Ethiopia at the bottom of the league constituted by it and its neighbouring countries despite its high livestock numbers.

2.7.2 Cattle

Cow reproductive careers in all of Ethiopia's livestock production systems are characterized by late ages at first parturition, long intervals between births of successive calves and low numbers of calves per lifetime. Overall calving rates assessed in several studies at 45-55 per cent per year imply a calving interval of two years. Calving is seasonal in most areas of the country and differs between regions: although the picture is not absolutely clear it is most likely that conception is related to rainfall and thus to the availability of feed and cow nutritional status.

Estimates of mean daily milk offtake for human consumption are about 1.3 kg from local cattle and about 2.8 kg from crossbreds. It is likely that the mean daily offtake is inversely correlated with the number of breeding females in the herd and the number of cows in milk. Milk is essentially a by-product of the traditional draught/beef herd with seasonal production peaks coinciding with the main rainy periods.

Meat output per unit total weight carried is low. This is not only because a large proportion of the highland cattle herd is draught animals but also because of slow growth rates and the fact that animals are often in poor condition at slaughter. Dressing percentages of carcass weight to empty body weight are usually well below 50 per cent. Carcass weights of cattle killed through official channels averaged 167 kg in the early 1990s with deboned meat representing 58 per cent of the carcass weight or 28 per cent of the live weight. Carcass weights of cattle killed "unofficially" are estimated at 135 kg.

The main function of cattle in the highland mixed farm economies is undoubtedly the provision of power. The overwhelming demand for oxen in these systems has a distorting effect on all other cattle production functions, even in the lowlands which act as reservoirs of draught stock. Herd composition varies as a function of the need for draught. The national herd probably comprises about 25 per cent oxen but the proportion varies in the range 2.6-32.1 per cent depending on the importance of agriculture and ox fattening (Table 3). In extreme cases, as in Tigray in the 1970s, work oxen make up as much as 70 per cent of the total herd as farmers strive to keep these alive or on the farm at the expense of other classes of stock.

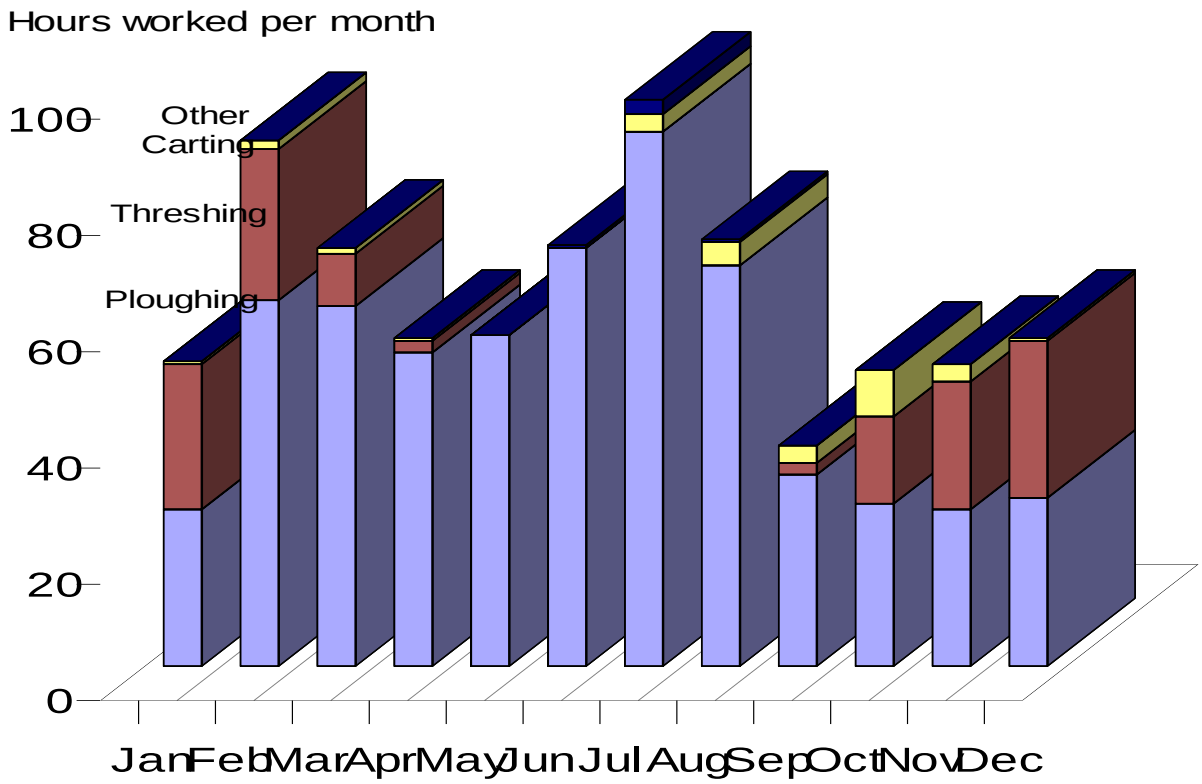
Table 2.3: Examples of cattle herd composition (per cent) in various regions

Region	Class of stock		
	Females	Males	Oxen
East Shewa	45.9	22.0	32.1
South Shewa	60.0	19.0	20.4
West Shewa	57.4	24.8	17.8
Borena	69.9	27.5	2.6
East Harerghe	62.7	26.4	11.0
Illubabor	43.0	26.3	30.6
Total	55.6	23.9	20.5

Source: GRM, 1994

In spite of their importance in farming systems oxen work only a short period. One estimate is of 120 days a year of which 93 ploughing, 21 threshing, 5 for transport and 1 for other work (Figure 4). The average working day for an ox is about 5 hours 10 minutes to 5 hours 40 minutes but it takes many breaks in this period. Power output per ox is low because of the generally weak condition they are in during the main working seasons and because they are of relatively light weight. In addition to these biological constraints on the work efficiency of oxen there are social ones that are associated in particular with the culture and tradition of the Ethiopian highlands. Even during peak periods work oxen are used for only about 75 per cent of the possible time and have to take enforced holidays on the several days a week when their owners are not allowed to do certain kinds of work for religious reasons. If farmers could be persuaded to use their oxen more effectively the approximately 24-27 per cent of possible time they work at present could be considerably improved and would reduce the need for large numbers of oxen. The use of cows for work, which is not practised so much in most area, would also increase the efficiency of the whole herd.

Figure 2.4: Number of work hours per ox by type of work and month



(Source: adapted from GRM, 1994)

Mortality rates are very high in calves and average about 25 per cent before weaning. Mortality in yearlings is probably about 13 per cent and in adults is about 5-8 per cent depending on the region.

2.7.3 Sheep

Reproductive performance is usually well below the optimum and the genetic potential. Nutrition and disease, especially internal parasites, are constraints to better reproductive performance. Late ages at first parturition, long intervals between lambings and low lifetime output of young are problems similar to those of cattle but most Ethiopian sheep have very small litter sizes. A large proportion of barren or infertile ewes (perhaps 20 per cent overall) also reduces reproductive performance in the national flock. The local Horro breed is exceptionally prolific in this respect. The litter size for the Horro in the yearly cohorts from 2 to 5 years is 1.21, 1,64, 1,66 and 1.76: the small size of the first (2-year old) litter is of particular note and leads to the suggestion that allowing first lambing at an earlier age (the ewe would be able to support this litter size) would lead to greater total lifetime production as another, larger litter could probably be born toward the end of the ewe's productive life. Poor reproductive performance has repercussions on flock structure as owners maintain older animals in a desperate attempt to get more lambs: although this practice may be marginally beneficial to individuals it has a negative community effect as it contributes to the maintenance of unproductive animals and to overstocking.

Weight gain is relatively rapid in the early stages of growth but overall can be considered to be poor: Afar sheep gain only 90 g/day to six months of age. Carcass weights represent about 40-45 per cent of empty live weight in sheep of average to fair condition but may be as low as 35 per cent in animals in poor condition. For most breeds the average carcass weight is thus in the range 10-12 kg with exceptional carcasses weighing 15-18 kg.

Skins are an important output of sheep (and of goats). More than one in five skins (and hides) coming onto the market are subsequently rejected for export and supplied to the domestic market. The main reasons for export rejection are damage due to mange, cuts Mortality rates in young stock are high. Preweaning mortalities of 25-30 per cent are not unusual. Annual mortality rates in animals 6-15 months old may be as high as 15-18 per cent. Adult mortality averages about 8-10 per cent per year.

2.7.4 Goats

Goat reproductive performance is usually better than that of sheep. Ages at first parturition may be 18 months. Because of their feeding habits goats are less affected by nutritional fluctuations than sheep and tend to have shorter intervals (8-10 months) between parturitions. Litter sizes may average 1.4 young over the national flock with the Nubian types in the north being especially prolific. The Afar goat has a very small litter size.

Native goats have birth weights of about 2.6 kg. In Highland goats weight increases progressively to 6.2 kg at 1 month (average daily gain = 120 g) to 9.0 and 12.6 kg at 3 and 6 months (a.d.g. = 71 and 40 g to 15.5 kg at 9 months (a.d.g. = 32 g). Weight gain of Afar goats is only 45 g/day to six months of age. Mature weights are 28-35 kg for Highland goats.

Mortality rates in young stock are very high. Preweaning mortalities of 30-35 per cent are not unusual. Annual mortality rates in animals 6-15 months old may be as high as 15-18 per cent. Adult mortality averages about 8-10 per cent per year.

2.7.5 Poultry

Poultry production is characterized by household scavenging flocks of local birds and is concentrated in the temperate zones at 1,500-3,000 m altitude. Output of products in this system is achieved from a feed resource which is unsuitable for human consumption. Information is of necessity unreliable but 1990 data suggest that total production is about 79,120 tonnes of eggs and 76,560 tonnes of meat per year. This level of production accounts for about 15 per cent of all Ethiopian meat production.

Average household flock sizes are 6-10 birds. Each hen produces between 55 and 80 eggs per year with an average egg weight of 30 g. Mature body weight ranges from 1.0 kg for hens to 1.5 kg for cocks. At least one clutch of 10-15 eggs is allowed to hatch under a broody hen. Egg fertility and hatchability are low resulting in a hatching rate of around 40 per cent of eggs set. Bird mortality is extremely high due to disease and predators: Newcastle disease alone can kill up to 80 per cent of the total unvaccinated bird population every year.

2.8 DEVELOPMENT STRATEGIES

Livestock are crucial to the rural economy as a source of food and wealth and as a source of draught power and fuel and as a hedge against the risk of crop failure. Animal production is not primarily directed to production of a marketable surplus. The challenges to guaranteeing food security and alleviating poverty require sustained increases in production and productivity. There is clearly good potential for this and some technologies exist or can be adapted to increase output. Farmers will probably respond to appropriate incentives, better market access and technology transfer.

Strategic options to improve livestock production in general include:

- giving more priority to livestock production;
- making more appropriate production technology available to farmers through better extension services and advice;
- continuing to reorient the role of government in creating an appropriate enabling environment;
- continued investment in human resources development and especially of farmers; and
- better natural resource management and beneficiary participation in efforts and rewards

2.9 LIVESTOCK AND FEED PRODUCTION: OPPORTUNITIES AND CONSTRAINTS

2.9.1 Opportunities

There are good possibilities for increased livestock production and productivity in the Project Area. Opportunities for improving what is a less than optimal livestock production situation lie in:

- continued improvement to farmer output by encouraging them to help themselves through private delivery and supply of most services and inputs and via training, empowerment and use of animal health auxiliaries or community veterinary workers drawn from within their own communities;
- improved amounts and quality of information (feed supply, disease situation, market availability and prices) for use by local services and livestock producers alike;
- the lucrative internal markets for meat;
- ensuring that the already improved land tenure situation remains in place to encourage farmers to invest in activities that would have beneficial effects on the environment and contribute towards sustainable production and that would also allow land to be used as collateral for access to credit;
- encouraging further diversification of animal production through promotion of apiculture (beekeeping) not only to supply human food and increase incomes but also to maintain biodiversity and improve crop yields through pollination activities;

- ensuring that existing and planned developments in the livestock subsector complement rather than compete with each other;
- continued and closer integration of livestock into the arable areas by introducing a range of forage and especially leguminous crops in the arable rotation to serve as livestock feed and to maintain and improve soil fertility and structure;
- a clear potential for intensification of fattening in the irrigated crop-livestock system as well as elsewhere; and
- possibilities for improved nutritional value of crop residues using any or several of the well known techniques for intervention.

There are clear opportunities to add value to the livestock subsector. These opportunities include assistance towards the transparent sale, safe and easy movement of healthy animals to local and export markets, increased production of standard and high quality feed, human resources development across the whole of the subsector from producer to policy maker, better provision and use of information, strengthening of public health and inspection capabilities and development of enhanced lines of input supply and credit. The adapted cattle, sheep and goats are a very suitable base for an increased supply of animal products. There is also a clear possibility of improving the genetic potential of indigenous livestock for increased and more efficient production. These are areas where, given an appropriate enabling environment, there is likely to be increased producer interest.

2.9.2 Constraints

Poor agricultural performance is reflected in the national annual food deficit which can rise to levels that are considerably more than 1 million tonnes in some years. The sector has been beset with natural calamities and in particular a series of periodic severe droughts. The substantial natural potential of the highlands, its fertile soil and good rainfall have not been realized. The main constraints have been lack of modern inputs for the small scale subsistence sector especially fertilizer, inadequate availability of credit to small farmers and poor credit recovery, civil war and widespread disorder. These have drawn resources away from productive uses within the sector. These constraints have been considerably compounded by poor sector policies including especially controls over input and output prices.

Animal nutrition and health are major constraints. Even in the Project Area where the quantity of feed at present is not limiting there are still likely to be nutritional problems. Because of the nature of the sex and age composition, especially of cattle, most feed is used for maintenance and probably less than 15 per cent of the total is used for production. In spite of the distribution of oxen to new settlers most farmers have only one draught animal whereas two are needed for adequate performance. In the absence of sufficient draught power food security is diminished. The negative influence of diseases and parasites affects production through increased mortality and affects productivity through low fertility, slow growth and limited milk production leading to yet less efficient use of feed. Some attempts have been made to address deficiencies in the subsector but field services remain plagued by inadequate support, poor motivation and insufficient direction. Government control over the supply of goods and services has been, and remains, very strong but continues to be inefficient. There have been considerable relaxations in regulations regarding veterinary pharmaceutical distribution and sales but it is to be noted that there are no privates sales of animal medicines in the Project Area[1].

[1] When the question of private supply of animal health services was raised with the wereda administration they considered the enquiry to be very odd: “oh, no, it is only Government that does that”

Non-technical constraints such as the balance of operations and management between central and local governments, an absence of clear livestock development policies and strategies, the pace of privatization and the possibilities of cost recovery for goods and services are also, and may become more, important in the development scenarios for the Project Area's domestic livestock.

2.10 LIVESTOCK PRODUCTION: POSSIBLE PROJECTS

2.10.1 Improved nutrition

There is a wealth of information available on techniques for improving the nutritive value and rendering fibrous content more digestible and palatable of crop residues including treatment with urea and with sodium hydroxide. These techniques are technically sound and can provide improved nutrition. The alternative of supplementation with readily available high protein feeds is widely understood (but currently less practised) in Sudan and also offers good prospects for intervention. Animal conversion of the fibrous content of both coarse range feed and crop residues can also be improved by providing readily available sources of energy (e.g. molasses) and protein (e.g. nitrogen in the form of urea). Most animals also have a deficit or imbalance of minerals and vitamins.

A project should be set up provide livestock producers with the necessary information, training and equipment to treat fibrous feeds as described and also to manufacture molasses-urea/multi nutrient blocks to feed to their stock.

2.10.2 Apiculture

The products of Ethiopian hives are well below their potential. Honey is already used as a sweetener and as a conserve and for making "t'ej". Beeswax has a variety of uses especially by the Ethiopian Orthodox church (Figure 5).

Output of hive products can be increased by a gradual shift from traditional production from hunter gathering and fixed bar hives to intermediate technology top bar hives and better processing. Apiculture is in line with Government policies in that it reduces risk, increases household incomes, adds to food security, can lead to the empowerment of women and is beneficial to the environment. The use of top bar hives can lead to 3-fold increases in yields of honey and can be very profitable because of low input costs. There are substantial market opportunities for honey, beeswax and other hive products and financial returns can be increased though various methods of adding value and through marketing of minor but very high value products such as royal jelly, pollen and propolis that can be used for cosmetics and in medical products.

The components of an apiculture product should include provision of improved hives, training of local craftsmen to manufacture hives, training of producers in management of bees and in processing of products, provision of marketing information and assistance with marketing. Such a project would be very suitable for women and for operating through a cooperative system.

Figure 2.5: Some products of the Ethiopian beehive

2.11 FEED PRODUCTION: POSSIBLE PROJECTS

Nutrition is a major constraint to improved production and efficiency in the livestock subsystem. Production of forage/fodder is a low cost intervention. Various forage interventions provide a mechanism for addressing potential land degradation and for improving the sustainability of crop farming. A forage programme would support improved output of work oxen which are often in poor bodily condition when work is required of them (Figure 6), stall fed fattening and poultry enterprises. Growing of fodder would improve the profitability and sustainability of the livestock enterprise, would help to stabilize the cropping system and would significantly improve the livelihoods of the people of the area. It would also have a marked impact in terms of addressing the potential and ever-present land degradation seemingly inherent to Ethiopian agriculture.

Figure 2.6: Draught oxen in poor condition at the start of the ploughing season

Interventions to improve the quantity and quality of livestock feed should include growing of fodder in backyard or feed gardens, contour forage strips and specialized plots for cultivation of legumes.

Activities in feed production should include:

- promotion of a variety of forage interventions for both individual and communal activity;
- provision of additional improved genetic material for the range of target interventions; and
- training of farmers and field staff with emphasis on hands-on approaches.

Criteria for the selection of forage material include:

- adaptation to prevailing site characteristics;
- highly productive;
- high nutritional value;
- capable of long term persistence and natural spread;
- conspicuous to foster farmer interest;

- dual or multipurpose to provide for livestock feed, human food and fuel wood; and
- suitable for ready multiplication (seed or vegetative systems).

Crops to be considered would include grasses, herbaceous legumes, tree/shrub legumes and some other fodder crops. Most emphasis should be on perennials and self-regenerating annuals.

2.11.1 On-farm (individual) activities

Figure 2.7: A successful backyard fodder plot

1. Back-yard forage (rainfed and irrigated). 200-1000 square metres. Emphasis on highly productive and dual purpose species (Figure 7). A perennial sward for cut-and-carry use only. Must have good protection from livestock.Hedgerows of leguminous trees and shrubs. 20-100 linear metres. Emphasis on more effective use and increasing the number of trees per unit. Leucaena would appear to be the most appropriate species.

2. Contour-planted forage strips. 50-200 linear metres. For sloping areas with annual cropping. Emphasis on erect grasses and companion legumes. Strategy to complement hedgerows in some cases.

3. Undersowing forage legumes in annual crops particularly maize and sorghum. 500-2000 square metres. In addition to the already popular use of vetch should include more intercropping with pigeon pea and other dual purpose species.

4. Cover cropping with shade tolerant forage legumes under perennial crops such as coffee. 200-1000 square metres. For cut-and-carry management.

5. Annual and short-term forage crops. 200-1000 square metres. Species should include butterfly pea and burgundy bean on better soils and emphasis on dual purpose feed-food species including quick maturing cowpeas and pigeon pea.. Useful also for break cropping on rainfed areas to address the invasion of *Striga* and other pests and diseases.

2.11.2 Community activities

Figure 2.8: Successful oversowing of a grazing area with Guinea grass (Panicum maximum)

1. Oversowing of grazing areas. 5-20 ha (Figure 8) or linear along road side (Figure 9). Very low seeding rates (e.g. 0.5-1 kg/ha) are indicated with gradual recruitment of introduced species over the medium term. On suitable sites oversowing will have a direct cost of less than EB 10 per ha and within 3-4 years could lead to improved livestock production ranging from 30 per cent to more than 100 per cent. With emphasis on leguminous species the benefits derive more from improving the protein level of the feed for much of the year rather than through incremental forage productivity.Reinforcement of stock exclusion areas. 1-10 ha. Development would include oversowing, sowing into prepared strips, some vegetative establishment and some planting of tree legume seedlings.

2. Forages in seasonally flooded lowland and drawdown areas. (Drawdown areas are those between high and low water levels in dams, etcetera.) . 1-10 ha. Good prospects even if flooding occurs only once every few years. Based primarily on quick maturing legumes with good tolerance of waterlogging which would regenerate after subsequent flooding.

The relative importance of the various interventions would depend on a number of factors with farmer/community response to increasing land pressures likely to be pre-eminent.

Figure 2.9: Forage strip planted along a roadside (jointvetch, Aeschynomene sp.)

The likely results are:

- the generally high rainfall of the Project Area will produce some successes but seasonally heavy cover of native grasses may occasionally be limiting;
- on suitable sites there will be good persistence and spread and in heavily grazed areas with little grass cover livestock gains will be directly related to legume productivity;
- where legumes are successfully established in areas with better grass cover there can be a synergistic effect through having a high protein legume available to complement the low-nutritive value of dry season grasses;

- livestock productivity gains may be in the region of 30-50 per cent even in the absence of other interventions; and

- in suitable areas lateral spread through grazing livestock can be rapid.

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