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

EXECUTIVE SUMMARY

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1. INTRODUCTION

1.1 Context of the Study

Under ENSAP it was decided to carry out the Eastern Nile Irrigation and Drainage Study (ENIDS). This Study aims at contributing to the enhancement of food security, reduction of rural poverty, and reduction of population pressures in the region, with all associated beneficial effects on the environment. It will also contribute to attaining the agricultural sector goals of the participating countries, towards an integrated approach to irrigation and drainage development in the Eastern Nile sub-basin as a means for enhancing food security, poverty reduction, improved welfare of the rural population and sustainable natural resource management. The Study has two components:

- The Engineering Sub-component to identify and study at feasibility level a total of 15,000 ha (net) in Ethiopia and Sudan for development of irrigated agriculture.

- The Cooperative Regional Assessment (CRA).

The Inception Phase of the Study commenced in September 2007. The findings of this phase indicated that there was a need to undertake detailed field surveys related to soils, topography, and geotechnical investigations that would be a critical input to the Phase 2 Feasibility study under the Engineering sub-component. However, the sites would have to be selected first during Phase 1 of the Engineering Study. The Joint Venture of consultants BRLi of France, MCE of Ethiopia and Shoraconsult of Sudan (hereinafter named ‘ the Consultant’) has been working on the Study since September 2007. During the Diagnosis Phase a large number of project sites in both countries were described, compared and ranked on basis of a number of criteria. The results have been presented in the respective reports. The analysis showed that many projects identified and ranked were already under study at feasibility level, apart from projects that were ranked low in the Abbay, Tekeze and Baro-Akobo Masterplans. Moreover, many sites not yet under study such as Galegu, Rahad and Lower Beles covered areas that were much larger than 7,500 ha net. The smaller sites included the Didessa Pumping Project and the Dabana Project in the Didessa Valley, as outlined during the Abbay Masterplan Studies.

The site for the Didessa Pumping Project was preselected for further study as it was located in a populous zone, near a major town and near good infrastructure and services. The Consultant carried out a brief study on this site and quickly came to the conclusion that is was not suitable at all for the development as proposed in the Masterplan. Subsequently, the Didessa State Farm on the right bank of the river and adjacent to the main road between Nekempte and Assossa was found to be a good site for irrigated agriculture, but further studies showed that the investment and recurrent costs for delivery of water either by gravity or by pumping would be prohibitive. During the latter studies, it appeared that the left bank of the river opposite the Didessa State Farm, upstream of the confluence with Dabana River presented better opportunities. This area was part of the Dabana Project, as formulated by the Abbay Masterplan. This project was ranked very low at the time because of many reasons that are not relevant anymore. A preliminary study was carried out for the new project site and the indicators were very positive so the Consultants strongly recommended to select this site for feasibility study.

1.2 ADDITIONAL INVESTIGATIONS

In October 2008, a preliminary go-ahead was given for the intended studies Dinger Bereha. In view of the topographic features of the Project area ENTRO and the National Coordinator (NC) requested the Consultants to justify the feasibility of the area for further studies. In association with the findings during the visit the NC requested the Consultants to investigate the technical feasibility of the Nekempte Project area as well, as the topography of the area located south of the Angar River was reported to be more suitable than the topography at Dinger Bereha. In November 2008, the Consultant prepared a technical note that would enable the Client to make a final decision. The note advised against the selection of Nekemte project and strongly recommended selecting Dinger Bereha for further studies, during which gravity and pump options would be compared. Following a review of the technical note the MoWR decided on 24th December 2008 to endorse the selection of the Dinger Bereha site for feasibility study. Subsequently, ENTRO made arrangements, intended to prepare soil and topographic maps as well as to undertake geotechnical investigations of the selected site. The terms of reference of the surveys were prepared in the beginning of 2008, and after funding was committed by the AfDB, a RFP was issued in March 2008. Proposals were submitted in July 2008 and after evaluation, selection and negotiations a contract was signed in January 2009 by ENTRO and the Consultant. The precise boundaries of the area to be studied were to be determined during the Inception Phase of the additional investigations. Inception Reports were prepared and the final version of these reports was approved in May 2009. Surveys, laboratory work, mapping and reporting were carried out between the end of April and the end of October. Part of the toposurvey work and geotechnical investigations could not be completed because fieldwork had to be suspended due to inaccessibility of part of the Study area during the rainy season. In spite of the best efforts of the Consultants this could not be avoided, as the start of the fieldwork had been delayed until the end of April due to circumstances beyond the control of the Consultant. Fieldwork was continued when the area became accessible again. Toposurvey work along the river could not be restarted before the end of January 2010 because of very tall wet elephant grass in swampy conditions. Finally, the fieldwork was completed in March 2010.

1.3 IDENTIFIED DEVELOPMENT OPTIONS AND PROJECT OUTLINE

During the first phase of the ENIDS two alternatives for irrigation were identified:

- Option 1: Pumping, without diversion weir: a pump station on the left bank of the Didessa River at an altitude of +1220m would lift water to +1240. Downstream of this site the riverbed drops 40 m over 4 km, thus increasing the required lift rapidly over a short distance and rendering pump irrigation very costly. A 31 km long canal running at +1240m would command the eastern area located between contour +1240 and the river. The western side would be irrigated by a 14 km long secondary taking-off at the d/s end of a siphon connected to the eastern main canal. The area located between +1260 and +1240 on the western side of Hora Chewaka valley would be irrigated by a booster pump station and associated conveyance and distribution systems.

- Option 2: Gravity diversion and boosterpumping: about 15 km upstream of the option 1 river pumpstation site the riverbed has an altitude of +1240m. At this site, the river has a bed width in the order of 150 m and water could be diverted by a 3-4 m high concrete weir to a main canal running on the left bank that would follow the +1244 contour at a gradient of 0.1-0.2m/km to the foot of the Lebena ridge, at the most eastern tip of the irrigation scheme. The canal would run closely to the river through an area with a cross slope between 3 and 10%. The command area between +1240 and +1260 would be irrigated by two boosterstations, as in option 1.

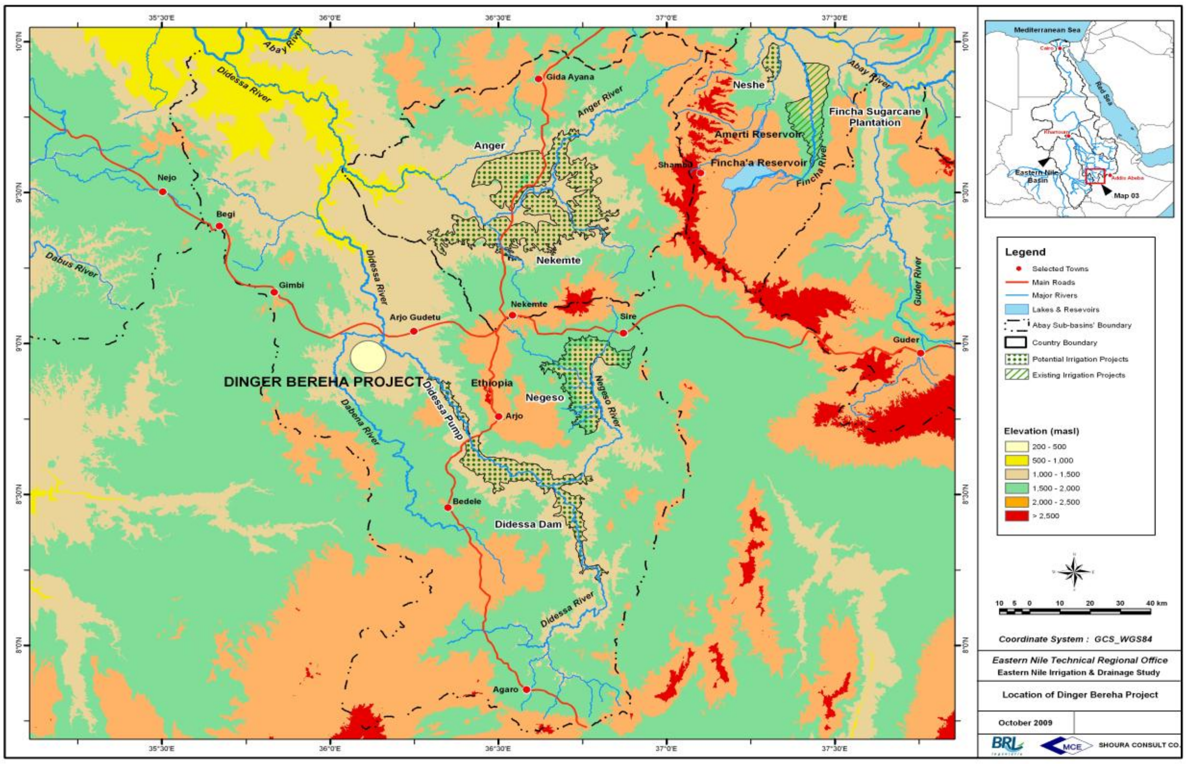
Irrigation of land would be possible on the left bank in an area, bounded by contour +1260 to the west, by river Dabana to the north and by Didessa River to the east. The gross command area would be in the order of 11,200 ha. Excluding a bufferzone the net irrigable area under command by gravity & one stage pumping or by two stage pumping was estimated at 7,850 ha or 70% of the total gross area. The survey and geotechnical investigations programme of fieldworks was based on option 2, with fieldwork for option 1 included.

2. DESCRIPTION OF THE PROJECT AREA

2.1 GENERAL

The project area is located in Chewaka Woreda of Illuababora zone, Oromia National Regional State (ONRS) (see map 1). Distances between Bedele and Addis Ababa are 74 and 560 km respectively. Access is currently difficult, but will be greatly improved by a bridge under construction linking the Woreda to the main road between Nekempte and Assossa. The Woreda is a newly established settlement scheme (2004) when people from drought stricken Eastern and Western Hararge Zones of ONRS were resettled in the area on free will basis. The original number of households resettled was estimated at 12,390. However, the current number of households is 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 55,400ha. The altitude variations from less than 1,100 masl in the low lying valley bottoms to about 1,800 masl in the nearby mountain ranges have little effect on variation in temperature and rainfall patterns in the Woreda. The command area is bounded by contours +1240 and +1260. However, these areas are characterized by undulating plains and strongly sloping terrains, with slopes ranging from 0 to 8%. A large portion of this area is currently under rainfed cultivation. The resettled population has previous experience of irrigation in its region of origin and has developed a number of traditional irrigation schemes tapping water from springs or streams to produce cash crops in the dry season. When the settlement scheme was initiated, allocation of land was determined to be 2 ha per household.

Map 1: Location of the Dinger Bereha Project



Currently, the program has been 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 land holding size, which is less than 1ha, farmers in the Project area are relatively better off than their contemporaries elsewhere in the country. As per the data secured from Chewaka Woreda Women's Affair Office, women headed households represent 4% of the total. The gender division of labour indicates that unlike in other places, women participate less on agricultural fields, though their role in marketing is very high. Their responsibility in household management is quite immense, partly exacerbated by a large family size. Polygamy is also quite frequent. Women's health is quite compromised due to frequent pregnancy, low awareness of primary health care issues and harmful traditional practices such as circumcisions. The school data shows a significant lesser number of girl's enrolment and higher dropout rate than boys, mainly because of early marriage. Chewaka district is accessible by rural all-weather road via Dabo district to Bedele town and Nekempte town using a 74km long and a 142km long road respectively. Currently an all-weather road is under construction with a bridge to cross the Didessa River and to join the area with the Asossa-Gimbi-Nekempte-Addis main highway. This bridge is expected to be completed by the end of 2010. The distance of the district from Addis will be significantly shortened from about 560 km to about 430 km, thus improving marketing opportunities significantly.

2.2 Vegetation, Fauna and Land Use

The natural vegetation of the area includes irregular patches of dense riverine forest along the Didessa River and gallery forest along the tributary valleys that reach up to the local plateau level at about 1700 masl. On the undulating plains that are cultivated for rainfed crops, the natural vegetation, is being cut or burnt by recent settlers and this is leading to substantial erosion on the more sandy soils. A few tall emergent species remain, and show that this deciduous savanna woodland was once a very dense and productive wooded savanna. Many of the trees on these undulating slopes have been burnt without being harvested first: a very substantial timber resource has been wasted and lost. The area has some residual wildlife. Oribi gazelle have been seen close to Ilullu Harrar settlement and Pangolin (ant eater) holes are quite common. Elsewhere in the Didessa valley, upstream of the proposed weir site, it was noticed that there are Warthog in bushlands, and Crocodile and Hippopotamus along the river. On the steep slopes of the catchment above the irrigation area Black and White Colobus Monkey, Anubis Baboons, and other small monkeys are common. There is some irrigation in the valleys by diversion of water from perennial streams. However, as the woodlands are cut back the gallery forest disappears and it is likely that these sources will dry up. The official land use data for Chewaka Woreda is shown in the table below. It is evident that the estimate for cultivated area is increasing annually, as new settlers clear forest and shrub lands for agricultural use.

Table 1: Chewaka land use

Category	**In Woreda Area (ha)**	**In Project area (ha)**
Cultivated land	19,400	4,942
Grassland	3,500 [3]	1,053
Natural forest (gallery & riverine forests)	24,900	1,721
Shrubland and wetlands	5,500 [3]	2,577
Settlements, farmsteads	1,100 [3]	253
Total	**54,400**	**10,546**

2.3 SOIL-LANDFORMS

The Study area lies on the western edge of the Ethiopian volcanic escarpment. From the plateau at Bedele, the land drops steeply to the Didessa River valley passing through almost 1,000m or so of the Tertiary volcanic succession down into the Pre-Cambrian Basement Complex, here comprising gneisses, schists and granites. The Project area lies on a gently dissected erosion surface, at about 1240 - 1270m, herewith termed the 'Chewaka Plains'. The Basement Complex rocks are exposed in the Didessa River, and also as an elevated fault-bounded horst block which forms a massive ridge along the eastern edge of the study area. The Dinger Bereha area lies west of this horst block, mostly on gently to moderately undulating landforms with steeper slopes towards the Didessa and Dabana rivers. The soil-landforms associations are developed over a thin veneer of highly weathered basalt lava and ash on the interfluves. These weathered volcanics, that appear to be either a downfaulted fragment of the Ethiopian volcanic plateau, or the residue of a lava flow that filled this part of the Didessa valley, passes down into the underlying Basement Complex metamorphic rocks that are exposed mostly on middle and basal slopes and in the rivers at the numerous rapid sites. The actual boundary between these geological formations is obscured by thick colluvial soil mantles. On the undulating lands of the Chewaka Plains, where slopes range up to 15%, the soils vary from shallow to lithic on convex sedentary soil exposures, down to moderately deep and deep on the colluvial slope deposits of the middle and lower slopes and valley floors. These valleys become much more incised near the Didessa River due to the downcutting of the main rivers in response to deepening of the Abbay gorge, but there has also been isolation and preservation, to a certain extent, of the Chewaka Plains. Much of the soil study area includes the undulating lands with convex interfluves, some granite tors, deep soils on middle and lower slopes, and passing down into flat, poorly drained uncultivated wetlands where significant parts remain as a dense gallery forest.

2.4 SOILS AND LAND SUITABILITY

Soils. The soils study of the proposed Project was carried out at a detailed level over 10,546ha of land. The survey has showed that out of the total surveyed area, about 6,260ha (59%) of land is characterized by gently undulating plains and valley floor landforms with a slope range of 0-5%, which are expected to be a potential area for irrigation development. Most of the gently undulating plain with convex interfluve area soils have loam to clay loam on surface and clay texture in subsurface. The Vertisols, which are situated in the valley floor area, have clay to clay loam soil texture, and the infiltration rate and hydraulic conductivity measurements are found to be at moderate level. Due to relatively low topographic features and high clay contents of the area, the soils have imperfect to poor drainage characteristics. This makes some soils well suited to rice cultivation. Cation Exchange Capacity (CEC) low to medium and the total nitrogen percentages medium to very high. On the other hand when comparing the organic carbon content with nitrogen content one finds constantly higher values for almost all soils. Six major soil types were identified, which include, Nitisols (NT), Acrisols (AC), Vertisols (VR), Cambisols (CM), Gleysols (GL) and Leptosols (LP). The most extensive soils of the Project area are found to be Nitisols which is followed by Acrisols and Cambisols. The laboratory results for electrical conductivity (EC) of all soils of the Study area show an average value of 0.1 dS/m, which is very low. It is far below the threshold critical values and therefore, salinity will not be causing any restriction on plant growth of soil of the Study area. Similarly, the average value of the exchangeable sodium percentage (ESP) within 100cm depth of the soils is also low. The levels of exchangeable sodium do not cause any adverse effect for both plant nutrition and physical properties of the soils. The main constraint for agriculture production in the Project area is believed to be acidity. Yields of any crops are limited mainly as a result of root damage because of aluminum toxicity. The sampled area has an acidity potential that will hinder crop production unless immediate remedial action is taken to improve the situation. One of the actions to be taken is the use of agricultural lime to neutralize the soil acidity and to suppress the negative effect of aluminum toxicity in the area.

The valley floor of the Study area is covered with Vertisols and they have an area coverage of 1,053ha. During the wet season the clays of these soils swell and cause pressure in the sub-soil. Therefore, to use these soils properly for future agricultural development, Vertisols management technologies like, broad bed-maker (BBM) should be considered or practised. Laboratory results indicated very low of organic carbon having over all an average value of 3.7%. Therefore, to increase the organic matter of the soils mulching has to be applied. The positive effect of a high organic matter content in the soil is, at the same time, increasing the cation exchange capacity of the soils. Therefore, ploughing back of the crop residues and mulching should be encouraged to raise the very low carbon levels and to improve the structure of the top soils.

Land Suitability Classification. The Field Investigations selected 5 land utilization types for onions, beans, citrus, maize and sesame. During the Feasibility Study it was decided to broaden this into a series of land utilization types which reflect more the types of crops that the Project had decided to concentrate on. These included cereals and sesame (oil crops) as LUT-A; Vegetables and Pulses as LUT-B; Citrus and Fruit Crops as LUT-C; and wetland rice as LUT-D. The Feasibility Study did not consider overhead irrigation a priority as the chosen method as the Project will be based on improved surface irrigation and localised irrigation. In general, most soils that have been identified in the Dinger Bereha irrigation project were found to be marginally suitable for surface (and overhead) irrigated agriculture. The limitations are moisture and oxygen unavailability, workability and unsuitability for mechanization.

Soil and Water Conservation. The Project will adopt and implement a novel type of irrigation system, using buried pipes that supply water directly to small fields. Although the farming community have some experience of irrigation, most are rainfed farmers. In addition, the Study area is being eroded by lack of soil and water conservation (SWC) practices. The introduction of a new irrigation system will require an immense effort to train the new irrigators so that the Project can be sustained. It must be stressed therefore that the DBIP will be as much a soil conservation project as an irrigation project. Much of the work to make this successful will fall on the agricultural services of the Chewaka Woreda to implement SWC measures in the coming seasons, in the rainfed lands and also in the catchment. It has good, well qualified staff, who can take on these tasks, but they will need support. It is recommended that mitigation to protect the catchment and command areas from erosion and ecosystem degradation is now implemented with the greatest speed and determination.

2.5 CLIMATE AND WATER RESOURCES

Climate. A summary of the average monthly rainfall at Didessa station is presented in the following table.

Table 2: Monthly rainfall characteristics at Didessa (mm)

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Didessa	3	6	26	49	158	274	312	277	209	104	28	8	1,454
Bedele	18	23	65	105	239	291	310	303	302	156	41	12	1,864
Jimma	33	49	88	133	172	219	208	210	182	103	68	36	1,502

The 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 3: Other climatic factors

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Temp (°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 (%)	65	59	57	68	76	81	88	89	89	85	79	72	76
Wind speed (m/s)	0.62	0.80	1.00	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)	115	115	143	135	134	107	92	97	114	125	114	107	1,398

Surface Water Resources and Peak Flows. Station 114001 with a catchment area of 9,981 km² is located about 25 km up-stream of the proposed weir site and has become operational since. The catchment area between station 114001 and the proposed project weir site was calculated at 625 km². Prior to the stream flow analysis, missing data were infilled and then checked for their consistency prior to different analyses. The mean annual and monthly flows at the weir site have been calculated and the results are as follows:

- Mean dependable flow = 3,232 MCM
- 75 % dependable flow = 2,415 MCM
- 80 % dependable flow = 2,351 MCM

Table 4: Mean monthly flows (MCM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	25	17	19	28	52	166	400	568	555	536	137	59

The peak floods at the weir site at different return periods were calculated at**:**

25 years = 1,083 m^3/s
50 years = 1,143 m^3/s
75 years = 1,187 m^3/s
100 years = 1,192 m^3/s
1000 years = 1,335 m^3/s

Water Availability. Since the Didessa River is gauged at the station near Arjo Bridge and has more than 30 years of recorded flow data, the availability of surface water at the proposed weir site assessed and analyzed. The frequency analysis of the mean monthly flow of the Didessa River at the proposed weir site is presented in Table 4.

In the Project area, the dry season starts in the month of November and extends up to the end of May. The dry season dependable monthly flow is given in the table below. From the analysis it was concluded that shortages during the months of March and April could occur at a peak demand of 6 m^3/s. Therefore, cropping patterns would have to be adjusted in such a way that peak demands fall inside periods with higher flows in the river. With the ongoing development in the upstream catchments it is highly likely that more water will be diverted in the future thus constraining water availability at the diversion point. This can only be counteracted by the construction of the Arjo-Didessa Dam or the Negeso Dam.

Table 5: Dry season dependable flow (MCM)

	Nov	Dec	Jan	Feb	Mar	Mar	May	Total	% to the Annual
50% Dep.	127.6	76.7	38.2	20.3	18.3	16.5	38.6	336.2	9.4 %
75% Dep.	112.4	62.7	31.7	16.04	13.9	13.7	36.6	287.1	10.5 %
80% Dep.	95.8	67.7	28.2	15.04	13.6	12.3	28.9	261.5	10 %
85% Dep.	92.3	65.7	27.6	14.7	13.3	11.9	28	253.5	9.8 %
90% Dep.	90.5	54.4	27.1	14.4	13	11.7	27.4	238.5	9.3 %

Sediment Loads and Water Quality. Suspended concentration rates varying between 162 mg/l at a depth of 3.3 feet to 1740 mg/l at a depth of 9 feet were observed in Didessa River at station 114001. The total annual sediment concentration at the weir site is 1.2 MCM (113 kg/km²/year). The analyses showed that the Didessa River water is fit and can be used without harm for irrigation in the Dinger Bereha Project area.

Peakflows for cross drainage structures. Command area peak flows QP at different return periods are:

Qp at 25 year return period = 0.28 m³/s/km²
Qp at 50 years return period = 0.3 m³/s/km²
Qp at 75 years return period = 0.315 m³/s/km²
Qp at 100 years return period = 0.32 m³/s/km²

Groundwater. The quantity of groundwater is not sufficient to justify the installation of motorized systems for augmenting the watersupply for surface irrigation. Many springs have been protected for the rural water supply sources in the Woreda.

2.6 Existing Agriculture, Land Use and Forestry

Crop Production. The farming system in the Woreda is cereal dominant, single cropping and mixed farming, where livestock production, though at a smaller scale, is undertaken complementary to crop production. The major crops 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. Since the last two years rice is a new addition to the cropping pattern. Sorghum commands the largest area coverage, which signifies its importance as staple crop for the population. 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. The two-year trend 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 the cultivated land and a substantial increase in the productivity per unit 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. Yields in 2009 were far better than indicated for the former two years. In fact, yields are estimated to range between 50 to 60qt/ha for sorghum, 40 to 50qt/ha for maize, and more than 50qt/ha for rice. The main production constraints are deforestation, poor farming practices, crop pest problems, soil acidity, and poor fertility status.

Marketing Infrastructure and Support Services. The Project is located in a new resettlement area with poor accessibility. Currently, market organisation is nonexistent and agricultural production is mainly oriented towards home consumption. The lack of roads and local motorised transport restricts the marketing of products outside the Project area.

Within the seven resettlement villages, trade is limited to traditional low value exchanges, sometimes in kind, between the families which are almost totally involved in farming activities. The farmers met in the villages say they sell approx 45% of their production on local markets, namely at the Woreda capital. The Project area is very fragmented in terms of settlement villages and communication means are minimal; this is a major constraint for good market information that can be alleviated by developing a cellular phone network. The resettled population is eager and very committed to the success of this Project and may adopt the right attitudes to win a strong position on the markets. There are no facilities for agro-processing, apart from some small mills. For the first three years after resettlement, the population had been receiving, free of charge, farming inputs and food. Afterwards, farmers had to form informal groups or cooperatives to purchase inputs in bulk with the assistance of the Woreda administration. Cooperatives were given insufficient assistance and follow-up. In general, the input supply cooperatives have provided significant benefits to farmers by making seeds and fertilizers available; however their impacts have been so far relatively limited. Agricultural extension services are provided by the Woreda Agricultural Development Office. These services, which are based on a participatory approach, aim at a better adoption rate of technological packages, providing a proper feedback mechanism and ensuring successful implementation of programs and projects.

The Woreda has 28 Kebeles and to fully implement the extension program, each Kebele should have three experts dealing with natural resources management, crop production and livestock development. Farmers Training Centres (FTCs) are being established in the area and these centres provide farmers with new technologies for agriculture and livestock production including for irrigated agriculture and liaising farmers with technology providers. The extension staff work in close contact with the farmers. They are expected to play an important role in the adoption and implementation of more efficient and environment friendly agricultural practices both for rain-fed and irrigated crops. The total absence of credit facilities is a large constraint in increasing and diversifying agricultural production.

3. THE PROJECT WORKS

3.1 GENERAL

3.1.1 Project Rationale and Objectives

In order to achieve its goal of reducing and preventing poverty, improving rural incomes and enhancing food security the Government of Ethiopia has placed high priority on increasing food production through the expansion of irrigated agriculture. The Project was selected from a range of projects that were identified by the Government. In addition to the development of an irrigation infrastructure the most effective means of improving farm income and preventing poverty is through increased agricultural productivity and improving marketing conditions. An integrated approach will be adopted that combines irrigation infrastructure, land and water management, crop diversification and intensification with emphasis on high value crops, improved agricultural practices and improvement of accessibility. The overall goals of the Project are to enhance food security, increase rural income, reduce poverty and improve health in the Project area and surroundings on a sustainable basis. In order to achieve these goals the main purposes have been defined as follows:

- Mitigate and reverse the adverse impact of periodic drought;
- Develop 7,500 hectares of land for irrigation and irrigate dry season crops as well as supplement wet season crops during times of late onset or early withdrawal of the rains;
- Improve existing wet season cropping systems, supported by crop diversification and introduce appropriate cropping patterns for dry season irrigated farming so as to improve crop productivity;
- Sustain crop productivity through better management of soil and water resources; and
- Introduce high value food and industrial crops and agro-processing facilities.

3.1.2 Characteristics and Size of the Irrigable Area

Gradients in the Project area range from around 4% in the upper part of the Project area to 30% in the steepest places close to the Didessa and Dabana Rivers. According to the soils and land suitability studies 6,800 ha are suitable for irrigated agriculture. This amount does not include the area covered by incised streams and riverine forest along banks of rivers and streams. This area was calculated at 1,721ha gross, of which 610ha will be occupied by streams and reforestation. Hence, an additional 1,111 ha would be available near streams for irrigated agriculture, bringing the total irrigable area to 7,911 ha gross. About 5% of the area would be taken for tracks and roads, so the total net irrigable area would be about 7,500 ha. For calculation purposes this figure will represent the net irrigable area that will be commanded by the system.

3.2 IRRIGATION INFRASTRUCTURE

3.2.1 Diversion

A gravity diversion has been selected for the proposed project because comparison of costs of various options has shown that the partly gravity-partly pump option is more cost effective than the alternative of full pumping from a point on the Didessa nearer to the command area. Water is taken from the Didessa River by a headworks made up of a mass concrete weir with a flushing channel with sediment excluder and Main Canal offtake on the left bank. Immediately downstream of the Main Canal offtake there is a settling basin, from which the settled sediment can be flushed back to the river. At the head of the Main Canal there will be a sediment removal reach and a flow measurement structure to ensure that the flow released to the canal is equal to the irrigation water requirements.

3.2.2 Main System for Conveyance

Main and Primary Canals. Trapezoidal concrete lined canals with a gradient of 0.20 m/km have been chosen for all canals because of the high permeability of the soils. A steeper canal gradient was examined but the additional pumping costs together with the loss of production exceeded the savings in canal construction cost.

A 15 km long Main Canal conveys water from the gauging weir near the intake to the boundary of the command area, following the Didessa River closely for most of its length. It is crossed by watercourses that are passing underneath via reinforced concrete drainage structures. Once the Main Canal reaches the command area it is designated Primary Canal. This canal conveys water to a balance reservoir at a pumpstation and has a number of downstream control gravity offtakes directly to the irrigation blocks. To ensure that these offtakes are always submerged there will be three sideweirs along this canal. The canal will cross four watercourses in inverted siphons consisting of Glass Reinforced Polyester (GRP) barrels. These will either be buried or installed above ground, according to the pipe size and geotechnical conditions.

Since irrigation will only take place during maximum 12 daylight hours, it is necessary to store the night time flow at a location close to the irrigated area. The provision of night storage reservoirs simplifies the management of the scheme and enables the scheme to make efficient use of the diverted irrigation water. At the pump station water will be lifted from the reservoir to four night storage reservoirs designated NW, SW, NE and SE. These are located at an elevation of approximately 1263 m asl. From night storage reservoir NE the offtakes will feed secondary pipelines with downstream control.

Although most of the scheme will be irrigated by secondary pipelines feeding directly from the reservoirs or Primary Canal, contour secondary canals are required in a number of locations. These will be supplied with irrigation water from the reservoirs using an "AVIO" type gate and a modular baffle distributor to ensure that the correct flow is delivered. The high level Primary Canals will operate with upstream control, i.e. the required amount of water will be released from the night storage reservoirs. Side weirs are used to control the water levels in the Primary Canals so that outflows from the canal can be accurately controlled. The weirs are found to be both less costly and less subject to mechanical failure than mechanical devices. They are very robust so there is also less opportunity for interference and vandalism. Each of the larger irrigation blocks supplied by gravity from the high level Primary Canals will have its own night storage reservoir. The offtakes from the night storage reservoirs will be either pipes or secondary canals, both with downstream control. The reservoir serving the NE part of the command area has no canals downstream but instead feeds directly to the secondary pipe networks which serve the surrounding command area.

Some of the secondary pipelines for this area will be taken directly off one of the rising mains. The flow from the Primary to the off-stream reservoirs will be accurately regulated by a Baffle Distributor and close control of the canal water level by a side weir. Water will be taken by the pipe systems "on-demand", i.e. with downstream control.

3.2.3 Pump Station and Rising Mains

The pump station will pump from the night storage reservoir. The station has a maximum capacity of 5 m3/s and will have a total of 10 pumps, with three pumps supplying the SE Primary Canal and the NE command area and the remaining 7 pumps the NW and SW command areas. It will be constructed as one or two reinforced concrete structures with the sets of pumps discharging, via butterfly and non-return valves, to separate buried manifolds. The possibility of interconnecting the manifolds to provide a degree of stand-by capacity may be investigated during the detailed design. The pumps will be of the mixed-flow vertical turbine type with close-coupled motors. Each pump will discharge about 500-600 l/s against a dynamic head of 36-37.5 m. The pumps will be weatherproof and installed in the open. A building will be provided for the switchgear that will be housed in a common switchboard and supplied by common transformers. The rising mains will, like the inverted siphons, be of GRP, albeit of a suitable class to withstand the operating and surge pressures that will occur in the rising mains. Along the main road Nekempte-Gimbi there is a 32 kV powerline. However, stepping down to 11 kV would cost 33 million ETB and is not allowed according to EEPCO regulations. The nearest transformer station where power is stepped down from the national 132 kV grid to 11 kV is in Nekempte, about 70 km away. Costs of electrification would be 12 million ETB.

3.2.4 Distribution Systems

Because of the terrain, conveyance and distribution of water perpendicular to the contours has to be mainly through piped networks, because a system with open lined canals coupled to a huge number of large drop structures would be very expensive and would require a large land take in a densely populated and cultivated area. The Project area is divided into 15 Command Areas corresponding to the main interfluves. For each command area, blocks are demarcated, taking into account the site geomorphology, slope, streams and gullies. The tertiary system comprises buried pipe networks connected to the secondary pipes or canals. The tertiary systems feed flow control hydrants each serving a block of 6 ha with a nominal discharge of 9.6 l/s/block. The flow from the hydrant is controlled by a flowlimiter and distributed by permanently buried PVC or PE pipes to a number of field outlets. Each farmer has its own field outlet and the full flow from the hydrant is rotated amongst the farmers united around the hydrant. The tertiary network and the hydrants are operated at maximum 12 hours/day when water requirements peak. Additional advantages of piped systems are increased distribution efficiency, large reduction in water theft, better control of quantities delivered to users and the possibility to use highly efficient localised irrigation systems with full and transparent control of water quantities delivered. The on-field irrigation system is connected to the individual outlets and comprises gated pipes or other improved surface irrigation equipment such as hoses or simple HDPE pipe that can be dragged from farm to farm. Where sufficient pressure is available at the hydrant, farmers can install localised irrigation systems such as drip and sprinkler (draghose system).

3.2.5 Drainage

Sufficient ground slopes, well draining soils and a dense network of existing streams that will be used as drainage network, mark the particular site geomorphology. Therefore, additional drainage works are not considered to be required for the Project.

3.3 Agricultural Development

3.3.1 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 & Soya bean
- Oil-crops: Groundnuts, Sunflower & Sesame
- Vegetables: Onion, Pepper, Sweet-potato & Potatoes, Tomatoes
- Fruits: Citrus & Mango

Though new crops have just begun to be grown, cereals, notably sorghum and maize, have 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. Most of these crops, apart from their agronomic benefits, have readily available markets, locally as well as for export. The envisaged crop mix should, therefore, create the opportunity for diversification.

3.3.2 Cropping Pattern

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 were 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 numbers of crops. The pattern has been 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, food crops will dominate the cropping pattern. 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), sesame and vegetables (onion, pepper and 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 thereby 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.

It will be the choice of the individual farmer that will prevail and therefore the cropping pattern presented in the table below only serves as a guide that eventually aids the project's cost/benefit analysis. On the other hand it is good to keep in mind the possibility to increase the revenue with ancillary tasks as selling activities, transport management, workshop founding, and agro industrial production, which generally are developed in the production context. In order to practice the complementary activities a too high intensity or a too big dispersion in the cropping pattern is not favourable to obtain good management of the farm.

Table 6: Representative cropping pattern (at 175 and 200% intensity)

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%

3.4 PROJECT ORGANISATION, MANAGEMENT AND COORDINATION

The operation and maintenance requirements of the Project call for a sound and organised structure to ensure a proper distribution of the irrigation water and an efficient and effective operation of the projects infrastructure. Such an organisation should have a well-established standard of technical procedures, an adequate financial basis and an appropriate administrative system. The Main system management entity (agency, company, government department), which may be a Government body established specifically for the purpose will be responsible for operation and maintenance of the headworks, the Main canal, Primary Canals, pumping station(s) and reservoirs. The entity will supply water to the secondary systems according to agreed quantities of water and a delivery schedule drawn up with the WUA's. Supply to the reservoirs will be on 24-hour per day basis.

In general the interface will be the reservoir that supplies water during 12 hours/day to its command area. The duties of the management entity will include:

- Determining and agreeing the secondary off take flows with the WUA's.
- Adjusting flows from the headwork's to give the required constant flow in the Main and Primary Canals
- Maintaining the headwork's, Main and Primary Canals, as well as the secondary canals and collecting the water fees from the WUA's
- Providing extension services to irrigated agriculture, irrigation management, WUA organisation and management and accounting.

Works will be by direct labour or by subcontracting to local and national contractors. Maintenance and operation of vital elements like diversion complex, canals and pump station will be subcontracted to suppliers/contractors. Regarding investment options for the private sector it can be concluded that all land in the command areas has been issued to smallholder farmers so there is no scope for private investors to lease irrigable land at medium or large scale.

4. AGRICULTURAL PRODUCTION AND MARKETING OPPORTUNITIES

4.1 Agricultural Production

4.1.1 Crop Production

Suitable crops were selected for both seasons (wet and dry). Farmers of the area are well acquainted with most 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

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 numbers of crops. 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 will command the major part of the area followed by pulses (haricot beans, soybean) and vegetables (onion, pepper and sweet potato). 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. From year 7 onwards, the forecasted irrigated crop yields reach a satisfactory and realistic level, provided that all production factors are present. Extension services should play a major role in supporting farmers obtaining good yields. Similarly, it is also important to stress the need for strengthening seasonal credit institutions and/or establishing new ones. Once the farmers will have reached the maximum projected yields, with a good income from cash crops, credit services should progressively re-orient their activities from seasonal credit toward investment credit for mechanisation, milling facilities, sprinklers, packaging facilities, or again storage facilities. Moreover, it must be noted here that the full production period of fruit trees will begin on the fourth year (for citrus) and the fifth year (for mango) after planting.

4.1.2 Production costs

Annual production costs for the first years and subsequent years of the Project are presented in the next table. For most crops, seeds, fertilizers and pesticides represent the highest share of the production costs.

However, for fruits and vegetables production, labour costs represent the highest share. The level of inputs use, namely fertilizers, chemicals and handling equipments, is likely to increase with the adoption of improved technology packages.

Table 7: Yields (qt/ha)

DINGER BEREHA IRRIGATION PROJECT								
Global Cropping Pattern & Yields		Yield 1	Yield 2	Yield 3	Yield 4	Yield 5	Yield 6	Yield 7 to 25
		qt/ha	qt/ha	qt/ha	qt/ha	qt/ha	qt/ha	qt/ha
Rainy season	Maize *	28.0	34.0	41.0	49.0	49.0	49.0	49.0
	Sorghum *	24.0	28.0	34.0	43.0	43.0	43.0	43.0
	Rice *	30.0	35.0	40.0	45.0	45.0	45.0	45.0
	Har.bean *	12.0	14.0	17.0	22.0	22.0	22.0	22.0
	Soya bean *	12.0	18.0	23.0	25.0	25.0	25.0	25.0
	Sesame *	5.5	6.0	6.5	7.5	7.5	7.5	7.5
Dry season	Maize irrig.	30.0	36.0	45.0	56.0	56.0	56.0	56.0
	Har.bean irrig.	20.0	25.0	30.0	25.0	25.0	25.0	25.0
	Soya bean irrig.	19.0	22.0	25.0	31.0	31.0	31.0	31.0
	Sesame irrig.	6.0	7.0	8.0	9.0	9.0	9.0	9.0
	Potato irrig.	130.0	140.0	180.0	240.0	240.0	240.0	240.0
	Cabbage irrig.	80.0	110.0	150.0	180.0	180.0	180.0	180.0
	Pepper irrig.	40.0	60.0	70.0	80.0	80.0	80.0	80.0
	Onion irrig.	120.0	150.0	170.0	220.0	220.0	220.0	220.0
	Mango					40.0	80.0	150.0
	Citrus				30.0	60.0	120.0	180.0

Table 8: Annual production costs

DINGER BEREHA IRRIGATION PROJECT		financial values						
Production Costs		Prod Costs Y1	Prod Costs Y2	Prod Costs Y3	Prod Costs Y4	Prod Costs Y5	Prod Costs Y6	Prod Costs Y7 - 25
		Birr/ha	Birr/ha	Birr/ha	Birr/ha	Birr/ha	Birr/ha	Birr/ha
Rainy season	Maize *	3 380.0	3 430.0	3 480.0	3 530.0	3 530.0	3 530.0	3 530.0
	Sorghum *	2 720.0	2 970.0	3 020.0	3 070.0	3 070.0	3 070.0	3 070.0
	Rice *	2 775.5	3 172.0	3 568.5	3 965.0	3 965.0	3 965.0	3 965.0
	Har.bean *	2 762.0	2 812.0	2 862.0	2 912.0	2 912.0	2 912.0	2 912.0
	Soya bean *	3 105.0	3 255.0	3 405.0	3 555.0	3 555.0	3 555.0	3 555.0
	Sesame *	2 136.0	2 286.0	2 436.0	2 586.0	2 586.0	2 586.0	2 586.0
	Mango							
	Citrus							
Dry season	Maize irrig.	4 020.0	4 070.0	4 120.0	4 170.0	4 170.0	4 170.0	4 170.0
	Har.bean irrig.	4 162.0	4 212.0	4 262.0	4 312.0	4 312.0	4 312.0	4 312.0
	Soya bean irrig.	4 805.0	4 855.0	4 905.0	4 955.0	4 955.0	4 955.0	4 955.0
	Sesame irrig.	3 836.0	3 886.0	3 936.0	3 986.0	3 986.0	3 986.0	3 986.0
	Potato irrig.	6 379.0	6 479.0	6 579.0	6 679.0	6 679.0	6 679.0	6 679.0
	Cabbage irrig.	5 712.0	5 887.0	6 062.0	6 237.0	6 237.0	6 237.0	6 237.0
	Pepper irrig.	6 485.0	6 655.0	6 825.0	6 995.0	6 995.0	6 995.0	6 995.0
	Onion irrig.	7 031.0	7 206.0	7 381.0	7 556.0	7 556.0	7 556.0	7 556.0
	Mango	6 157.0	3 049.0	3 049.0	3 049.0	3 199.0	3 349.0	4 739.0
	Citrus	7 024.0	3 204.0	3 204.0	3 204.0	3 404.0	3 604.0	5 004.0

For practical purposes and according to 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. This indication may be useful as references when the need arises.

4.1.3 Livestock Production

Livestock production is a small but not unimportant component of local production systems. Smallholder farmers consider animals an integral part of crop production and an essential component in their contribution to household food security, agricultural operations, raising capital and providing cash in times of need. 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 that 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. 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" using a primitive and low input system that in the main does not include an element of concentrate feeding. 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. In November 2009 a family owned 1.46 oxen, 1.56 cows, 19.58 sheep and goats and 24.83 poultry. About 50% of the households, however, own no animals. Cattle, sheep, goats and poultry are all of the indigenous type. Livestock production and productivity is low. Natural vegetation provides most of the feed consumed by livestock: at present it is more than adequate in quantity but is low in quality for much of the year. Crop residues provide a smaller proportion of total livestock feed but these also are generally of low nutritive value. Extension advice to farmers is provided in only limited amounts. Animal health services include three clinics and eight animal health assistants that provide little more than rudimentary support. There is no private provision of veterinary service of drug supplies. Marketing is in the private sector although few animals are marketed. There are clear opportunities to add value to the livestock subsector. These 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. Animal nutrition and health are major constraints. Even in the Project area where the quantity of feed at present is not limited 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. Possible projects to improve livestock output include nutritional interventions and development of apiculture. A number of interventions are possible to improve the feed base both under rained and irrigated conditions.

4.2 Marketing Opportunities

4.2.1 Crops and marketing options

In the Ethiopian context where the domestic production does not match the national demand, the domestic market is obviously the primary market opportunity. Since many years, the demand reaches high levels, namely for cereals, pulses and oil seeds and the demand growth has even been accelerating these past few years. At the same time, crop prices remained high reflecting high demand and withholding of grains (farmers have learned holding back their products to get better prices). Due to the geography of Ethiopia, the various production areas do not have the same opportunity for selling the agricultural commodities they produce to the major marketing sites.

Recurrent food crisis have enlightened the difficulties in the transport of agricultural commodities from surplus areas to deficit ones. When establishing their marketing plan, farmers must find means to overcome the constraints related to distance and access to transportation. At this crucial stage, it will be relevant making estimates of market size and prices and identifying the best marketing sites; supporting farmers to get adequate and reliable market information would create an enabling environment for doing so. Information on local markets are easier to collect and analyse, moreover selling to local markets offers a greater opportunity to establish more efficient, because shortest, marketing chains.

The remoteness of the Project area and the continuous population increase are certainly the best reasons for considering the local market as the main marketing site for most of the crop production. Therefore the marketing of agricultural commodities, in the "with Project situation", would mainly occur locally with some surplus sold at more distant sites. At this stage, the export market cannot be considered as a relevant option. However it cannot be excluded that the new bridge will offer opportunities to create market linkages with Addis Ababa and other distant cities in Ethiopia and even with Sudan. Market potential of the Project area is indeed high, with a good development prospect for the next 10-20 years.

The description of the possible cropping patterns in this study underlines the willingness of farmers to grow rice and crops they are already familiar with, namely sorghum, maize, soya beans, sesame, potatoes, and fruits. Such cropping patterns are in line with the food needs of the local population, and moreover they would allow farming households to get high return since the market prospect for these crops are very good both in terms of size and prices; the two main conditions to tackle the market. The level of the projected prices is reasonably optimistic and certainly not over estimated in a long-term prospect. Cereals prices witnessed during the shock price in the first half of 2008 were not considered although cereal prices still remain higher than in the pre-crisis period.

Table 9: Share of output production

Local consumption and Output destinations	Project area Production T	Food Requirements / C / Year	Project area needs: 31 000 people in 2015 T	Woreda needs: 31 000 + 45 000 people in 2015 T	Gross tradable production to Woreda Markets T	Gross tradable production to other national Market Places T
Cereals	44 213	180 kg	5 580	13 680	8 100	30 533
Pulses	21 338	45 kg	1 395	3 420	2 025	17 918
Oil seeds	3 750	14 kg	434	1 064	630	2 686
Fruits	6 525	10 kg	310	760	450	5 765

The estimates of local food requirement are based on the MoWR surveys monitoring the annual consumption of rural households. The computation is made in calories using a conversion table indicating the equivalent cereals consumption. The need per capita per day is about 270 kg equivalent cereals. The precise breakdown figures are 180 kg for cereals, 45 kg for pulses, and 14 kg for oil seeds. These needs can be considered as a strict minimum. The figures match the present situation in the Project area where farmers sell about 45% of their production. The assumption of local population inside the command area of the proposed irrigation Project is based on 25,000 inhabitants in 2009, a natural annual growth rate 2.5%, and an annual immigration rate 1.15%. Woreda requirements are based on 100,000 inhabitants in 2009 (including Project area: 75,000 + 25,000), an annual growth rate 3.11% (natural rate 2.5% + immigration rate outside the command area of 0.61%). Within the Project area, the quantities marketable at the national (second) level, are about 30,000 tonnes of cereals. That means less than 1% of the national production. For pulses the marketable production represents 2.1% of the national production and for oil seeds 2.5%. In other words, the Project will have a very limited, if any, impact on Ethiopia's domestic market.

4.2.2 Credit Facilities

Farmers, through their cooperatives will mainly require small loans for purchasing inputs such as seeds and fertilisers as well as for storage facilities to limit post-harvest losses and to increase their market bargaining power. The loans will be repaid within 12 months. The interest rate for 12 months is 8.5%, which is relatively high despite the recent efforts made by the regional government to act as collaterals. The current conditions are certainly unsatisfactory for the farmers and many of them may be reluctant to take a credit at such an interest rate. A set of accompanying measures including quality control of inputs, efficient extension services and market information will be needed to overcome farmers' reluctance to take credit.

5. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

5.1 METHODS USED AND DEFINITIONS OF IMPACTS

The methods used in the environmental and social impact assessment (ESIA) of the Project follow the procedure given in the ToR: namely that the study will make reference to EIA guidelines of the ADB, the World Bank, and Ethiopia. These have been followed. Prior to the start of the assessment no indication was given of the category of the project. The study has concluded though that the project can be placed as a Category 'A' Project, for which an Environmental and Social Impact Assessment (ESIA) study is required (World Bank EA Sourcebook Update Number 2, 1993 and ADB requirements). Base line assessments included using the data collected by the detailed soil survey, and socioeconomic situation in the area. As time allocated for this assessment was limited to a month for an Ethiopian environmentalist and three weeks for an international consultant it was not possible to make detailed assessments of several issues: fauna and flora; archaeological surveys; and the origins and importance of the indigenous Gumuz riverine peoples. These are important issues that will need to be followed up at the start of the detailed design for this proposed project. Due to budgetary limits it was not possible to make many of these studies during the Feasibility Study. It is strongly recommended that ENTRO ensures that such assessments are initiated during the Tender Design Stage.

While in the field, all relevant institutions at Kebele and Woreda level were visited for data acquisition and discussion purposes. Interviews and discussions with key informants were also made. However, it is worth mentioning here that there is a general lack of organized and well documented data and information at the Woreda office, and less so in the Kebeles/Tabias. The ESIA has utilised the findings from the land tenure, socio-economic, livestock, soils and land use and topographical baseline surveys. The Project would involve large-scale engineering works starting from the abstraction of the required water from the Didessa River by the construction of a mass concrete weir, a 15 km long main canal and primary and secondary canals. Whilst positive impacts are indeed likely from the Project, it is also probable that negative impacts will occur to the ecology and biodiversity of these ecosystems and to the livelihoods of existing inhabitants. Mitigation to minimize such disruptions would need to be put in place. Negative impacts are likely from this proposed development. These include:

- Losses to the existing riverine and gallery forests along the side of the Didessa and other watershed streams that drain the proposed command area, will impact on groundwater availability and biodiversity.

- Seasonal movements of wildlife within to and from a proposed wildlife reserve could be disrupted by canals acting as barriers and other activities related to the development and running of the project.

- The soils are highly erodible under existing rain fed conditions and further deterioration will be likely if appropriate soil and water conservation (SWC) measures are not put in place throughout the Project area at an early date.

- There is serious concern that the livelihoods and life style of the indigenous riverine Gumuz people, who live along the right bank of the Didessa River and probably elsewhere, might be disturbed as the result of the activities related to the construction and maintenance of the weir and feeder canal: a detailed socio-anthropological study of the Gumuz is recommended.

The main positive impacts are likely to include:

- Creation of reservoirs and other permanent movement of fresh water in the form of the different canals, which add water to areas where there was none or little before, can create better microclimate in addition to the provision of water that can be utilized for different purposes;
- Creation of opportunities for having recreation areas using the reservoirs that come as part of the irrigation scheme;
- Relatively better vegetation cover on both the command area and the hinterland which in turn is responsible for the rich biodiversity can be an asset if properly managed;
- Creation of wet condition on the land surface of the command area which can lower wind and water erosion;
- Increase in agricultural yields and production, generating additional revenues directly from the project output;
- Increased and diversified food supply all year long fulfilling basic local needs and Improvement in quality of life due to new economic opportunities;
- Increase in revenues for the local population due to induced development and complementary activities;
- The possibility of improving the wellbeing of women again due to induced development and complementary activities as well as development of appropriate skills and knowledge;
- Increased income and improved nutrition from irrigated agriculture will benefit women and children in particular;
- A possibility of development of appropriate skills and knowledge;
- Increased opportunities for high value crop productions with access to irrigated water and appropriate irrigation technology;
- Improvement of existing traditional agriculture, skills, and in land values and price due to irrigation water.

The likely mitigation of negative impacts that are expected will depend first on acquiring a full understanding of environmental conditions. Therefore, mitigation has to be part of an environmental management plan. At present this covers the Project area but ideally should cover the entire watershed. Whilst there are numerous positive impacts resulting from the Project, the likely main negative impacts that will require mitigation include possible spread of water borne diseases in the irrigation system and changes to disease ecology, spread of crop and animal pests and diseases, increased soil erosion, pollution of ground and surface waters from agrochemicals, destruction of gallery forests and loss of associated water resources and reduction in plant biodiversity. These will be tackled as part of an environmental management plan that will implement mitigation measures to minimise these impacts.

5.2 ENVIRONMENTAL MONITORING

It is proposed that an Environmental and Social Management Unit (ESMU) would be established as part of the project's construction supervision office/Project Management Unit.

It is recommended that there should be three staff: one land and vegetation specialist, one aquatic biologist, and one social environmentalist professional working in this unit. These would draw on additional specialist staff from Government agencies and also the staff at Chewaka Wereda. The monitoring programme for the present project will be undertaken to meet the following objectives:

- To check on whether mitigation and benefit enhancement measures have actually been adopted, and are proving effective in practice
- To provide a means whereby any impacts which were subject to uncertainty at the time of preparation of the EIA, or which were unforeseen, can be identified, and to provide a basis for formulating appropriate additional impact control measures
- To provide information on the actual nature and extent of key impacts and the effectiveness of mitigation and benefit enhancement measures which, through a feedback mechanism, can improve the planning and execution of future, similar projects.

The overall responsibility for monitoring will mainly be the responsibility of the Regional Water, Agriculture & Rural Development, Health Bureaux, and other pertinent institutions at Zonal and Woreda level as specified for the responsibility for mitigation. It has to be supported by Federal, Regional, Zonal as well as Wereda and Kebele institutions with responsibilities as specified in the institutional and legal framework and the recommendations given by the Institutional Study conducted as part of the project. Post-construction phase monitoring will be concerned with identification of the need for routine checking and rectification as required. For this particular project 15 environmental and social monitoring indicators have been defined.

5.3 Monitoring Costs

An Environmental and Social Management Unit (ESMU) would be established as part of the project's construction supervision office/Project Management Unit. There should be three staff: one land and vegetation specialist; one aquatic biologist; and one social environmentalist professional. Additional specialists might have to be called in, for example, pesticide management, range management and livestock husbandry: these should be available in line agencies in Oromia State. Good technical staff, most of which are graduates and some in natural resources management, are employed at Chewaka Woreda. The permanent staff of the monitoring unit should be recent graduates, but with MSc in these fields, and good experience in environmental impact assessment and mitigation. They should be willing to devote several years to this project. The ADB could provide additional advanced specialised training and/or short courses in Ethiopia or overseas, for the selected staff. Recurrent costs for environmental monitoring during construction and first five years of implementation have been estimated as follows:

- 20,000 USD/year for bio-physical (soil, vegetation ecosystem) environmental monitoring and 41,000 USD for equipment.
- 23,800 USD/year (settlements, health, water) year for monitoring of social issues.
- 10,000 USD / year for public information and meetings in the Kebele villages. A permanent display should be set up in Ilullu Harar to advertise the progress of the project.

Annual auditing of the ESMU and its output will be essential to demonstrate that the EMP is proceeding as desired. This audit should be made by an independent body selected by Oromia state EPA. In turn the ESMU will report regularly to the Woreda, Oromia state EPA agency on progress in its work so that any shortcomings in the design and problems with stakeholders can be identified at an early stage and attempts made to resolve issues.

6. FINANCIAL AND ECONOMIC ANALYSIS

6.1 Main Assumptions, Parameters and Methodology

The analyses have been carried out at three levels.

- Assess the return on investments, at short and medium term, on the basis of financial analysis, with components as debt service and cash flow status. Prepare financial elements available either for farm analysis, or for identifying shadow prices.
- Forecast the situation at farming household level using data on the household food needs and monetary income, and check whether or not farmers will have the capacity to pay for the irrigation water fee.
- Quantify the benefits of the Project for the national economy through an economical analysis.

For the proposed irrigation project, the financial and economic analyses are built on Cost-Benefits Analysis and the return on investment. Specific attention is given to the estimates of all costs and prices. In both analyses, the actualization technique is used for cost and benefits occurring along the Project years. A discounting rate of 10% is currently used in Ethiopia (MoFED).

6.2 Financial Analysis

6.2.1 Investment and recurrent costs

Total investments costs amount to 985 million ETB. This amount is distributed over a period of six years. The breakdown is presented in Table 10 on the following page. The investment costs are estimated at market prices in November 2009. The total amount includes the Project study and design costs. These figures include 10% for contingencies. Investments are distributed over a six years period. The renewal of main equipment such as gates on canals, pumps, and on farm equipment is positioned along the time of analysis, according to their normal service life:

- 10 years for steel gate, 500,000 birr initial value
- 20 years for pumps , 30,000,000 birr initial value
- 10 years for farm equipments, for 40,000,000 birr value

The recurrent costs include maintenance costs (0.5% for civil engineering work and 3.5% for pumping station), energy costs (483 Birr/ha), and management costs (250 Birr/ha). The recurrent costs shall be charged to the farmers. The calculation process is using the actualization technique to insure a right balance along the 50 years of the project.

6.2.2 Project benefits and current production

The only source of benefit for the Project is the profit resulting of agricultural production. Calculation is based on crop yields, farm gate prices, commercial income, and production costs.

Table 10: Summary of investment costs

No	Description	Total of BOQ (Birr)
	Preliminaries and general (Contractors establishment, etc)	28,000,000
1	Headworks	20,672,774
2	Gauging weir	184,300
3	Main Canal	67,743,430
4	Primary canal	97,486,160
5	GRP rising mains	60,690,804
6	Secondary canals	15,427,078
7	Reservoirs	35,407,539
8	Secondary&tertiary pipe distribution system	395,012,500
9	Cross drainage structures type 1	2,907,236
10	Cross drainage structures type 2	3,718,274
11	Cross drainage structures type 3	2,896,482
12	GRP Syphons	36,193,668
13	Main Canal Offtakes	1,616,600
14	Side Weirs	1,736,564
15	Civil Engineering Works Pump station	880,957
16	P&HM&E&MI Pump station	91,050,300
17	Road bridges&culverts, footbridges	15,550,002
18	Engineers requirements and additional studies 2%	17,000,000
	SUB-TOTAL	894,174,667
	contingencies items 1-15 and 17	90,974,924
	TOTAL	985,149,591

Table 11 on the following page shows the **profit per ha** of the various crops in Project cruising years (year 7 and onward). Cash crops, namely onions and potatoes, provide the highest profit. The gross margin (profit) for the whole area amounts to 151 million Birr/year, equivalent to 20,144 Birr/ha.

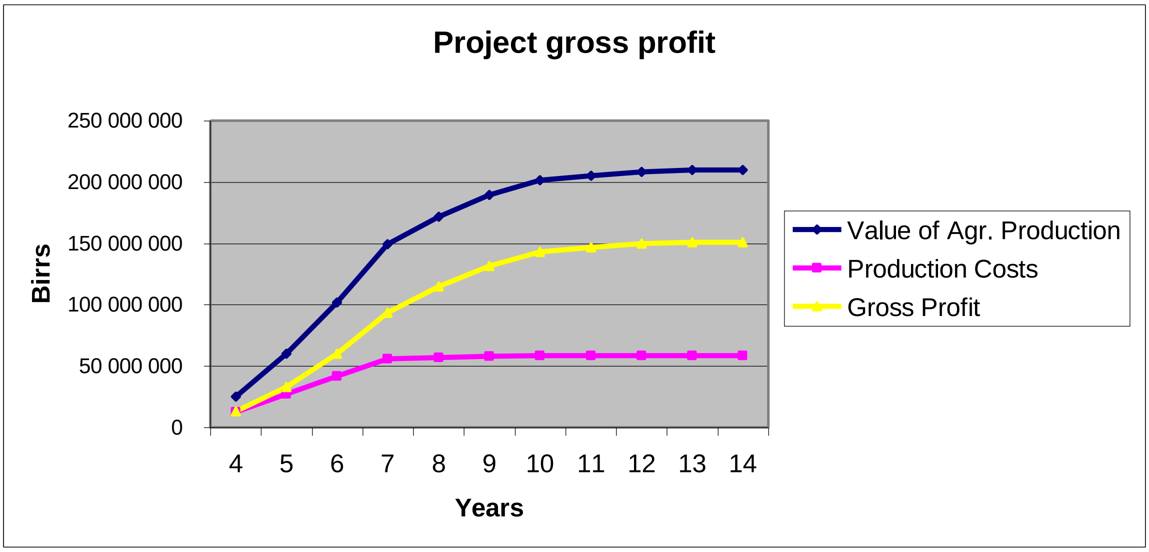
An average gross margin of 1,167 Birr/ha was calculated, taking into account the market prices in 2009 (local survey made during the field visits). Assuming that agricultural production in the without Project situation is considered as lost the 30 years analysis shows that cash flow level is quickly stabilized at 125 million Birr/year from the 13th year onward, when fruit trees are in full production. Operation and maintenance costs are stabilized from the 5th year onwards when the whole irrigation system is fully operational.

The cash flow in the first 6 years is negative, corresponding to the investment phase without an agricultural stabilized benefit. Starting from the seventh year of the Project after all investments have been made, the cash flow becomes positive.

Table 11: Agricultural gross margin ha, in full regime situation

DINGER BEREHA IRRIGATION PROJECT				Financial Analysis		
Results for 1 ha		YIELDS tradable	Farm gate price	Gross value of agricultural production	Production costs	Gross profits
		qt/ha	Birr/qt	Birr/ha	Birr/ha	Birr/ha
Rainy season	Maize *	22.5	307.0	6 907.5	3 530.0	3 377.5
	Sorghum *	30.5	325.0	9 903.2	3 070.0	6 833.2
	Rice *	36.9	450.0	16 605.0	3 965.0	12 640.0
	Har.bean *	12.6	364.6	4 593.5	2 912.0	1 681.5
	Soya bean *	18.9	584.3	11 043.6	3 555.0	7 488.6
	Sesame *	4.0	1 127.0	4 451.7	2 586.0	1 865.7
	Mango					
	Citrus					
Dry season	Maize irrig.	45.6	307.0	13 999.2	4 170.0	9 829.2
	Har.bean irrig.	22.5	364.6	8 202.6	4 312.0	3 890.6
	Soya bean irrig.	27.9	584.3	16 302.5	4 955.0	11 347.5
	Sesame irrig.	8.1	1 127.0	9 128.7	3 986.0	5 142.7
	Potato irrig.	215.6	334.4	72 085.9	6 679.0	65 406.9
	Cabbage irrig.	161.7	197.1	31 869.6	6 237.0	25 632.6
	Pepper irrig.	71.9	596.6	42 872.2	6 995.0	35 877.2
	Onion irrig.	197.6	436.0	86 155.3	7 556.0	78 599.3
	Mango	123.0	271.0	33 337.9	4 739.0	28 598.9
	Citrus	155.0	371.4	57 560.8	5 004.0	52 556.8

Figure 1: Project gross profit



6.2.3 Financial results and Project Management

The Financial Internal Rate of Return F-IRR was computed for a 50 years long period in line with the amount of investments and amounts 8.72%. At a 30 year period for F-IRR would be 7.64%. This confirms that the Project is financially viable.

The selection of a Project discount rate usually results of discussions amongst experts about financing rules (loan interest rates, bank risk and availability of self-owned funds).

To keep the discussion to a minimum, International Development Partners generally require performing sensitivity tests within a range of 8% to 12%. The discount rate used for the Dinger Bereha Project is 10%, consistent with the usual practices in Ethiopia; this would also permit comparisons with other projects in the country. The NPV value is -115.8 million Birr. This does not reflect the distribution of costs and benefits amongst the main stakeholders: the government of Ethiopia (or the investor), the management agency, farmers, inputs suppliers, traders and IWUAs. With a 12% discount rate the NPV becomes -237.8 million Birr. The B/C ratio is computed using the same discount rate of 10%. The financial analysis indicates that costs are higher than benefits; the B/C ratio is 0.9.

The general rule is to go ahead with a Project when the B/C ratio is above 1. The significance of a B/C ratio below 1 is that benefits do not compensate investments and recurrent cost. For this particular project, investments will come from public funds exclusively. Regarding the recurrent costs they should be compensated for by beneficiaries. The recurrent costs of the Project could be shared between the farmers and the public entity in charge of irrigation management, operation and maintenance. For doing so, farmers' capacity to pay for recurrent costs must be assessed. The opportunity cost of water is the average dynamic (real-time) cost per cubic metre or the equilibrium price of water for the considered period of 50 years. The value obtained is 2.8 birr/m^3 if all investments and recurrent costs are taken into account, and 0.46 birr/m^3 if only recurrent costs are taken into account. The latter figure represents the actualized recurrent costs per consumed m^3 of water at 10% discount rate.

Having identified the main results, it is possible to consider the management style of the Project and address its cash flow status. If the recurrent costs are taken in charge by the farmers, the value of birr 0.46 for m^3 becomes a source of funding for Project management. There is a need for working capital for the first four years only. There is a deficit in the first four years, while the following years the farmers' fees will match the current costs. Using a 10% discounting rate for a 50 years period, the difference between the respective values of the source and the needs of funds is nil. In the technical jargon, the deficit during the first years is known as intermediary charges, they result of the very nature of an investment project, and they are generally supported by the investor. Here the intermediary charges amount to a total of birr 14.7 million for the first four years. This gap is compensated by the surplus paid by farmers the following years.

6.2.4 Sensitivity tests

Generally, sensitivity tests consider variations within a range of -10 % to + 10%, and combine several scenarios with variations of the costs and benefits to forecast the Project situation for both the most optimistic and the most pessimistic scenarios. The results of the tests are shown in the following table. The figures show the strong impact of negative variations in farm gate prices and yields; the worst situation occurs when they are combined. The success of the Project is therefore strongly linked to the profit generated by the agricultural production. This result emphasizes the crucial role of good market organisation and efficient extension services to support farmers for production and marketing activities. Without accompanying measures related to both market organization and extension services, the Project would not be viable.

The impact of variation in the level of investments is relatively limited while the impact of energy cost variations is almost negligible. The F-IRR becomes negative if investments are doubled, or if farm gate prices or yields are only 65% of their levels in the current situation. A more specific sensitivity test was conducted to test the impact of a 175% cropping intensity instead of 200%. In this case de F-IRR becomes 7.7% instead of 8.7%. Even if the difference is relatively small, it shows the interest for having a cropping intensity as high as possible.

Table 12: Results of sensitivity tests

DINGER BEREHA IRRIGATION PROJECT					
Sensitivity Analysis					
	F-IRR	NPV discount rate 10%	B/C discount rate 10%	Opportunity Cost m³ All costs	Opportunity Cost m³ Currents Costs
	%	million birrs		birr/m³	birr/m³
Results	8.7%	-115.8	0.90	2.80	0.46
10% investment increase	8.0%	-192.7	0.80	3.00	0.46
10% Energie increase	8.7%	-118.1	0.87	2.80	0.47
10% Total cost increase	7.8%	-207.8	0.79	3.10	0.46
10% Yield decrease	7.3%	-237.4	0.74	2.80	0.46
10% Farm gate price decrease	7.3%	-237.4	0.74	2.80	0.46
10% Yield & Farm gate price decrease	5.9%	-346.7	0.62	2.80	0.46

6.3 Economic Analysis

6.3.1 The economic values methodology

The economic analysis assesses the contribution of an investment Project to the economic growth (or GDP growth) of a country. The economic analysis uses shadow prices to the maximum possible extent. Shadow prices are the market prices that would prevail without taxes, subsidies or policy restrictions on market activity. Project should not go ahead if its economic value added depends on taxes or subsidies. The estimates of shadow prices are carried out using a conversion factor applied to the financial (market) prices excluding VAT.

The conversion factors are useful to take into account the marketing costs (transportation, handling costs and commercial margins) on the basis of CIF/FOB prices to integrate export and import parity prices for each commodity. For this Project shadow prices are estimated on the basis of the data given by MoARD (Ministry of Agriculture and Rural Development) and were discussed with the Oromiya BoARD (Bureau of Agriculture and Rural Development) and Oromya BoFED (Bureau of Finance and Economy Development). Conversion factors were used for agricultural commodities and inputs.

For labour costs (20 birr/day for unskilled labour, and 30 birr/day for skilled labour), the conversion factor is based on the World Bank methodology, whereby daily wage rates are reduced by a conversion factor corresponding to the rate of unemployment among the active population living in a specific Project area. In the case of the proposed Project area where there is a continuous influx of new settlers, the unemployment rate is very high, about 50%. Cost estimates are expressed in economic prices.

The labour costs are considered as opportunity costs to enlighten the change in the employment situation, and to assess the overall wealth creation at country’s level. The investments are corrected on the basis of the respective share of local and imported equipments. The locally made equipments represent 20% of the total amount of investment expressed in constant birr (value of November 2009). The conversion factor applied to the investments is 0.9.

6.3.2 Project costs

The computation of the E-IRR is made according to the same methodology as for the financial analysis: 1) the renewal of main equipment is positioned along the time of analysis according to their normal service life, 2) operation and maintenance costs are estimated using a percentage applied to the initial value of the equipment used, and 3) energy costs are computed based on the amount of pumped quantities and using an efficiency of 60%. The unit economic price is 483 birr/ha. The management costs relate to the operation of the management agency including salaries and contingencies costs and to the IWUA operation including supervision of water distribution to the farms; the unit economic cost is 250 Birr/ha.

Table 13: Conversion factors applied in the economic model

Farm Gate Price	Financial value	Economic value	Conversion factor
Crops	birr/qt	birr/qt	
Maize	307.0	233.3	0.76
Sorghum	325.0	371.5	1.14
Rice	450.0	379.8	0.84
Haricot bean	364.6	291.6	0.80
Soya bean	584.3	467.5	0.80
Sesame	1 127.0	1 329.9	1.18
Potato	334.4	267.5	0.80
Cabbage	197.1	197.1	1.00
Pepper (fresh)	596.6	596.6	1.00
Onion	436.0	436.0	1.00
Mango	271.0	271.0	1.00
Citrus	371.4	371.4	1.00
Inputs	Crops	birr/qt	birr/qt
D.A.P	410.0	512.5	1.25
Urea	360.0	479.9	1.33
Agrochemicals	85.0	85.0	1.00
Labour	birr/day	birr/day	
Skill worker	30.0	15.0	0.50
Unskill worker	20.0	10.0	0.50

6.3.3 Project Benefits

The benefits equal the value of agricultural production minus agricultural production costs. In the economic analysis, all produced agricultural commodities, either sold or consumed by the farming households are considered as economic goods. In the economic analysis, the estimates of benefits are carried out on the same principle as for the financial analysis, taking into account:

- The yield of each crop. Yields increase during the first years when farmers adopt improved agricultural practices. Yields of irrigated crops are higher than yields for rain-fed crops. The economic yields are 90% of the agronomic yields to take into account losses occurring during harvest or a later stage (post harvest). The losses during harvesting and handling activities represent 10% of agronomic production.
- The shadow or economic prices at farm gate;
- The shadow or economic production costs;
- A 200% cropping intensity.

The following table shows the results per ha for each crop, when the irrigation scheme is fully operational. The results are similar to those of the financial analysis: high for vegetables and relatively low for sesame and haricot beans, which nevertheless remain important commodities of the diet of farming households. The gross annual profit of the whole Project is 189 million birr corresponding to 25,212 birr/hectare.

Table 14: Annual gross margin per ha, in full regime situation

DINGER BEREHA IRRIGATION PROJECT			Economic values			
Results for 1 ha		YIELDS usable=90%	Farm gate price	Gross value of agricultural production	Production costs	Gross profit
		qt/ha	Birr/qt	Birr/ha	Birr/ha	Birr/ha
Rainy season	Maize *	44.1	233.3	10 289.4	3 037.3	7 252.1
	Sorghum *	38.7	371.5	14 376.1	2 636.3	11 739.8
	Rice *	40.5	379.8	15 381.9	3 107.0	12 275.0
	Har.bean *	19.8	404.7	8 012.3	2 260.9	5 751.4
	Soya bean *	22.5	467.5	10 517.8	2 847.9	7 669.9
	Sesame *	6.8	1 329.9	8 976.6	2 075.5	6 901.1
	Mango	0.0				
	Citrus	0.0				
Dry season	Maize irrig.	50.4	233.3	11 759.3	3 507.3	8 252.0
	Har.bean irrig.	22.5	404.7	9 104.9	3 460.9	5 644.0
	Soya bean irrig.	27.9	467.5	13 042.0	4 047.9	8 994.1
	Sesame irrig.	8.1	1 329.9	10 771.9	3 275.5	7 496.4
	Potato irrig.	216.0	267.5	57 784.3	4 761.5	53 022.8
	Cabbage irrig.	162.0	197.1	31 933.4	4 529.8	27 403.7
	Pepper irrig.	72.0	596.6	42 958.1	5 527.0	37 431.1
	Onion irrig.	198.0	348.8	69 062.4	5 532.3	63 530.1
	Mango	135.0	271.0	36 590.4	4 082.6	32 507.8
	Citrus	162.0	371.4	60 160.3	4 255.2	55 905.1

Cash flow for economic analysis. The cash flow is the difference between Project benefits and Project costs. The value of agricultural benefits in the current situation (4,942 ha currently cultivated) is gradually lost for the Project area (foregone production). The cash flow is negative during the first six years 6 years corresponding to Project implementation phase. In the fourth year of production (project seventh year) when the Project becomes fully operational, the cash flow becomes positive and then increases with production growth.

Results of the economic analysis. All indicators are good, encouraging going ahead with the project. The E-IRR is 12.02%, higher than the 10% discounting rate. Thus, the NPV is positive, amounting to 178 million birr. The B/C is more than 1, with a good value of 1.21. These results indicate the Project is economically viable; it can offer employment opportunities for the current population and newcomers to the area through the development of processing, marketing and service activities. The Project will strongly contribute to ensure social peace by ensuring food security and reducing unemployment rate.

Table 15: Cash flow

DINGER BEREHA IRRIGATION PROJECT															
CASH FLOW Values: Million birrs		Economic Analysis													
	Y	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gross value of production					28.6	68.1	115.4	168.9	193.9	213.5	226.8	231.5	235.1	236.8	236.8
Gross value of foregone production					3.1	6.7	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Total Production Costs					10.0	21.8	34.0	45.4	46.2	46.9	47.4	47.5	47.6	47.6	47.6
Total Project Profit					15.5	39.6	72.5	114.7	138.8	157.7	170.6	175.1	178.5	180.3	180.3
Investments		246.8	147.3	149.7	143.9	104.6	94.2								
O&M costs					9.9	12.2	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
Management costs				0.2	0.4	0.9	1.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Renewal costs													0.5	9.1	11.1
Energy costs					0.8	1.8	2.8	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Total Costs		246.797	147.314	149.915	155.081	119.553	112.630	19.794	19.794	19.794	19.794	19.794	20.244	28.860	30.910
Cash Flow		-246.797	-147.314	-149.915	-139.545	-79.969	-40.147	94.892	118.995	137.889	150.809	155.310	158.302	151.437	149.387
EIRR	12.02%														

6.4 Financial Analysis at farm level

6.4.1 Components

The financial analysis is built on a "pilot irrigated farm" of 1.75 ha, the average farm acreage since land was attributed to farmers at sizes ranging from 1.5 to 2.0 ha. The simulation shown below assumes a cropping intensity of 200% as for the economic and financial analysis. The cropping pattern is the typical cropping pattern used for the analysis. Identification of household's food requirements is based on the average household size of seven persons. According to information made available by the Ministry of Agriculture, the average annual food requirement per capita is 180 kg of cereals, 45 kg of pulses and 14 kg of oil seeds. The habit of consuming fruits in the Project area led to adding at least 10 kg of fruits (mango and citrus) per capita per year. Vegetables requirements were also added in a higher proportion than fruits and based on the regular households' diet in the Project area. Computations were made using a labour cost of 20 birr/day. The cost of water was not included in this analysis since one objective of the analysis is to assess farmers' capacity to pay for water. Marketing costs were estimated at 10% of farm gate prices.

6.4.2 Three Cropping Pattern Scenarios and Results at Farm Level

Three distinct cropping patterns were considered. The *first* scenario (or reference scenario) is the one used for the financial and economic analysis with a relatively large number of crops and a well-balanced proportion of food and cash crops. Cereals are predominant to insure food security. Rice, one of farmers' preferred crops, is introduced. The cropping intensity is 200%, therefore the annual cultivated area is 3.50 ha: 1.75 ha in the dry season (rain-fed crops) and 1.75 ha in the dry season (irrigated crops). The *second s*cenario was designed for farms with shallow soils and/or located in hilly areas; rice and fruits trees were discarded and substituted by pulses, sesame and to a lesser extent by vegetables. The cropping intensity is 175%. The *third* scenario introduces a cropping pattern for more market-oriented farmers. In the dry season (irrigated crops), the area under maize is reduced and pulses are discarded to the profit of vegetables.

The area of irrigated crops in the dry season is reduced due to labour constraints (vegetables). The cropping intensity is reduced to 160% and the annual cultivated area is 2.80 ha. The financial results are good for the three scenarios and very satisfactory with regard to food security status. For each scenario, the volume of marketable crops is higher than the food requirements. With an emphasis on cash crops, the net profit under the third scenario is approx twice higher than for the other two scenarios. The net profit in scenario 2 is lower than for scenario 1, as increase of area under cereals does not fully compensate the discarding of rice and fruit trees. The labour requirements are all well suited to a typical farming household with at least one or two persons working full time for agricultural production. With a maximum of 300 man-days, the labour calendar is almost full around the year. In the computation some options are considered, for instance income taxes are estimated as a reduction by 5% of the gross profit. The cooperative registration fees were arbitrarily fixed at 500 birr/year. This contribution is determined by the cooperative general assembly therefore this amount could vary between cooperatives and with time.

Estimates of the debt service are based on the amount of working capital (for inputs) borrowed every year and with an interest rate of 8.5%.

All results are good. This base case can now be used to assess the level of farmers' financial participation to the Project. Applying the discounting of 10% used in the financial analysis system the TOTAL annual farmer participation is birr 5,451 for 1.75 ha or birr 3,115 for 1 ha. This amount reflects all recurrent costs of the project. The estimated annual gross financial profit before payment of water charges of farming households shows that this cost can be supported by farmers; however in that case farmer's financial contribution to the Project would amount to approx 14% for scenarios 1 & 2; 10% for scenario 3. From international experience, the level of farmers' contribution should not exceed 5% of the gross financial profit. Moreover irrigation development will not benefit to farming households only. A significant portion of the overall benefits will go to the off-farm sector, in particular to those who will benefit from expanded opportunities flowing from the irrigation Project (the so-called multiplier effects).

6.4.3 Benefit Distribution, Poverty Impact and Employment

The first important indicators are the F-IRR and the E-IRR. A F-IRR close to 9% means a significant impact of the Project on the off-farm sector, in particular on economic agents involved in marketing and transportation. Thus, the primarily concerned economic agents are traders, transportation companies, inputs suppliers and service providers. A number of farmers would also develop off-farm profit making activities. An E-IRR of 12% guarantees, for a Project of this nature, that the risks taken for investing in off-farm activities will be limited. The main social impact of the Project is ensuring food security in the Project area and the whole Woreda. The cereals production exceed 44,000 tons per year and projected estimates of food requirements of 13,700 tons in the year 2016 indicate that the Project will ensure food security and will allow farmers to market the major part of their products. In other words, the Project will create jobs at farmlevel and in the off-farm sectors and will create wealth for the households. Approx 8,000 workers can find around the year on-farm employment earning an annual salary of 4,000 birr or more. In the off-farm sector, approx 1,000 jobs would be created for water management (through IWUAs), marketing activities (storage, transport, sale of goods), input providers of the private or cooperative sector, spare part retailers, and repair services. The figure indicates that more than 142 million Birr is gained by the farming households, which would serve to pay taxes, to increase their livelihood standards and to have a better access to health care. At least, the Project will redistribute about 3.2 million Birr per year corresponding to VAT calculated on input needs, and more than 8 million Birr as income taxes. The total 23.3 million birr that farmers would pay for recurrent expenses (on the base of 0.46 birr per m3) must be added to the impacts of the Project.

7. PROJECT IMPLEMENTATION

The organisation of the implementation will be the responsibility of the MoWR and the Oromiya Bureau of Water Resources. It is proposed that a special Project Implementation Unit (PMU) is created in or nearby the Project site (possibly Nekempte) and that this PMU is receiving support from international consultants. The training requirements for the staff of the main system operator will have to be defined during the detailed design phase and after the modalities regarding the identification and selection of the main system operator have been formulated by the MoWR and the Oromiya Bureau of Water Resources. Capacity building activities should aim to provide WUAs with information and knowledge for carrying-out, monitoring and assessing their activities. This knowledge and information should materialize under the form of a series of *management tools* such as by-laws, performance indicators, worksheets for maintenance, irrigation schedule, mechanisms for assessing and collecting the water supply charge, bookkeeping system, communication and conflict resolution mechanisms and so on. The capacity building activities should address on-farm water management, selection of cropping patterns, promotion of technology packages for irrigated agriculture, determination of farm budgets, compatibility with an irrigation cost recovery approach, assessment and monitoring of the performance of irrigated agriculture.

8. RISKS AND UNCERTAINTIES

The following risks and uncertainties have been identified:

1) Shortages of river water during the months of March and April might occur at the peak demand of $6m^3/s$. Therefore, cropping patterns would have to be adjusted in such a way that peaks fall inside periods with higher flows in the river. With the ongoing development in the upstream catchments it is highly likely that more water will be diverted in the future thus constraining water availability at the diversion point. This can only be counteracted by the construction of the Arjo-Didessa Dam or the Negeso Dam.

2) Although the beneficiaries are keen to accept the Project, their preparedness and willingness to accept reallocation of land for development of irrigated agriculture is an unknown factor. The land take for the irrigation system is kept to a minimum.

3) The preparedness of the farmers to carry out soil and water conservation works on the steep land to mitigate any negative impact of surface irrigation.

4) The availability of sufficient labour for irrigated agriculture over the full 7,500 ha during two seasons, each at 100% cropping intensity.

5) The availability and reliability of electric power supply. Investment in standby capacity for the pumping station is too costly.