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Prefeasibility Report

Phase I
Southwest Development

United States Agency
For International
Development

Ministry of Agriculture
Imperial Ethiopian
Government

August 1974

TAMS
Agricultural
Development
Group

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BACKGROUND DATA

US$ 1.00	Eth.$ 2.07
Population (Est. 1970)	24.3 million
Labor Force (Est. 1970)	11.2 million
Population Growth Rate	2.5 percent
Per Capita GDP (1970)	Eth.$ 168
Food Price Index (1970) In Addis Ababa (1963=100)	156
Main Agricultural Exports	Coffee, hides, oilseeds and pulses
Main Agricultural Imports	Wheat, cotton, milk and tea
Agricultural Exports (1970)	
Value	Eth.$ 268 million
Percent of Total Merchandise Exported	96 percent
Agricultural Imports (1970)	
Value	Eth.$ 40 million
Percent of Total Merchandise Imported	9.4 percent
Total Agricultural Land	84 million hectares
Total Number of Farms (Est.)	4 million
Total Area	122.2 million hectares

CONVERSION TABLE

1 millimeter (mm)	= 0.039 inches
1 meter (m)	= 39.37 inches
1 kilometer (km)	= 0.62 miles
1 hectare (ha)	= 2.471 acres
1 square kilometer (km^2)	= 0.386 square miles
1 metric ton	= 2,205 pounds (1000 kg)
1 quintal (qq)	= 100 kg
1 gasha	= 40 hectares (approximately)

ABBREVIATIONS USED IN THIS REPORT

IEG - Imperial Ethiopian Government

USAID - United States Agency for International Development

MOA - Ministry of Agriculture

IHA - Imperial Highway Authority

IBRD - International Bank for Reconstruction and Development (World Bank)

IAR - Institute of Agricultural Research

NCB - National Coffee Board

DDA - Dairy Development Agency

HADP - Humera Agricultural Development Project

EPID - Extension and Project Implementation Department (MOA)

DVS - Department of Veterinary Services (MOA)

PPD - Planning and Programming Department (MOA)

NWRC - National Water Resources Commission

UNDP - United Nations Development Programme

TAMS - Tippetts-Abbott-McCarthy-Stratton, Consulting Engineers

MLRA - Ministry of Land Reform and Administration

MNCD - Ministry of National Community Development and Social Affairs

LMB - Livestock and Meat Board

CSO - Central Statistical Office

MPP - Minimum Package Program of EPID/MOA

DWR - Department of Water Resources

NCS - National Climatological Section

ADMINISTRATIVE DIVISIONS IN ETHIOPIA

Jurisdictions	Equivalent	Administered By
Governorate General or Province	State	Governor General or Enderassie
Awraja	County	Awraja Governor
Woreda	Division of a County	Woreda Governor

PART I

GENERAL REPORT

INTRODUCTION

Ethiopia is a constitutional hereditary monarchy located on the northeast coast of Africa between latitudes 4° and 18° North and longitudes 33° and 48° East. It is bounded on the northeast by the Red Sea and the French Territory of the Afars and Issas; on the east and southeast by the Somali Republic; on the south and southwest by Kenya; and on the west and northwest by the Republic of Sudan. The total area of the country is approximately 1,166,000 square kilometers.

The heart of the land is a high dissected tableland known as the Ethiopian Plateau, covering more than half of the country's area, with peak elevations exceeding 4,500 meters. The plateau is split diagonally from northeast to southwest by the Great Rift Valley. The majority of the population (estimated at 24.3 million in 1970) live and farm in these highlands. The northern and eastern edges of the plateau are marked by abrupt escarpments which drop 1,500 meters or more to the hot, arid coastal plains. To the west, the edge falls more gradually to broad, nearly uninhabited semi-tropical savannah grass plains along the frontier with the Sudan. In the south and southwest, the highlands give way to semiarid desertic savannah towards Lake Rudolf, Kenya and Somalia.

The economy of Ethiopia is heavily dependent upon the earning of the agricultural sector and is likely to continue to be so in the future. Recent agricultural sector analyses have indicated that growth rates anticipated in the first three five-year development plans have not been realized and, in spite of current efforts to increase crop yields through experimentation and extension, population increases continue to exceed the rate of agricultural growth. The Interministerial Sub-Committee, under the leadership of the Planning and Programming Department of the Ministry of Agriculture (PPD/MOA), in 1972 conducted a reconnaissance survey of the Southwest Region of Ethiopia to identify underdeveloped and largely unsettled areas whose apparent economic potential deserved more attention in

terms of government development effort. Such areas would offer attractive agricultural and livestock investment benefits and, at the same time, provide large tracts of government owned lands for resettlement of peasant farmers who are now crowded onto the central plateau and Rift Valley areas.

Authority and Scope

The pre-feasibility work comprising Phase I of the Southwest Development Studies, was undertaken pursuant to the terms of Contract No. AID/afr-C-1070 between the United States Department of State, Agency for International Development, and the Contractor, Tippetts-Abbett-McCarthy-Stratton, effectively dated June 10, 1974. As originally constituted, the prefeasibility studies were designed to include five potential agricultural development areas which were among a larger group of areas previously investigated in the 1972 reconnaissance survey by the Interministerial Sub-Committee. The "Objectives" stated in the Contract are as follows:

> "The primary objective of this Contract is for Contractor to determine from review of five geographical areas in Southwestern Ethiopia the two areas most suited for further study in terms of suitability for resettlement and agricultural development. The secondary objective is the refinement of existing General Guidelines into a workable scope of work for the two areas selected."

The "Scope of Work" stated in the Contract is as follows:

> "1. Contractor, as Phase I, will review and study from the standpoint of determining suitability for resettlement and agricultural development the following five geographical areas in Southwestern Ethiopia:
>
> a. the Bedele-Mota Road area,
> b. the Omo Valley in Gemu Gofa,
> c. the Gambela area in Illubabor,
> d. the Sagan Valley in Gemu Gofa, and
> e. the Kucho-Menema Valley areas in Gemu Gofa Province.[1/]

[1/] Shortly after commencement of field and office studies, the Interministerial Committee of the IEC requested the Contractor to delete these areas to prevent possible duplication of effort or conflict with another development study being planned there; this request was concurred with by the USAID Mission and the areas were accordingly deleted from Phase I studies.

2. The above five areas will be ranked by Contractor as to suitability for resettlement/development in terms of the potential economic and social benefits at varying investment costs and strategies. Since the five areas indicated have different ecological and land use aspects the following will be investigated:

a. land capability survey which would include soil and water conservation, forestry protection and exploitation;
b. irrigation possibilities;
c. settlement; and
d. road development.

3. In order to facilitate comparison among the five areas and to select the two areas for a more comprehensive study and project preparation under Phase II, the following tasks will be carried out in the five designated areas:

a. the project areas will be demarcated more closely;
b. indicate the number and present condition of the would be beneficiaries;
c. prepare proforma estimates on expected cost and benefits and indicate preliminary financial and internal economic rates of return; and
d. make a comparative analysis of the economic, financial and social data to aid policy makers in making a decision on the selection of the areas for the Phase II study.

4. As the final step of Phase I, Contractor shall develop a scope of work for Phase II based on its findings from the survey and study of Phase I and using the following as general guidelines:

a. the recommendation of definitive production practices, including the use of inputs for all relevant cereal, pulse and specialty crops;
b. the recommendation for present and future utilization of all forest products and resources;
c. an ecological overview of the effect that development and/or settlement projects may have on the interrelation of plant and animal life in their environment;
d. the preparation of detailed transportation plans and financial cost estimates necessary to accommodate project development taking into consideration the plans of the Imperial Highway Authority and the proposed Rural Road Administration;
e. analyze the present role of livestock in the selected areas and prepare detailed plans indicating the future position of livestock in the proposed development and/or settlement projects;
f. prepare settlement plans for the two selected areas;

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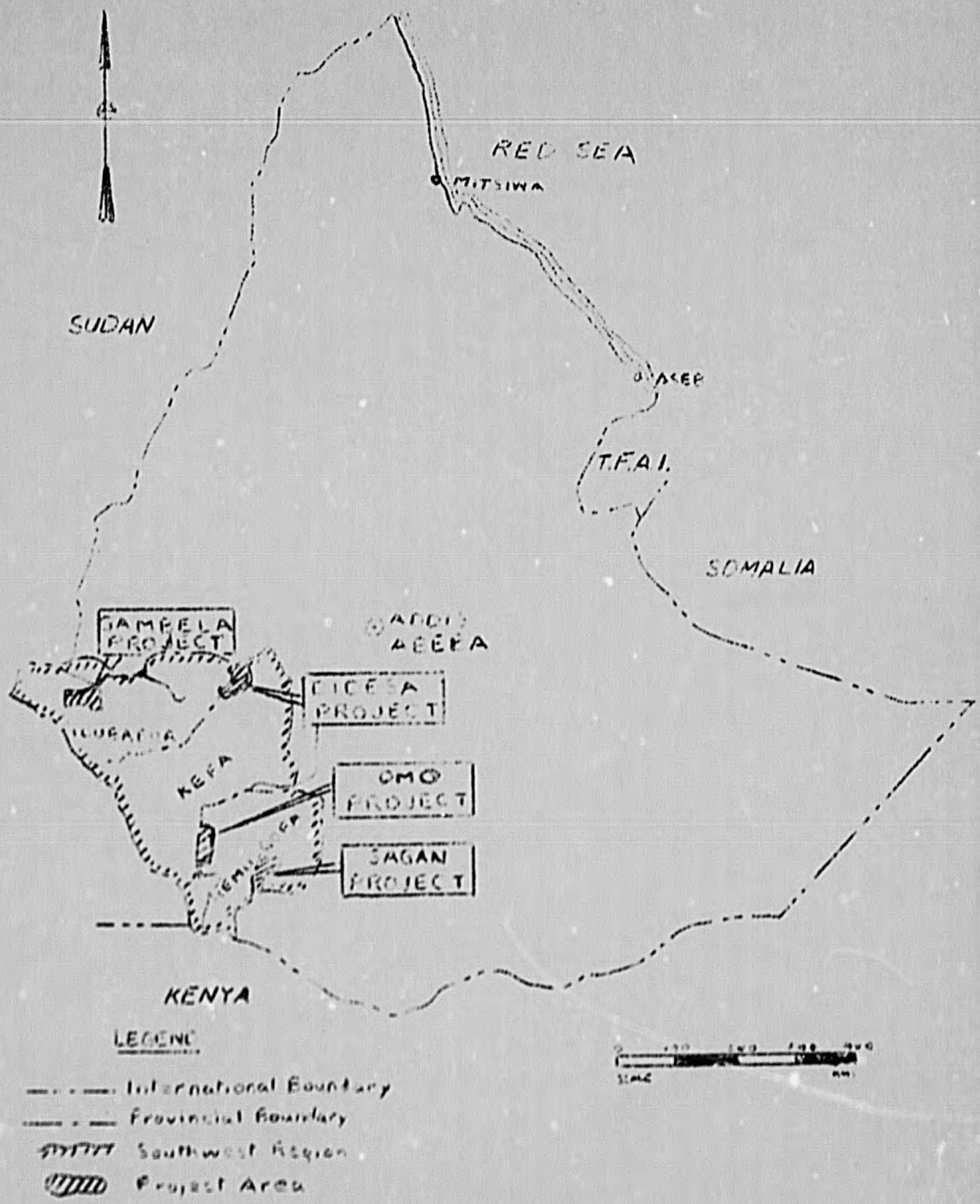
g. analyze the existing land tenure systems and identify constraints the system will place on future development and/or settlement projects;
h. recommend detailed marketing systems, i.e. marketing practices and procedures, storage and handling and transportation facilities, for major selected crops;
i. analyze current domestic and international demand for the crops and present judgments vis-a-vis the likely impact of incremental production on prices; and
j. collate and present on each selected area all of the above information in a comprehensive document that will provide an analytical base upon which to develop viable projects in the selected areas."

Description and Location of Project Areas

Presented on Figure I-1, General Location Map, are the general locations of the areas under investigation. More detailed project locations will be shown for the individual areas under the appropriate headings in the text of this report. Two of the areas lie mainly within Ilubabor Province and two within Gemu Gofa Province, both in the Southwest Region. Until recently, this section of the country, though believed to have a high potential for agricultural production, has been largely overlooked in development planning.

The province of Gemu Gofa is in the extreme south bordering with Kenya. The Omo River, one of the major sources of Lake Rudolf and one of the longest rivers in Ethiopia, marks the northern and western provincial boundaries. The province of Sidamo borders to the East. The total land area is taken to be approximately 39,500 square kilometers with an estimated population of 990,000. The bulk of the inhabitants are concentrated in the overpopulated highland portions of Gemu and Gofa Awrajas. In the lower Sagan and Omo River basins, the population density has been estimated at three per square kilometer.

Two projects have been identified and studied in the sparsely populated southern portion of this Province. Approximately 40 kilometers north of the Sagan River Delta at Lake Chow Bahir, the Galana Dulei River confluences with the Sagan after flowing through a valley ranging in width from four to 16 kilometers and some 60 kilometers in length. Existing studies and aerial observations indicate the suitability of these lands for resettlement based on irrigated



GENERAL LOCATION MAP FIG 1·1

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agriculture and possible controlled livestock grazing. For pre-feasibility purposes, some 25,000 hectares are considered for farmland settlement and up to 25,000 hectares for livestock.

The western edge of Gofa Awraja borders on the Omo River. Some 100 kilometers due north of Lake Rudolf and the frontier with Kenya, a suitable study area is clearly identifiable along the Omo's eastern bank. It includes some 50,000 hectares of flat to moderately sloping lands of high irrigated agricultural potential. For purposes of comparison with other sites, 25,000 hectares are considered for settled farming and 25,000 hectares in a pasture program.

Ilubabor Province is bordered by Kefa Province to the south and east, Wollega to the north and the Republic of Sudan to the west. The total area is approximately 47,400 square kilometers divided fairly equally between high, forested, mountainous land in the eastern part and low savannah bushland and swampy areas in the western half. Gambela Awraja covers these lowlands to the Sudanese border. The Baro River, one of the major tributaries to the White Nile System, crosses Gambela Awraja and provides a source of irrigation water for development. A potential project has been identified along the southern bank of the Baro beginning some 20 kilometers downstream from Gambela. An initial development effort could include 25,000 hectares for irrigated agriculture and 25,000 hectares for improved livestock grazing. The area is reported to be entirely government owned.

The recently completed all-weather paved road linking Bedele and Metu in the mountainous eastern half of Illubabor province, provides access to a high rainfall, densely populated zone including some of the country's most important coffee producing areas. The new road has contributed to economic development but further institutionalized support is required for expanding upon farmer credit, extension services, forest conservation and exploitation, land conservation and erosion control, crop improvements, introduction of new varieties, and other activities in the agricultural and social sectors. A definite project could not be readily identified in this immediate area which would include the element of settlement. Land tenture is complicated and involves many large and small owners, renters, share croppers and conflicting claims.

Near Bedelo, the Didesa River Valley lying mostly within Ilubabor but including parts of Kefa province, provides a valid prospect for development of rainfed farms and new settlements and has been demarcated for inclusion in this prefeasibility study. Approximately 25,000 hectares of valley land, mostly government owned, would be suited for project type development. Considering the high rainfall and lack of a prolonged dry season, it is apparent that one rainfed crop may be harvested by the provision of surface drains to facilitate runoff of excess rainfall.

Work Performed

Work on Phase I effectively began on 21 June 1974 following the arrival of the Contractor's Team Leader in Addis Ababa on 18 June 1974 and terminated with the presentation of the draft of this prefeasibility report. During the period of study, the team was expanded to six professionals from the staff of the Contractor and three specialists from the Ministry of Agriculture, the Ministry of Land Reform and Administration and Haile Selassie I University.

Initially, a number of meetings were held with various ministries, semi-autonomous government agencies, the United States Agency for International Development, the United Nations Development Programme, and with several fully autonomous enterprises related to development and expansion of agricultural resources. More than 80 pertinent reports, surveys and documents were accumulated for study and were used as references. This material indicated that the areas under review had several common features, e.g. - remoteness from commercial centers, lack of infrastructure including even dry-weather access roads in some cases, underpopulation, little or no present farming activity - but all appeared to have potential for capital investments in development projects and for resettlement schemes.

Surface hydrology and climatology were investigated utilizing records which in some instances dated from 1905. Tables have been prepared for each area giving average monthly precipitation, evaporation, relative humidity and temperature. Theoretical evapotranspiration values have been computed for several crops and cropping patterns based on the information as reported in the Climatology and Hydrology sections under each project discussion.

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The lack of access roads has always been one of the major constraints to development in the Southwest Region. The existing road net as well as the Fifth, Sixth, and Seventh Highway Construction Programs of the Imperial Highway Authority (IHA) have been studied and analyzed in terms of project needs and priorities. One and two-lane tertiary roads have been designed for internal project traffic and preliminary criteria, scheduling and costs developed.

The role of livestock in agricultural development has been studied. Valuable assistance was obtained from United Nations staff with direct experience in livestock disease control in the region. Animal diseases presently considered as serious constraints are discussed, treatments recommended and benefits from livestock improvement measures are included in appropriate sections of the report.

The study of numerous reports and discussions with various individuals familiar with the four areas have aided in an evaluation of the prevailing social, economic and agricultural conditions. The land tenure system, often complicated and difficult to determine in heavily populated areas, is simplified as all projects are underpopulated and partially or wholly government owned. Present population residing near the defined areas has been roughly estimated and potential beneficiaries of development activities identified. The present land use has been studied from reports, air photos, aerial reconnaissance, and on the ground where access permitted. Ecological and soil information, as available, was sufficient for an evaluation of land capability at prefeasibility level.

Based on these studies, simplified cropping systems have been prepared for each area. As each zone has different eco-climatological conditions, various engineering works were considered to provide the areas with either irrigation, flood protection, surface drainage or combinations of control measures. The required structures have been sized and preliminary order of magnitude costs estimated for project economic analyses.

Crop yields, costs, labor requirements and markets have been studied in order to compute development returns and to clearly identify major constraints. The economic streams of costs and benefits and computed internal economic rates of returns provide the economic basis for the report's recommendations.

Acknowledgements

The Southwest Development (Phase I) studies were carried out with the support and direction of the Planning and Programming Department of the Ministry of Agriculture (PPD/MOA). The Director General of PPD/MOA also serves as Chairman of the Interministerial Committee.

Several agencies closely associated with, or integrated into the Ministry of Agriculture supported the work, provided pertinent reports and offered particularly valuable assistance. Included were the Institute of Agricultural Research (IAR), the Extension and Project Implementation Department (EPID), the Department of Veterinary Services (DVS) and the State Forest Development Agency. The assistance and cooperation of these agencies is gratefully acknowledged.

Many other ministeries, agencies, international organizations and private firms contributed substantially to the work. They included:

- Ministry of Interior
- Ministry of Land Reform and Administration (MLRA)
- Ministry of National Community Development and Social Affairs (MNCD)
- Ministry of Mines
- Ministry of Public Health
- Imperial Highway Authority (IHA)
- Civil Aviation Authority (CAA)
- National Water Resources Commission (NWRC)
- National Climatological Service (NCS)
- Ethiopian Grain Corporation
- Dairy Development Agency (DDA)
- Haile Selassie I University
- National Coffee Board (NCB)
- Tobacco Monopoly
- Imperial Central Laboratory and Research Institute
- United Nations Development Programme (UNDP)
- United States AID, NAMRU and Peace Corps
- Economic Commission for Africa (ECA)
- Livestock and Meat Board (LMB)
- The Grain Board

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Study Organization

The report has been prepared in Addis Ababa by a six-man team representing the TAMS Agricultural Development Group and its participating members, with the assistance of three specialists from IDG agencies. Backup assistance has been provided by TAMS principals in the New York office.

The team posted to Ethiopia included:

Name	Position and Responsibility	Date of Arrival in Ethiopia
R. L. Barr	Team Leader: Overall Supervision, Planning, Engineering, and Economic Analysis	June 18, 1974
W. F. Gibson	Deputy Team Leader: Land Use and Agriculture	June 26, 1974
M. L. David	Agricultural Economist: Markets, Farm Budgets, Financial Analyses and Shadow Pricing	July 17, 1974
Dr. E. Coles	Veterinarian: Animal Health and Livestock	July 14, 1974
R. F. Kriess	Hydrologist: Hydrology and Climatology	June 27, 1974
C. Van Cook	Civil Engineer: Highways and Transport	July 14, 1974

The Ethiopian staff included:

Dr. Tewoldo Berhan Gebre Egziabher, Ph.D., Ecologist and Assistant Professor in Biology, Haile Selassie I University

Ato Tamrat Beyene, Junior Economist seconded from the Planning and Programming Department, MOA

Ato Taye Germu, Settlement and Land Tenure Expert from MLRA

References

The following partial list includes reports, surveys and studies published in Ethiopia and various other technical books which have provided a valuable supply of reference material for this report.

TITLES

"Report of Pilot Coffee Survey, 1971-72 Planning." 1973, NCB.

"Plan for the Formulation of an Agricultural Development Project in the Major Coffee Growing Areas of Ethiopia for IBRD Financing." 1973, NCB.

"Coffee Survey Project - Supplemental Marketing Investigations." 1972, NCB.

"Proposal for a Study of Land Capabilities and Scope for Coffee Diversification in Didessa-Yachio Pilot Area - Ilubabor Province." 1972, NCB.

"Coffee Exports of Ethiopia." (Based on Mulat, 1972), NCB.

"Coffee Survey Project, Marketing Investigations - Coffee Washing Questionnaire." 1973, NCB.

"Coffee Survey Project Proposal for Farm Management Investigations." 1973, NCB.

"Agricultural Development Project in Major Coffee Growing Areas of Ethiopia. Household Questionnaire." 1973, NCB.

"Fourth Five-Year Development Plan, Draft Plan for the Coffee Subsector." 1973, NCB.

"The Wildlife Situation in the Gambela Awraja, Southwest Ethiopia." Duckworth, 1973, Wildlife Conservation Organization.

"Study of River Transport over the Baro-Akobo-Sobat Rivers." 1973, Prepared by the Ethio-Sudanese Team.

"Evaluation of the Awash Valley Authority Settlement Programme." 1973, A report by Consultants, including Dr. Fadda.

"An Agricultural and Socio-Economic Survey of South Sudan Refugee Settlements and Surrounding Areas in Gambela Awraja, Ethiopia." Ellman, 1972, IAR.

"Proposals for the Fourth Five-Year Development Plan GC 1974/5 - 1978/79." MOA.

"Regional Dairy Development Projects." 1973, DDA.

"Economic Feasibility Study for the Construction of the Sodu-Bulki-Baco Road." 1973, IHA.

"A Review of Animal Health and Livestock Productivity Factors in Ethiopia, 1965-1971." 1972, Department of Veterinary Services.

"Provincial Livestock Development Studies-Gemu Gofa Province." 1971-72, LMB.

"Provincial Livestock Development Studies-Ilubabor Province." 1972, LMB.

"Hydrological Investigations Program of the Water Resources Department." 1968, U. S. Geological Survey and MPWC.

"Report of Land Tenure Survey of Kefa Province." 1968, MLRA.

"Report of Land Tenure Survey of Ilubabor Province." 1969, MLRA.

"Report of the Fertility Status and Other Data on Some Soils in Ethiopia." 1968, Dr. H. F. Murphy of Haile Sellassie I University.

"Progress Report for the Period April 1972 to March 1973." Gedo Research Station, IAR.

"Initial Farm Management Survey, 1972-1973." 1973, IAR.

"Settlement of Nomads and Semi-Nomads in the Wabi Shebelle Valley." IAR.

"Progress Report for the Period April 1971 to March 1972." Holetta Guenet Research Station, IAR.

"Results of the National Crop Trials, 1967-1971." 1973, IAR.

"Recent History of an Ethiopian Delta." 1971, Karl W. Butzer, University of Chicago, Department of Geography, Research Paper No. 136x.

"Progress Report for the Period April 1971 to March 1972." 1972, Melka Werer Research Station, IAR.

"Progress Report for the Period April 1970 to March 1971." 1971, Melka Werer Research Station, IAR.

"Progress Report for the Period April 1970 to March 1971." 1971, Holetta Guenet Research Station, IAR.

"An Atlas of Ethiopia." 1970, Mesfin Woldo Mariam.

"Rice Production Manual." 1970, University of the Philippines with IRRI.

"Development Prospects in the Southern Rift Valley, Ethiopia." In 3 Volumes, 1972, Makin, et. al., ODA.

"The Humera Report." 1974, TAMS for MOA.

"Southwest Rural Development Reconnaissance Survey." 1972, Interministerial Sub-committee and the PPO/MOA.

"Statistical Abstract-1972." Central Statistical Office.

"List of Publications." 1973, ECA/FAO Forest Industries Advisory Group for Africa.

"Survey of Mechanical Woodworking Industries in Ethiopia." Vol. A and B, 1972, UN/ECA Forest Industries Advisory Group.

"Weather Summary of the 'Bega Season' October 1972 - January 1973." Agromet Section of the Meteorological Department.

"Soil Resources Appraisal and Evaluation Studies for Rural Development in Ethiopia." 1974, Debele and Ochtman, IAR.

"Soil Survey Manual." 1951, U. S. Department of Agriculture.

"Economic Analysis of Agricultural Projects." 1972, IBRD.

"Findings of a Market Structure Survey and Analysis of Those Grains That Provide the Basic Subsistence for the People of Ethiopia." 1973, PPD/MOA.

"Report to the Government of Ethiopia on Integrated Rural Development 1970. Gench Project Development Plan and Loan Proposal." 1974, DDA.

"Ghimbi-Dembidollo-Gambela Highway." 3 Volumes Reconnaissance Study, Feasibility Study and Map Annex, 1973, IHA,

"Report on Rural Traffic Movement in Ethiopia." 1974, IHA.

"Provincial Livestock Development Studies-Kefa Province." 1972, LMB.

"Report for the Period April 1971 to March 1972." 1973, IAR.

"Report No. 1. The Feasibility of Producing Pulse Crops for Export Markets." 1972, Experience Incorporate.

"A Policy Oriented Study of Land Settlement, Volumes I and II." MLRA.

"Southern Rangelands Livestock Development Project, Studies and Surveys, Range Ecology." 1973, LMB.

"Southern Rangelands Livestock Development Project, General Report." 1973, LMB.

"Veterinary Services Development Plan." 1973, MOA.

"Bulletin of Epizootic Diseases of Africa." Vol. No. 3, 1971, OAU/STRC.

"Guidance to the Efficient Implementation of Dipping Scheme." 1974, Dr. M. Buljina, (unpublished).

"Building, Assembly and Working Instructions-Pfizer Challenge Cattle Spray Race." 1973, Dr. M. Buljina, (unpublished).

"Southern Rangelands Livestock Development Project, Studies and Surveys, Animal Husbandry and Health." 1973, LMB.

"Southern Rangelands Livestock Development Project, Surface Hydrology and Climatology Report." 1973, LMB.

"Handbook of Applied Hydraulics." 1969, McGraw-Hill Book Company.

"Handbook of Hydraulics." 1963, McGraw-Hill Company.

"Final Report of Crop Condition Survey for the 1972-73 Harvest." 1973, MOA.

"The Demography of Ethiopia." 1974, CSO.

"Annual Report for 1972/73 Financial Year." 1973, EPID.

"Annual Report for 1971/72 Financial Year." 1973, EPID.

"Bibliography of IHA Reports and Feasibility Studies." 1974, IHA.

"Low Cost Settlement Project for PFYP (1967-1971 E.C.)" 1973, MLRA.

DEVELOPMENT OBJECTIVES AND CONSTRAINTS

Resettlement

One of the government's prime objectives is the utilization of the vast plains of the Southwest Region to relieve pressure from the overcrowded highlands. Before the highland farmers are brought down to the plains, however, the semi-nomadic pastoralists and the primitive farmers who already use portions of these plains should be catered to. The use of the plains by the pastoralists is inefficient as they are entirely dependent on animal products which is generally more wasteful of the land resources than living on plant products. Also, the pastoralists are few in numbers but claim tribal rights on vast areas which are periodically grazed during the annual migrations to and from their more permanent camps.

The first step in developing the agricultural potential of the plains should be an effort to incorporate both the semi-nomadic herdsmen and the primitive farmers into the proposed program and to attempt to settle them on viable units. When this is done, the excess people from the highlands - especially from drought prone parts - could be resettled in the large spare spaces which will have been freed by the resulting increased efficiency of land utilization. If the highland farmers are brought down to the plains before the indigenous people are settled, or offered ample opportunity and assistance to do so, it would be morally wrong since it would dispossess them of portions of their traditional land. It would also give a new dimension to the usual conflict and consequent animosity that exists between neighboring highland agriculturalists and plains pastoralists.

The central plateau, being considerably more developed than the lowlands, has been subjected to severe population pressures for centuries. A major portion of the farmers are renters with uncertain tenancy, or are enmeshed in rental/share arrangements with absentee owners. Farm sizes are small and are usually fragmented into scattered fields. Inheritance further divides land until even subsistence farming cannot be realized. Farm livestock are crowded into overgrazed pastures. These measures on the mountainous terrain accelerate the unchecked forest destruction and soil erosion so

clearly seen from the air.

Farmers in some portions of Ethiopia, while not restricted to minimal farm units, are subjected to periodic droughts and famines. Surface and ground water resources are scarce and costly to develop. Many of these areas are better suited for extensive grazing of livestock rather than uncertain rainfed farming. Relief operations to prevent malnutrition and starvation receive considerable bilateral and multilateral support from many nations and international organizations and continues to drain off domestic capital, material, supplies and manpower.

If there were few or no constraints to resettlement, there would be no need for resettlement. People would spontaneously migrate from a distressed area to one offering more opportunities for expansion and economic gain. In the southwestern lowlands, the existing constraints are of major importance and have, to date, effectively prevented migration into the areas. Many prevailing conditions have been responsible for population exodus in the past. The primary factors limiting, or constraining, resettlement and agricultural development in the southwest are listed below and are discussed more fully in subsequent sections of the report.

- Presence of endemic livestock and human diseases
- Lack of highways and penetration roads.
- Fear of hostile nomadic tribes
- Uncertain government policy towards ownership and tenancy on settled lands
- Lack of farm credit
- Traditional reluctance against moving from the temperate highlands to the hot, humid semi-tropical plains inhabited by people of different ethnic and religious backgrounds
- Distance from the principal market and commercial centers
- Environmental limitations, including climatic and soil constraints

Improvement of Agricultural Production

Ethiopia is reported to have an annual per capita income (GDP) of less than Eth.$ 170, ranking it among the most economically depressed countries in the world. Until recently, the agricultural sector did not receive effective government support for experimentation, seed multiplication, extension, education, provision of inputs and formation of cooperative activities. Speculative land grants to a favoured few prevented the exploitation and settlement of many fertile and underpopulated areas. Indiscriminate forest destruction was either allowed or condoned. Soil conservation measures, urgently required, were not adopted. The deep, fertile volcanic highland soil, under intensive farming and population pressures, has weathered and eroded, and its capability to produce without increasingly heavier applications of fertilizers has been reduced.

In the past decade, the government has become aware of these factors and has made impressive efforts to reverse the downward trends. Yet, until now, production increases - sectorwide - do not offset annual percentage population gains. While recognizing that experimentation, credit, conservation, extension, development of cooperatives, and other direct agricultural services must be continually strengthened, it became clear to planners that a project approach involving large tracts of undeveloped arable lands and including commercial operations would be the only method of providing sufficient quantities of marketable farm produce to offset these trends. In recent years, development schemes such as the Humera Agricultural Development Project (HADP), Awash Valley Authority developments (AVA), Chilalo Agricultural Development Unit (CADU), Wollamo Agricultural Development Unit (WADU), Ada Development Project (ADP) and the Extension and Project Implementation Division (EPID) activities of MOA including the Minimum Package Program (MPP) have been studied, financed and are in various stages of implementation. Other projects are either under study or being prepared for financial consideration.

The areas selected by the Interministerial Committee are largely uninhabited except for nomadic or semi-nomadic herdsmen. The desired improvement in agricultural production requires the initiation of settled farming. Spontaneous settlement and agricultural developments

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have been restricted by those constraints described in the previous section.

The economic value of the existing agricultural production in the four study areas may be taken as nil if no allowance is considered for off-take from the few nomadic herds which move in and out seasonally.

Improvements depend upon the technical and economic feasibility of eliminating, or alleviating, the existing constraints and providing the necessary facilities (structures, credit, inputs, storage, equipment, etc.) for settlement and agricultural development.

The principal objectives of the studies leading to the preparation of this report have been to: 1) devise methods whereby those constraints could be eliminated or eased; 2) to survey the land's capability to produce various crops under different development strategies and timing; 3) to estimate cost, benefits, and rates of return for the proposed improvements; and 4) to recommend more detailed studies for two selected areas.

In subsequent sections of this report, the improvement strategy for each study area is outlined and analyzed and in the final section, a comparative analysis is presented to justify the selection of two areas for detailed feasibility study and investment preparation.

Model Farm Sizes

A preliminary assessment of viable farm units, considering both the government's objective to resettle the maximum numbers of farm families from the crowded highlands into the developing southwest region and the economic advantage of producing marketable surpluses of crops for the country's principal markets and for export abroad, has led to the proposed division of arable lands in all four projects between smallholder oxen-powered units and larger tractor-powered (mechanized) units.

For the purpose of comparative economic analyses, based on order-of-magnitude costs and benefits, the same sizes and numbers of model farms were developed and used for each of the four project areas studied. In the case of smallholder settlers a model farm size of five hectares was used for a total of 2,500 farms covering 12,500 hectares; this is considered to be a realistic average size manageable

by a farm family and is believed to conform to policies of MIRA. For mechanized units, a model size of 250 hectares was used as being representative of an average two-tractor operation on an irrigated farm raising two crops annually and an average one-tractor operation on a rainfed farm raising one crop annually. While this model size was used for preliminary analyses and would provide for 50 mechanized farms covering 12,500 hectares in each project area, it in no way comprises a recommendation for actual implementation; optimum, minimum and maximum size mechanized units will be analyzed and recommended for implementation during Phase II feasibility studies and will reflect Government policy and legislation in effect or pending at that time; for example, if legislation decrees a ceiling of two gashas (approximately 80 hectares), then it may require a partnership of two or more landholders to form a viable mechanized operation. Concessions to the extent permitted by law may also be considered.

There are many advantages to a mix such as described above. The larger mechanized farmers, operating profit-oriented enterprises, could greatly assist the smallholders (e.g., through provision of custom machine operations which would increase yields), and would also provide a source of both permanent and seasonal labor opportunities.

Role of Livestock

The development of streams of economic livestock activities within the areas under consideration, depends upon the provision of protected zones where both the traditional pastoralist and the more settled farmer with an interest in livestock production, will have an opportunity to improve upon their present status and ultimately contribute production benefits to regional and national growth. Each of the four areas have similar, though not identical, livestock potentials and existing constraints. Future project settlers, whether local residents or those migrating from other points in the Empire, will bring with them those animals they traditionally keep. On small farm units, the primary source of power for plowing, harrowing and ridging will be a team of oxen - at least for the immediate future. Each farm family possess on the average a few animals (sheep, goats, chickens) and would increase this stock if

conditions for livestock expansion were improved. In all areas, the commercial production of animals appears to be an attractive mix with agricultural development.

The prevalence of serious diseases has constrained the development of a viable livestock economy.

Major Livestock Diseases and Parasites - The endemic and debilitating diseases and parasites, common to all areas, and recommended control measures are briefly discussed below.

1. Trypanosomiasis - The increasing incidence of Trypanosomiasis in the lowlands of Ethiopia can be attributed to either Tsetse fly invasion or the spread of the Trypanosome parasite to previously parasite-free Tsetse flies. Some lowlands were once excellent for livestock production, but as Trypanosomiasis increased and deaths occurred, cattle production ceased although the potential for viable livestock programs remains.

   Cattle become infected with Trypanosomiasis in two ways. First, by the typical cyclic transmission when animals are in contact with the Tsetse vectors. Infected Tsetse flies remain infected throughout their lifetime and are capable of producing infection in any animal they bite. Secondly, mechanical transmission occurs when non-infected susceptible animals come into contact with infected domestic or game animals and biting flies (other than Tsetse) are present. Such flies bite an infected animal and move directly to and bite a non-infected one. Biting flies carry an infection for only a few minutes.

   Tsetse normally invade and survive in areas where low-bush provides a resting and breeding place. During dry months, dense thickets also serve as shelter and breeding sites.

   Tsetse free zones can be created by brush clearance which is an accepted but frequently expensive method of Tsetse fly eradication. Although impractical for extremely large areas, it has a definite application to smaller land masses. If there is a low brush density, hand clearance is often the

most economical, but usually mechanical clearing is preferred. The normal mechanical method is a unit of two caterpillar tractors fitted with bulldozer blades and bush clearing chains. One such unit can clear 15-20 hectares per working day. Heavy thickets may also be bulldozed.

Another control measure is the use of insecticides sprayed either by air or from the ground. Spraying will generally reduce the fly population but must be followed by clearing or respraying to prevent reinfestation. The entire eradication of Tsetse by spraying insecticides directly or by use of a residual chemical is costly; however, for small areas, not too heavily infested, spraying is quite effective.

Many pastoralists resort to burning to clear areas for cattle grazing and for control of Tsetse. If the burn is hot, Tsetse will not survive and considerable low brush is removed. However, many fires are not of sufficient intensity to destroy the brush and significant infestation of Tsetse remains. Another practice is to burn only small patches and Tsetse continue to proliferate nearby and reinvade the burned area later.

Trypanosomiasis control using drug treatment of all animals is also possible and may be effectively used on work oxen. Massive treatment of large numbers of animals is not economically or operationally feasible. In order to be effective in Tsetse inhabited zones, all animals would have to be treated every two months. The use of drugs, particularly at below recommended levels, is hazardous. Drug-resistant Trypanosomes frequently develop under such circumstances. If drugs are used, Trypamidium (Samorin) is preferred as it is prophylactic and will protect for up to two months.

Once an area is cleared of Tsetse, it will usually remain so as long as brush growth is controlled or a cleared buffer zone (1.5 to 2 kilometers wide) is maintained. This zone should be kept cleared and should be routinely sprayed with a residual insecticide.

2. Rinderpest - The virus causing Rinderpest is probably present in all project areas. This disease has a very high mortality rate in susceptible animals, particularly calves. In the project areas under consideration, a high percentage of cattle have been vaccinated for Rinderpest under the OAU/STRC-JP-15 eradication program initiated in 1972. The tissue culture vaccine being used apparently gives lifetime immunity. The routine adopted is based on annual vaccination of the young. This latter procedure must be continued in order to reduce possible transmission of the virus from infected game animals to cattle.

According to officials of the Veterinary Service Division, the incidence of Rinderpest has been effectively reduced to controlled status in southwest Ethiopia under the JP-15 program.

3. Contagious Bovine Pleuro-Pneumonia (CBPP) - CBPP is known to exist is all awrajas of Ilubabor and Gemu Gofa Provinces. Large outbreaks may occur but more frequently, the disease is chronic. An effective vaccine is available but imparts immunity of only short duration necessitating revaccination on a yearly basis. Control by vaccination can be effective only if systematic quarantine of infected animals and effective control of stock routes are introduced and maintained.

4. Anthrax - This disease has a high mortality rate and the infection is transmissible to man. Although it usually occurs in limited areas, it is known to be present in all awrajas of Gemu Gofa and Ilubabor Provinces. Anthrax is readily controlled by vaccination but may continue to be a problem until mass vaccination programs are introduced into endemic areas and along trade routes.

5. Blacklog - This disease is caused by a spore-forming organism capable of survival in soil for years and exists in all project areas. Vaccines are effective and provide yearly

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immunity. Control is readily accomplished by yearly vaccination of young cattle and animals introduced into a herd.

6. Foot and Mouth Disease (FMD) - The incidence of this disease is relatively low in the project areas but has been reported in Gardula Awraja of Gemu Gofa and Buno and Gambela Awrajas in Ilubabor. Although not considered to be a major disease constraining cattle production, the sporadic occurrence of the disease reduces the potential for development of a meat export industry. By 1975, the Debre Zeit vaccine laboratory will have the capability of producing FMD vaccine specific for the virus types (A,O,C) known to be present in Ethiopia.

7. East Coast Fever (ECF) - This highly fatal disease has not been identified in Ethiopia although the vector is present. ECF is found in neighboring countries and it is a potential hazard in the project areas. No effective vaccine is available and the only known effective control method is eradication of the vector. Complete tick eradication is difficult but control is possible by spraying or dipping animals on a routine basis throughout the year. Research at the East African Veterinary Research Organization (EAVRO) and at the newly formed International Laboratory for Research on Animal Diseases (ILRAD) is being directed towards development of an effective vaccine. Until a suitable vaccine is available, control of ECF will be difficult if it should appear in Ethiopia.

8. Liver Flukes - Liver Fluke infections occur where the intermediate host snail is present. Liver Flukes are found in cattle in Gambela, Mocha and Gore Awrajas of Ilubabor and in all highland areas of Gemu Gofa province. Elimination of the intermediate host is possible by chemical treatment or drainage of the water habitat. However, it is costly to implement such a program and the livestock owner must depend on treatment of infected animals. Deaths due to Liver Fluke infections are rare but liver damage caused by this parasite

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reduces growth and productivity. After slaughter, infected livers are condemned at a considerable loss of carcass value.

9. Helminth Parasites of the Digestive Tract - Helminth parasites of one kind or another are found in the digestive tracts of most animals in the project areas. In low numbers they probably do not represent a major constraint to livestock production. If the parasite load becomes large, as may occur on heavily stocked pastures, deaths occur and continual heavy infections reduce productivity and growth. Most of these parasites can be controlled by pasture rotation and use of drugs.

10. Brucellosis - This disease of reproduction has been reported to occur in Ilubabor Province but there is no information relative to its existence in Gomu Gofa. Before the initiation of a livestock program, the disease incidence should be determined. An effective vaccine is available for control of brucellosis and is produced in Ethiopia.

11. Rabies - This virus disease occurs in all provinces of Ethiopia and represents a hazard not only to domestic animals but also to man. A reservoir undoubtedly exists in wild animals (especially jackals, hyenas and stray dogs) but the magnitude is unknown. Rabies does not cause great loss of life among livestock but its presence must be considered. Effective vaccines are available and are or will be produced in Ethiopia.

12. Anaplasmosis, Piroplasmosis, Heartwater - These tick-borne diseases are undoubtedly present in the proposed project areas as the vectors exist. Control measures evolve around and are dependent on tick control. Medication of clinically ill animals is feasible and effective.

13. Pastuerellosis - This bacterial disease appears sporadically early in the rainy season in most parts of Ethiopia. The most common form is pulmonic and is said to be caused by Pasteurella Multicida-Type B. A formalized alumprecipitated vaccine is

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produced that appears to be effective in reducing the incidence of this disease.

Control Program - As livestock production is an integral part of project planning, an effective program of disease and parasite control is a development prerequisite requiring early and effective implementation. The programs summarized below are practical guidelines designed to maintain an area of low disease incidence.

I. Selection and treatment of original and replacement animals entering a program area.

A. Clinically healthy animals should be selected by:

1. Physical examination of all livestock by a qualified Veterinarian.
2. Testing for Brucellosis, Tuberculosis, Anaplasmosis and Pastuerellosis and any positives removed.

B. Treatment to be administered:

1. Immunization for Rinderpest, CBPP, Anthrax, Blackleg, Pastuerellosis and FMD (if to be a disease-free zone).
2. All livestock dipped to remove external parasites.
3. Any animals positive for blood parasites should be treated or removed.
4. All animals treated for Liver Flukes and Helminths to reduce the parasite load.
5. All animals treated for Trypanosomiasis.

II. Prevention and control measures to be used for limiting disease incidences.

A. Trypanosomiasis

1. Pretreatment of program area including brush clearance and/or spraying all pastures and possible breeding areas and, if possible, clearing the land of wild game animals.
2. Maintenance of Tsetse-free pasture following treatment by clearing a 1½ to 2 kilometer buffer zone around the perimeter of the area and routinely spraying this strip with residual insecticides.
3. Treatment of animals becoming infected using an adequate dose of the most effective drug.

4. Avoiding mixing of sheep and goats except in Tsetse-free areas.
5. Maintaining the control area as free of wild game as possible.

B. Rinderpest

1. Vaccinate all animals entering the control area.
2. Annual vaccination of young animals for 3 years or more.
3. Revaccination of all animals if the disease is again detected.

C. Contagious Bovine Pleuro Pneumonia (CBPP)

Vaccine is administered along with Rinderpest vaccine but, as immunity is for a limited time only, yearly re-vaccination of all cattle should be maintained for 3 to 4 years.

D. Blacklog

1. Vaccinate all calves at 6-8 months of age.
2. Vaccinate any animals entering project area.

E. Anthrax

Vaccinate all animals on a yearly basis (time intervals may vary according to type of vaccine used).

F. Foot and Mouth Disease

1. Unless outbreaks occur, vaccination is not recommended unless the area is to be designated a disease-free zone for export of raw meat and live animals.
2. If an outbreak,occurs, all cloven-hoofed animals should be vaccinated using a polyvalent vaccine prepared from virus strains known to exist in Ethiopia.

G. East Coast Fever (ECF)

1. Routine dipping must be practiced.
2. Game animals should be prevented from entering the area.
3. If a vaccine becomes available, it should be used routinely on all animals.

H. Tick-borne Diseases (Anaplasmosis, Piroplasmosis, Heartwater, etc.)

1. Dipping or spraying of all animals must be maintained on a routine basis with intervals between treatments dependent upon season of year and tick population. Possibly as often as once weekly during high incidence season and

every two to four weeks for remainder of year.

2. Any animal clinically ill with a tick-borne disease should be treated.

I. Helminth Parasites

Routine treatment for these parasites should be carried out with intervals between treatment dependent on parasite load. Probably 2 or 3 times during wet season and once or twice during the dry season.

Disease Control Program for Oxen - All of the elements required to protect cattle in the livestock production project will also be necessary to reduce disease incidence among the draft oxen.

The control established for Tsetse will also protect the oxen; however, provision must be made to provide effective therapy for these animals. Such treatment should be administered only by trained personnel as underdosing may initiate development of drug-resistant Trypanosomes. This will necessitate frequent visitations to treatment centers (dipping facilities) by the Animal Health Assistants. In the early development stages, possibly before establishment of the Tsetse-free zone, all oxen should be routinely treated with a trypanocidal drug as Trypanidium (Samorin) which provides a long-lasting effect. Until the area is Tsetse-free, all oxen should be treated at two-month intervals by a professional from the Veterinary Services Division.

Tick control on the draft oxen would be best accomplished by having the owner treat his own animals. This can be accomplished with a back-pack sprayer or use of a cloth soaked in the insecticide which is then generously applied to the entire body.

Vaccination should be maintained for the oxen just as for the production cattle.

Human Health in Project Areas

Human Trypanosomiasis (Sleeping Sickness) may exist in all proposed project areas. The species of Tsetse capable of serving as a vector for human Trypanosomiasis is known to exist in Gambela and in the Didessa Valley and confirmed cases have been described. Presence of the specific vector in the Omo and Sagan Valleys has not

been confirmed but as these are Tsetse areas, it may be assumed that the type carrying human strains may exist. Clearing of land, maintenance of a buffer zone and routine spraying to create a Tsetse-free area should protect inhabitants from the risk of contracting this disease.

Another health hazard to man in all of the lowland areas is the ever-present mosquito capable of transmitting malaria. As many local inhabitants are infected, malaria becomes a major constraint to resettlement and realistic and effective mosquito control measures must be established. Local inhabitants must be educated in methods of prevention and control of the mosquito population and medical facilities for treatment of malaria and other diseases and internal parasites should be established. Health-care facilities are minimal or non-existant in the suggested project areas.

Schistosomiasis may be present in the project areas. The same is true of Onchercerciosis (River blindness) and some reports suggest that it may exist in Gambela.

Conservation

The conservation and controlled exploitation of natural resources is a prime objective of an agricultural development project. Misuse and over-exploitation of land and forest reserves intensifies erosion and results in soil infertility; streams clogged with heavy sediment loads; excessive runoff; and flooding in the lowlands of major river basins.

Soil Conservation - In Ethiopia, soil erosion is particularly severe and its effect on the agricultural potential is evident. Fournier[1] has shown that more than 52 percent of the area of the country (including plateaux, escarpments and lowland hills) loses an estimated amount of more than 2,000 tons of soil per square kilometer every year. Losses for the rest of the country range from 40 to 1,000 tons of soil per square kilometer annually. In the project areas, the annual soil erosion loss is shown to range from 40 to

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[1] Soil Erosion Map from "Carte du Danger D'Erosion en Afrique au Sud Sahara" by F. Fournier presented in an Atlas of Ethiopia.

200 tons per square kilometer. The government must organize an effective program of soil conservation, particularly in the highlands, to combat this wastage. Such an effort would accelerate the present reforestation work and initiate campaigns of contouring the exposed and heavily eroded slopes. Farmers should be instructed to plow and ridge using contours as guides rather than in the direction of the slope. Stream banks should be protected by bands of natural vegetation and grasslands and maximum livestock densities established for grazing lands.

In later sections of this report, the existing conditions and proposed conservation measures relating to the individual project areas will be discussed.

Soil Conservation - Maps showing the natural vegetation cover in Ethiopia, dramatically illustrate the extent of deforestation in the country. Less than seven percent of the total land area remains in solid stands of virgin forest. These stands are presently under attack from logging enterprises seeking valuable timber; wood cutters selling firewood; charcoal makers; and farmers who cut and burn in practicing shifting agriculture.

Some reforestation efforts, mainly centering around Addis Ababa using eucalyptus species and some conifers, provide a ready source of building poles and firewood for the principal towns in the central highlands. But this effort does not counteract the destruction elsewhere.

The areas studied in this report were selected for their capability of supporting resettlement and agricultural development. Such areas would necessarily be either primarily government lands which could be allocated to settlers without exhaustive legal complications, or lands not presently divided into small farms of complicated tenure. Within the selected study areas, there are no forest lands to be protected, but in describing the development strategy in each project, the conservation and/or restoration of wooded areas is considered.

Wildlife Conservation - The Southwestern Region of Ethiopia is reported to have a higher population of wildlife species than any other section of the country. Several reports have stressed the importance of establishing and policing wildlife preserves before many

endangered species have been exterminated by indiscriminate slaughter. Such game parks, if properly maintained and provided with suitable facilities, should attract tourism and earn foreign exchange.

In the preceding section on livestock diseases, it was pointed out that the presence of wildlife constrains the development of livestock as wild animals are uncontrollable carriers of serious diseases. In order to establish disease-free zones, wild animals must be excluded. The projects would, therefore, strongly support the establishment of well-supervised game preserves in both Ilubabor and Gemu Gofa provinces. Phase II detailed studies would include consideration of both restriction and conservation of wildlife and indicate the benefits of providing financial support for developing and policing the game preserves.

TRANSPORTATION

Lack of road transportation has been one of the principal factors constraining development in the study areas. Implementation of the proposed agricultural development and settlement schemes will require the timely provision of adequate supporting transportation networks. The objective of this analysis is to investigate the relative merits of the study areas in terms of their existing and programmed connections to the main processing, consumption and distribution centers and with respect to the proposed internal roadway networks that will handle vehicular circulation within the areas themselves.

Existing and Programmed Highways

With the exception of the Bedele-Metu area, the study areas are relatively inaccessible by road. Direct road access to each of the areas is planned, however, via road construction scheduled for the Imperial Highway Authority's (IHA) Sixth and Seventh Highway Programs.

In Gemu Gofa Province, which includes the Omo and Sagan Valley study areas, the only existing all-weather road connects the Governorate General capital of Arba Minch to Addis Ababa (474 kilometers).

A dry-weather track extends south from Arba Minch to Gidolo (60 kilometers) and from Gidolo to Yabolo in Sidamo (155 kilometers) and beyond.

During the Sixth Highway Program, for which construction is expected to commence in 1976, an all-weather feeder road has been planned to connect Sodo to Bulki and Bulki to Bako. During the Seventh Highway Program, which is expected to begin in 1978, the existing all-weather road to Arba Minch is scheduled to be extended south to Gidolo and then east to Bako and the Omo River, passing through the Omo and Sagan Valley study areas.

The Gambela study area in Ilubaber Province is presently accessible only on dry-weather tracks. During the Sixth Highway Program, feeder roads are planned to connect Ghimbi to Dembidolo, Dembidolo to Gambela and Gambela to Jikao on the frontier with Sudan. The Seventh Highway Program includes roads from Motu to Gore and the south, and between Gore and Gambela.

The proposed feeder road between Nekemte and Bedelo through Arjo will provide direct access to the Didessa Valley study area.

Existing Traffic

Since 1953, the Traffic Studies Branch of the Planning and Programming Division of the Imperial Highway Authority has regularly conducted traffic counts throughout the all-weather highway network of Ethiopia. In 1973, twelve-hour manual counts were conducted at 55 count stations three times during the year. The Bedelo-Motu road, which is the only all weather road within or adjacent to any of the proposed study areas, was completed in 1973 and no traffic data are yet available. For the dry-weather roads that are adjacent to the proposed study areas, no traffic data exist but these tracks, which are often negotiable only by four-wheel drive vehicles, usually carry very little traffic; generally, traffic volumes average less than 20 vehicles per day.

According to the "Report on Rural Traffic Movement in Ethiopia, 1973", average annual daily traffic (AADT) throughout the country ranged from 31 to 3,136 vehicles per day with the highest volume on the Addis Ababa - Nazareth road and the lowest on Adigrat - Adwa - Adi Abun road. With the relatively low traffic volumes involved, it is not anticipated that average vehicular travel speeds on the

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principal roads leading from the various study areas to Addis Ababa will be significantly reduced due to congestion.

Existing River and Air Transport

The Baro River, which connects with the Akobo and Sobat Rivers near the border with Sudan, is the only navigable waterway in Ethiopia. Under Ethiopian supervision, there is one boat owned and operated by the Ministry of Communications, Telecommunications and Post under control of the Marine Department, and several motor boats owned by the mission at Pokwo and the Red Cross at Itang. On the Sudanese side, there are six steamers owned by the River Transport Department and operated by the Commissioner of Upper Nile Province.

In Gambela Awraja and the eastern Nuer District, most production is for subsistence and there is essentially no marketable surplus or disposable income. For this reason, existing cargo and passenger movement is negligible during the two months that the river is operational. Nevertheless, the Baro River offers a possible transportation channel for both trade between Sudan and Ethiopia and for export of Ethiopian cargo through the ports of Sudan. The transportation of cargo along the Baro and Sobat Rivers to the White Nile into Khartoum and then by rail to Port Sudan could prove to be more efficient and economical than an overland route from the Gambela area to the ports of Massawa, Assab and Djibouti on the Red Sea.

Implementation of year-around service along the Baro would require some form of canalization. If the Gambela area is selected for further study, use of the Baro River should be considered in depth, in light of its great potential stimulative effect on the economy of this relatively undeveloped area of Ethiopia. According to the "Study of River Transport over the Baro-Akobo-Sobat Rivers" of 1 May 1973, prepared by an Ethio-Sudanese Study Team:

> ". . . there is an economic social need for improving the existing track between Gambela and Jikao and river transport routes. This conclusion is reached not because the team found evidence of established trade relations between the two communities, but because the team believed that improved transport means may become a springboard for transforming the way of life of the people."

There are numerous small airports throughout the southwestern part of the country. In Ilubabor Province, the western route of

Ethiopian Airlines connects Gore, Gambela, Buno Bedele and Tepi with Jimma and Addis Ababa. In Gemu Gofa, Arba Minch, Bulki and Bako are also connected to Addis Ababa by the Ethiopian Airlines western route.

Transport Requirements and Design Standards

Vehicular transportation between the study areas and the major population centers of Ethiopia is scheduled to be carried out on the existing road network and on the roads planned for construction during the Sixth and Seventh Highway Programs. Since these road construction projects will be funded and carried out as part of IHA's regular rural road construction program, the costs of these roads will not be considered or assigned as project costs. It has been assumed, however, for purposes of this prefeasibility analysis, that construction scheduling of these roads can be adjusted to coincide with the opening of the selected study areas.

Transportation within the areas themselves would be carried out on a proposed network of internal tertiary roads, the costs of which would be assigned to the projects. These roads would be primarily land-service roads designed to handle low traffic volumes. During the period of analysis (20 years) traffic volumes would not exceed 100 vehicles per day on the recommended two-lane tertiary roads and 40 vehicles per day on the one-lane tertiary roads. It is unlikely that vehicles larger than ten tons would use these internal networks.

Economy dictates that these tertiary roads be built to minimum design standards. In order to achieve the forecast levels of agricultural production, however, it is mandatory that they be all-weather roads that will be maintained throughout the year. The recommended roadway design standards shown in Table I-1 were developed from experience gained in Ethiopia and other developing countries with this type of road.

Table I - 1

Proposed Tertiary Road Design Standards

Item	Roadway Standard	
	Tertiary Two-Lane	Tertiary One-Lane
ADT (1)	40-100	40
Minimum Design Speed (Kph)(2)		
Flat-Rolling	50	40
Hilly	40	30
Maximum Degree of Curve		
Flat-Rolling	15°	25°
Hilly	25°	45°
Minimum Radius (m) (3)		
Flat-Rolling	77	46
Hilly	46	26
Maximum Gradient (%) (4)		
Flat-Rolling	9	9
Hilly	10	10
Roadway Platform Width (m)	5.5	3.5 (5)
Normal Crown Slope (%)	4.0	4.0
Maximum Superelevation (%)	10.0	10.0
Structures		
20.m. Length (Total)		
Curb-Curb Width (m)	5.5	4.7 (6)
Full Deck Width (m) (7)	6.0	5.2
Design Load		
Structures	H20-S16	H20-S16
Roadway (m.Tons)	11.0	8.0
Right of Way (m) (8)	30	20

1) Projected average daily traffic 10 years after construction.
2) Criteria for stopping sight distance, pavement widening for horizontal curvature, superelevation transitions, vertical curve lengths, etc., to be consistent with the recommended design speeds.
3) 20-meter chord definition.
4) Maximum gradients may be increased by 1% on short grades under 200m in length.
5) Widen platform to 6.00m at 500m intervals for passing. Length of full two-Lane passing section (excluding tapers) to be not less than 20m.
6) This width required to pass mechanized farm equipment.
7) Widths do not provide sidewalks. At population centers where pedestrian traffic warrants, provide 0.75m side walk on one or two sides as required.
8) Widths shown are normal, additional width for side slopes as required.

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Approximate construction costs per kilometer are shown in Table I-2 for one-lane tertiary roads in flat (zero percent grade), flat to rolling (zero to three percent), rolling (three to five percent), and hilly (five to seven percent) terrain and for two-lane tertiary roads in flat and flat to rolling terrain. (For the study areas under consideration, the two-lane tertiary roads would be built in flat or flat to rolling terrain and costs are shown only for these conditions.) It is assumed that the construction of these tertiary roads would be handled by the Rural Roads Administration and that construction would be carried out by force account with the costs being evenly distributed over a three-year construction period.

Table I-2

Estimated Construction Costs Per Kilometer
(Ethiopian Dollars)

Road Type	Flat	Flat to Rolling	Rolling	Hilly
	(0%)	(0-3%)	(3-5%)	(5-7%
Tertiary 1-Lane	15,200	18,600	20,200	21,900
Tertiary 2-Lane	21,400	23,800	—	—

Proposed Internal Road Layouts

It would be uneconomical to provide direct access to all potential farm sites. The recommended preliminary internal networks were planned so that all arable sectors will be within five kilometers of an all-weather tertiary road.

Figures included in subsequent sections of this report for each project, show the preliminary proposed internal road layouts for each study area - The Gambela Area, the Didesa Valley, the Lower Omo Valley and the Sagan Area, respectively. It should be noted that these road schemes are schematic in nature, intended to facilitate order-of-magnitude cost comparisons. Once the selected areas have been surveyed as part of the Phase II work, substantial location adjustments may be required. In each of the areas, a two-lane tertiary road serves as the "spine" or collector road which would connect with the national feeder and penetration roads, which, in

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[illegible] the nation's principal asphalt roads. Settlement can be expected to occur along these spine roads. One-lane tertiary roads crossing the spine road at approximately 10 kilometer intervals and extending laterally across the study areas, would provide the land-service function.

LAND CAPABILITY

Existing Soils Data

Soils information available for the report was extremely limited and confined largely to two references: "A Report on the Fertility Status and Other Data on Some Soils of Ethiopia" by Dr. H. F. Murphy; and the UNESCO/FAO "Soils Maps of Africa" series which includes tentative soil associations identified in Ethiopia. These data have been useful and have aided in the initial land classification effort reported herein for each project area. Other reports included in the list of references have mentioned soils in certain areas. Also, reports on existing grasses and ground cover have served to indicate the value of the soils. Aerial photographs and recent topographic maps (Joint Operations Graphic, Scale 1:250,000, August 1973) were used in establishing capability occurances and limits and finally, aerial overflights at low elevations provided a valuable insight.

It would be impossible, however, to plan a development project on the strength of the land use capability classifications shown in this report. These merely serve as guidelines and are intended to show extent of magnitude regarding production capability and crop adaptability. More detailed information is required for all areas before development plans can be formalized. At feasibility level, reconnaissance-type surveys would more accurately identify major soil boundaries and would include descriptions of characteristics and limitations of each. Project-wide ground surveys would establish elevation contours at one-meter intervals, or less. Laboratory analyses would clearly show the chemical and physical characteristics of the major soils associations. Based on this more reliable information, and actual field observations, more accurate capability classifications would emerge.

Criteria Used

All areas covered by this report are presently used to varying degrees for grazing and, in the economic analyses, are considered as being inactive (except in the case of livestock analyses). Agricultural development would depend upon the capability of the soils to sustain continual crop production provided that required reclamation and irrigation works were feasible or that adequate precipitation occurs for rainfed agriculture.

Capability classification is an interpretive grouping of soils based on identifiable land units, to indicate both the potentials and the limitations of the soils for intensive and sustained utilization. Without the benefit of extensive field or laboratory studies, simplified preliminary classification is possible by analysing aerial photographs and topographic maps, making aerial observations, and considering what limited soils data may be available.

Capability classes, the broadest of all soil groupings, are based on the Land Capability Classification system used by the United States Department of Agriculture, Soil Conservation Service. Classes designated by Roman numerals I through V indicating progressively greater limitations and narrower choices for practical use, are defined as follows:

Class I — Soils having few, if any limitations that restrict their use. They can support a wide range of crops that are adapted to the prevailing conditions.

Class II — Soils having moderate limitations reducing the choice of crops, or requiring moderate conservation practices.

Class III — Soils having severe limitations or requiring special conservation measures, or both.

Class IV — Soils having very severe limitations or requiring very careful management, or both.

Class V — Soils not generally suited for cultivation due to topographic, textural, structural or other limitations, or with other characteristics which preclude their use for economic crop production. They may be used for grazing, woodlands or wildlife.

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It has not been possible to identify Class I lands at this time but it is likely some may exist. Class V lands have been excluded from consideration as in each project there was more than sufficient arable land for delineation of the areas. During more detailed field studies, it is likely that limited areas of Class V land will be mapped. It has also not been possible to establish capability sub-classes or sub-class units as these refinements require reliable field observations, soil studies and maps, and laboratory analyses of representative soil profile samples. During Phase II feasibility studies, these classifications would be established and crop suitability more clearly identified.

MARKETS AND PRICES

Domestic Demand

Consumption levels for farm goods and related family living expenses in Ethiopia are not well known, particularly in rural areas. The Central Statistical Office (CSO) is reported to have conducted a rural consumption study; however, the results were judged to be unreliable and the study was not released. Although these data are not well documented, it seems clear that consumption levels are quite low, both for urban and rural population.

Southwestern Region - The Southwestern Region, encompassing the projects under consideration, is generally believed to be a deficit grain and pulse area. The situation is further compounded by farmers selling grains and pulses at low harvest prices to generate cash for land taxes and other family expenses and then purchasing grain imported from Addis Ababa for family consumption later in the year.

With the above pattern, it seems likely that consumption levels will be relatively low. For purposes of this preliminary analysis, present consumption levels and indicative per capita income elasticities were developed for the Southwest Region and are shown in Table I-5. To illustrate the magnitude of possible per capita increases, Table I-5 also contains an estimated ten-year forecast of annual consumption assuming a three percent annual income increase and the indicated income elasticities. These elasticity

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estimates are orders of magnitude based largely on judgement; however, they are indicative of the income effect, which could be significant.

Table I-3

Estimated Per Capita Consumption in Southwestern Ethiopia

	Annual Consumption (kgs/capita)	Annual Consumption (kgs/family of six)	Income Elasticity	Forecast Annual Consumption in Ten Years (kgs/capita)
Cereals(1)	115	690	0.5	130
Starches	20	120	0.3	22
Pulses	15	90	0.5	17
Meat	5	30	1.0	7
Milk	10	60	0.4	11
Vegetables	20	120	0.6	24
Fruits	2	12	0.4	2
Purchased goods(2)	E$ 40	E$ 240	-	-

(1) includes cereal consumed as food and as beverages.

(2) clothing, sugar, spices, fats, oils, salt and miscellaneous family living expenses.

Feasibility investigations carried out for selected Phase II study areas should include analyses of local consumption levels which will have important implications to the financial viability of the farmer beneficiaries.

While little is known at this time about the size of local markets, it is believed that the cash market (effective demand) in the study areas is relatively small. Future effective demand will depend upon the nature and extent of development in the region. Given the terms of reference which call for resettlement, one can conclude that, excepting infrastructure, population and labor employed by possible larger mechanized farmers, local market demand would remain relatively small and stable and marketable surpluses would be exported to other regions of Ethiopia and abroad.

Ethiopian Demand - A population growth rate of about 2.5 percent is expected. This, combined with 2 to 2.5 percent real income growth per capita and an income elasticity of 0.5 for cereals will likely increase the demand for the basic food crops of cereals and pulses at about 3.5 percent per annum. Although the rate of supply growth will be subject to a number of factors, it seems unlikely that it will exceed the market growth and could conceivably fall short of the market growth rate.

As a preliminary overview, it would appear that the market for major cereals (maize and sorghum) and pulses should not be a limitation.

Ethiopian cotton production has virtually met the domestic demand. However, high quality cotton produced from an irrigated agriculture development scheme would be marketable abroad. Shorter staple cotton grown in a rainfed agriculture development scheme could supply the domestic market, while surpluses of longer staple cotton from irrigated farms (e.g. the Awash Valley) could be exported.

As will be pointed out in the specific project presentations in this report, various portions of the Southwest Region (Gambela in particular) appear to be well-suited to rice and sugar cane production. Rice is not consumed in Ethiopia, excepting in minor quantities. (235 tons were reported to have been imported in 1973 at E$ 1.13 per kilogram. 1,094 tons were imported in 1972 when the price had lowered to E$ 0.38 per kilogram). With the apparent taste preferences for teff, sorghum and maize, the potential domestic market demand for rice is considered to be uncertain. Detailed feasibility investigations should include evaluation of the potential markets (both domestic and foreign) for rice, including the need for test marketing.

Detailed feasibility investigations should also include an in-depth study of domestic and foreign markets for refined cane sugar.

Export Markets

The only export crop considered in this prefeasibility study is cotton, for which a continued world demand at favorable prices is expected.

While a continued strong growth in the world sesame market is expected, this crop was not considered at this time due to the excessive transport costs to move it to Massawa. It is possible that

this picture could be changed at some future time by means of combined river and rail transport through the Sudan; however, this would be contingent on international agreements and improvement of the various river channels tributary to the White Nile.

Other potential world export produce, adapted to certain of the areas studied, includes refined sugar, rice and haricot beans. The actual market potentials for these and possibly other crops should be studied in detail during the Phase II feasibility study.

Prices

Price series for commodities of interest, specific to the project areas under consideration, are virtually non-existent. Furthermore, the few spot prices reported from these areas represent the prevailing pattern of low harvest prices as farmers sell minimal quantities of produce to meet cash needs and high prices during the dry, food-deficit period. The introduction of an intensive investment program will in all probability turn the region from a deficit and importing area into a position of exporting surpluses.

Under this situation, prices in Addis Ababa and major intermediate markets, less freight, will likely govern. Historic prices in the markets of greatest interest from which price series were reported are shown in Table I-4. Only intermittent prices are reported for Jimma, Gore, Nekemte, Arba Minch and Gambela. This lack of price data and readily available marketing volumes, plus the potential for major change, makes pricing a difficult task. Because of the volume and history of the Addis Ababa wholesale market, it must be considered as the most reliable price indicator. The prices (farm gate basis) used in the subsequent analyses, are shown in Table I-5. A brief description of the assumptions used in arriving at these prices follows below. A full scale feasibility study should include careful consideration of the demand-supply-price relationship in the various major domestic markets as well as potential export markets for the crops used in the following analyses, including others of high potential value such as rice, haricot beans, and sugar cane.

Table I - 4

Historic Wholesale Prices of Selected Products at Selected Markets
(E$ per quintal)

	Maize			Sorghum			Horsebeans		
Year	Addis	Metu	Chimbi	Addis	Metu	Chimbi	Addis	Metu	Chimbi
1969	13.56	14.05	15.85	20.45	NA	NA	14.06	24.39	18.47
1970	21.17	28.28	27.09	28.67	29.25	NA	22.64	34.05	25.83
1971	20.38	26.83	21.51	25.83	NA	NA	21.06	37.25	27.24
1972	11.17	14.59	11.93	19.30	NA	17.00	11.93	25.14	16.65
1973	17.79	17.36	NA	22.35	NA	NA	19.04	25.37	- -
Av.	16.81	20.22	19.10	23.32	NA	NA	17.25	29.24	22.05

Year	Chickpeas			Cotton
	Addis	Metu	Chimbi	Addis
1969	18.21	NA	NA	57.00
1970	28.38	45.00	NA	67.00
1971	26.61	40.66	NA	67.00
1972	16.36	34.29	NA	68.50
1973	25.14	32.67	NA	105.00
Av.	29.99	38.16	NA	78.00[1)]

Source: Cereal and pulse prices from the Ethiopian Grain Corporation and compared with data received from the National Bank.

1) Includes estimates of E$70 and E$80 per qq for 1974/5 and 1975/6 respectively. Information furnished by the Awash Valley Authority.

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Table I-5

Farmgate Prices Used in Financial and Economic Analyses
(E$ per quintal)

Crop	Price Used for All Project Areas
Maize	12
Sorghum	14
Pulses	20
Cotton	55[1]

[1] Economic price used

Maize - It appears that maize prices increase from Addis Ababa westwards. However, these higher priced markets are not believed to be sufficiently large to absorb large quantities without serious price erosion. For purposes of this study it was assumed that 50 percent of the maize would move to Addis Ababa, 10 percent to Metu and 40 percent to Jimma (using the Metu prices). From the respective five-year price averages, and in the absence of notable trends, transportation costs were subtracted (E$0.09 per ton kilometer) as well as a handling charge of E$0.50 per quintal.

Sorghum - Although a complete price series for sorghum was available only for Addis Ababa, it appears that prices fall roughly in proportion to distance westward from Addis. With this pattern, it was assumed that sorghum would receive E$22 per quintal at Addis, less freight and an E$0.50 handling charge.

Pulses - The prices of horsebeans and chickpeas were selected to represent pulse prices in general. The prices were weighted by the market volumes used for maize (50 percent in Addis, 10 percent in Metu, 40 percent in Jimma) and equal weights were given to both pulses. Haricot beans, an increasingly important export crop, demonstrated a much higher price (E$40 per quintal in 1973) than the other pulses, but due to technical uncertainties of the export market, the higher Haricot bean price was excluded.

Cotton - Of the products thus far discussed, cotton offers a special problem in that it is a major internationally traded crop,

including Ethiopian activity. Ethiopian cotton lint prices will increasingly move in concert with the world price. The future world price is open to much current speculation in that prices of the past year are the highest in recent history. Those prices could attract new cotton production, but with an ever increasing pressure for foodstuffs and capital limitations for the construction of synthetic fiber plants, it seems possible that US$0.45 to US$0.50 per pound lint cotton (c.i.f. Liverpool) could continue.

Examination of recent prices and expected prices for seed cotton in Addis Ababa leads to a normalized price of E$78 per quintal. Since this price is taken to represent top quality cotton, a 10 percent reduction for a lesser grade cotton was taken.[1] From this Addis price, freight at E$0.12 per ton kilometer[2] and an E$0.75 per quintal handling charge were deducted.

Although cotton prices in Ethiopia are tending towards the world price, it appears that the actual price exceeds the equivalent world price.[3] But, since the two prices are tending towards one another, the financial and economic (shadow) price will likely become nearly identical by 1990. For purposes of this analysis, a constant reduction of E$4.00 per quintal of the financial cotton price was used to arrive at the economic price.

1/ Irrigation and water control should result in quality long staple cotton, but considering that it will be a new crop, top quality is not expected to be achieved until the project matures.

2/ Represents a 30 percent increase over the cereals and pulses rates, reflecting the greater bulk in handling cotton.

3/ The approximate equivalent world price (or economic price) was computed as follows:

	US$0.45	per pound CIF Liverpool assumed
minus	.04	per pound to Ethiopia
	US$0.41	per pound FOB Ethiopia, or
	E$1.88	per kg FOB Ethiopia, or
	E$62.00	per quintal considering .33 lint conversion.

RESETTLEMENT ALLOWANCES

Resettlement of farm families from the overcrowded highland and drought-stricken areas and settlement of indigenous families on farm units would involve certain direct costs. It is assumed that the potential smallholder farmers are presently on a bare subsistence, or sub-subsistence level and will have no cash. Consequently, it would be necessary for the Government to either advance or subsidize these costs.

For the purpose of this prefeasibility study, it is assumed that the Government would advance a food allowance of E$ 240 to each family which is considered adequate to cover living expenses up to the first harvest. It is suggested that this advance would be repayed withrut interest over a period of three to six years. It is assumed that other costs to cover transportation and sundry expenses would amount to about E$ 260 per family and would be subsidized by the Government.

The above costs were used in the preliminary evaluation of smallholder oxen-powered farms for all four projects. The total for each project would then be E$ 1,250,000, considering 2,500 smallholder farm families.

No resettlement allowances were considered for the larger tractor farmers as they would be operating commercial farms and are assumed to possess sufficient cash to preclude the need for any advance or subsidy.

Other financial requirements for equipment, farmsteads, land preparation, production costs, etc., were considered on a farm credit and repayment basis are are presented and analyzed for each project area in parts II through V of this report.

MANAGEMENT, TESTING AND EXTENSION SERVICES

Efficient overall management, together with testing and extension services, are prerequisite to implementation of any of the projects presented in parts II through V of this report. This section includes provisions for establishment of a project management organization, a test-demonstration farm, and an extension service to provide information and training for farmers in well-tested and profitable agricultural techniques.

In view of the preliminary nature of this report, the same organization and order-of-magnitude costs were used for all four projects. During Phase II detailed studies, each area selected will be treated separately.

Management

It is envisaged that project development and operation will work within the framework of the Ministry of Agriculture (MOA) and will, therefore, be an integral part of the Extension and Project Implementation Department (EPID) thereof.

The chief executive to EPID would be the Project Director, responsible for implementing all project development and the operation thereof. He and his staff should be located in the project area from the outset and should continue to reside there.

Project management should have the highest possible degree of autonomy and should be directly responsible for implementation and operation of the various project phases and for administration of funds allocated for this purpose.

From time to time, special committees would need to be formed to deal with problems and decisions concerning roads, research, credit, marketing, livestock, water supply, cooperatives, financial matters, land tenure, training, etc. A close working relationship would be required with such organizations as the following:

- Imperial Highway Authority
- National Water Resources Commission
- Agricultural and Industrial Development Bank (AID Bank)
- various department of the Ministry of Land Reform and Administration
- various departments of the Ministry of National Community Development
- training institutions
- Institute of Agricultural Research
- Livestock and Meat Board
- Veterinary Department
- Grain Board
- Grain Corporation
- State Forest Agency

- Soil and Water Conservation Division
- Extension Service Division
- Other departments and divisions of the Ministry of Agriculture and other agencies as required.

Direct Responsibility - Project management would have direct responsibility:

1) agricultural extension services;
2) establishment of a test-demonstration farm and crop testing and experimentation with a view to improving varieties and distributing seeds;
3) mapping the area and demarcating farm boundaries;
4) livestock testing;
5) planning, design and supervision of internal road construction; and
6) planning, design, supervision of construction, and operation and maintenance of water control and water supply works.

Coordinating Function - In addition to the direct responsibilities listed above, management would have a coordinating role in connection with other developmental activities in the project area, including, but not necessarily limited to:

1) land leasing, concessions, registrations and disputes (with Ministry of Land Reform and Administration);
2) agricultural credit and marketing and cooperatives(with AID Bank and Ministry of National Community Development);
3) processing facilities (private or private cum Government enterprises);
4) town and village planning and organization (with Ministry of National Community Development);
5) health and sanitation (with Ministry of Public Health);
6) education (with Ministry of Education and Fine Arts)
7) post and telecommunications (with Ministry of Post, Communications and Telecommunications);
8) security (with Ministry of Interior and police authorities); and
9) power supply (with Ethiopian Electric Light and Power Authority).

Test-Demonstration Farm

Research in a project area should be limited to testing the applicability of the results of original research carried out elsewhere, in close collaboration with the Institute of Agricultural

Research (IAR).

Adequate test, demonstration, and possibly seed multiplication facilities should be provided for a project area by establishment of a project-operated test-demonstration farm. The size of this farm should be on the order of 400 hectares. Of this, the agricultural portion might comprise an arable area of 300 hectares, 250 hectares devoted to mechanized farming and 50 hectares to oxen farming. The remaining 100 hectares would be utilized for project headquarters, housing, training facilities, shops, laboratory, etc. In the event of livestock testing and demonstration, an additional 400 hectares might be required.

Extension Services

A program to extend information to farmers about agricultural technology and improved practices is essential to both tractor and oxen operations. Extension would also collect and disseminate information on cultivation practices and results in the farm areas. Cultivators are willing to adopt changes in farming practices only when they are convinced that new techniques and innovations are feasible.

There exists an acute shortage of well-trained extension workers in Ethiopia. Consequently, an extension staff must be trained by skilled technicians (imported from abroad if necessary) assigned to the project organization.

The basic theoretical and practical training for the first group of extension agents would require a minimum of three months. In a subsequent period totalling some eight to ten months in the field, the agents would be intensively involved in the day-to-day operations of their respective farmers. At the end of this time, the agents would assess the first year in the field and prepare for the following year.

The extension agent training center would be located on the project farm and would include housing, classrooms, tractors, plows, seed drills, mowers, oxen teams, oxen implements, sprayers, miscellaneous tools, etc.

The bulk of the training would be in the first four years of project implementation, after which retraining would be needed together with the training of some few new personnel due to attrition

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each year. Thereafter, the training center would be utilized at times as a conference center for farmers and for training sessions in the use of mechanized and oxen equipment.

Initially, each extension agent should be provided with "packages," which he conveys to his respective farmers, sufficient to serve farm demonstration plots. The "packages" would contain, for example, improved seeds, seed treatment preparations, fertilizers (if required), and insecticides. The farmer should pay for these inputs the first two years and supply them himself from there on.

Project Organization

The tentative staffing plan for management, testing and extension services, pertinent to each of the four project areas studied is given below. It is noted that this does not include operation and maintenance of water control works or internal roads; the costs of these items vary from project to project and are included in parts II through V for each project.

Project Director	1
Deputy Director	1
Auditor, Secretaries and Clerks	6
Farm Manager	1
Technical Assistants	2
Agriculturist (1)	1
Agricultural Engineer (1)	1
Senior Extension Agents	4
Junior Extension Agents (2)	25
Drivers/Mechanics	10
Surveyors	4
Laborers	12

(1) Assumed to be expatriates for first 3 years only
(2) Buildup over first four years

Estimated Costs

The estimated capital and recurring costs for implementing the management, testing, and extension services programs in each of the four project areas are summarized in Table I-6.

CREDIT, MARKETING AND STORAGE

Implementation of any of the four projects studied would require investments in the fields of agricultural credit, marketing, and grain storage. No crop processing was considered in this pre-feasibility study; however the Phase II feasibility study should include investigations of the feasibility of processing crops recommended at that time; possibilities may include cotton gins, oil presses, sugar refineries, rice mills, etc.

Credit and Marketing

In order to ensure the agricultural production potential of the land and water resources of the project areas, the timely provision of adequate agricultural credit and efficient marketing strategies are essential. Ideally, cooperatives should be organized and trained to channel credit funds, obtained by loans from the Agricultural and Industrial Development Bank (AID Bank), to the farmers, and to handle the movement and marketing of crops.

Three types of credit would be required: 1) crop production credit (short-term); 2) harvest and marketing credit (short-term); and 3) medium-term credit for farm equipment and farmsteads. Long-term credit for farm capital improvements may also be required by the more progressive farmers.

Order-of-magnitude costs for revolving fund short-term credit and medium-term capital (equipment and farmsteads) credit are included in the model farm cash flow analyses and the economic analyses presented in Parts II through V of this report. Estimated costs for administering agricultural credit appear at the end of this section.

Storage

To maximize marketing efficiency and ensure the farmer equitable returns for his crops, it is considered necessary to provide grain storage facilities in each project area. These stores would best be

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Table I - 6

Estimated Costs - Management, Testing and Extension Services

All Projects

(Thousand E$)

Item	Initial Capital Costs				Annual Recurring Costs			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4
Staff	--	--	--	--	288	369	401	314
Housing	213	28	28	27	11	12	13	14
Buildings	90	--	--	--	4	4	4	4
Furniture & Office Equipment	74	14	14	13	4	5	6	7
Vehicles	75	45	--	--	48	76	76	76
Farm Equipment	--	50	--	--	--	8	8	8
Water Supply & Electricity	50	--	--	--	8	8	8	8
Miscellaneous	10	10	--	--	1	2	2	2
Materials	--	--	--	--	--	5	5	5
General Expenses	--	--	--	--	10	10	10	10
Total	512	147	42	40	374	499	533	448

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managed by a cooperative organization.

For the purpose of this study, it was assumed that four grain stores would be constructed, one each in project years two, five, eight, and ten. These stores would provide an all-weather means for holding grain crops against seasonal price swings and would meet bank specifications for security when offered as storage for financed crops. A weigh station and drying facilities would also be installed.

Estimated Costs

The estimated capital and recurring costs for implementing and operating credit, marketing and storage facilities in each of the four project areas are summarized in Table I-7 for credit and marketing and in Table I-8 for storage facilities.

PUBLIC SERVICES

Implementation of any of the four projects studied would result in a considerable increase in permanent population in the project area and in nearby towns and villages. Inevitably, new villages would also be formed to provide support services such as shops, tea houses, casual and permanent labor, etc. Project implementation would ultimately result in the settlement of 2,500 to 3,000 farm families. Assuming an average family of six, the farm population then would total up to 18,000 (assuming a livestock raising element). Non-farm families, providing support services and living in the existing and new towns and villages, might be as much as double this number, or 36,000. In summation a total project-related population of 50,000 or more would be expected to accumulate over a periodof, say, ten years.

The success of a new project, such as the four studied, will depend to a large degree upon the public services provided in the area. Within the context of this section of the report, services

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Table I - 7

Estimated Costs Credit and Marketing
All Projects
(Thousand B$)

Item	Initial Capital Costs				Annual Reccuring Costs			
	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4 on
Staff (Manager, 7 Senior officers, 18 Junior officers, 3 clerks, and Casual Labor)	--	--	--	--	63	112	139	171
Offices, Furniture & Equipment	50	--	--	--	3	3	3	3
Housing	54	6	3	3	3	3	3	3
Furnishings	18	3	2	2	1	1	1	1
Office Expenses	--	--	--	--	5	5	5	5
Total	122	9	5	5	75	124	151	183

Table I - 8

Estimated Costs Storage Facilities
All Projects
(Thousand B$)

Item	Initial Capital Costs				Annual Recurring Costs			
	Year 2	Year 5	Year 8	Year 10	Years 2-4	Years 5-7	Years 8-9	Years 10 on
Staff (Warehouse Manager, 2 clerks, and Casual Labor)	--	--	--	--	18	19	21	22
Grain Stores (10,000 ton Capacity)	125	125	125	125	6	13	19	25
Weigh Station and Drying Facility	17	--	--	--	1	1	1	1
Miscellaneous	6	--	--	--	--	--	--	--
Totals	148	125	125	125	25	33	41	48

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included, and common to all four project areas, are:

- Health (including malaria and other disease control)
- Education
- Police

Other services are treated elsewhere in this report; they include water control facilities (estimated cost would also cover domestic and animal water supplies), transportation and agricultural extension services. A brief description of the public service facilities included in this prefeasibility study follows.

Health

Malaria Control - Malaria control in these lowland areas would be effected both by routine spraying and by widespread dissemination of drugs.

Clinical Medicine - The anticipated population in a project area (50,000±) would justify the establishment of a health center plus strategically located health stations. For the purpose of this preliminary evaluation, however, only two health stations are included.

Education

The educational facilities included for each of the project areas are ten minimum formal education (MFE) schools (grades 1 to 4) with a capacity of 200 students each. It is anticipated that these schools would be built over a period of five years and reach peak enrolment within ten years.

Police

Planning at this very preliminary stage of investigation, indicates that one police sub-station in each project area should be adequate to maintain law and order.

Estimated Costs

The estimated capital and recurring costs for implementing the public service facilities discussed in the foregoing paragraphs, common to all projects, are summarized in Table I-9.

Table I - 9

Estimated Costs Public Services
(All Projects)
(Thousand B$)

Project Years	Malaria Control		Health Stations		Education		Police		Total Costs	
	Capital	Recurring	Capital	Recurring	Capital	Recurring	Capital	Recurring	Capital	Recurring
1	20	52	10	9	36	8	--	--	66	69
2	--	54	--	9	36	16	30	15	66	94
3	--	56	10	18	36	24	--	15	46	113
4	--	58	--	18	36	32	--	15	36	123
5	--	60	--	18	36	40	--	15	36	133
6	--	62	--	18	--	48	--	15	--	143
7	--	64	--	18	--	56	--	15	--	153
8	--	66	--	18	--	64	--	15	--	163
9	--	68	--	18	--	72	--	15	--	173
10 on	--	70	--	18	--	80	--	15	--	183
	20	610	20	162	180	440	30	135	250	
	4%	45%	9%	12%	72%	33%	12	10%	16%	

ECONOMIC ANALYSIS PARAMETERS

Presented in this section are a general description of the benefits to be expected from implementation of any of the four projects studied and the parameters used to convert from financial to economic values.

Project Benefits

In comprehensive projects, of the types studied, both costs and benefits are numerous and varied. The economic analysis must, out of practical necessity, focus on the costs and benefits which can feasibly be identified and evaluated.

The theoretical assumption used in this preliminary study is that all benefits introduced into the analysis are reflected in the model farm budgets and, therefore, appear as net income figures. Other benefits which would inevitably result from project implementation are only accounted for on a qualitative basis, for example:

1) reduced input costs due to provision of internal project roads;
2) jobs and income generated in the transport industry due to increased volume;
3) jobs and income generated in the handling of agricultural produce;
4) value of orchards, gardens, woodlots and small animals expected on each farm;
5) improved labor productivity due to better health care and educational facilities;
6) jobs and income in retail trade and input distribution;
7) jobs and income in construction and construction materials; and
8) reduced cost of agricultural produce to local, non-farm consumers.

Aggregation of Benefits - The two farm models discussed in an earlier section of this part (five-hectare oxen farm and 250-hectare mechanized farm) are the basic units from which aggregate farm benefits are derived in Parts II through IV of this report. For

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all four projects, it was assumed that farm units will build up at the rate of 500 oxen farms per year for five years, and 50 mechanized farms in a three-year period. Net annual benefits for each model type were aggregated according to this schedule. These aggregated benefit streams for each project produced the gross benefit streams before deducting development and operating costs and farm investment costs.

Economic Prices

The estimated market prices, backed up to farmgate, presented in an earlier section of this part, were considered to also represent economic prices in that: 1) maize, sorghum, and pulses were assumed to be marketed and consumed within Ethiopia; and 2) the international cotton price was used in view of the current abnormally high cotton prices prevailing in Ethiopia.

Economic Costs

The "Guide to Project Planning in Ethiopia"[1/] was generally followed in converting financial costs to economic costs for this preliminary analysis.

Development and operating costs were shadow priced using the following conversion factors:

Construction of Water Control Works	0.90
Construction of Internal Roads	0.90
Mapping and Surveys	0.85
Operation and Maintenance	0.85
Credit, Marketing and Storage	0.85
Resettlement Allowances	0.85
Public Services	0.85
Management, Testing and Extension Services	0.85

Farm costs were shadow priced by applying the conversion factors listed in Table I-10.

1/ "A Guide to Project Planning in Ethiopia," Planning Commission Office, Prime Minister's Office, Imperial Ethiopian Government, June 1972, Chapter Four.

Table I-10

Economic Conversion Factors Used in Farm Budgets

All Projects

Item	Conversion Factor
Annual Costs	
Seed	0.85
Fertilizer	1.00
Insecticides	1.00
Labor-Oxen Farm	0.00(1)
Labor-Mechanized Farm	0.60
Minerals	0.85
Drugs and Chemicals	1.00
Repairs and Maintenance	0.60
Fuel	0.50
Tractor Operations	1.00
Family Living Expenses	0.00
Miscellaneous Materials	0.85
Salaries and Management	0.85
Land Tax	0.00
Income Tax	0.00
Investment Costs	
Animals - Oxen, Donkeys, etc.	0.85
Farm Machinery	1.00
Building Materials - Purchased	0.85
Buildings - Labor and Materials	0.60
Land Development	0.85

(1) Assumed 0.50 for years 10 through 20.

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Internal Economic Rate of Return

In the case of each project analyzed in Parts II through V of this report, gross benefit margins were computed over a 20-year period of analysis. Gross economic project costs (including development and operating costs and farm investment costs) were estimated year by year over the same period and deducted from the gross benefit margins. The result is the basic order-of-magnitude benefit stream which would be generated by each project. The internal economic rate of return from each project was found by discounting this net benefit stream.

PART II

GAMBELA AREA IN ILUBABOR

DESCRIPTION OF PROJECT AREA

Location

Gambela Awraja, with a total area of some 26,000 square kilometers, comprises more than half of Ilubabor Province. With the exception of a small mountainous area along its eastern edge, most of the awraja is a lowland savannah plain with seasonally flooded and swampy lands stretching to the Sudanese border. The plain is drained by the Baro River in the northern section, and the Gilo and Akobo Rivers to the south. The total expanse of the plain, including associated intermediate brush lands, is approximately 1.5 million hectares.

From this total, a 50,000 hectare block has been selected for initial development. Figure II-1 shows the location of the triangular-shaped area in relation to the Baro River near Gambela. The project is located along the southern bank of the Baro River beginning about 20 kilometers downstream (west) from Gambela where topography indicates a suitable site for an irrigation pumping station. The main canal would be approximately 40 kilometers long meandering in a southerly direction and terminating at Alwero River, an intermittent tributary to the Baro. The northern boundary of the project roughly parallels the river for approximately 40 kilometers and will be defined by a flood control embankment to be located sufficiently away from the river so as not to interfere with existing river bank settlements and agricultural practices.

The selected area lies within latitudes 7°-57' and 8°-14'N and longitudes 34°-5' and 34°-25'E.

Climatology and Hydrology

The Baro River Basin--Simplistic Perceptions - The Baro River system, almost entirely in Ethiopia, and the Pibor River, draining from both Ethiopia and Sudan, join to form the Sobat River, a substantial tributary to the White Nile, and thus are important not only

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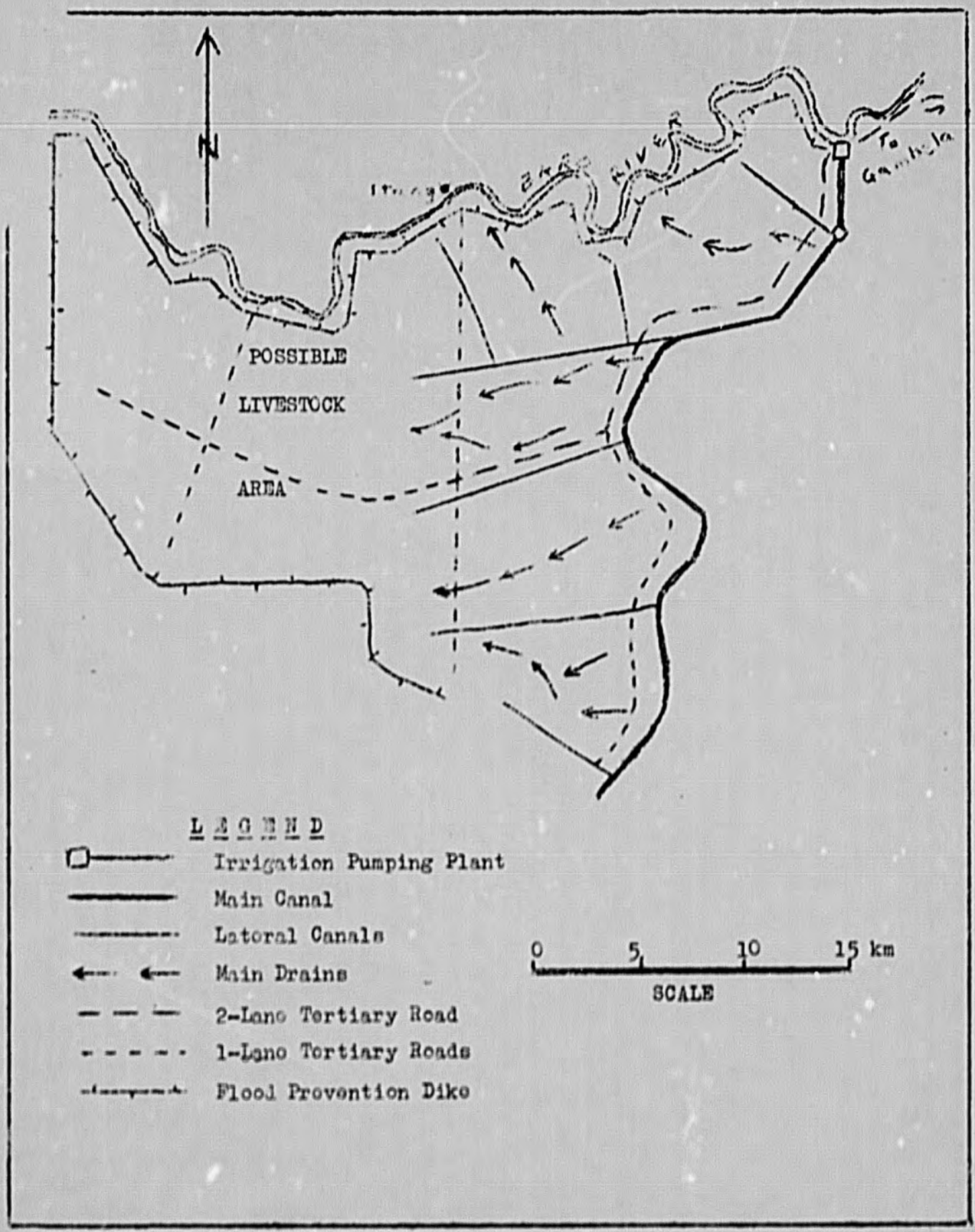

GAMBELA PROJECT AREA FIG. II-1

thiopia but to Sudan and Egypt. At present, the Baro River is developed and the Sobat poorly, if at all, developed, with much of its annual runoff lost to evaporation from vast areas inundated every year, at high river stages.

The town of Gambela lies at about the division point on the Baro River between mountains and plains. Formerly, its importance was greater than now with warehouses and storage yards to hold coffee, cotton, livestock, lumber, gold, etc. Much of the produce came from the nearby mountainous areas of Ilubabor and Wollega Provinces, pending arrival of steamboats that could carry the goods to Khartoum during periods of high floods. These products were shipped down the Nile and via the Mediterranean to Europe, Turkey and the Orient.

The plains below Gambela are vast and the overland spill from the Baro joins that of other streams----Jakau, Makwai, Gilo and Akobo. The annual flooding is so great that the land, under existing conditions, is only suitable mainly for seasonal pasturage and grazing by domestic and game animals, with little more than natural river levees available for a precarious cultivation.

Upstream from Gambela, steep rivers drain approximately 23,900 square kilometers of land ranging from about 450 to 3,300 meters elevation. G. Dekker in "A Note on the Nile," Water Resources Research, Vol. 8, no. 4, August 1972, states that the potential storage capacity on the Baro may be up to 10,000 million cubic meters and writes of a possible multipurpose storage project of 5,500 million cubic meters in a list of existing and possible projects for full development of the Nile River Basin. Such an amount for storage project or projects seems a realistic assessment for multipurpose water resource development of the Baro River. With agriculture as one of the beneficiaries, the control of runoff would both substantially decrease the overland flooding and permit irrigation. Land could be put to two or three crops per year with water now lost by evapotranspiration from overbank flooding of land, yet with water entering the White Nile in accord with established rights of downstream users being protected.

<u>Climatological and Hydrological Stations</u> - Historically, the Sobat River and its source streams have been important to Egypt and Sudan. Consequently, the Ministry of Public Works, in Cairo, was the first to

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stall climatological and hydrological stations in the area. Because Gambela was a Sudanese enclave within Ethiopia, hydrological stations were established by the Cairo office at many sites from the mouth of the Sobat as far up the Baro River as Gambela. Climatological stations were installed even farther up river. For the plains area in Ethiopia, the climatological stations of interest were located at Pibor Post, Akobo, and Nasser in Sudan and Gambela, Gore and Saiyo in Ethiopia. For the area being considered herein, the Gambela record - 1905 - 1967 - is of interest. The hydrological stations of interest for the Ethiopian plain were located on the Pibor, Akobo, Gilo, the Sobat at its mouth and at Nasser and the Baro at Gambela. Mainly, the Gambela record (1905 - 1957) is considered herein.

Data through 1957 from these stations have been published in "The Nile Basin," by Hurst et. al., Ministry of Public Works, Cairo, in various volumes and supplements thereto. "The Hydrology of the Sobat and White Nile and the Topography of the Blue Nile and Atbara," by Hurst, has a very apt description of runoff and flooding of the rivers and plains below Gambela. Parts of the records, i.e. 1914-1936, for Gambela, Gore and Saiyo, were published also in "Contributo Alla Climatologia Doll' Ethiopia," by Amilcare Fantoli, 1965. In addition, the National Climatology Service (NCS) in Addis Ababa has a copy of the monthly precipitation records for Gambela up to 1967, obtained from the files of the Meteorological Service, Sudan Government.

In recent years, the agencies of Ethiopia have established stations in the area. Short records of climate are available for Jikao, Itang, Pokwo and Gambela along the Baro River plus other stations in the mountains. River gauge records, but not runoff, are available for Gambela. Other stations in the basin are planned. For Gambela, a more suitable gauging site than that now used could easily be located upriver.

<u>Climate at Gambela</u> - The Ministry of Public Works, Cairo, and later a similar office in Khartoum, have operated a climatological station at Gambela from 1905 to 1957. Stations with a short period of record have been operated by the NCS at Itang, Pokwo and Jikao in the plains area downstream from Gambela.

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The mean annual precipitation at Gambela is 1,314 millimeters. According to data shown on Table II-1, the precipitation is distributed monthly in a wet season from April to October and a dry season from November to March. Annual precipitation is log-normally distributed according to a probability of exceedence graph as shown on Figure II-2 with median precipitation at about 1300 millimeters and with 5 percent and 95 percent chances that rainfall will be exceeded in any year at about 1,800 and 900 millimeters, respectively. Monthly precipitation is quite variable as is shown on Figure II-3. Precipitation is sometimes insufficient in the rainy season to supply the potential evapotranspiration from the area and nearly always is insufficient in the dry season. Mean precipitation decreases in a westerly or downstream direction from Gambela and there the insufficiency is accentuated.

Evaporation has not been observed from a Class A pan at any station in the area. Evaporation data obtained from a Piche Evaporimeter are included on Table II-1. The nearest Class A pan at low elevation, is Wad Madani, where the mean annual evaporation for 1959-1960 was stated to be 4,120 millimeters.

Mean relative humidity taken at hour 12 GMT at Gambela, is included on Table II-1.

The mean annual air temperature at Gambela is 26.2°C. Absolute extremes for the period 1909-1940 have been 44°C. in March and April, and and 9°C. in February. Monthly absolute and mean temperatures are included on Table II-1.

Observations of wind velocity, direction of wind movement, solar radiation and sunshine hours are not known to exist at any station in the Baro plains of Ethiopia.

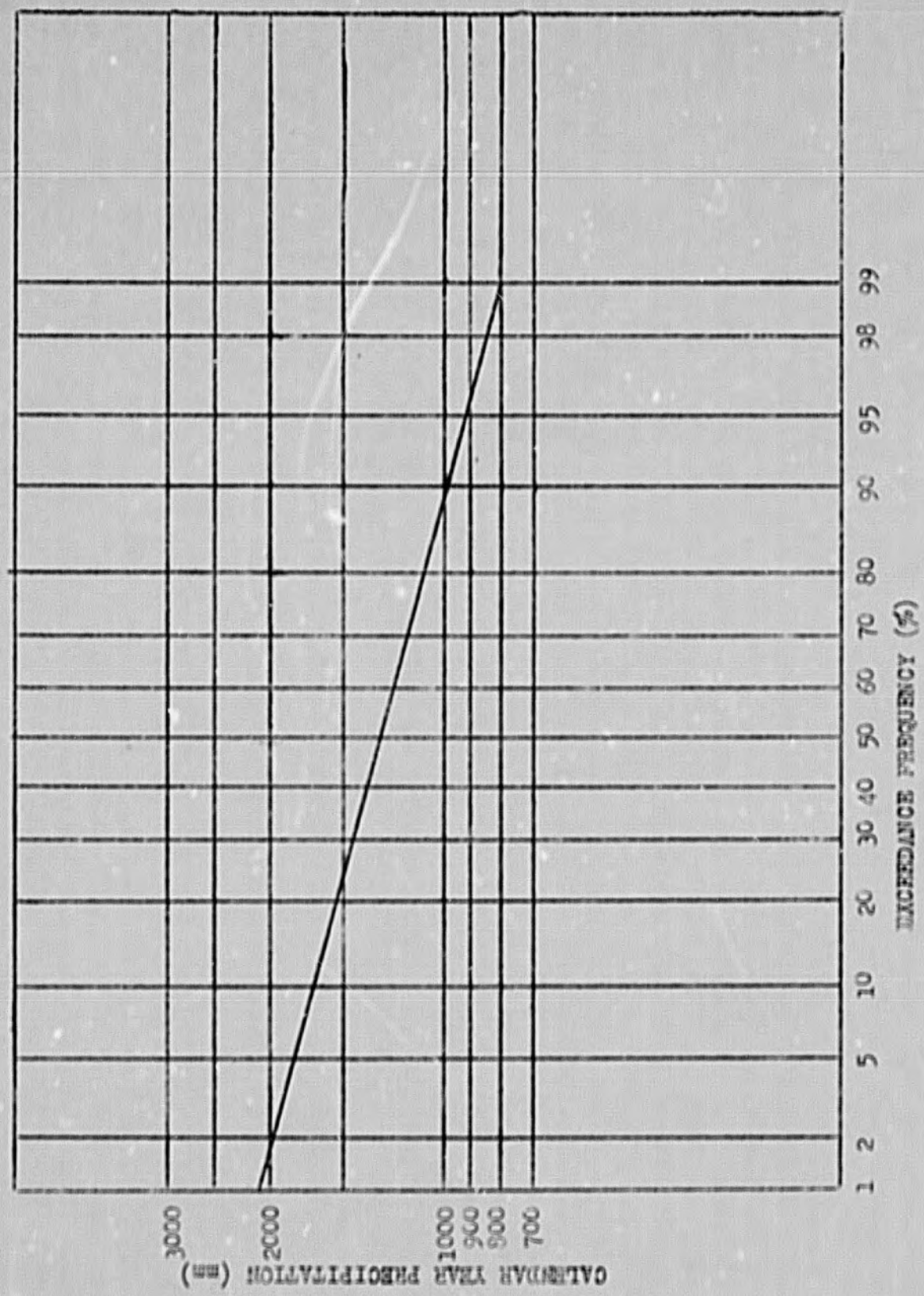
River Runoff - The National Water Resources Commission (NWR) established a staff gauge at Gambela in 1960 and has installed an automatic water-stage recorder within the past year. A cableway for discharge measurements has not been installed, though one is planned.

The first station was established at Gambela by the Ministry of Public Works, Cairo, in 1905. Discharges of decades of months, months and years for the period 1928 to 1957 have been published by that agency in "The Nile Basin," Vol. IV and Supplements. Data after 1957 probably exist but are not known to exist in Ethiopia.

Table II - 1

Mean Annual Climatological Data for Gambela

Month	Precipitation mm	Daily Piche Evaporation mm	Relative Humidity at 12GMT percent	Air Temperature; °C: Absolute Maximum	Average Daily Maximum	Average Daily	Average Daily Minimum	Absolute Minimum
J	7.1	8.4	27	41.0	36.8	27.5	18.2	11.0
F	11.4	9.9	26	42.0	37.6	28.6	19.7	9.0
M	35.9	10.4	29	44.0	38.5	29.9	21.3	12.0
A	79.0	8.0	36	44.0	36.8	28.4	22.0	14.9
M	160.8	4.6	39	40.0	33.6	27.5	21.4	14.5
J	174.6	3.6	57	39.5	31.8	26.2	20.7	14.9
J	232.1	2.7	60	36.0	30.7	25.6	20.4	16.5
A	262.3	2.6	62	37.0	30.8	25.6	20.3	16.0
S	180.8	3.2	57	39.0	31.7	25.6	20.1	16.6
O	105.5	4.1	52	40.0	33.4	26.5	19.6	13.4
N	50.7	5.1	42	39.4	34.6	26.8	18.9	15.0
D	14.2	6.6	34	41.0	35.8	27.0	18.3	12.0
Year	1314.4	5.8		44.0	34.0	26.2	20.1	9.0



RAINFALL FREQUENCY
AT GAMBELA FIG. II-2

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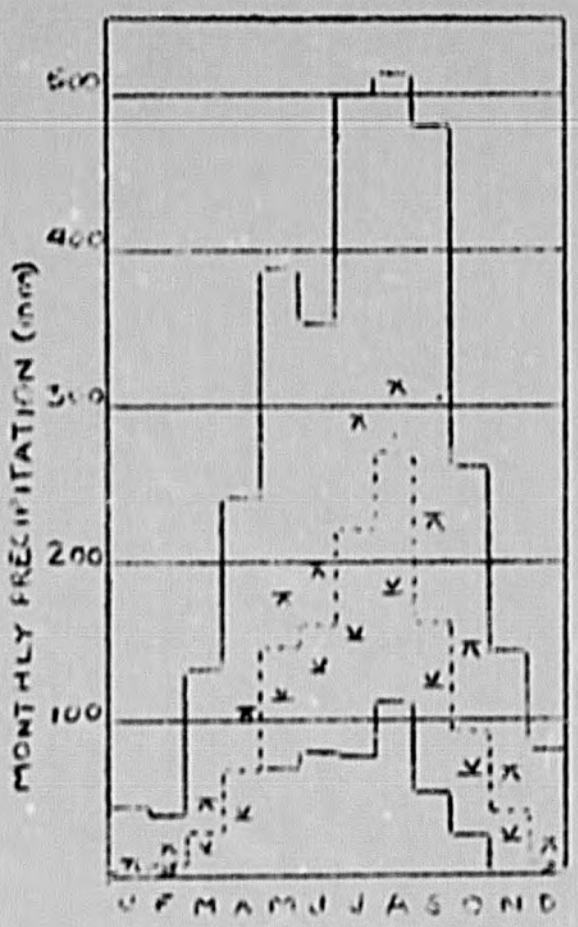

LEGEND

——— Extreme max. & min.

- - - - - Median

Upper & Lower Quartiles

CHARACTERISTIC OF MONTHLY PRECIPITATION AT GAMBELA FIG. II-3

From a mean discharge rating equation for the period 1928-1947, discharges from mean gauge heights for decades of months have been computed for the period 1905 to 1927, and these data exhibit similar and consistant characteristics with the published information of 1928 to 1957.

The mean discharge of the period of record is 420 cubic meters per second or 13,200 million cubic meters per year for a yield of 556 millimeters from an area taken as 23,900 square kilometers. (A revision of the latter amount will be possible when new maps of the Baro River Basin become available and a more reliable drainage area is determined).

The probability that annual yield will be exceeded in any year is shown on Figure II-4. The annual flow is log-normally distributed, using Beard's plotting position. The five percent, 50 percent and 95 percent chances that yield will be exceeded are 670, 540 and 430 millimeters, respectively. High yields occurred in 1929 and 1956. Low yields occurred in 1940 and 1913, in each case the gauge height record being incomplete and the discharge record being roughly estimated by comparisons and correlations with data of downstream stations. The greatest monthly mean runoff was 1,460 cubic meters per second and occurred during September 1950. The greatest daily mean discharge and the greatest momentary discharge cannot be determined from the published data; likewise, it is not possible to determine the lowest discharge, though it may have been at or near zero in March 1914 and early in 1941, periods when gauge height data were not taken.

Information of the sediment transport of the river is not known to exist. The Baro River, at high stages, on emerging from the mountains overflows its banks and is distributed laterally by numerous creeks and drains. Thus vast areas are overflown and marshes are filled with silt laden waters each year. The river channel itself diminishes in carrying capacity so that at flood time the flow may be a third less at the Sudan border than at Gambela. Apt descriptions of the hydrology of the plains is given by Hurst in "The Nile Basin," Vol. VIII. Discharge records are available at Nasser in Sudan, so that historic patterns of runoff for users of prior rights are well documented.

The mean runoff and yield of the Baro River at Gambela were computed and the values are shown in Table II-2.

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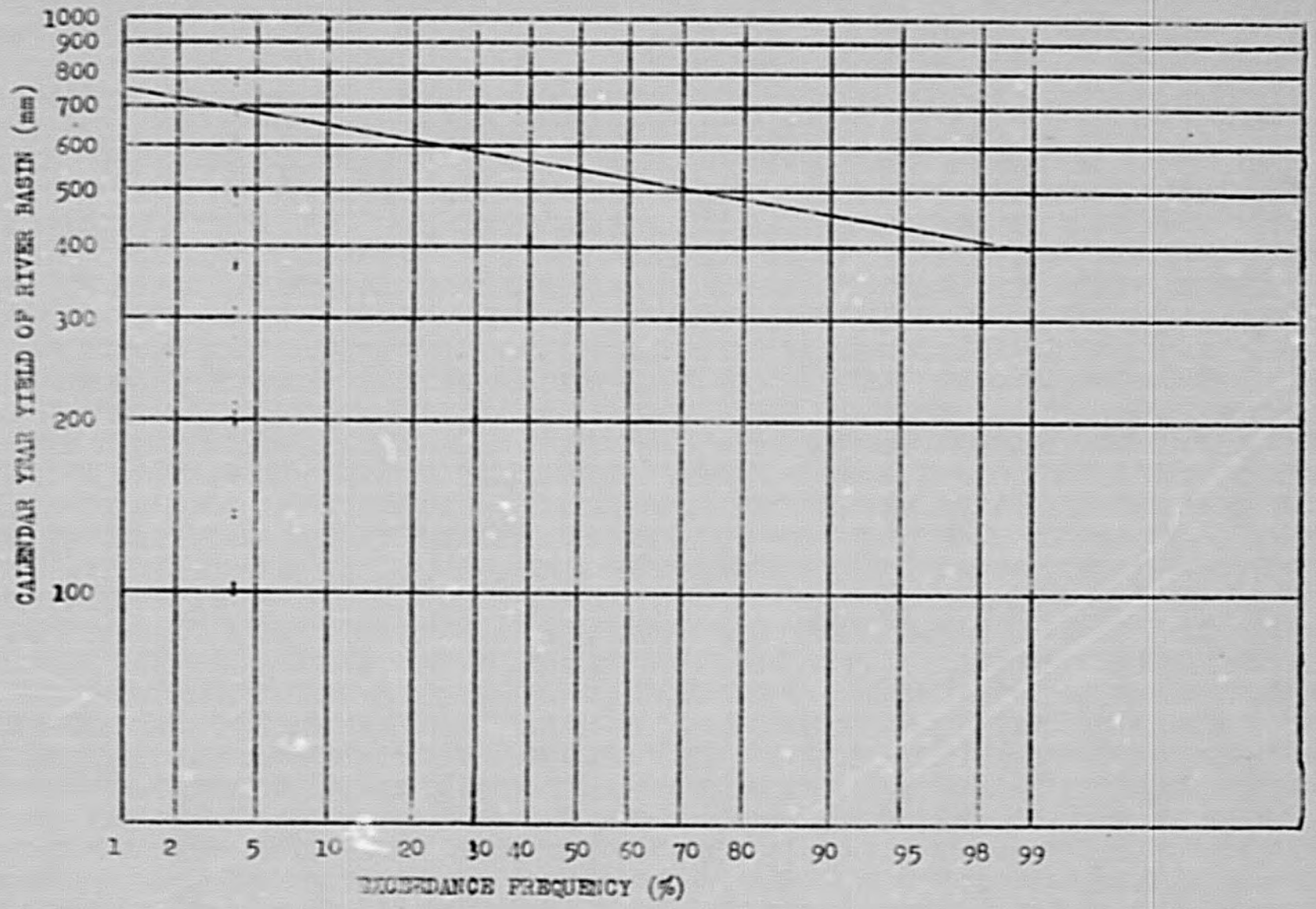

ANNUAL RUNOFF FREQUENCY
BARO RIVER FIG. II-4

Table II - 2

Mean Runoff and Yield of the Baro River at Gambela

Month	Runoff (m^3/sec)	Runoff ($10^6 m^3$/yr)	Yield (mm)
J	97	259	10.8
F	70	172	9.2
M	63	169	7.1
A	84	219	99.2
M	170	455	19.0
J	447	1159	48.4
J	730	1954	81.7
A	979	2621	109.6
S	1140	2959	123.8
O	748	2003	83.8
N	316	819	34.3
D	167	448	18.7
Average	420	-	-
Total	-	13,237	555.6

The only known chemical analysis of Baro River water was reported in 1967 by Pittwell of the Department of Chemistry, Haile Selassie I University. This data is given in Table II-3.

Table II-3

Chemical Analysis of Baro River Water Samples
(in Mg/liter)

Location	pH	HCO_3	CO_3	SO_4	Cl	F	SiO_2	Heavy Metal Oxides	Na+	K+	CA+	Spectrographic Highs
Pokwo	7.4	70	-	-	-	6	-	0.15	38	3	4	Si, Al
Gambela	7.4	48	-	-	-	22	0.4	900	45	6	5	Si, Al Mg, Fe, Sn
Jikao	7.6	103	-	-	-	6	high	?	44	7	6	?
Gilo Junction	6.2	68	-	-	2	-	-	27	?	?	?	Si, Al, Mg, Fe

- indicates no reaction

? indicates no determination

Note: The notable differences shown between the analyses of these samples are difficult to understand and clearly illustrate the need for additional sampling.

Soils

Crops in the lower Baro River Basin are presently confined to the slightly elevated natural levees formed by the sedimentation of heavier alluvium near the banks of the river. These levee soils are sandy loams in texture and drain more rapidly than the finer textured lands found farther inland from the river at slightly lower elevations.

Existing analytical data[1/] are indicative of the nature of soils expected to be encountered within the proposed study area. In general, these soils are acid in reaction ranging from medium (pH5.6) to strongly (pH5.1) acid. They are high to very high in total nitrogen, phosphorus and organic matter and range from low to medium in available potassium. There is no evidence of overcropping along the embankments and the soils remain exceptionally fertile. Manure is

1/ "A Report on the Fertility Status and Other Data on Some Soils of Ethiopia." Murphy, 1968.

managed by a United States Peace Corps volunteer, is located near Gambela with trial plots in various accessible areas. Both Gambela and Itang have piped water in the village supplied from shallow cased wells. Postal, telegraph and telephone connections with Addis Ababa are available at Gambela.

PRESENT CONDITIONS

Existing Land Use

Land use in Gambela Awraja is sharply differentiated along tribal boundary lines and reflects the traditional cultural practices and transhumant patterns of the two predominant Nilotic tribes - the Anuaks and the Nuers.

Land Use on Anuak Land - Along the low, narrow, discontinuous alluvial levees of the Baro, Alwero and Gilo Rivers, the Anuaks practice subsistence farming. Their fields range from 0.2 to 1.0 hectare in size; all cultural operations are manual, and oxen are not utilized. Normally, maize (white corn) is planted following the early rains in the hope of a harvest before floods destroy the crop. Following harvest, a second crop of either maize or sorghum (which is more drought resistant) follows with sowing coincident with the recession of the flood waters as determined by the gradual lowering of the river stage. The only implement possessed by the vast majority of the Anuaks is a straight digging stick ending in a sharp metal tip some six to eight centimeters wide. Weeding is done manually after the ground has softened. Prior to the first planting of maize in May, the fields are usually burned off and some hand weeding is done. Both first and second crops are weeded at least twice and often three times. In general, fertilizers, herbicides, insecticides and fungicides are not used and hardly known. Crop rotation, except for alternating maize with sorghum, is not practiced.

Land Use On Nuer Lands - As previously described, the Nuers graze their herds of cattle (including lesser numbers of sheep and goats) over vast areas of western Gambela and the neighboring plains of Sudan. Some limited efforts at farming are attempted along stream

banks as floods recede, depending upon residual soil moisture and the occasional late rains for crop water requirements. In some instances, Nuer and Anuak groups have developed cooperative systems in which they live in close proximity to each other. In such recorded cases, the Nuers exchange milk, ghee (butter oil) and meat for the Anuak's maize, fermented maize beer, and sorghum.

Agricultural and Livestock Production

Existing Agricultural Production - There are no known data indicative of the volume of farm production presently harvested in Gambela Awraja. Some indication may be inferred from Table I-5, previously shown in Part I, which gives estimates of annual per capita food consumption in the Southwest Region. Considering an estimated population of 80,000, it might be assumed that 9,200 metric tons of cereals, 1,600 metric tons of starches and 33,600 metric tons of other foods are consumed in the awraja annually. However, the awraja is known to be a deficit production area and, without detailed studies, no determination of import volume is possible.

Within the designated project boundaries, present agricultural production is considered nil, as the selection has avoided these lands currently under cultivation.

Existing Livestock Production - The area south of the Baro River consists, for the most part, of a coarse grassland savannah with small trees and brush of relatively low density. The carrying capacity is estimated to be about 150-200 kilograms liveweight per hectare per year. Water is available during the dry season from the Baro River and standing water holes along tributary streams. During the wet season, much of the plain is flooded.

In Ilubabor Province, it is estimated that the cattle population is about 750,000 head of which some 150,000 are in Gambela Awraja. In Gambela, the majority are located in Itang and Jikao Worodas (estimated by Dr. M. Buljina, FAO Field Officer, JP-15 Rinderpest Campaign, July, 1974). The cattle in Gambela are of relatively large size (320 to 350 kilograms) with good physical characteristics for meat production. Locally, they are called, "Abigar". Typically, the cattle migrate according to the season. In the dry

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season (December-April), they are located near the Baro, Akobo and Gilo Rivers; during the flood season, they move to the highlands away from the rivers with some herds migrating to drier lands in Sudan. Very few of the Anuaks in this area are now engaged in limited livestock production. Cattle are mainly owned by Nuers and are pastured as communal herds. Most livestock owners are unfamiliar with the basic concepts of selection for meat and milk production; therefore, there is little control over the quality of animals retained in the breeding herds.

As the major portion of the project lands lie within Anuak tribal territory, the present value of livestock production has been taken to be nil since this tribe has few livestock. Several abandoned Nuer camps are seen in the western section of the project area; however, it is impractical, at this time, to allocate a pro rata value of offtake from the relatively small number of Nuer cattle which may periodically graze in this area.

Health

Livestock Health - The following diseases and parasites are known to exist in the awraja: Trypanosomiasis, Rinderpest, CBBP, Anthrax, Blackleg, Liver Flukes, Helminth digestive tract parasites, external parasites (ticks, leeches, etc.), Foot and Mouth disease, and Rabies in carnivores.

Personnel in the Veterinary Services of Ilubabor Province include: one Veterinarian, four Veterinary Assistants and 19 Vaccinators. In addition, there has been an FAO field officer, a Veterinarian, assigned to the Province for the last two years as a part of the JP-15 Rinderpest Control Program. Laboratory facilities are limited and consequently disease diagnosis and treatment are based on the observable clinical signs. Most of the activities of the Veterinary Services in the province are devoted to prophylaxis with minimal drug treatments of diseased livestock.

Human Health - Human Trypanosomiasis (sleeping sickness) has been confirmed to exist in some parts of Gambela Awraja. The species of Tsetse capable of serving as a vector for human sleeping sickness is thought to be present over most of the Baro Valley plains. The same control measures for eradictting Tsetse fly, discussed in Part I, would be equally effective for eliminating the danger from the human

disease occurrence as well.

Malaria is endemic and it has been estimated that between 80 and 90 percent of all people living near the banks of the major rivers are infected. Incidence of infection is extremely high during the rainy season when mosquitos breed in the swamps of the flooded fields. The Malaria Eradication Organization has had a branch office in Gambela for many years but has conducted only research and to date no effective action has been taken to eradicate the disease. Schistosomiasis and Oncherocerciosis are both suspected to exist in Gambela Awraja but have not been confirmed. Other than the above, the most common types of diseases receiving treatment in the awraja are respiratory and urinary infections and internal parasites.

Gambela has a health center which was operated by the Swedish Red Cross for a number of years with a doctor in charge. It has recently reverted to government control with the intention of expanding the facilities into a fully equipped hospital. At present, it serves as little more than an out-patient clinic. Other health services available in the area of the project include clinics at Itang, Pokwo, Jikao, Gog and Abobo.

Communications

An all-weather road, National Highway 43, connects Metu to Jimma via Bedele (263 kilometers) and on to Addis Ababa via Highway 7 (335 kilometers). A dry weather, poorly maintained road (Highway 47) joins Metu with Gore, a distance of 23 kilometers, from which point, Highway 43 proceeds via an extremely difficult track to Gambela, 169 kilometers distance. Highway 45 joins Gambela to Ghimbi via Dembidolo (280 kilometers)but is only passable during the dry season with heavy-duty four-wheel drive vehicles.

From Gambela, a track continues west along the northern bank of the Baro River to Jikao, on the Sudanese border, a distance of 130 kilometers. This track is practically unfit for use. Another similar track runs south from Gambela, where a ferry is in operation for crossing the Baro, to Abobo mission (80 kilometers) and on to Gog on the Gilo River (42 kilometers from Abobo). There are other foot paths and animal trails, but for practical purposes, there are no internal

roadway systems. Future construction plans of IHA have been discussed in Part I and will not be repeated here.

Existing and past navigation on the Baro has also been mentioned in Part I along with the scheduled airline services of Ethiopian Airlines.

Markets

Existing Agricultural Markets - Considering the subsistence nature on which agricultural production is based, the local markets in Gambela, and to a lesser extent Pokwo and Itang, are expected to remain small and unable to absorb greatly increased volumes. Existing markets in Gambela and Jikao operate daily except Sunday but the volume of trading is quite low. Most cereals are sold by the liter or half-liter can full. Seasonal vegetables are vended by wives of farmers who spread produce on paper or plastic sheets on the ground in the market area. Jikao market has the advantage of luring buyers from the Sudan when prices of selected commodities are cheaper in Ethiopia. This market offers good prospects for expansion and for a possible outlet for increased agricultural production in Gambela Awraja; however, currency exchange difficulties presently limit trading activities. Project produce could easily be transported downriver in flat-bottom barges, or moved along the road between Gambela and Jikao once it has been improved to all weather status, to outlets in the Sudan. This prospect should be investigated in detail during Phase II feasibility studies.

The present market patterns governing cereals is one of minimal sales by farmers to local merchants at very low harvest time prices. These merchants can store only a limited amount, which is resold in the dry season (when food is scarce) at inflated prices. Additional quantities of grain are imported from Addis Ababa at this time when heavy trucks can penetrate via Dembidolo or Gore.

Existing Livestock Markets - The livestock marketing pattern in Ilubaber Province is seasonal with the largest numbers sold in the highlands during the coffee harvest period (December through April). Migratory labor, picking coffee for cash wages, greatly increase the effective demand during these months. The majority of the animals traded on the major markets, about 75 percent, are slaughtered. The

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remainder are draft oxen and young breeding stock.

The largest livestock markets in the province are located at Janfa, Bedele, Buro Wabeko, Toba, Metu and Ababora. The trade flow through these combined markets approximate 50,000 head annually. About one half of this number is estimated to originate from outside of the province. The main flow of slaughtered cattle is along the all weather road towards the consumption centers of Gore, Metu and Bedele, thence on towards Jimma.

There is a daily (except Sunday) cattle market at Gambela which is reported to have a flow of from 60 to 100 head per day from November through June (the driest months) and from five to ten head per day the rest of the year. The total cattle transactions in this market can thus be estimated as between 9,000 and 16,000 animals yearly. There is a very low daily slaughter rate stated to be no more than three to four animals, the balance being moved towards the three principal provincial consumption centers for remarketing. There is also an established trade route for herding cattle on foot to Dembidolo in Wellega Province.

The average selling price in Gambela was reported in 1972 to be between E$200 and E$220 for a fat animal, E$130 and E$160 for an average animal, and E$80 and E$100 for young breeding stock.

DEVELOPMENT STRATEGY

To develop the selected project area and to alter its existing land use, requires solutions to the major constraints that have to date kept the area in a virgin or practically primordial state. The combination of vast, fertile plains with abundant water resources and climatic conditions favorable to continuous cultivation, have remained under-utilized and the fief of primitive nomadic tribal chieftains and a handful of unproductive subsistence farmers, while much of the rest of the country suffers from overcrowding on the arable highlands or from recurrent droughts and food shortages on semi-arid lowlands.

The 50,000 hectares considered herein, represent about three percent of that portion of the arable land mass in Gambela which lies between the escarpment slopes on the east and the border with Sudan on the west, and between the Baro River on the north and the

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Akobo River on the south. It may be considered as a pilot area in respect to the total possible future development.

To control the overland flooding, the project area would be protected by low flood embankments as required. A pumping station would be located on the Baro River to provide the area with a dependable supply of irrigation water. Primary, secondary and tertiary canal systems would deliver water to each farm headgate by gravity. A supervised program of livestock disease eradication would permit the expansion of cattle production while aiding in eliminating human disease as well. Testing and extension services would be provided by a demonstration and seed multiplication farm to be established in the project area. An interior road system would be constructed to provide easy access to the proposed all weather roads and thence to the principal markets. Public services would be provided and a resettlement program would be designed to assist new settlers to adapt to the created environment.

The measures required for such alterations would be investigated in detail during an indepth feasibility study. The broad guidelines, order-of-magnitude costs, and preliminary evaluations of benefits are discussed in subsequent portions of the Gambela project overview.

Conservation

Development objectives must continually be balanced by the desirability to conserve, protect and, when possible, improve upon the natural environment and resources. For the Gambela project, there are distinct prospects for each element of conservation.

Soil Conservation - As mentioned in Part I, the soil loss from annual erosion has been estimated to range from 40 to 200 tons per square kilometer. Considering the flatness of the terrain on the project, it is likely that the annual soil loss in this area would approach the minimum - 40 tons per square kilometer - if allowances are made for the amount of sediment deposited on the flooded fields each year by the Baro River. While this deposit aids in maintaining natural fertility, it cannot offset the loss of top soil through erosion.

The provision of flood protection levees around the project

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would effectively eliminate soil erosion losses, as only fractional losses would occur from rainfall over the area. Through pumping of suspended sediment-laden Baro River water into the project for irrigation, sedimentation would be evenly distributed over all the area and its value would counter the cost of occasionally desilting the distribution system.

Forest Conservation - Low brush and shrubs would be removed from the project during the Tsetse fly eradication program and some of the existing medium-sized trees may be eliminated. However, on each of the 2,500 model five-hectare farms, one hectare has been set aside for residence and other farm structures, home gardens, and the establishment of a small woodlot or forested area. Wood is consumed daily as it is the principal material used for cooking fires. Without woodlots, the farm families would quickly consume the remaining trees on the project and then seek timber in the nearby hilly and wooded lands to the east of the area, thus hastening the destruction of the remnants of the natural forests and greatly increasing the rate of erosion there.

Quick-growing tree seedlings, especially tall straight species which would not harbor Tsetse flies, could be provided each family through the extension services included in the project's budget. In addition to firewood, such trees would be a source of building poles and fence posts. Fruit trees, such as mangoes, avocadoes, citrus and papayas, would provide the farm family with supplemental food and a more nutritious diet. The balance of forest conservation thus favors the establishment of the project.

Wildlife Conservation - As mentioned in Part I, it is impossible to eradicate or effectively maintain a low incidence of livestock disease unless wild animals can be prevented from entering the area. It is likely that the construction of flood control levees, the excavation of drainage ditches, and the increase of population would serve as a partial barrier to the intrusion of some wild animal species. However, the availability of water throughout the year, over all of the project, would attract others. Measures would have to be adopted to eliminate or reduce the risks of infected wildlife invading the developed area.

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The Wildlife Conservation Organization has proposed that over 70 percent of Gambela Awraja be divided into areas for a wildlife reserve and two controlled hunting areas. Such a move would prevent any agricultural development or resettlement in the awraja and would obviously not be in the best interest of the people there or for the economic development of the Empire. Land use planning dictates that areas whose agricultural and settlement potentials are such that they must be developed, should not be included in wildlife or recreational reservations.

There are approximately one and a half million hectares of potential agricultural land in the lowland plains of Gambela Awraja which may be required by subsequent generations to supply the Empire with food and meat. There are many other potential wildlife protection areas in the Southwest Region which do not possess the enviable combination of arable virgin lands, abundant water resources with storage and power generating potential, and climatic conditions favorable for continuous cultivation.

The project would support the establishment of a game reserve in the Gambela area providing it did not utilize an inordinate portion of the potential agricultural land, and providing the Wildlife Conservation Organization had the necessary funding and personnel to properly maintain and police the reserve.

Resettlement

The approach to resettlement would demand definitive studies relating to the cultural habits of the Nuer and Anuak people. Their tribal customs deter individual efforts by stressing family, communal and tribal sharing. If at all possible, however, these groups must be given priority in resettlement planning and every effort must be made to integrate them into cooperative systems of productive and economic agriculture and/or livestock raising. Of the 25,000 hectares planned for irrigated (or rainfed) farming, half of the area would be allocated to oxen-powered five-hectare units; thus allowing for the resettlement of 2,500 families. Protective measures to be enforced on the 25,000 hectares of grazing lands would allow for an eventual herd of up to 20,000 cattle with an ultimate annual

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offtake of 18 percent. It is likely that production of this magnitude would exceed the value of all current animal yields from the entire plain.

It cannot be determined at this time how many of the 2,500 households could be drawn from the Anuak people in the Gambela area, or how many Nuer tribesmen would avail of the pasturage. It is clear, however, that in the nearby highlands around Gore and Motu, there are many families presently restricted to small rented farms, who could provide the balance of the settlers. In a discussion with the Governor of Gambela Awraja, it was determined that he would welcome the settling of some families from these highlands, or from drought stricken areas elsewhere in the Empire, so that the local tribes could see how such farmers worked and could pattern their own activities accordingly.

Land Capability

Under present conditions, the vast majority of the project area would be classed as non-arable. These lands are submerged for 5 to 6 months each year; then on recession of the overland floods, they dry into hard clay blocks with typical Vertisol cracks penetrating deep into the solum. Only on some slightly elevated interriverine strips (probably ancient river levees) could agriculture be attempted in the wet season, and only near larger waterholes could limited farming be possible in the dry months.

Once the area is protected from overland flooding and drainage facilities are provided, the land use capability is changed. Rainfall during the wet season is often sufficient for agriculture and, with irrigation, two and possibly three crops per year are quite feasible. Based on current knowledge, the land capability classification for the 50,000 hectares would roughly be:

Class II - 15,000 hectares or 30 percent
Class III - 25,000 hectares or 50 percent
Class IV - 10,000 hectares or 20 percent

Class II - lands have a high potential for production of lentils, groundnuts (peanuts), tobacco, and a wide variety of vegetable crops, including

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melons. They are the somewhat higher lands and old river terraces are are better drained internally and on the surface. They have a somewhat lighter texture and would be more easily cultivated with oxen than the other lands.

Class III - intermediate lands that are presently flooded during the wet season but which will be protected by the proposed levees. They are heavy clay soils with moderate fertility and organic content in the upper debris layer. With continuous cultivation and incorporation of humus into these soils, they will greatly improve in tilth. They can continually support double-cropping if fertilized after the first 3 or 4 years. They are particularly suited for cotton, sugarcane, maize, sorghum and other cereals including rice.

Class IV - Lowland soils found in depressions and intermediate lands of uneven topography both fit into this broad category. With conservation practices, including leveling by the farm operator, these lands can produce as well as Class III, and the same crops would be adaptable.

More detailed land capability classification mapping would permit selection of the more productive areas for agricultural development and the lands of lower potential for pastures.

Cropping Patterns

For the comparative analyses of the four projects studied, simplified cropping patterns, based on both traditional cultivation experience and land capability, were used. The Gambela project was then studied under two basic assumptions: 1) the rainfed agriculture project with flood protection and drainage facilities; and 2) the project with flood control, drainage and irrigation. In the former, only one rainfed crop is harvested, while in the latter alternative, two cropping seasons were used (with proper management, 2½ or 3 crops per year are possible). Many crops and patterns were examined and some have exceptional possibilities. Sugarcane

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would produce well and require only supplemental irrigation with over 1,200 millimeters of rainfall on the average. A sugar refinery producing raw brown sugar for processing by the existing refineries at Wonji and Metahara would provide the Gambela area with an industrial development capable of adding justification for the proposed road improvement program, and providing employment for non-farm population.

The land and climate are suitable for large scale planting of rice. Rice mills, dryers, polishers and storage silos would likewise give the area a nucleus of industrial development, with polished rice being introduced on the Ethiopian market at competitive price with other grains for the first time. Export opportunities might also exist to transport rice down river to Khartoum and on to Port Sudan.

Similarly, groundnuts (peanuts) have been considered with full or partial processing and the related industrial development. These crops and many others deserve additional study at feasibility level and the eventual cropping pattern may be altered to accommodate the results of subsequent indepth investigations, including: 1) present and future projections of national and international market prices and demands; 2) costs of industrial plants including direct and indirect inputs; 3) detailed freight studies and transportation costs; 4) comparative benefits in marketing raw products against primary or total processing; 5) power and labor requirements; and 6) the impact of such developments upon the ecology, environment and cultural background of the indigenous people in the area.

Cotton is well-suited and has been taken as the principal cash crop in the pattern. It can be readily marketed in Addis Ababa as seed cotton without requiring ginning facilities on the project at the initial development stage.

The selected patterns for the model five-hectare farms using oxen power and the model 250-hectare commercial tractor farms under both irrigated and rainfed alternatives are shown on Table II-4.

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Table II-4

Cropping Patterns - Gambela Project

	Five-Hectare Oxen Farms (ha)	250-Hectare Tractor Farms (ha)
With Irrigation		
Wet Season		
Maize	2	-
Sorghum	2	250
Dry Season		
Cotton	2	250
Pulses	1	-
Sorghum	1	-
Rainfed		
Wet Season		
Maize	1	-
Sorghum	1	125
Cotton	2	125

The five-hectare farms are designed to provide four net hectares of crops. Under the irrigated agriculture alternative, two hectares each of maize and sorghum would be cultivated in the wet season, followed by two hectares of cotton and one hectare each of pulses and sorghum in the dry season. With flood control and drainage only, a wet season rainfed pattern of two hectares of cotton and one hectare each of maize and sorghum would be grown.

Cotton is the only crop in the pattern not presently grown in Gambela. However, the market structure in Addis Ababa is well established and ginning facilities are available. Extension services would assist the farmers in their initial cultivation experiences. Further marketing and economic studies to be undertaken as part of Phase II, would evaluate the benefits of establishing ginning and other facilities either within the project, or in nearby Gambela town, as compared to shipping seed cotton to Addis Ababa. The prospects of shipping cotton down river through the Sobat River to Khartoum and beyond, should also be explored as this could open

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new export channels for Ethiopia in the future.

Under the irrigated agriculture alternative, the model 250 hectare mechanized farms would concentrate on sorghum in the wet season, followed by cotton in the dry season. Without irrigation, these farms would plant equal areas of sorghum and cotton in the wet season, rotating the fields each year.

Model Farm Budgets

Model Five-hectare Oxen Farms - Tables II-5 and II-6 show the basic direct parameters adopted for financial analysis of the smaller farms with and without irrigation facilities, respectively. Yields are believed to be conservative and consider the capability of the soil, favorable climatic conditions, the availability of inputs and the ability of the prospective farmers. Yields would be higher for irrigated farms than for rainfed farms. With irrigation, it would be possible to prepare lands at the convenience of the farmer and the planting could be timed to take maximum advantage of rainfall. During the wet season, it is probable for short periods of two to three weeks of drought to periodically occur, resulting in decreased yields if irrigation is not readily available. Prices used were discussed in Part I of this report.

The estimated indirect costs, also utilized in computing the financial analyses of the model farm units, are given in Tables II-7 and II-8.

Model 250-Hectare Tractor Farms - Tables II-9 and II-10 show the basic direct parameters used for crops on the model 250-hectare commercial farm units with and without irrigation, respectively. Cropping patterns have been simplified to show border-to-border sorghum in the wet season and cotton in the dry season under irrigated agriculture and 125 hectares each of sorghum and cotton in the wet season without irrigation. Wet season sorghum and cotton planted with the assistance of supplemental irrigation would produce higher yields than under rainfed conditions.

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Table II-5

Basic Direct Parameters for Crops on 5-Hectare Oxen Farms
Gambela Project - Irrigated

		Wet Season		Dry Season		
Item	Units	Maize	Sorghum	Pulses	Cotton	Sorghum
Returns						
Yield	qq/ha	30	27	15	18	27
Price	E$/qq	12	14	20	55	14
Sales	E$/ha	360	378	300	990	378
Direct Inputs						
Seed & Seed Treatment	E$/ha	11	6	26	18	6
Fertilizer	E$/ha	32	23	-	77	23
Insecticide	E$/ha	32	32	32	80	32
Bags	E$/ha	-	-	-	12	-
Total	E$/ha	75	61	58	167	61
Labor	hrs/ha	785	665	560	850	690
Oxen	hrs/ha	90	90	90	90	90

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Table II - 6

Basic Direct Parameters for Crops on Oxen Farms
Gambela Project - Rainfed

Item	Unit	Maize	Sorghum	Cotton
Returns				
Yield	qq/ha	24	22	14
Price	E$/qq	12	14	55
Sales	E$/ha	288	308	770
Direct Inputs				
Seed & Seed Treatment	E$/ha	11	6	18
Fertilizer	E$/ha	32	23	77
Insecticides	E$/ha	32	32	89
Bags	E$/ha	-	-	-
Total		75	61	184
Labor	hrs/ha	670	575	750
Oxen	hrs/ha	90	90	90

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Table II - 7

Indirect Costs for Model Five-Hectare Oxen Farm

Gambela Project - Rainfed (E$)

Item	Annual Cost
Oxen Maintenance (1)	10
Small Animal Maintenance (1)	2
Repairs and Maintenance	44
Land Tax	9
Family Cash Expenses (2)	240
Home Consumption Maize (3)	84
Home Consumption - Sorghum (4)	42
Total	431

(1) Minerals, Tick Control and Medical
(2) Assumes a Family of six
(3) 7 quintals @ E$12/qq
(4) 3 quintals @ E$14/qq

Table II - 8

Indirect Costs for Model Five-Hectare Oxen Farm

Gambela Project - Irrigated (E$)

Item	Annual Cost
Oxen Maintenance (1)	10
Goats, Sheep, etc. Maintenance (1)	2
Repairs and Maintenance	44
Land Tax	9
Family Cash Expenses (2)	240
Hired Labor (3)	125
Home Consumption - Maize (4)	84
Home Consumption - Sorghum (5)	42
Home Consumption - Pulses (6)	20
Total	576

(1) Minerals, tick control, and medical
(2) Assumes family of six
(3) Assumes 1,000 hours annually
(4) 7 quintals @ E$12 per quintal
(5) 3 quintals @ E$14 per quintal
(6) 1 quintal @ E$20 per quintal

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Table II - 9

Basic Direct Parameters for Crops on Tractor Farms
Gambela Project - Irrigated

Item	units	Wet Season Sorghum	Dry Season Cotton
Returns			
Yield	qq/ha	30	25
Price	E$/qq	14	55
Sales	E$/ha	420	1375
Direct inputs			
Preharvest			
Machine	E$/ha	11	16
Labor	E$/ha	31	35
Seed & seed treatment	E$/ha	6	24
Fertilizer	E$/ha	23	77
Food for labor	E$/ha	4	6
Insecticides	E$/ha	32	80
Subtotal		107	238
Harvest			
Machine	E$/qq	0.20	0.30
Labor	E$/qq	1.50	5.20
Materials	E$/qq	1.90	1.40
Subtotal	E$/qq	3.60	6.90
Subtotal	E$/ha	108	172
Total	E$/ha	215	410

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Table II - 10

Basic Direct Parameter for Crops on Tractor Farms
Gambela Project-Rainfed

Item	Unit	Cotton	Sorghum
Returns			
Yield	qq/ha	20	24
Price	E$/qq	55	14
Sales	E$/ha	1100	336
Direct Inputs			
Preharvest			
Machine	E$/ha	16	11
Labor	E$/ha	35	31
Seed and Seed Treatment	E$/ha	24	6
Fertilizer	E$/ha	77	23
Food for Laborers	E$/ha	6	4
Insecticides	E$/ha	80	32
Subtotal		238	107
Harvest			
Machine	E$/qq	0.30	0.20
Labor	E$/qq	5.20	1.50
Materials	E$/qq	1.40	1.90
Subtotal	E$/qq	6.90	3.60
Subtotal	E$/ha	138	86
Total	E$/ha	376	193

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The estimated indirect costs for the model 250-hectare tractor farm, for either irrigated or rainfed agriculture, are given in Table II-11.

Table II - 11

Indirect Costs for Model 250-Hectare Tractor Farm

Gambela Project

Item	Annual Costs(E$)
Salaries	3,100
Repairs and Maintenance (buildings)	700
General Transportation	700
Management - Imputed	4,200
Land Tax	500
Total	9,200

Financial Analyses of Model Farms

Cash flow projections were worked out for model farms under both the irrigated and rainfed alternatives. The projections were based on the cost and revenue data derived in the preceding paragraphs and on investment expenditures presented herein below.

Model Five-Hectare Oxen Farm - The investment and replacement schedule adopted for the five-hectare oxen farm is given in Table II-12. These investment requirements apply to both the irrigated and rainfed alternatives.

The cash flow analyses for the irrigated and rainfed alternatives are presented in Tables II-13 and II-14, respectively. In the case of the irrigated alternative, loan repayment (at 12 percent interest) was assumed over a period of four years with a one-year grace period and, for the rainfed alternative, over a period of four years with a two-year grace period. Short term interest for production loans was assumed at 14 percent. Buildup to full production was taken to be five years for the irrigated alternative and four years for the rainfed alternative. Water charges were derived from amortization of capital costs for water control facilities and the annual operation and maintenance costs thereof (see the section, Infrastructural Development Plan). Agricultural income tax is based on the official Imperial Ethiopian Government Tax

Table II - 12

Investment Requirements for Model Five-Hectare Oxen Farm
Gambela Project (E$)

Item	Units	Life (Year)	Year 1	Year 6	Year 9	Year 11	Year 16	Year 17
Oxen	1 pair	5	360	240(1)	-	240	240	--
Donkey	1	10	25	--	--	25	--	--
Sheep, Goats, Chickens	Set	--	100	--	--	--	--	--
Plow	1	8	50	--	50	--	--	50
Plow-ridger	1	8	50	--	50	--	--	50
Harrow	1	8	50	--	50	--	--	50
Back-Pack Sprayer	1	5	70	70	--	70	70	--
Miscellaneous	1 set	5	50	50	--	50	50	--
Tukul	1	10	150	--	--	150	--	--
Store	Materials	10	75	--	--	75	--	--
Thresher-hand	1	10	75	--	--	75	--	--
Total	--	--	1055	360	150	685	360	150

(1) Assumes sales price of E$120 for old pair or net replacement cost of E$240 per pair.

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Table II - 13

Cash-flow for Model Five-Hectare Oxen Farm
Gambola Project - Irrigated (Ethiopian Dollars)

	Years-1	2	3	4	5	6	7-8	9	10-12
Cash inflow									
Gross returns (1)(2)	413	1240	2480	3721	4134	4134	4134	4134	4134
Less home consumption	146	146	146	146	146	146	146	146	146
Loan	1295								
Total	1562	1114	2334	3575	3988	3988	3988	3988	3988
Cash outflow									
Direct expenses (2)	77	230	459	688	765	765	765	765	765
Indirect Expenses (3)	56	56	181	181	181	181	181	181	181
Land tax	9	9	9	9	9	9	9	9	9
Income tax	2	33	75	108	162	162	162	162	162
Investment(4)	1055					360		150	
Short term interest	6	13	27	38	42	42	42	42	42
Family expenses	240	240	240	240	240	240	240	240	240
Total	1445	581	991	1264	1399	1759	1399	1549	1399
Cash Balance	117	533	1343	2311	2589	2229	2589	2439	2589
Debt service (5)	80	469	469	389	389				
Cash Balance	37	64	874	1922	2200	2229	2589	2439	2589
Water charge	--	--	--	1064	1064	1064	1064	1064	1064
Cash Balance	37	64	874	858	1136	1165	1525	1375	1525

(1) assumes buildup of 10, 30, 60, 90 and 100 percent for years 1 through 5
(2) full development based 2 hectares each of maize soughum in wet season and one hectare each of pulses and sorghum and 2 hectares of cotton in the dry season.
(3) annual maintenance and repairs for years one and two plus hired labor therafter
(4) taxable income computed as sales less land taxes less $\frac{1}{3}$ sales representing costs
(5) assumes E$240 food allowance interest free.

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Table II - 14

Cash Flow for Model Five-Hectare Oxen Farm
Gambela Project-Rainfed (Ethiopian Dollars)

Years	1	2	3	4-5	6	7-8	9	10-12
Cash Inflow								
Gross returns (1)(2)	641	1068	1709	2136	2136	2136	2136	2136
Less home consumption	126	126	126	126	126	126	126	126
	1295	--	--	--	--	--	--	--
Total	1810	942	1583	2010	2010	2010	2010	2010
Cash Outflow								
Direct expenses (2)	151	252	403	504	504	504	504	504
Indirect expenses (3)	56	56	56	56	56	56	56	56
Land tax	9	9	9	9	9	9	9	9
Income tax	6	24	45	60	60	60	60	60
Investment	1055	--	--	--	360	--	150	--
Short term interest	10	14	21	26	26	26	26	26
Family expenses	240	240	240	240	240	240	240	240
Total	1527	595	774	895	1255	895	1045	895
Cash Balance	283	347	809	1115	755	1115	965	1115
Debt Service	80	80	516	436	436	--	--	--
Cash Balance	203	267	293	679	319	1115	965	1115

(1) Assumes buildup of 30, 50, 80 and 100 percent for years 1 through 4
(2) Assumes 1 hectare each of maize and sorghum and 2 hectares cotton
(3) Annual maintenance and repairs for years one and two plus hired labor thereafter
(4) Taxable income computed as sales less land taxes less 1 sales representing costs
(5) Assumes E$240 food allowance interest free

Schedule (Negarit Gazeta, 27th year, No. 4, November 23, 1967).

The resulting cash flows, even with considerable water charges, are indicative of a very viable oxen-farm under either the irrigated or rainfed alternatives.

Model 250-Hectare Tractor Farm - The investment and replacement schedule assumed for the model 250-hectare tractor farm is given in Table II-15 for both the rainfed and irrigated agriculture alternatives. It was assumed that 70 percent of the initial outlays would be financed at 12 percent interest.

The cash flow analyses for the irrigated and rainfed alternatives are presented in Tables II-16 and II-17, respectively. For both alternatives, loan repayment (at 12 percent interest) was assumed over three years with no grace period. Short term interest for production and harvest loans was assumed at 14 percent. Buildup to full production was taken to be four years. Water charges and income tax were derived as stated above for the oxen farm.

The resulting cash flows are indicative of very viable commercial operations, especially under the irrigated agriculture alternative.

LIVESTOCK DEVELOPMENT PLAN

If a livestock program is to be economically viable in Gambela, the constraints must be identified and methodology developed to overcome or minimize their effects. The principle constraints visualized include:

- the presence of disease, particularly Trypanosomiasis which not only causes death but restricts normal production in chronically affected animals, as well as other viral, bacterial and parasite infections;
- a shortage of water during the dry season;
- flooding of much of the grazing land during the wet season;
- the use of non-selective breeding practices for the ultimate goal of producing numbers of cattle without regard to quality;
- the lack of modern infrastructure (roads, etc.);

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Table II - 15

Investment Requirements for Model 250-Hectare Farm
Gambela Project
(Thousand E$)

Item	No Units	Outlay	Life (yrs)	Year 1	Year 9	Year 11	Year 17
Rainfed							
Tractor - 70hp	1	15.0	8	15.0	15.0	--	15.0
Widelevel 15'	1	6.8	8	6.8	6.8	--	6.8
Drill - 12'	1	6.0	8	6.0	6.0	--	6.0
Sprayer - 32'	1	6.0	8	6.0	6.0	--	6.0
Trailer - 3T	1	2.4	8	2.4	2.4	--	2.4
Land development	-	1.5	-	1.5	--	--	--
Tukuls	3	1.8	10	1.8	--	1.8	--
Pole shed	1	4.8	10	4.8	--	4.8	--
Total		44.3		44.3	36.2	6.6	36.2
Irrigated							
Tractor - 70hp	2	30.0	8	30.0	30.0	--	30.0
Widelevel - 15'	2	13.6	8	13.6	13.6	--	13.6
Drill - 12'	2	12.0	8	12.0	12.0	--	12.0
Sprayer - 32'	1	6.0	8	6.0	6.0	--	6.0
Trailer - 3T	2	4.8	8	4.8	4.8	--	4.8
Land development	-	2.5	20-	2.5	--	--	--
Tukuls	3	1.8	10	1.8	--	1.8	--
Pole shed	1	4.8	10	4.8	--	4.8	--
Total		75.5		75.5	66.4	6.6	66.4

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Table II - 16

Cash-Flow for Model 250-Hectare Tractor Farm
Gambela Project-Irrigated (Thousand E$)

	year -1	2	3	4-8	9	10	11	12
Cash inflow								
Sales (1)(2)	269.3	359.0	403.9	448.8	448.8	448.8	448.8	448.8
Loan	52.8	--	--	--	--	--	--	--
Total	322.1	359.0	403.9	448.8	448.8	448.8	448.8	448.8
Cash outflow								
Direct expenses (2)	93.8	125.0	140.7	156.3	156.3	156.3	156.3	156.3
Indirect expenses	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Land tax	.5	.5	.5	.5	.5	.5	.5	.5
Income tax (3)	51.0	69.0	78.0	87.1	87.1	87.1	87.1	87.1
Investment	75.5				66.		6.6	
Short term interest	5.0	6.2	7.0	7.7	7.7	7.7	7.7	7.7
Total	234.5	209.4	234.9	260.3	326.7	260.3	266.9	260.3
Cash Balance	87.6	149.6	169.0	188.5	122.1	188.5	181.9	188.5
Debt service	22.0	22.0	22.0	--	--	--	--	--
Cash balance	65.6	127.6	147.0	188.5	122.1	188.5	181.9	188.5
Water charge	66.6	66.6	66.6	66.6	66.6	66.6	66.6	66.6
Cash Balance	1.0	61.0	80.4	121.9	55.5	121.9	115.3	121.9

(1) Assumes buildup of 60,80,90 and 100 percent for years 1 through 4
(2) Full development assumes 250 hectares each of cotton and sorghum
(3) Taxable income computed as sales less land taxes less ⅓ of sales representing costs.

Table II - 17

Cash Flow for Model 250-Hectare Tractor Farm
Gambela Project-Rainfed (Thousand E$)

Years	1	2	3	4-8	9	10	11	12
Cash Inflow								
Gross Returns (1) (2)	107.7	143.6	161.5	179.5	179.5	179.5	179.5	179.5
Loan	31.0	--	--	--	--	--	--	--
Total	138.7	143.6	161.5	179.5	179.5	179.5	179.5	179.5
Cash Outflow								
Direct expenses (2)	42.7	46.9	64.0	71.1	71.1	71.1	71.1	71.1
Indirect expenses	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Land tax	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Income tax	18.6	25.8	29.4	33.0	33.0	33.0	33.0	33.0
Investment	44.3	--	--	--	36.2	--	6.6	--
Short term interest	2.4	3.1	3.4	3.7	3.7	3.7	3.7	3.7
Total	117.2	95.0	106.0	117.0	153.2	117.0	123.6	117.0
Cash Balance	21.5	48.6	55.5	62.5	26.3	62.5	55.9	62.5
Debt Service	12.9	12.9	12.9	--	--	--	--	--
Cash Balance	8.6	37.7	42.6	62.5	26.3	62.5	55.9	62.5

(1) Assumes buildup of 60, 80, 90 and 100 percent for years 1 through 4
(2) Assumes full development of 125 hectares each of cotton and sorghum
(3) Taxable income computed as sales less land taxes less ⅓ of sales representing costs

- the lack of any organized effort to educate the livestock owner relative to management and disease prevention practices; and
- understaffing and undersupply of technical facilities for the Veterinary Services Division in Gambela Awraja.

There are, however, several positive factors that must be considered, such as:

- a sufficient number of cattle (150,000 in immediate or adjacent areas) to stock a cattle production project;
- a population of pastoralists that might be induced to settle if given the opportunity;
- a type of cattle that has the potential to produce highly acceptable meat animals;
- Rinderpest appears to be fairly well under control with 67,790 of the cattle in the province vaccinated in the second full round of the JP-15 Rinderpest Control Program;
- incidence of other infectious diseases (CBPP, FMD, Anthrax, and Blackleg) appears to be decreasing;
- the higher price of cattle in Gambela market as compared to others in Ilubabor;
- a quality range pasture with good carrying capacity; and
- a plain that has few shrubs and trees which should simplify development of a Tsetse fly-free area.

Principal Diseases

Those diseases and parasites which have restrained livestock production in Gambela Awraja, indications of their importance, the methods of control, and the effectiveness of the recommended treatments are listed in Table II-18.

Components of the Program

The program for cattle production is allied to, but not directly associated with, the suggested intensive farming proposal for Gambela area. These two projects are complementary and, to a limited extent, integrated.

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Table II - 18

Diseases Constraining Livestock Production
in Gambela

Disease	Importance as Constraint If not Controlled (1)	Method of Prevention, Control or Treatment	Effectiveness of Prevention, Control or Treatment (2)
Trypanosomiasis	++++	Tsetse eradication	xxx
Rinderpest	++++	Vaccination	xxxx
CBPP	+++	Vaccination	xx
Blackleg	+++	Vaccination	xxxx
Anthrax	+++	Vaccination	xxxx
FMD	+	Vaccination	xx (3)
Liver Flukes	++	Snail eradication Drug treatment	xx xx
Helminths	+++	Pasture rotation Antholmintics	xx xx
External Parasites	+	Spray or Dip	xxx
Tick Borne Diseases	++	Spray or Dip Drugs	xxx xxx
Rabies	+	Destroy Stray dogs Vaccinate	xxx xxx (4)

(1) + = minor to ++++ = major in areas under study

(2) x = fairly effective, xx = moderately effective, xxx = very effective, and xxxx = absolutely effective

(3) Lack of effectiveness often due to appearance of antigenic variables in virus - new strains

(4) Difficult to control in wild carnivores

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In order to take advantage of existent positive factors and to overcome some of the constraints, a series of interventions are planned including:

- provision of intensive veterinary services in order to implement a program of disease control (See outline of a disease control program in Part I) for draft and production cattle;
- provision of adequate water points during the dry season;
- construction of dikes to protect the lowlands from flooding during the wet season;
- initiation of an extensive program to educate the pastoralists in more modern methods of cattle production;
- pasture management program; and
- construction of access roads to project area.

Location and Size of the Livestock Project Area - An area of approximately 25,000 hectares would be designated for the livestock project. This area would be located along the Baro River west of, but adjacent to, the proposed intensive agriculture project. When the entire area is utilized, it should support a herd of up to 20,000 head.

Stock for Project Area - Cattle for the project would be derived from indigenous animals either by outright purchase of breeding stock or by movement into an area of pastoralists with existing herds, preferably the latter.

Disease Control - A disease control program, as previously outlined, would be instituted. The effectiveness of maintaining an area of low disease incidence is dependent on the availability of adequate personnel within the Veterinary Services Division of the MOA. Another factor of significance is the availability of laboratory diagnostic services to continually monitor disease incidence within the present area. The organizational listing below contains the additional personnel required to provide the necessary services which would complement the existing personnel.

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Organization List - Additional Veterinary Personnel

- One Veterinarian - at provincial capital in Motu
- Two Animal Health Assistants - one in the project, and one in the Gambela laboratory
- Four Vaccinators - two in the project and two in Gambela
- Two dip attendants - stationed in the project
- Casual laborers - as required for aiding in dipping, spraying and vaccination in the project and for cleaning in the laboratory and maintenance of staff quarters

Water points - An essential for use of this area for livestock is provision of a constant source of water for livestock and human population. Water points would be installed throughout the area utilizing water from the adjacent irrigation project. These water points would be located so that no animal would need to move over five to seven kilometers to have access to water.

Flood prevention - As mentioned previously, many parts of the project area are flooded during the rainy season thus making it unsuitable for grazing. This would be overcome by construction of a low dike to prevent the river flooding during the wet season.

Extension services - Before the potential for livestock production can be achieved, realistic programs in disease control, pasture management, and more modern methods of cattle selection must be adopted. This would be accomplished only when the livestock owner becomes more knowledgeable and is willing to accept the improved innovations in handling cattle. Such education can most easily be accomplished by initiation or expansion of extension services, and consideration should be given to the establishment of a model livestock production area within the confines of the project. Creation of such a unit would provide the cattle owner with an opportunity to learn by observation.

Pasture Management - Many of the pasture management concepts would be initiated through extension services. Of particular importance is enforced pasture rotation accomplished by periodically closing water points in areas of overgrazing. Such an area can be burned at the onset of the following rainy season and reopened later for grazing. Themeda ranges usually maintain a good carrying capa-

city unless overgrazed or inadequately burned which permits less desirable vegetation to become established. Consideration should be given to the possibility of pasture improvement by the introduction of legumes and other grass species. Soil and plant analyses may indicate the need for mineral supplementation.

Benefits - Qualitative

As a consequence of project activities designed to improve animal health and production methods, specific benefits are expected to accrue. One of the most significant benefits will be a restructuring of the herd within the project area. This restructuring would be a gradual process requiring at least six years before the character of the herd is stabilized.

As the cattle herd is restructured, the annual offtake would be increased thus providing the owners with greater return on their investment. The following factors would be responsible for the gradual changes in herd dynamics, animal quality and economic return:

- The percentage of females in the herd would increase.
- The number of females of reproductive age would increase.
- The calving rate would increase.
- Death losses among calves and mature animals would be reduced.
- Animal weight would be increased.
- Annual offtake (both in percent and kilograms of liveweight) would increase in relation to total herd size.
- Annual financial return to individual owner would increase.

Estimated Costs

The estimated capital and recurring costs required to support a cow-calf operation of up to 20,000 livestock units are summarized in Table II-19.

Model Livestock Development Unit

For this preliminary study, a model family herd of 50 head was assumed. An ultimate aggregate herd size of 20,000, then, would comprise 400 family units.

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Table II - 19

Estimated Costs Livestock Development Plan

Gambela Project
(Thousand E$)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Initial Capital Costs						
Protection Zones (Tsetse and Firebreak)	156	-	-	-	-	-
Buildings (1)	60	18	30	60	60	60
Handling Facilities (2)	7	2	7	4	11	4
Flood Control	3121	-	-	-	-	-
Water Supply	72	-	73	-	73	-
Vehicles (3)	17	-	-	-	-	17
10 Backpack Sprayers	1	-	-	-	-	1
Miscellaneous	5	-	-	-	-	-
Subtotals	3439	20	110	64	144	82
Annual Recurring Costs						
Salaries and Wages	48	48	48	48	48	48
Repair, Operation and Maintenance	42	43	46	49	53	58
Laboratory Supplies	1	2	2	2	3	3
Tsetse Control	15	15	15	15	15	15
Subtotals	106	108	111	114	119	124
Totals	3545	128	221	178	263	206

(1) Includes four apartments, 400 tukuls for family units, office, laboratory, furnishings and equipment.
(2) Includes 20 night paddocks, three dip and spray races, and miscellaneous equipment.
(3) Includes one four-wheel drive vehicle and four motorcycles; replacement in years 6, 11, etc.

Table II - 20

Tentative Cash Flow for Model 50-Head Family Unit
(Ethiopian Dollars)

Years	1	2-3	4-5	6-10	11	12-14	15
Cash Inflow							
Herd	50	50	50	50	50	50	50
Offtake-Head (1)	3	4	5	6	7	8	9
Price (E$/hd)	150	150	150	150	150	150	150
Sales E$	450	600	750	900	1050	1200	1350
Cash Outflow							
Cattle Tax E$ 0.25/hd	12	12	12	12	12	12	12
Minerals @ 1.00/hd	50	50	50	50	50	50	50
Family Living Expenses	160	160	160	160	160	160	160
	222	222	222	222	222	222	222
Cash Balance	228	378	528	678	828	978	1128
Less Without Project	450	450	450	450	450	450	450
Net Cash Flow	(222)	(72)	78	228	378	528	678

IRR = 33%

(1) Assumes a gradual increase in offtake from the assumed present of 7.3% to 18% in year 15

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The preliminary layout of one and two-lane tertiary roads for the Gambela Project is shown on Figure II-1, following page II-1. Summarized in Table II-21 are the approximate lengths and order-of-magnitude costs of these tertiary standard roads.

Table II-21

Estimated Cost Internal Roads
Gambela Project

Item	Length (Km)	Unit Cost(E$/Km)	Cost(1,000E$)
2-Lane Tertiary	44	21,800	960
1-Lane Tertiary	67	15,500	1,040
Total Cost			2,000

The annual maintenance cost of the above road network is estimated to be in the order of E$ 50,000.

Water Control Facilities - Irrigated Agriculture Alternative

In order to implement a two (or more) crop development, irrigation, drainage, and flood prevention facilities would be required. Preliminary, schematic layouts of these facilities are shown on Figure II-1, following page II-1.

It is envisaged that the irrigation water supply would be provided by a multiple-unit pumping plant lifting water about 35 meters from the Baro River into a gravity irrigation canal system.

Drainage canals would flow by gravity into the several water courses and depressions within the project area, thence through control structures in the peripheral flood prevention dike into the Baro River and other natural drainage courses; it may be found necessary, during detailed Phase II studies, to provide some low-lift drainage pumps.

Overbank flooding would be prevented by constructing a low peripheral dike along the Baro River (behind the presently cultivated natural river levee) to the eastern limit of the project, thence in a southerly direction to the higher ground, lying above flood level.

Irrigation Water Requirements - The consumptive uses of the various crops were estimated by the Blaney-Criddle method, modified to fit the climatic conditions of the area.

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The amount of precipitation that is effective for irrigated crops was estimated on the basis of a method presented in "Technical Release No. 21" of the Soil Conservation Service (SCS) of the United States Department of Agriculture (USDA), 1964.

The net irrigation amounts at the field have not been modified by water requirements that may be required for tillage and seeding and by changes in soil moisture at the beginning, during, and at the end of cropping seasons.

For purposes of this pre-feasibility study, overall irrigation facilities have been taken conservatively as 50 percent for all crops.

The diversion requirements at the pumping plant, in liters per second per hectare for the individual crops are summarized in Table II-22.

Table II - 22

Mean Monthly Irrigation Requirements at Pumping Plant
Gambela Project (liters/sec/ha)

Month	Crop			
	Cotton	Maize	Sorghum	Pulses
January	1.80			
February	1.49			
March	0.66			
April	0.00			
May		0.05	0.00	
June		0.28	0.80	
July		0.28	0.24	
August		0.08	0.00	
September	0.00		0.00	0.00
October	0.00		1.08	1.08
November	0.52		1.06	1.06
December	1.40		0.37	0.37

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On the basis of the unit irrigation requirements summarized in Table II-22 and the cropping patterns discussed in a previous section, the overall project irrigation water requirements were estimated and are summarized in Table II-23.

Estimated Costs - The estimated order-of-magnitude costs of water control facilities for the Gambela irrigated agriculture project are summarized in Table II-24.

Table II - 24
Estimated Capital Costs - Water Control
Gambela Project - Irrigated (Thousand E$)

Item	Project Years					
	-1	1	2	3	4	Total
Pre-Construction	800	-	-	-	-	800
Pumping Plant	-	1,350	1,350	1,350	1,350	5,400
Main Canal	-	900	1,000	800	608	3,308
Lateral Canals	-	2,500	3,000	3,500	3,266	12,266
Distribution System	-	3,500	4,500	5,000	5,000	18,000
Drainage System	-	2,500	4,223	4,200	4,211	15,134
Flood Prevention Dike	-	4,562	-	-	-	4,562
Control Structures	-	988	2,227	1,450	1,365	6,030
Land Development	-	1,000	1,000	1,000	1,500	4,500
Totals	800	17,300	17,300	17,300	17,300	70,000

The order-of-magnitude operation and maintenance costs for the complete water control system were estimated at roughly E$ 2,700,000.

To provide provisional figures for water charges in the model farm cash flow analyses, presented earlier in this part, the total order-of-magnitude capital cost was amortized over a period of 40 years at 3½ percent interest. The resultant annual amount was E$ 3,278,000. Adding the annual operation and maintenance costs to this amount and dividing by the total cultivated area (2[illegible],500 hectares) resulted in a provisional water charge of E$ 266 per irrigated hectare.

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Table II - 23

Monthly Irrigation Water Requirements
Gambela Project (cubic meters per second)

Crop	Area(ha)	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Wet Season													
Maize	5,000	-	-	-	-	0.3	1.4	1.4	0.4	-	-	-	-
Sorghum	17,500	-	-	-	-	-	14.0	4.2	-	-	-	-	-
Dry Season													
Cotton	17,500	31.5	26.1	11.6	-	-	-	-	-	-	-	9.1	24.5
Sorghum	2,500	-	-	-	-	-	-	-	-	-	2.7	2.7	0.9
Pulses	2,500	-	-	-	-	-	-	-	-	-	2.7	2.7	0.9
Totals		31.5	26.1	11.6	-	0.3	15.4	5.6	0.4	-	5.4	14.5	26.3

Water Control Facilities - Rainfed Agriculture Alternative

Implementation of a rainfed agriculture development would require both drainage and flood prevention facilities. These facilities would be as described in the previous alternative for irrigated agriculture.

Estimated Costs - The estimated order-of-magnitude costs of drainage and flood prevention works are summarized in Table II - 25.

Table II - 25

Estimated Capital Costs - Water Control
Gambela Project - Rainfed (Thousand E$)

Item	Project Years -1	1	2	3	4	5	Total
Pre-Construction	200	-	-	-	-	-	200
Drainage System	-	1,800	1,800	3,844	3,845	3,845	15,134
Flood Prevention Dike	-	2,281	2,281	-	-	-	4,562
Control Structures	-	387	387	624	623	623	2,644
Totals	200	4,468	4,468	4,468	4,468	4,468	22,540

PRELIMINARY ECONOMIC ANALYSIS

Economic Costs

To determine the order-of-magnitude economic costs of the Gambela Project, the methodology described in Part I of this report was applied to the capital and recurring costs estimated for roads; water control facilities; and farm investment costs, in this part, and for mapping and surveys; credit, marketing and storage; resettlement allowances; and management, testing and extension services, presented in Part I. The resulting economic cost streams over a 20-year period of analysis are given for the irrigated and rainfed agriculture alternatives in Tables II - 26 and II - 27, respectively.

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Table II - 26
Economic Costs of Gambela Project-Irrigated
(Million E$)

Project Year	Water control	Roads	Legal & Surveys	Credit Marketing & Storage	Resettlement Allowance	Public Services	Improvement, Testing, Training & Extension	Total Farm Investment	Gross Project Costs
-1	0.73	0.09	0.04	--	--	--	--	--	0.86
1	15.56	0.51	0.04	0.17	0.21	0.12	0.75	0.51	17.90
2	16.47	0.63	--	0.26	0.21	0.14	0.54	1.82	20.07
3	16.93	0.63	--	0.15	0.21	0.14	0.49	3.32	21.87
4	17.39	0.04	--	0.18	0.21	0.14	0.42	3.64	22.02
5	2.29	0.04	--	0.29	0.21	0.14	0.42	1.30	4.69
6	2.29	0.04	--	0.19	--	0.12	0.50	0.73	3.87
7	2.29	0.04	--	0.19	--	0.13	0.45	0.52	3.62
8	2.29	0.04	--	0.30	--	0.14	0.42	0.25	3.44
9	2.29	0.04	--	0.19	--	0.15	0.47	0.91	4.05
10	2.29	0.04	--	0.31	--	0.16	0.42	1.55	4.77
11	2.29	0.04	--	0.20	--	0.16	0.52	1.73	4.94
12	2.29	0.04	--	0.20	--	0.16	0.45	0.46	3.60
13	2.29	0.04	--	0.20	--	0.16	0.42	0.46	3.57
14	2.29	0.04	--	0.20	--	0.16	0.42	0.30	3.41
15	2.29	0.04	--	0.20	--	0.16	0.42	0.30	3.41
16	2.29	0.04	--	0.20	--	0.16	0.50	0.18	3.37
17	2.29	0.04	--	0.20	--	0.16	0.50	0.91	4.10
18	2.29	0.04	--	0.20	--	0.16	0.42	1.57	4.68
19	2.29	0.04	--	0.20	--	0.16	0.42	1.57	4.68
20	2.29	0.04	--	0.20	--	0.16	0.42	(5.53)	(2.42)

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Table II - 27

Economic Costs of Gambela Project - Rainfed
(Million B$)

Project Year	Water Control (Flood Control & Drainage)	Roads	Mapping & Surveys	Credit Marketing & Storage	Resettlement Allowance	Public Services	Management, Testing, Training & Extension	Total Farm Investmentt	Gross Project Costs
-1	0.18	0.09	0.04	--	--	--	--	--	0.31
1	4.02	0.54	0.04	0.17	0.21	0.12	0.75	1.22	7.07
2	4.16	0.63	--	0.26	0.21	0.14	0.54	2.02	7.96
3	4.29	0.63	--	0.15	0.21	0.14	0.49	2.21	8.12
4	4.43	0.04	--	0.18	0.21	0.14	0.42	0.98	6.40
5	4.57	0.04	--	0.29	0.21	0.14	0.42	0.85	6.52
6	0.68	0.04	--	0.19	--	0.12	0.50	0.38	1.91
7	0.68	0.04	--	0.19	--	0.13	0.45	0.25	1.74
8	0.68	0.04	--	0.30	--	0.14	0.42	0.20	1.78
9	0.68	0.04	--	0.19	--	0.15	0.47	0.59	2.12
10	0.68	0.04	--	0.31	--	0.16	0.42	0.95	2.56
11	0.68	0.04	--	0.20	--	0.16	0.52	1.13	2.73
12	0.68	0.04	--	0.20	--	0.16	0.45	0.46	1.99
13	0.68	0.04	--	0.20	--	0.16	0.42	0.46	1.96
14	0.68	0.04	--	0.20	--	0.16	0.42	0.30	1.80
15	0.68	0.04	--	0.20	--	0.16	0.42	0.30	1.80
16	0.68	0.04	--	0.20	--	0.16	0.50	0.18	1.76
17	0.68	0.04	--	0.20	--	0.16	0.50	0.61	2.19
18	0.68	0.04	--	0.20	--	0.16	0.42	0.97	2.47
19	0.68	0.04	--	0.20	--	0.16	0.42	0.97	2.47
20	0.68	0.04	--	0.20	--	0.16	0.42	(3.49)	(1.99)

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Net Project Benefits and Internal Economic Rate of Return

To determine the gross benefit margins, model farm costs were converted to economic costs, using the factors presented in Part I of this report, and subtracted from sales. These figures were aggregated according to the assumed rate of buildup (500 oxen farms per year over a five year period for both alternatives; 10 tractor farms in year 2 and 20 each in years 3 and 4 for the irrigated alternative; 10 tractor farms in year 1 and 20 each in years 2 and 3 for the rainfed alternative). The resulting benefit streams are given in Tables II-28 and II-29 for the irrigated and rainfed alternatives, respectively.

The gross project costs (Tables II-26 and II-27) were then subtracted from the gross benefit streams to yield the net project benefit streams (also shown in Tables II-28 and II-29). The preliminary internal economic rates of returns from the two project alternatives were found by discounting these net benefit streams. The rates of return on total project investments were 21 percent for the irrigated alternative and 26 percent for the rainfed alternative.

Table II - 28

Derivation of Net Project Benefits

and Basic Internal Economic Rate of Return

Gambela Project - Irrigated

(Million E$)

Project Year	Gross Benefit Margin 0-5	T-250	Total	Gross Project Costs	Net Project Benefits
-1	-	-	-	0.86	(0.86)
1	0.15	-	0.15	17.90	(17.75)
2	0.34	1.86	2.20	20.07	(17.87)
3	1.63	6.22	7.85	21.87	(14.02)
4	3.13	11.54	14.67	22.02	(7.35)
5	4.79	13.83	18.62	4.69	13.93
6	6.31	15.18	21.49	3.87	17.62
7	7.49	15.89	23.38	3.62	19.76
8	8.16	15.89	24.05	3.44	20.61
9	8.33	15.89	24.22	4.05	20.17
10	8.33	15.89	24.22	4.77	19.45
11	8.15	15.89	24.04	4.94	19.10
12	7.97	15.89	23.86	3.60	20.26
13	7.80	15.89	23.69	3.57	20.12
14	7.62	15.89	23.51	3.41	20.10
15	7.44	15.89	23.33	3.41	19.92
16	7.44	15.89	23.33	3.37	19.96
17	7.44	15.89	23.33	4.10	19.23
18	7.44	15.89	23.33	4.68	18.65
19	7.44	15.89	23.33	4.68	18.65
20	7.44	15.89	23.33	(2.42)	25.75
				NPW @ 20%	+2.56
				IERR	21%

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Table II - 29
Derivation of Net Project Benefits
and Basic Internal Economic Rate of Return
Gambela Project - Rainfed
(Million E$)

Project Year	Gross Benefit Margin 0-5	T-250	Total	Gross Project Costs	Net Project Benefits
-1	-	-	-	0.31	(0.31)
1	0.23	0.65	0.88	7.07	(6.19)
2	0.62	2.20	2.82	7.96	(5.14)
3	1.25	4.10	5.35	8.12	(2.77)
4	2.05	4.95	7.00	6.40	0.60
5	2.84	5.43	8.27	6.52	1.75
6	3.41	5.68	9.09	1.91	7.18
7	3.82	5.68	9.50	1.74	7.76
8	3.99	5.68	9.67	1.78	7.89
9	3.99	5.68	9.67	2.12	7.55
10	3.99	5.68	9.67	2.56	7.11
11	3.90	5.68	9.58	2.73	6.85
12	3.81	5.68	9.49	1.99	7.50
13	3.73	5.68	9.41	1.96	7.45
14	3.64	5.68	9.32	1.80	7.52
15	3.56	5.68	9.24	1.80	7.44
16	3.56	5.68	9.24	1.76	7.48
17	3.56	5.68	9.24	2.19	7.05
18	3.56	5.68	9.24	2.47	6.77
19	3.56	5.68	9.24	2.47	6.77
20	3.56	5.68	9.24	(1.99)	11.23

NPV @ 25%	+0.40
IERR	26%

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PART III

UPPER DIDESA VALLEY PROJECT

DESCRIPTION OF PROJECT AREA

Location

Approximately 30 kilometers north of Bedele, the Bedele-Arjo road (Highway No. 39) crosses the Didesa Valley and spans the Didesa River via a well-constructed bridge. This road is scheduled to be upgraded to all-weather status during IHA's Sixth Highway Program. The northern boundary of the project area is tentatively identified as that stretch of the road, some eight to ten kilometers in length, passing across the valley floor and the intermediate slopes up to the sharply rising escarpments on either side.

The selected study area lies approximately between latitudes 8°30' and 8°42' North and longitudes 36°23' and 36°36' East. The Didesa River in this area forms the boundary between Ilubabor and Kefa Provinces. About 65 percent of the project lies in Ilubabor and 35 percent in Kefa.

The location of the project, comprising an arable area of about 25,000 hectares suitable for resettlement, is shown on Figure III - 1. Livestock development potential is small with only 6,000 to 8,000 hectares of adjacent upstream valley land available for grazing.

Climatology and Hydrology

Location of Climatological and Hydrological Stations - In the vicinity of Metu and Bedele many climatological stations have been or are now in operation, many having been established recently. The stations of interest herein are those of third order at Metu (hospital) and Bedele (German mission) and also those of first order at Gore and Nekemte operated by the Civil Aviation Authority.

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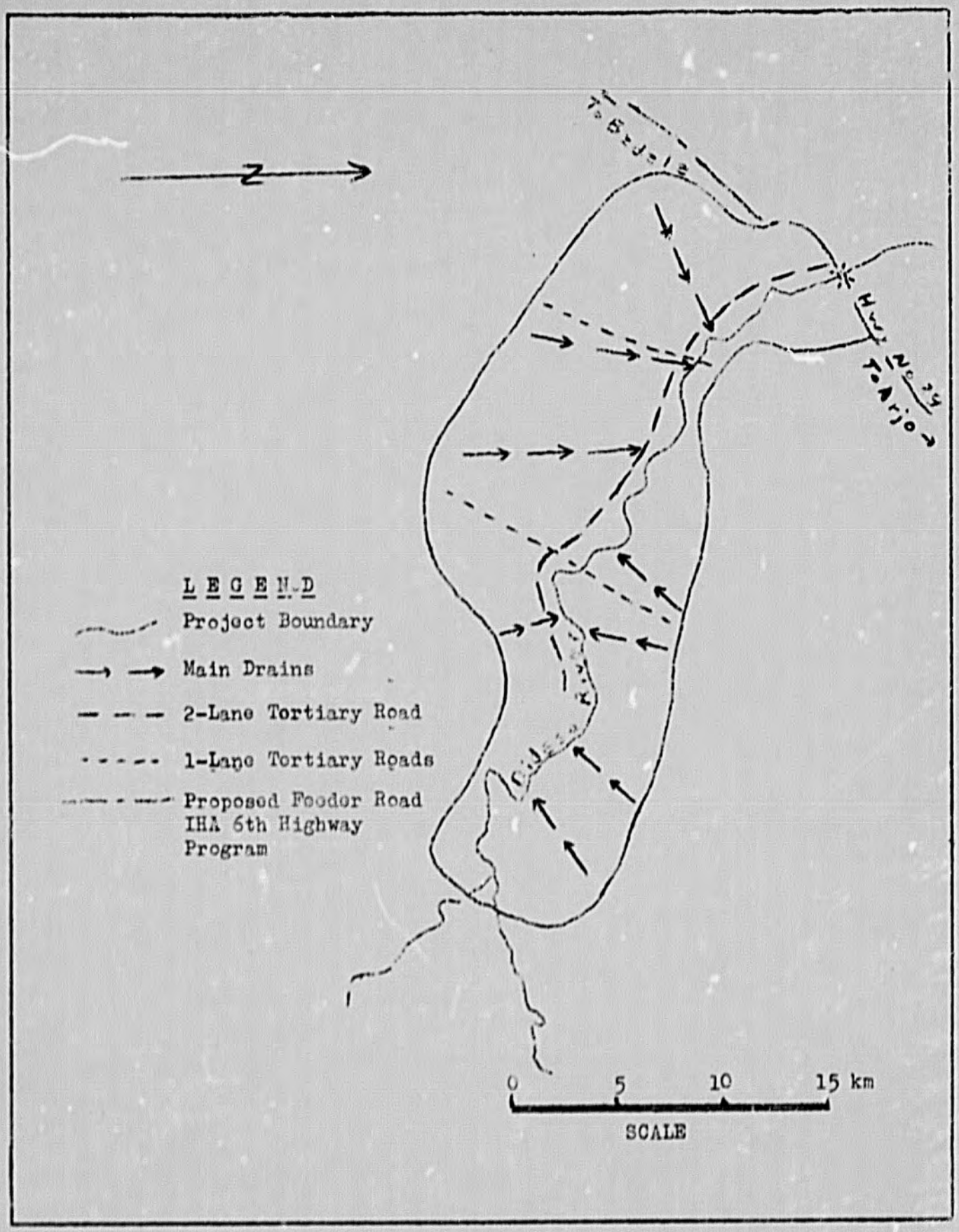

DIDESA PROJECT AREA FIG. III-1

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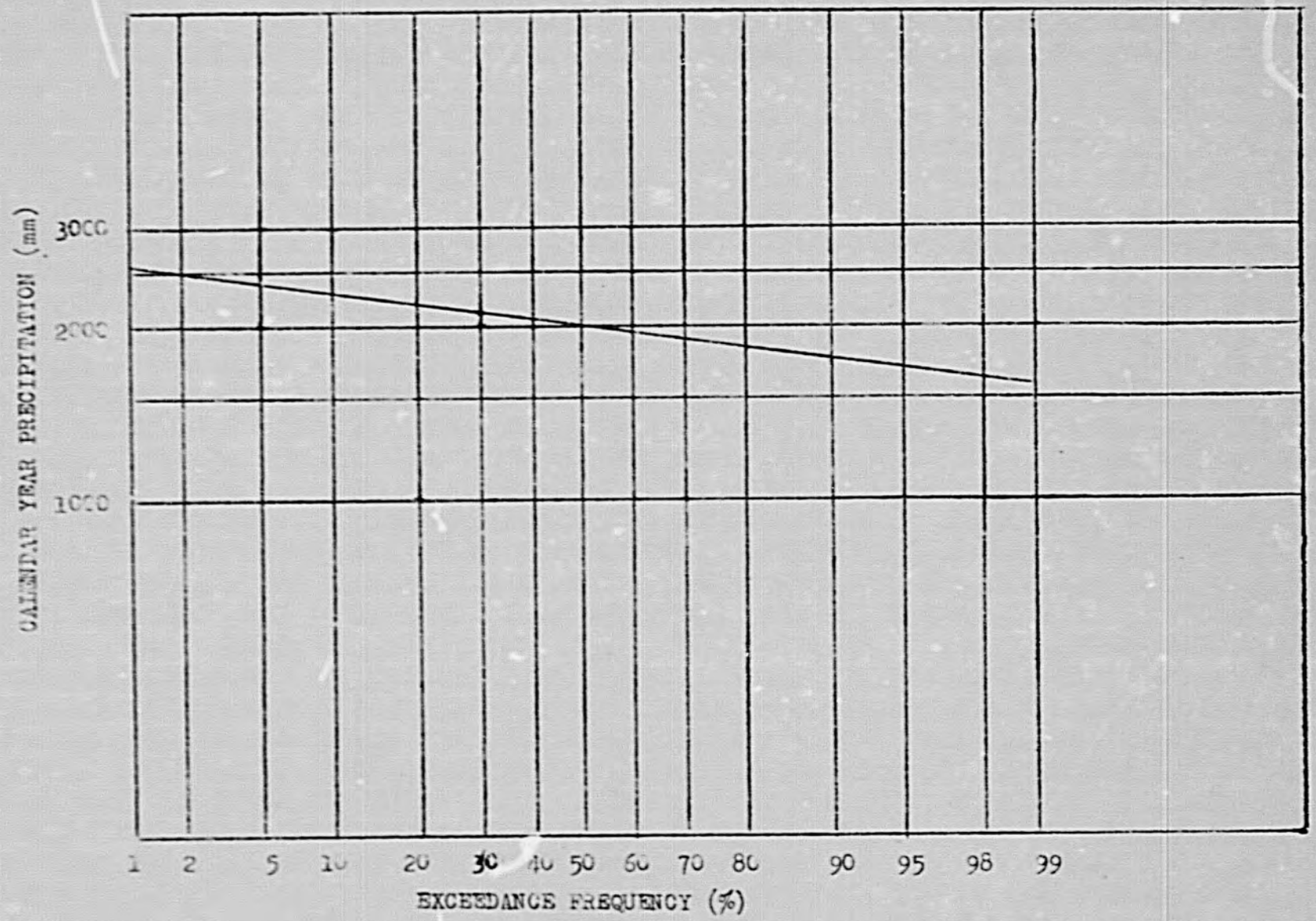
Data are available from NCS, NWRC, from "Contributo Alla Climatologia Dell'Etiopia", Amilcare Fantoli, 1965 (in the library of the Italian Cultural Institute), from "The Nile Basin", Vol. VI and its supplements, Hurst et al, Ministry of Public Works, Cairo, (in the libraries of the Economic Commission for Africa in Addis Ababa), and from Princeton University, Princeton, N.J., U.S.A.

Runoff data of streams are available for several streams of the Blue Nile basin: Didesa River near Arjo; Dabana River near Abasina; and Angar River near Nekemte. The National Water Resources Commission (NWRC) plans to obtain runoff data of streams in the Baro River basin with gauges at and downstream from Metu. The data now available are in the files of the Hydrometeorological Section of the NWRC.

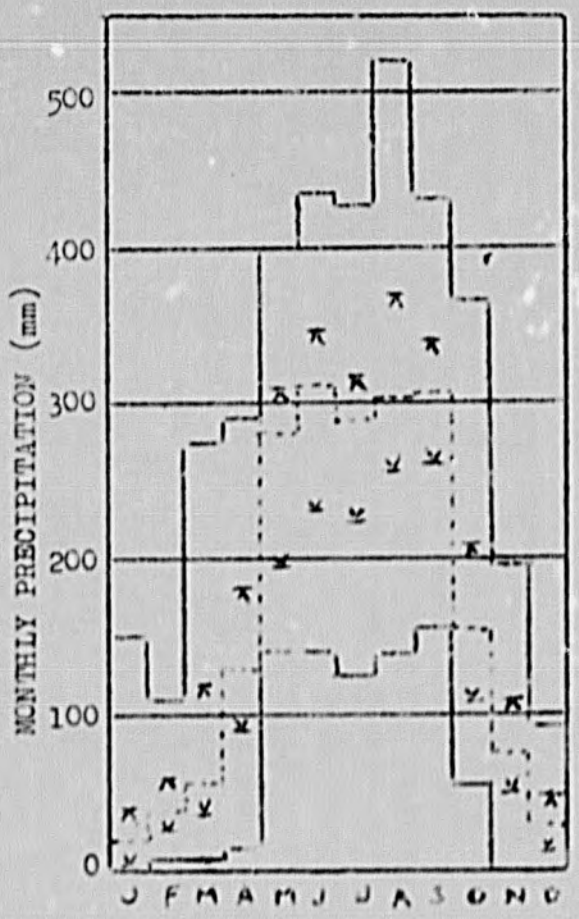
Climate - Mean annual precipitation of the area is about 2000 millimeters according to a 1972 isohyetal map prepared by NCS. These highlands have the greatest precipitation reported for Ethiopia. Mean annual precipitation is 2029 millimeters at Gore, 1908 - 1936, (Hurst, Fantoli); 2471 millimeters at Gore Airport, 1953 - 1973, (NCS/NWRC); 1891 millimeters at Metu (hospital), 1967 - 1972, (NCS); 1972 millimeters at Bedele (German Mission), 1967 - 1972, (NCS); and 2150 millimeters at Nekemte, 1952 - 1973, (NCS/NWRC). Precipitation is distributed monthly as shown in Table III - 1.

Frequency of exceedance of annual precipitation is shown in Figure III-2 for Gore, the record of longest duration, based on the plotting positions of Beard. Precipitation is shown to be log normally distributed, with five, 50 and 95 percent chances that precipitation will be exceeded in any one year at about 2600, 2000 and 1600 millimeters, respectively.

The extremes, medians and quartiles of monthly precipitation for the same stations are shown in Figure III-3. Precipitation is more than adequate for evapotranspiration from May to September, sometimes sufficient in March-April and October-November and rarely sufficient from December through February. During the dry



RAINFALL FREQUENCY
AT GORE FIG. III-2



——— Extreme max. & min.

- - - - - Median

Upper & Lower Quartiles

CHARACTERISTICS OF MONTHLY PRECIPITATION
AT GORE FIG. III-3

seasons, trees and other perennial plants survive by drawing on residual soil moisture and groundwater or becoming dormant. Maximum 24-hour precipitation has ranged from 54 to 108 millimeters at Gore airport.

Evaporation from a USDA-type class A pan has been observed briefly at Nekemte. The amounts are compared with other highland stations in Table III-2.

Lake evaporation, or potential evaporation, assumed as 70 percent of pan evaporation would be roughly 3 millimeters per day from June to November and 4 millimeters per day from December through May. Consumptive use, by Hargreave's coefficients would range from about 50 to 250 millimeters per month, depending on the specific crop, the stage of its growth, and the month of the year, with say 150 millimeters per month as a plausible average.

Air temperature data for Metu (hospital) and Bedele (German mission) for the period 1967-1972 are summarized in Table III-3. Bedele is shown to be about 1½°C cooler than Metu, and in one month of the period of record experienced frost at -1.8°C.

Climatological data presented herein by no means exhaust the information that is available. Other elements (relative humidity, cloud cover, wind movement, etc.) are available for more comprehensive reports on development of the area.

Runoff - Runoff data of the Dabana River near Abasina (latitude 9°-02'N, longitude 36°-03'E) are more complete than data of the Didesa and Angar Rivers. Mean monthly yields in millimeters for the basin of 3077 square kilometers are shown in Table III-4 for the period 1961-1970 (the data for 1971 and 1972 are now at the printers for preparation of the annual hydrometeorological publications of the MWRC).

Thus, for the basin with roughly 2000 millimeters mean annual precipitation, mean runoff yield is about 640 millimeters leaving 1360 millimeters mainly for deep percolation and evapotranspiration, the latter of which may be in the order of 1300 millimeters per year.

The Didesa River flows continuously during the year, but dry-season runoff is insufficient for irrigation unless augmented by draw-down of storage reservoirs or by pumping from groundwater.

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Table III - 1

Mean Precipitation Bedele-Metu Area (mm)

Station Month	Gore Elev 2130m	Gore Elev 2002m	Metu Elev 1940m	Bedele Elev 1993m	Nekemte Elev 2005m
J	28	38	53	36	10
F	49	86	38	46	26
M	83	111	56	68	74
A	138	151	86	92	90
M	264	252	202	195	215
J	297	360	271	266	390
J	279	367	346	315	390
A	315	364	281	322	391
S	301	364	304	363	289
O	159	193	144	175	179
N	82	133	78	81	83
D	34	52	32	13	13
year	2029	2471	1891	1972	2150

Table III - 2

Pan Evaporation (mm)

Station. Elevation. Period Month	Asosa 1750m 1960-70	Nekemte 2005 m 1972	Finchaa 2216 m 1964-1970	Average
J	223	-	147	185
F	225	-	153	189
M	265	-	175	220
A	204	-	170	187
M	163	-	175	169
J	139	-	157	148
J	118	-	141	130
A	114	147	146	136
S	135	105	155	132
O	110	125	156	130
N	140	129	142	137
D	186	—	140	163
year	2022	—	1857	1926

Pan evaporation may be taken at about 4½ mm per day in the period June to November and 6 mm per day as an average rate during December to May.

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Table III - 3

Air Temperatures, 1967-1972, Metu-Bedele Area (°C)

	Metu - 1940 M Elev.					Bedele - 1993 M Elev.				
Month	Absol. Max. of Record	Aver. Daily Max.	Aver. Daily	Aver. Daily Min.	Absol. Min. of record	Absol. Max. of record	Aver. Daily Max.	Aver. Daily	Aver. Daily Min.	Absol. Min. of record
J	0.5	27.3	18.6	10.0	6.0	29.6	26.7	17.5	8.2	-1.8
F	33.5	28.9	20.0	11.0	5.0	32.0	27.6	18.8	10.1	3.0
M	32.5	29.5	21.6	13.7	5.0	32.0	28.4	20.0	11.5	1.5
A	33.7	29.6	21.9	13.2	6.5	32.0	28.4	19.6	10.8	5.4
M	31.5	27.8	20.6	13.5	10.0	31.5	27.0	19.4	11.8	7.9
J	29.5	25.1	19.3	13.4	8.5	32.0	25.4	19.1	12.9	5.0
J	27.5	24.2	18.9	13.5	10.0	29.0	22.8	17.6	12.4	8.5
A	27.5	24.4	18.8	13.2	9.5	26.5	22.7	17.5	12.3	7.5
S	27.0	24.4	18.7	13.0	10.0	30.1	23.8	17.6	11.4	4.5
O	28.2	25.7	19.6	12.5	8.0	27.0	24.5	16.9	9.4	1.5
N	28.5	26.0	18.5	11.1	5.0	27.3	25.1	16.3	7.5	0.0
D	30.0	26.8	17.3	7.7	5.0	28.5	26.1	16.3	6.6	0.3
Av.	33.7		19.5		5.0	32.0		18.0		-1.8

Table III - 4

Mean Yield of the Dabana River Near Abasina (mm)

Month	Yield	Month	Yield
J	10.2	J	87.8
F	7.2	A	140.3
M	5.4	S	164.2
A	5.8	O	115.6
M	8.5	N	37.1
J	33.2	D	20.9
Year			636.2

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Probability exceedance of calander-year yield is shown on Figure III-4 (for purposes of this analysis, runoff has been roughly estimated for some months, but only in the low or near low runoff months of missing data). The data appear to be log-normally distributed but probably would be better represented if based on a runoff year, March to February, instead of a calander year. Yields of five, 50 and 95 percent chance of occurrence in any year are shown to be 770, 620 and 490 millimeters, respectively.

Frequency of exceedance of the maximum annual flood (of 24 hours duration) is shown on Figure III-5, a one percent chance flood (average of one per 100 years) is 530 cubic meters per second. The one percent chance of the momentary peack of the annual flood (not shown in Figure III-5) is about 700 cubic meters per second.

Soils

Existing soils data covering the Didesa Valley are scarce. No soil surveys have been made in the area and present knowledge is limited to a scattered sampling reported by Murphy[1/]. However broad in scope and subject to error this information may be, it is sufficient for the present purpose and would be revised by reconnaissance level soil surveys and mapping in Phase II.

The dominant soil association common to the area between Gore to Jima may be defined as Eutric Nitosols which are locally associated with intrusions of Pellic Vertisols. The upland soils are typical of forest soils throughout the coffee growing belt of central southwest Ethiopia. They are generally reddish brown to dark reddish brown clays or clay loams yielding in the valleys to reddish brown silty clays.

The valley soils have been identified by FAO as being Humic Cambisols[2/]. In general, Cambisols have acambic B Horizon which

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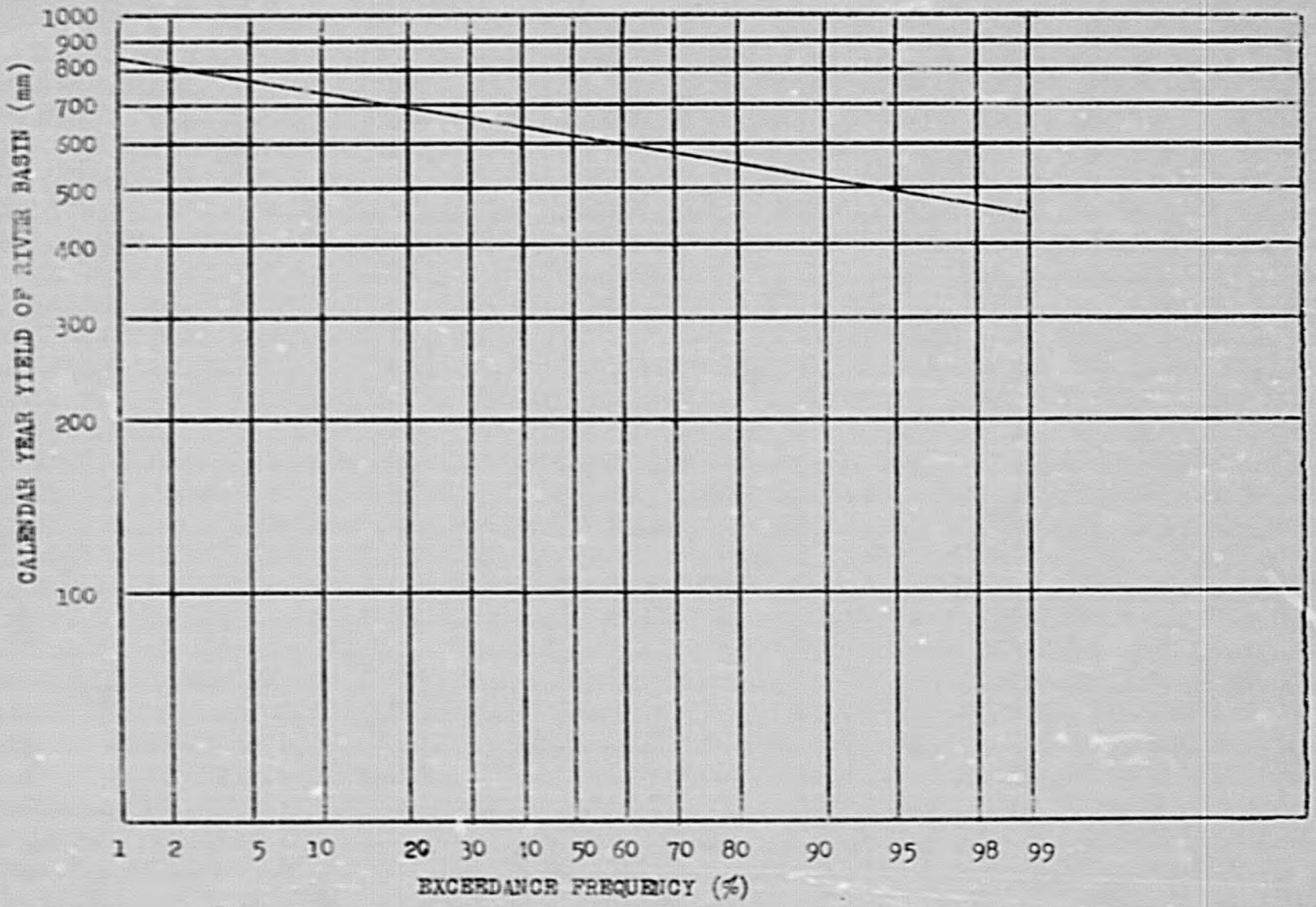
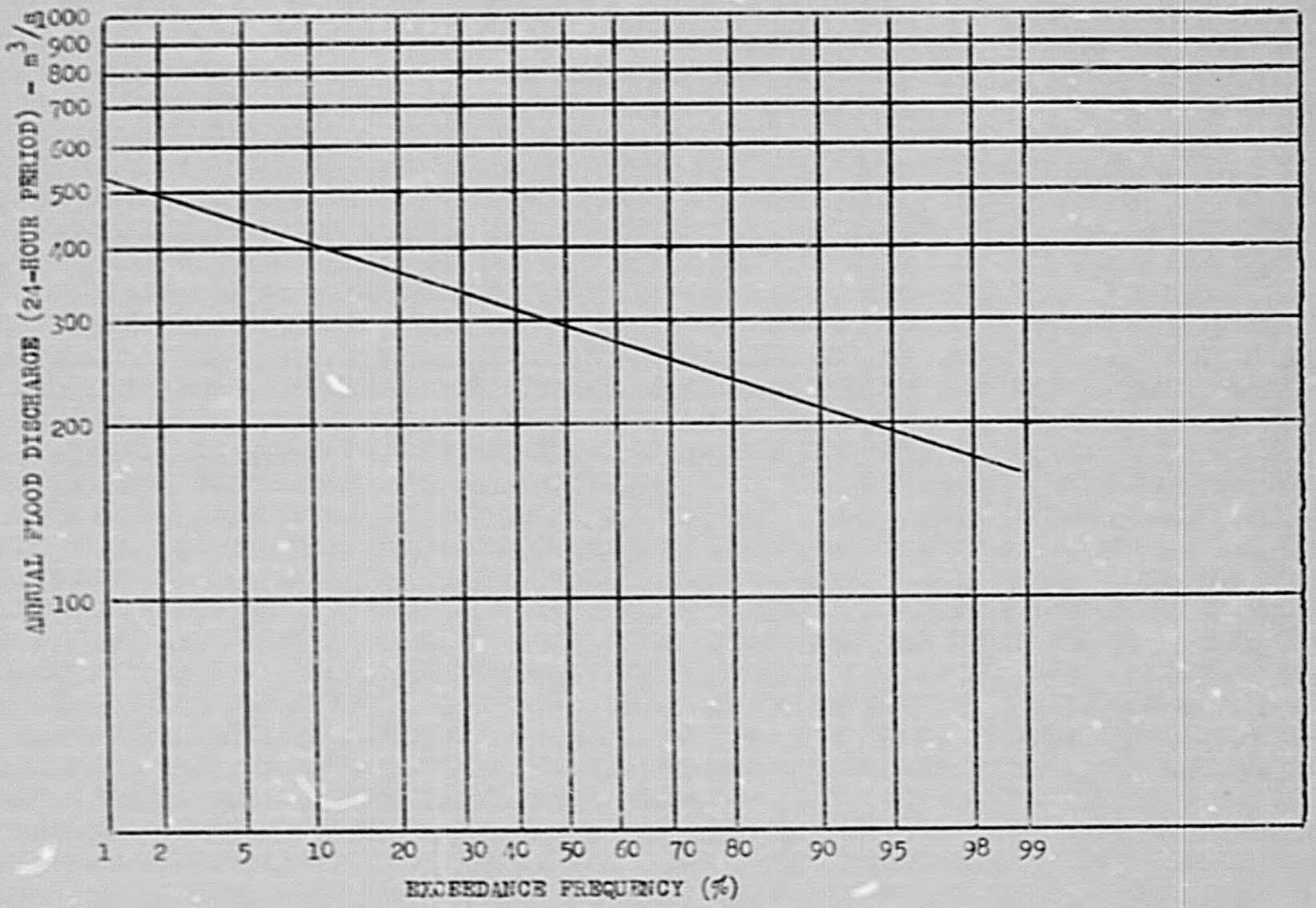
1/ "A Report on the Fertility Status and Other Data on Some Soils of Ethiopia." Dr. H.F. Murphy, College of Agriculture, Haile Sellassie I University, 1968.

2/ "FAO/UNESCO Soil Map of the World-Africa Series" Soil Resources Development and Conservation Service, Land and water Development Division, FAO, Rome, 1973.



ANNUAL RUNOFF FREQUENCY
DABAIA RIVER FIG. III-4



ONE-DAY FLOOD FREQUENCY
DABAWA RIVER FIG. III-5

the only fertilizer being applied by the indigenous farmers.

Soil texture near the river varies from sandy loam to sandy clay, while the virgin inland soils range from silty clay to clay. Salinity is not presently a problem within the Baro Basin nor is it anticipated that it would be in the future even under an intensive irrigation schedule due to the apparent good quality of the Baro River water and the heavy annual rainfall.

The riverine soils along the Baro and Gilo Rivers, as well as those slightly higher soils in the inter-riverine depressions, are predominantly Chromic Vertisols.[1/] At least the top 50 centimeters are constantly being mixed due to the regular shrinking and cracking during the dry season and swelling and closing when resaturated in the wet months. Leaching may be expected to be very slow due to the relative impermeability of these soils and, consequently, both the clay content and the base saturation status would be high.

The Vertisols away from the rivers are associated with Orthic Acrisols, particularly in the lower lands and the interior depressions. These soils could be expected to have been subjected to less mixing in the upper layers and to more annual leaching. The topsoil, which is an Ochric A horizon, tends to be lower in organic matter (excepting the decomposing organic debris layer) and to harden into massive blocks on drying. In deeper layers, the soil accumulates clay and the base saturation status is thus likely to be low.

Population and Social Conditions

Ilubabor Province has the smallest population in Ethiopia - 650,000. The majority of the population is concentrated in the highland awrajas of Bedele and Gore. Gambela is the least populated awraja and is estimated to have no more than 80,000 inhabitants for a density of about three per square kilometer. The town of Gambela is the awraja capital and may have between 2,500 and 3,000 permanent residents. The balance of the awraja population is scattered in various settlements and small villages (such as Pekwo, Itang and Jikao) along the Baro River; in the several woreda capitals (Abobo, Gog and Tirgol); and in semi-nomadic Nuer tribes who graze livestock

1/ UNESCO/FAO "Tentative Soil Map of Africa," 1971.

on both the Ethiopian and Sudanese plains.

The proposed project site lies on the south bank of the Baro River (see Figure II-1) across from the mission posts of Pokwo (American mission) and Itang (Red Cross mission). There are several small villages along the river levee on the south bank but these would be excluded from the project.

Aerial inspections show no permanent settlements within the proposed development area; however, several abandoned cattle camps (under water in July/August 1974) were seen comprising about a dozen huts each. It is likely that fewer than 400 people would camp in the 50,000-hectare project area during the dry season.

The People - The major ethnic groups in Gambela Awraja are two tribes of Nilotic origen - the Anuak and the Nuer. Originally, they were both semi-nomadic, but the Anuaks are now settled cultivators with a limited amount of livestock.

A Nuer legend relates that in the beginning, God gave one cow each to both the Nuers and the Anuaks. The Nuers cared for their cow and, as she was already bred, she bore a male calf, and these two formed the beginning of the Nuer herds. The Anuaks slaughtered their cow and ate it, then were forced to become farmers in order to survive, and were not allowed by God to have cattle again.

The Anuaks are mainly sedentary farmers and are found concentrated along river banks in Gambela, Abobo and the eastern part of Gog Woreda, where they practice subsistence agriculture.

The Nuers meet basic economic necessities through occasional sales of surplus livestock; otherwise cattle are accumulated for other purposes. They graze over vast areas of Akobo, Jikoa and western Gog Woredas (and into Sudan) but do not pay government taxes for grazing rights. In the dry season, the herdsmen move to the banks of the perennial rivers as water becomes scarce in the interior plains. When the rivers flood and mosquitos threaten, they migrate inland to dryer ground. They also attempt to plant sorghum along the river levees as the floods recede.

Land Tenure - The government is reported to collect little, or no, land taxes from the entire Gambela awraja; thus, the lands are automatically considered to be owned by the government. There have

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been some recent land grants northwest of Gambela by the former governor who, in an effort to encourage settlement of highland people, gave indefinite lease-hold tenancy to sixty applicants on ten-gasha (400 hectares) units. Each applicant pays the governor Eth.$ 5.00 per gasha or Eth.$ 50.00 per leasing holding. The Ministry of Land Reform and Administration (MLRA) now controls all aspects of administration of public lands previously administered by the Ministry of Interior and considers the 60 lease-hold grants to be illegal but has taken no action to recover control of the 600 gashas.

Other than this disputed land, the tenure system in the awraja is unique from other forms of tenure found elsewhere in the country. When the Gambela region (formerly a Sudanese enclave) was incorporated into the Empire, all land was claimed by the government. The usual system of awarding "sisso" land (one third of all tribal land) to local balabats (chiefs or lords) was avoided.

There remain quite distinct tribal boundaries and tribal administration is the privilege and responsibility of the local chiefs. Even this tribal system differs from other communal systems in the Empire, in that there is no family ownership or inheritance rights to land. The Buware (balabat or chief) grants permission to each member of the community who requests farm land, the only limitation in size being what the individual is capable of cultivating.

Among the pastoral tribal groups, land rights are also considered as being collectively held, but dominant family segments of these groups will control grazing rights during the dry season, while willing to share such privileges with people of other lineage during the wet months.

Obviously, there is conflict between the government's legal rights to ownership and the traditional tribal authority over communal lands.

<u>Social Services</u> - Government primary schools in the vicinity of the proposed development area are located in Gambela, Itang, Akobo and Jikao. There is a mission school at Pokwo. Health clinics, either government or mission operated, exist in Gambela, Itang, Jikao and Pokwo. An agricultural research station under EPID/IAR and

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claims in the valley and no pending disputes. The area is clearly available for resettlement and development as soon as the prevalent diseases can be brought under control.

The People - Members of the Galla tribe form the largest segment of the population in both Buno Bedele Awraja and adjacent Gore Awraja of Ilubabor Province and in Limu and Jima Awrajas of Kefa Province. This tribe is known to practice settled cultivation. In addition to their work oxen, they maintain only small numbers of livestock, mainly for domestic consumption.

PRESENT CONDITIONS

Existing Land Use

The absence of settlement in the area is clearly visible from the air. Only two mechanized farms can be seen on which planting may begin this year. Some fields had been plowed for the first time but operations had ceased due to waterlogging of the soils. This condition is presumably caused by a combination of poor external drainage and slow infiltration rates common to saturated vertisols. With the exception of these farms, the entire valley appears deserted. No livestock could be detected grazing on the valley floor and it was apparent that the land was too wet for cattle at this time of the year (June/July/August) even if Tsetse flies were not prevalent. Year around grazing under improved conditions could be excellent if the area were drained and cleared of disease. On the surrounding highland plateaus population appeared dense and small herds of cattle were seen; farming operations were fully mobilized and many teams of oxen were seen in the fields. Though these higher lands receive somewhat more precipitation than the valley, surface drainage is more than adequate and the soils are of a lighter texture, more permeable and dry faster.

Agricultural Production

As mentioned before, the area is considered to be virtually deserted, In the economic analysis, the present value of farm production from the area is assumed to be nil. During the more detailed studies required in Phase II, production values may be assigned for the anticipated yields on the two large farms.

Health

The general comments regarding livestock diseases and parasites previously discussed in Part I of this report, are valid for the Didesa Valley. It has been reported that the valley was once settled and carried a considerable human and livestock population. Then Trypanosomiasis appeared; Tsetse flies were probably always present and only needed an infected domestic or wild animal to begin spreading the disease. Human Trypanosomiasis has been confirmed in the area and malaria is endemic.

Communications

The area is presently served by Highway No. 39 which connects Bedele to Arjo. The road is, in fact, a poorly defined trail passable only in the dry season by four-wheel drive vehicles. Considering the condition of the road, it is surprising to note the well constructed bridge over the Didesa River. Some maps show a foot path leading directly eastward from Bedele to the mid-project area, but this path could not be seen from the air. No roads exist on the valley floor. The mechanized equipment and service vehicles, employed on the two farms mentioned previously, obviously were able to reach their respective areas by travelling across open land in the dry season.

Ethiopian Airlines has flights to and from Gore five times a week and connects with Nekemte once a week.

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Postal, telephone and telegraph services are available at both Bedele and Nekemte.

Markets

Existing Agricultural Markets - This project is more favorably located with regard to existing markets and population centers than are the other three areas studied. It lies midway between Bedele and Arjo where daily markets function. Both markets are reported to be net importers of food commodities. Bedele is on the principal all weather artery connecting Addis Ababa with Metu (planned to be eventually extended to Jakao on the Sudan border). This road is destined to become an important means of transporting agricultural and livestock produce in the future as additional areas in the Southwest Region are opened for settlement and exploitation.

Arjo is connected to Nekemte, the capital of Welega province, via a 57 kilometer dry season road which IHA plans to upgrade. Surplus project produce could then move into Welega markets and along the existing all-weather highway between Addis Ababa and Ghimbi.

Existing Livestock Markets - A large seasonal market for livestock exists in the Metu-Bedele-Jimma area during the coffee harvesting period of December through April, when prices are considerably higher than average. Bedele is a major market, primarily for slaughter cattle, and surplus stock flows to Addis Ababa via Jimma.

DEVELOPMENT STRATEGY

For the purpose of this report, and in order to provide a basis for comparative analysis between the four study areas,

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25,000 hectareswas selected for rainfed agriculture. The remaining 8,000 to 10,000 hectares available in the valley could be used for livestock grazing following the eradication of animal disease hazards.

The development strategy does not include supplemental irrigation for the Didesa Valley at this stage. Sufficient dependable precipitation occurs for single crop rain-fed farming provided surface drains are constructed to facilitate runoff from heavy rainfall over the valley and the surrounding watershed.

Infrastructural developments would include surface drains, internal roads, storage facilities, extension services, and various public services.

Conservation

One of the primary objectives of any development scheme should be the conservation and, where possible, the improvement of the environment of the project. While the ecological aspects would be altered by agriculture, the conservation of other natural resources are assured.

Soil Conservation - The Didesa River Valley is losing valuable top soil through unchecked erosion. Many streamlets entering the valley through extremely steep canyons from the surrounding escarpments, carry flash floods following heavy showers and cut numerous channels deep into the valley floor. While the flows from these freshlets is slight, they have a high velocity which has effectively cut through the solum.

The development strategy would be to provide excavated drainage ditches which would collect this flow from the outside as well as the surplus rainfall which causes water-logging of the farmlands in the wet season, and divert it through natural water courses into the river. As this project is designed for rainfed agriculture, additional soil conservation practices should be investigated during detailed Phase II studies. Terracing and contouring would be desirable measures combined with leveling the lands along the established contours.

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Thus, the early and late rains would be conserved, while surplus wet season precipitation would be directed into the drainage system along the terrace channels.

Forest Conservation - The project lands, as presently identified, are basically open type savannah, with a limited number of trees, along the banks of the Didesa River, and a few scattered species away from the river associated with some low brush and thorn trees in the grasslands. Much of this low brush would be removed during the campaign to eradicate Tsetse flies. This slight loss would be countered by the individual farmers on five-hectare plots preserving a woodlot and fruit tree area from seedlings supplied by the extension services. This wooded area would avoid species that would harbor Tsetse flies and would provide firewood, building poles and fruit for the farm families.

Wildlife Conservation - While there undoubtably are various species of wild game in the area, it is unlikely that they exist in numbers large enough to be of particular importance to the valley's ecology. Any animals displaced by agricultural activities could seek refuge further up into the southern reaches of the valley, or could migrate downstream where conditions are more favorable.

Resettlement

Of the 25,000 hectares planned for rainfed farming, half of the area would be allocated to oxen-powered, five-hectare units, thus allowing for the resettlement of 2,500 families. It is most likely, that the entire number could readily be drawn from the reservoir of more than 500,000 estimated present inhabitants of Limu and Buno Bedele Awrajas. These would primarily be those families either leaseholding small farms of less than one hectare or working on a share basis for an absentee owner. From available data it may be estimated that there are some 40,000 such families within Buno Bedele and Limu Awrajas.

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These families presently exist on subsistence or sub-subsistence levels and depend on livestock and occassional labor opportunities for supplemental food and cash income.

Land Capability

The seasonal and prolonged waterlogging of the major portion of the valley is a severe limitation restricting agricultural production to the drier season of less dependable precipitation. With the project, the land capability would be improved by surface drains which would prevent seasonal waterlogging and permit earlier seed bed preparation.

The final selection of the area for settled farming will depend upon the results of reconnaissance level soil surveys and land use capability classifications which would be undertaken during the initial months of Phase II operations. Based on current knowledge, the selected project area is classified roughly as follows:

Class II - 2,500 hectares or 10 percent
Class III - 18,500 hectares or 74 percent
Class IV - 4,000 hectares or 16 percent

Class II Lands (2,500 hectares) - confined to a narrow band some one to three kilometers wide nearest to the river on each side of the valley. These are alluvial associated soils presently restricted due to poor surface and internal drainage. After construction of drains, they would be suitable for a wide range of adaptable crops, particularly garden vegetables, pulses, fruits and peanuts. In future practice, they may be intensively farmed using small low-lift pumps from the river for supplemental dry-season irrigation. For this preliminary project analysis, this prospect has not been considered.

Class III Lands (18,500 hectares) - comprise most of the project area and cover the flatter portions of the valley floor. These are typical expanding lattice clay vertisols and are presently limited by waterlogging, low permeability and structural defects.

These soils are reported to be high in organic matter and nutrients and could be expected to produce better than average yields. Fertilizer response may be negative or depressive on yields for the first few years of the development program; however, fertilizer input costs are considered in the financial analysis for the long run.

These soils, and the climate, are well adapted to cereals - such as maize, wheat, sorghum, teff, oats, barley - especially under mechanized farming. Oxen farmers may find itadvantageous to hire a tractor for initial plowing until the tilth can be improved by continual incorporation of humus and crop residues into the upper solum.

Class IV Lands (4,000 hectares) - are silty clays and comprise lands of uneven topography closer to the escarpments. They are free from subtained water logging and are relatively well drained. They are limited by topography, development cost, structural defects and lower fertility. With fertilizers, they will produce reasonable yields and when mixed with Class III lands, can be economically farmed. Similiar cereals as shown for Class III are suited to Class IV but yields would be somewhat lower.

Cropping Patterns

Simplistic cropping patterns have been selected for the purpose of this preliminary analysis. In the Didesa Valley, which is planned for development of one rainfed crop per year, the following was adopted:

Crop	Model Five-Hectare Oxen Farms (ha)	Model 250-Hectare Tractor Farms (ha)
Maize	2	-
Sorghum	1	125
Pulses	1	125

The oxen farmers would be primarily producing for home consumption and local markets, while the tractor farmers would con-

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sider market demands in major population centers and export abroad. It is emphasized that cropping patterns have been adopted to obtain indications of magnitude of production on as equal a basis as possible for each project area (climatic and other conditions permitting). Definitive patterns cannot be determined until more detailed knowledge is obtained on soils, land capabilities, crop adaptability and markets.

Model Farm Budgets

As with all crops in each project analysis, conservative yields have been assumed. Consideration has been given to provincial averages, results obtained by controlled experiments, and finally to field conditions which would prevail upon completion of the proposed drainage network. The larger farms, with better management and superior equipment, would be expected to obtain higher yields than the average oxen farms.

Model Five-Hectare Oxen Farms - Table III-5 shows the basic direct parameters adopted for financial analysis of the smaller farms. Yields are believed to be conservative and consider the capability of the soil, favorable climatic conditions, the availability of inputs and the ability of the prospective farmers. Prices used were discussed in Part I of this report.

The estimated indirect costs, also utilized in computing the financial analysis of the model farm units, are given in Table III-6.

Model 250-Hectare Tractor Farms - Table III-7 shows the basic direct parameters used for crops on the model 250-hectare commercial farm units. Cropping patterns have been simplified to show 125 hectares each of sorghum and pulses. The estimated indirect costs, also utilized in computing the model farm financial analysis are given in Table III-8.

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Table III - 5

Basic Direct Parameters for Crops on Oxen Farms
Didesa Project - Rainfed

Item	Units	Maize	Sorghum	Pulses
Returns				
Yield	(qq/ha)	27	24	14
Price	(E$/qq)	12	14	20
Sales	(E$/ha)	324	336	280
Direct inputs				
Seed & Seed treatment	($/ha)	11	6	6
Fertilizer	($/ha)	32	23	20
Insecticide	($/ha)	32	32	32
Total		75	61	58
Labor	(hrs/ha)	715	600	490
Oxen	(hrs/ha)	90	90	90

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Table III - 6

Indirect Costs for Model Five-Hectare Oxen Farm
Didesa Project - Rainfed

Item	Annual Costs (R$)
Oxen Maintenance (1)	10
Small Animals Maintenance (1)	2
Repairs and Maintenance	44
Land Tax	9
Family Cash Expense (2)	240
Home Consumption - Maize (3)	84
Home Consumption - Sorghum (4)	42
Home Consumption - Pulses (5)	20
Total	451

(1) Minerals, tick control and medical
(2) Assumes family at six
(3) 7 quintals @ R$12/qq
(4) 3 quintals @ R$14/qq
(5) 1 quintal @ R$/qq

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Table III - 7

Basic Direct Parameters for Crops on Tractor Farms

Didesa Project - Rainfed

Item	Units	Sorghum	Pulses
Returns			
Yield	(qq/ha)	27	16
Price	(E$/qq)	14	20
Sales	(E$/ha)	378	320
Direct inputs			
Preharvest			
Machine	(E$/ha)	11	11
Labor	(E$/ha)	31	31
Seed & Seed Treatment	(E$/ha)	6	6
Fertilizer	(E$/ha)	23	20
Food for Labor	(E$/ha)	4	4
Inspecticide	(E$/ha)	32	32
Subtotal	(E$/ha)	107	104
Harvest			
Machine	($/qq)	.20	.20
Labor	($/qq)	1.50	2.00
Materials	($/qq)	1.90	1.90
Subtotal	($/qq)	3.60	4.10
Subtotal	($/ha)	97	66
Total	(E$/ha)	204	170

Table III-8

Indirect Costs for Model 250 - Hectare Tractor Farm
Didesa Project

Item	Annual Costs (E$)
Salaries	3100
Repairs and Maintenance (buildings)	700
General Transportation	700
Management - Imputed	4200
Land tax	500
Total	9,200

Financial Analyses of Model Farms

Cash flow projections were worked out for both model farms based on the cost and revenue data derived in the preceding paragraphs and on investment expenditures presented herdnbelow.

Model Five-Hectare Oxen Farm - The investment and replacement schedule adopted for the five-hectare oxen farm is given in Table III-9.

The results of the cash flow analysis is presented in Table III-10. Loan repayment (at 12 percent interest) was assumed over a period of five years with a two-year grace period. Short term interest for production loans was assumed at 14 percent. Buildup to full production was taken to be four years. Agricultural income tax is based on the official Imperial Ethiopian Government Tax Schedule (Negarit Gazeta, 27th year, No. 4, November 23, 1967).

The resulting cash flow is indicative of a viable oxen-farm operation.

Model 250-Hectare Tractor Farm - The investment and replacement schedule assumed for the model 250-hectare tractor farm is given in Table III-11. It was assumed that 70 percent of the

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Table III - 9

Investment Requirements for Model Five-Hectare Oxen Farm
Didesa Project (E$)

Item	Units	Life (Years)	Year 1	Year 6	Year 9	Year 11	Year 16	Year 17
Oxen	1 pair	5	360	240(1)	-	240	240	--
Donkey	1	10	25	--	--	25	--	--
Sheep, Goats, Chickens	set	--	100	--	--	--	--	--
Plow	1	8	50	--	50	--	--	50
Plow-ridger	1	8	50	--	50	--	--	50
Harrow	1	8	50	--	50	--	--	50
Back-Pack Sprayer	1	5	70	70	--	70	70	--
Miscellaneous	1 set	5	50	50	--	50	50	--
Tukul	1	10	150	--	--	150	--	--
Store	Materials	10	75	--	--	75	--	--
Thresher-hand	1	10	75	--	--	75	--	--
Total	--	--	1055	360	150	685	360	150

(1) Assumes sales price of E$120 for old pair or net replacement cost of E$240 per pair.

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Table III-10

Cashflow for Model Five-Hectare Oxen Farm
Didesa Project - Rainfed

Years	1	2	3	4-5	6	7	8	9	10	11	12
Cash inflow											
Gross returns (1)(2)	383	638	1021	1276	1276	1276	1276	1276	1276	1276	1276
Less home consumption	146	146	146	146	146	146	146	146	146	146	146
Loan	1295	--	--	--	--	--	--	--	--	--	--
Total	1532	492	875	1130	1130	1130	1130	1130	1130	1130	1130
Cash outflow											
Direct expenses	77	128	204	255	255	255	255	255	255	255	255
Indirect expenses	56	56	56	56	56	56	56	56	56	56	56
Land tax	9	9	9	9	9	9	9	9	9	9	9
Income tax	2	6	18	33	33	33	33	33	33	33	33
Investment	1055	--	--	--	360	--	--	150	--	685	--
Short term interest	6	9	12	15	15	15	15	15	15	15	15
Family expenses	240	240	240	240	240	240	240	240	240	240	240
Total	1445	448	539	608	967	606	608	758	608	1293	608
Cash Balance	87	44	336	522	163	522	522	372	522	(163)	522
Debt Service (3)	--	73	395	395	395	395	355	--	--	--	--
Cash Balance	87	(29)	(59)	127	(232)	127	167	372	522	(163)	522

(1) assumes buildup of 30, 50, 80 and 100 percent for years 1 through 4
(2) full development based on 2 hectares of sorghum and 1 hectare each of maize and pulses.
(3) assumes interest free repayment of E$240 food allowance.

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Table III -11

Investment Requirements for Model 250-Hectare Tractor Farm

Didesa Project

(Thousand E$)

Item	No Units	Life (yrs)	Year 1	Year 9	Year 11	Year 17
Tractor - 70hp	1	8	15.0	15.0	--	15.0
Widelevel 15'	1	8	6.8	6.8	--	6.8
Drill - 12'	1	8	6.0	6.0	--	6.0
Sprayer - 32'	1	8	6.0	6.0	--	6.0
Trailer -3T	1	8	2.4	2.4	--	2.4
Land development	-	-	1.5	--	--	--
Tukuls	3	10	1.8	--	1.8	--
Pole shed	1	10	4.8	--	4.8	--
Total			44.3	36.2	6.6	36.2

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initial outlay would be financed at 12 percent interest.

The cash flow analysis is presented in Table III-12. Loan repayment (at 12 percent interest) was assumed over three years with no grace period. Short term interest for production and harvest loans was assumed at 14 percent. Buildup to full production was taken to be four years. Water charges and income tax were derived as stated above for the oxen farm.

The resulting cash flows are indicative of viable commercial operations.

LIVESTOCK DEVELOPMENT PLAN

There does not appear to be sufficient land within the project area for a full-scale livestock development. At the most, between 6,000 to 8,000 hectares of pastureland may remain following implementation of the agricultural settlement program. Nevertheless, it remains important to provide disease protection for the small farmer's oxen and small animals. This requires the elimination of Tsetse flies and a regular program of innocultation and vaccination. A compaign to eradicate malarial mosquitos should be carried on simultaneously with a Tsetse fly control program.

It is expected that more detailed studies in Phase II would determine the economic feasibility of attempting a livestock development program in this area. Preliminary calculations based on cow-calf operations do not appear to be attractive when compared to rainfed agricultural returns. It may be more advantageous to study a stocker-type alternative but this will also likely result in lower gains than crop operations.

INFRASTRUCTURAL DEVELOPMENT PLAN

Included in this section are: 1) internal roads; and 2) surface drainage works. Other infrastructure, including: 1) management, testing and extension services; 2) credit, marketing and storage; and 3) public services, common to all four projects studied, were presented in Part I of this report.

Table III-12

Cash Flow for Model 250-Hectare Tractor Farm
Didesa Project - Rainfed (Thousand E$)

Years	1	2	3	4-8	9	10	11	12
Cash inflow								
Sales (1)(2)	52.3	70.0	78.5	87.2	87.2	87.2	87.2	87.2
Loan	31.0	-	-	-	-	-	-	-
Total	83.3	70.0	78.5	87.2	87.2	87.2	87.2	87.2
Cash outflow								
Direct expenses (2)	15.8	21.1	23.8	26.4	26.4	26.4	26.4	26.4
Indirect expenses	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Land tax	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Income tax	7.3	10.9	12.6	14.4	14.4	14.4	14.4	14.4
Investment	44.3	-	-	-	36.2	-	6.6	-
Short term interest	1.1	1.4	1.5	1.6	1.6	1.6	1.6	1.6
Total	77.7	42.6	47.1	51.6	87.8	51.6	58.2	51.6
Cash Balance	5.6	27.4	31.4	36.1	(0.6)	35.6	29.0	35.6
Debt service	12.9	12.9	12.9	-	-	-	-	-
Cash Balance	(7.3)	14.5	18.5	36.1	(0.6)	35.6	28.0	35.6

(1) Assumes building of 60, 80, 90 and 100 percent years 1 through 4

(2) Full development assumes 125 hectares each of pulses and sorghum.

Internal Roads

The preliminary criteria, design standards, and estimated unit (per kilometer) costs for the internal road networks for all projects studied were given in Part I of this report.

The preliminary layout of one and two-lane tertiary roads for the Didesa Project is shown on Figure III-1, following page III-1. Summarized in Table III-13 are the approximate lengths and order-of-magnitude costs of these tertiary standard roads.

Table III-13
Estimated Cost Internal Roads
Didesa Project

Item	Length(Km)	Unit Cost (E$/Km)	Cost (1,000E$)
2-Lane Tertiary	26	21,800	566
1-Lane Tertiary	19	16,500	314
Bridges	--	--	120
Total Cost			1,000

The annual maintenance cost of the above road network is estimated to be in the order of E$25,000.

Drainage Facilities

In order to implement a one crop rainfed development, surface drainage works would be required. Surface drainage channels would flow by gravity into the several water courses within the project area, thence into the Didesa River.

Estimated Costs - The estimated order-of-magnitude cost of surface drainage works would be E$5,000,000 with construction being carried out over a period of five years. Annual maintenance costs would be roughly E$185,000.

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PRELIMINARY ECONOMIC ANALYSIS

Economic Costs

To determine the order-of-magnitude economic costs of the Didesa Project, the methodology described in Part I of this report was applied to the capital and recurring costs estimated for roads; drainage facilities; and farm investment costs, in this part, and for mapping and surveys; credit, marketing and storage; resettlement allowances; and management, testing and extension services, presented in Part I. The resulting economic cost stream over a 20-year period of analysis is given in Table III-14.

Net Project Benefits and Internal Economic Rate of Return

To determine the gross benefit margins, model farm costs were converted to economic costs, using the factors presented in Part I of this report, and subtracted from sales. These figures were aggregated according to the assumed rate of buildup (500 oxen farms per year over a five year period and 10 tractor farms in year 1 and 20 each in years 2 and 3). The resulting benefit stream is given in Table III-15.

The gross project costs (Table III-14) were then subtracted from the gross benefit streams to yield the net project benefit stream (also shown in Table III-15). The preliminary internal economic rate of return was found by discounting this net benefit stream. The rate of return on total project investment was 21 percent.

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Table III-14

Economic Costs of Didessa Project - Rainfed
(Million E$)

Project Year	Water Control (Drainage only)	Roads	Mapping &Surveys	Credit, Marketing & Storage	Resettlement Allowance	Public Services	Management Testing Training &Extension	Total Farm Investment	Gross Project Costs
-1	0.09	0.05	0.04	--	--	--	--	--	0.18
1	0.90	0.27	0.04	0.17	0.21	0.12	0.75	1.10	3.56
2	0.93	0.36	--	0.26	0.21	0.14	0.54	1.75	4.19
3	0.96	0.27	--	0.15	0.21	0.14	0.49	1.87	4.09
4	1.00	0.02	--	0.18	0.21	0.14	0.42	0.78	2.75
5	1.03	0.02	--	0.29	0.21	0.14	0.42	0.69	2.80
6	0.16	0.02	--	0.19	--	0.12	0.50	0.28	1.27
7	0.16	0.02	--	0.19	--	0.13	0.45	0.21	1.16
8	0.16	0.02	--	0.30	--	0.14	0.42	0.18	1.22
9	0.16	0.02	--	0.19	--	0.15	0.47	0.59	1.58
10	0.16	0.02	--	0.31	--	0.16	0.42	0.95	2.02
11	0.16	0.02	--	0.20	--	0.16	0.52	1.13	2.19
12	0.16	0.02	--	0.20	--	0.16	0.45	0.46	1.45
13	0.16	0.02	--	0.20	--	0.16	0.42	0.46	1.42
14	0.16	0.02	--	0.20	--	0.16	0.42	0.30	1.26
15	0.16	0.02	--	0.20	--	0.16	0.42	0.30	1.26
16	0.16	0.02	--	0.20	--	0.16	0.50	0.18	1.22
17	0.16	0.02	--	0.20	--	0.16	0.50	0.61	1.65
18	0.16	0.02	--	0.20	--	0.16	0.42	0.97	1.93
19	0.16	0.02	--	0.20	--	0.16	0.42	0.97	1.93
20	0.16	0.02	--	0.20	--	0.16	0.42	(4.99)	(1.03)

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Table III-15
Derivation of Net Project Benefits
and Basic Internal Economic Rate of Return
Didessa Project - Rainfed
(Million E$)

Project Year	Gross Benefit Margin 0-5	T-250	Total	Gross Project Costs	Net Project Benefits
-1	-	-	-	0.18	(0.18)
1	0.13	0.22	0.35	3.56	(3.21)
2	0.39	0.77	1.16	4.19	(3.03)
3	0.78	1.47	2.25	4.09	(1.84)
4	1.27	1.82	3.09	2.75	0.34
5	1.76	2.01	3.77	2.80	0.97
6	2.12	2.11	4.23	1.27	2.96
7	2.36	2.11	4.47	1.16	3.31
8	2.46	2.11	4.57	1.22	3.35
9	2.46	2.11	4.57	1.58	2.99
10	2.46	2.11	4.57	2.02	2.55
11	2.38	2.11	4.49	2.19	2.30
12	2.31	2.11	4.42	1.45	2.97
13	2.23	2.11	4.34	1.42	2.92
14	2.16	2.11	4.27	1.26	3.01
15	2.08	2.11	4.19	1.26	2.93
16	2.08	2.11	4.19	1.22	2.97
17	2.08	2.11	4.19	1.65	2.54
18	2.08	2.11	4.19	1.93	2.26
19	2.08	2.11	4.19	1.93	2.26
20	2.08	2.11	4.19	(1.03)	5.22
				NPW @ 20 %	+0.33
				IERR	21%

PART IV

OMO PROJECT

DESCRIPTION OF PROJECT AREA

Location

The Omo River, the major source of supply to Lake Rudolf and one of the country's longest rivers, forms the western and northern boundaries of Gemu Gofa Province. The Omo enters Lake Rudolf, on the border with Kenya, through flat deltaic swamps via numerous braided and meandering channels.

Some 100 kilometers due north of Lake Rudolf and adjacent to the eastern bank of the Omo River (between latitudes 5°30' and 6°20'N and longitudes 35°55' and 36°15'E) lies a smooth to gently undulating plain approximately 70 kilometers long and varying in width between five and twelve kilometers. Elevations range from about 600 meters near the river to roughly 800 meters on the upper slopes, with a project average taken as 650 meters. The plain lies wholly within Gofa Awraja of Gemu Gofa Province and has been identified as a potential development project based on irrigated agriculture and controlled livestock grazing.

Figure IV-1 shows the general location of this Omo plain. For the comparative analysis among the four study areas, a 50,000-hectare area has been selected for initial development with 25,000 hectares to comprise a mix of oxen-power and tractor farms. The remaining 25,000 hectares would be utilized for controlled livestock grazing.

Climatology and Hydrology

Climatological and Hydrological Stations - Omo Basin - In the part of the Omo River Basin from its delta at the border with Kenya to its junction with the Dincia River, and including that tributary's basin, climatological stations are located at Bonga, Wushwush, Gerisho, Maji, Bako (Mission) and Kalam Bulchi which is slightly beyond the eastern divide. Additional stations are proposed at numerous sites.

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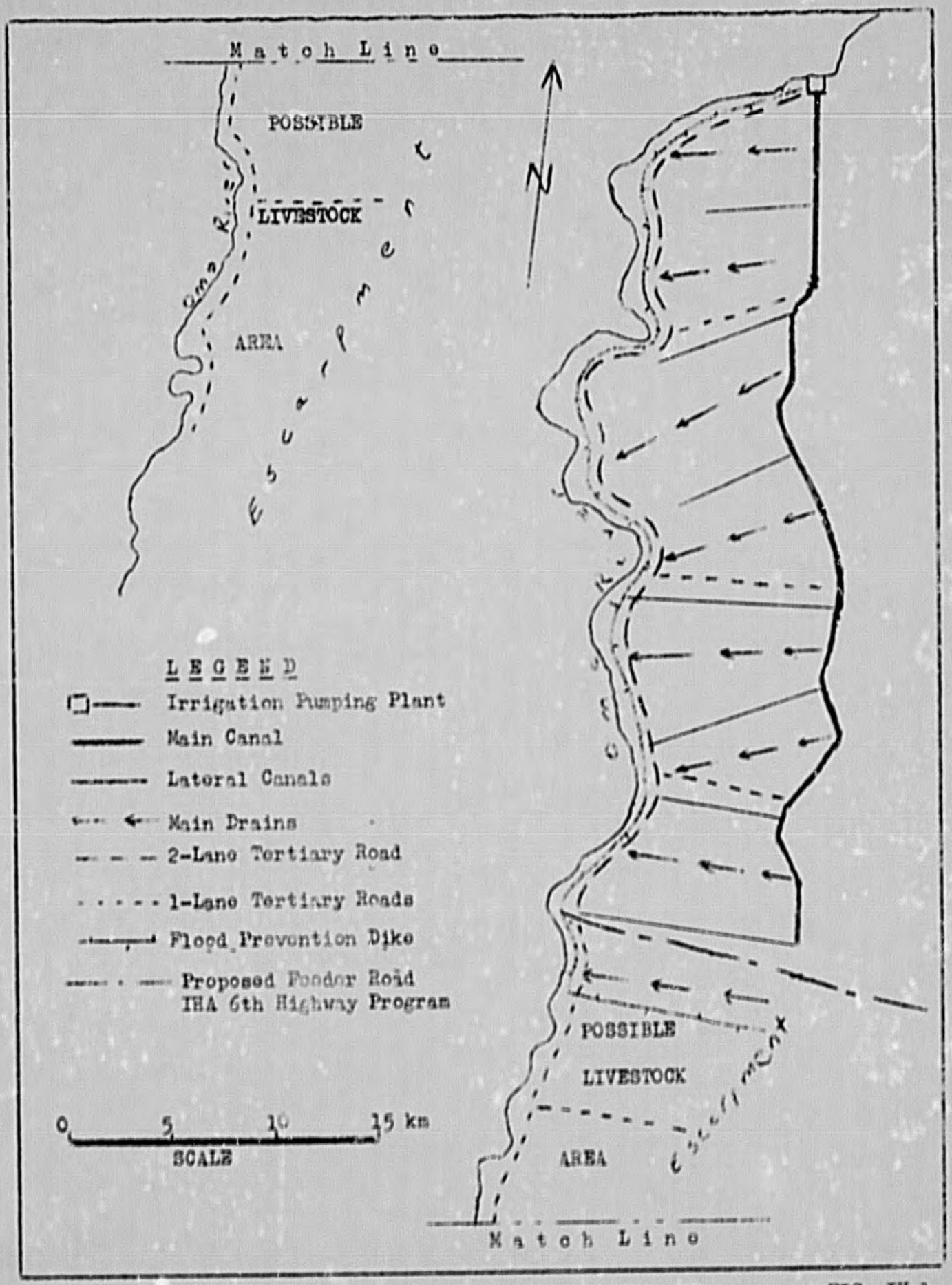

OMO PROJECT AREA FIG. IV-1

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For purposes of demonstrating the financial viability of a cow-calf operation family unit, a tentative cash flow analysis was made as shown in Table II-20. The assumed "without project" sales were based on an existing offtake rate of 7.3 percent; this presupposes that all settlers are taken from existing semi-nomadic herdsmen. The analysis did not include charges for the required infrastructural and annual costs shown in Table II-9, the only cash outflow being cattle tax, minerals, and family living expenses. The internal rate of return under the above assumptions was 33 percent which would only be possible if all development and operating costs were fully subsidized by the Government.

To test the economic viability of the above development plan, model family units were aggregated over a six year period and the offtake rate increased to 18 percent at year 15. All values were then shadow priced to economic valuations. The resultant accumulative net flow was negative over a 20-year period of analysis. This, in part, was caused by assuming high "without project" sales.

In spite of the negative results, livestock should be considered during the Phase II feasibility investigations. Field surveys may indicate greater carrying capacities of the pasture. If, during Phase II studies, a cow-calf herd concept still proves negative, then the alternative of developing a stocker program should be investigated. Feed lot operations may also be considered.

INFRASTRUCTURAL DEVELOPMENT PLAN

Included in this section are: 1) internal roads; 2) irrigation, drainage and flood control facilities for the irrigated agriculture alternative; and 3) drainage and flood control facilities for the rainfed agriculture alternative. Other infrastructure, including: 1) management, testing and extension services; 2) credit, marketing and storage; and 3) public services, common to all four projects studied, were presented in Part I of this report.

Internal Roads

The preliminary criteria, design standards, and estimated unit (per kilometer) costs for the internal road networks for all projects studied were given in Part I of this report.

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Runoff and stream gauge data are non-existent within the area, but several stations are proposed. Gauge-height data, but not discharges, are available at an upriver station near Bole.

Rainfall - Mean monthly precipitation is shown on Table IV-1 for for the long-period stations--Bonga, Maji, Bako and Bulchi.

The variation in calendar-year precipitation is shown in Table IV-2 for Bonga and Maji. The extremes, medians and quartiles of monthly precipitation are shown for Bonga and Maji on Figure IV-2 and the frequency of exceedance of mean annual rainfall is shown graphically on Figure IV-3 for the same stations.

Bonga is favorably situated for precipitation as it receives rain with both the southeast and southwest winds. This station has relatively uniform and substantial rains for a long wet season (March through October) and a less intense dearth of rain in its dry season (November through February). In the wet season, monthly rains between the upper and lower quartiles, i.e., half of the events, are generally between about 130 and 230 millimeters. Maji has somewhat the same characteristics as Bonga but with less mean annual precipitation and the dependability of monthly rains is less, as is shown by the scatter of the quartile points.

Precipitation at lower elevations in the area would be less than at Bonga and probably more variable from year to year.

Evaporation

Evaporation at Bako (Jinka) has been observed from May 1970 from a USDA class A pan. Monthly evaporation rates are presented in Table IV-3 in comparison with monthly precipitation.

Taking lake evaporation at 70 percent of pan evaporation, the mean annual amount would be about 1160 millimeters. It is anticipated that this value would be higher for a lower elevation.

Temperatures - Characteristics of monthly temperatures at higher elevations in the catchment area are shown on Table IV-4.

Surface Hydrology

Runoff and stream flow data are not available for the basin. Some personal observations regarding low Omo River flows are mentioned in several reports but are unconfirmed and of doubtful value. The

Table IV - 1
Mean Monthly Precipitation - Omo River Basin
(mm)

Station	Bonga		Maji		Bako	Bako (Jinka)	Bulkie
Lat.N.	7°13'	7°14'	6°-10'	6°-10'	5°-49'		
Long.E.	36°-17'	36°-15'	35°-35'	35°-35	36°-38'	N.A.	N.A.
Elev.m	1725	1650	2316	N.A.	2260	1980	
Period	1937-40 (1)	1953-73 (2)	1938-40 (1)	1952-72 (3)	1954-66 (3)	1970-73 (2)	1970-73 (2)
J	69.3	56.7	15.5	56.0	17.7	44.8	48.6
F	100.9	75.5	109.3	86.8	75.0	51.9	62.9
M	141.1	143.4	36.6	166.9	139.6	44.6	71.5
A	177.8	190.6	90.1	220.2	183.3	174.3	144.0
M	266.3	200.0	44.4	194.7	87.3	169.0	239.4
J	234.7	205.9	27.8	128.8	145.0	107.1	144.7
J	172.2	183.0	199.3	151.3	136.6	100.3	169.8
A	150.7	192.9	68.0	167.2	150.4	170.4	164.3
S	126.2	194.3	56.0	110.3	122.8	110.0	63.1
O	131.4	149.5	101.2	139.5	114.5	189.3	119.7
N	32.3	84.6	39.0	129.3	122.2	125.0	72.3
D	43.2	62.8	32.0	77.3	47.1	25.3	17.4
Year	1651.1	1739.2	809.2	1628.3	1341.5	1312.0	1317.7

(1) From "Contributo Alla Climatologia Dell' Ethiopia," Fantolo, 1965.

(2) From files, DWR

(3) From files, NCS

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Table IV - 2
Annual Precipitation and Probabilities
at Bonga and Maji

	Bonga				Maji		
Yr.	Annual Precip.(1) (mm)	Rank	Beard's Plot Pos. %	Yr.	Annual Precip.(1) (mm)	Rank	Beard's Plot Pos. %
1953	1604.7	18	82.7	1954	1652.6	5	28.6
1954	1598.4	19	87.4	55	1489.9	12	71.4
5	1650.5	16	73.4	56	1358.4	14	83.6
6	2006.6	3	12.6				
7	1797.5	7	31.3	60	1493.6	11	65.3
8	1625.6	17	78.0	1	1859.4	3	16.4
9	1658.3	14	64.0	2	1597.0	9	53.1
1960	1694.0	11	50.0	3	1630.3	6	34.7
1	1943.3	4	17.3	4	1653.2	4	22.5
2	1760.1	9	40.6	5	1355.6	15	89.9
3	2029.5	2	7.9	6	1878.2	2	10.3
4	2117.5	1	3.2	7	2179.6	1	4.2
5	1751.0	10	45.3	8	1599.7	8	46.9
6	1578.5	20	92.1	9	1221.5	16	95.8
7	1667.5	13	59.4	1970	1577.9	10	59.2
8	1651.2	15	68.7	1	1457.4	13	77.5
9	1430.8	21	96.8	2	1618.6	7	40.8
1970	1846.6	5	22.0			16	
1	1682.3	12	54.7				
2	1770.3	8	36.7				
3	1806	6	26.6				
		21					

(1) For months of missing data mean monthly precipitation was used to obtain long records for frequency analysis.

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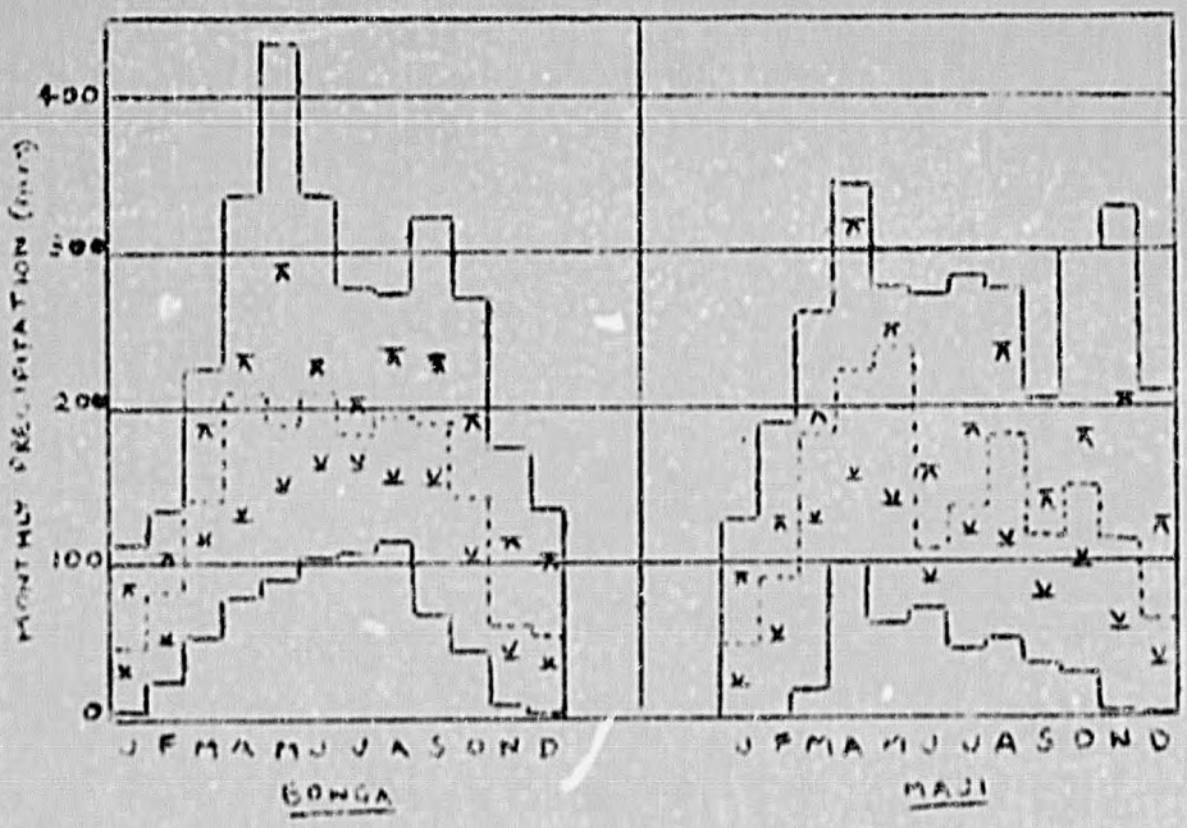


LEGEND

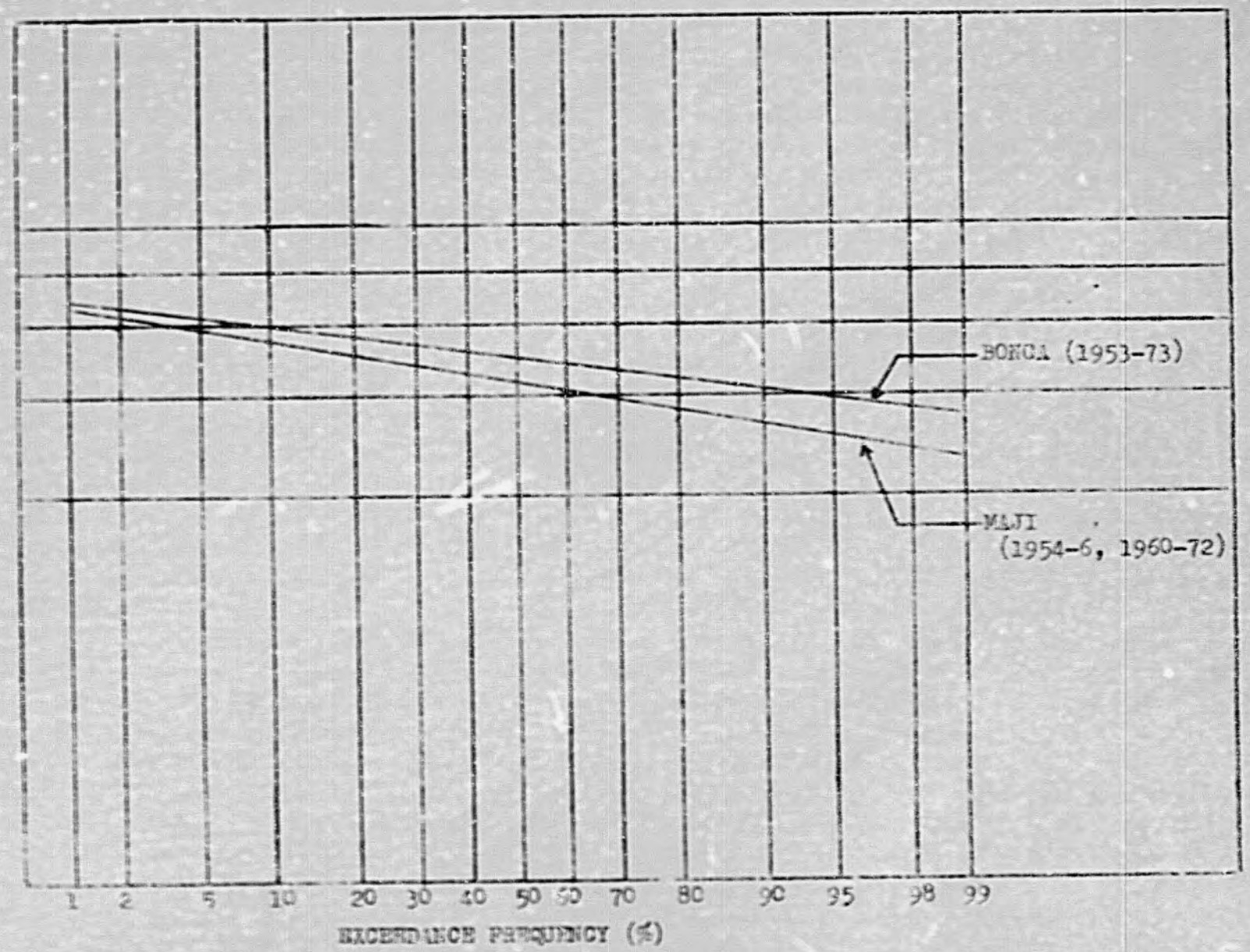
Extreme Max and Min

Median

Upper and Lower Quartiles

CHARACTERISTICS OF MONTHLY PRECIPITATION

AT BONGA AND MAJI FIG IV-2



RELATIVE FREQUENCY
OF 16 C. ED MAJI FIG. II-3

Table IV - 3

Pan Evaporation and Precipitation at Bako (Jinka)

Month	Pan Evaporation, (mm) 1970	1971	1972	1973	Mean	Precipitation (mm) 1970	1971	1972	1973	Mean
J	---	157	142	147	149	--	33.1	28.3	73.0	44.8
F	--	160	155	140	138	--	0.0	92.7	63.0	51.9
M	---	195	142	176	171	--	52.0	58.9	22.9	44.6
A	--	115	132	192	146	--	175.9	186.8	160.1	174.3
M	104	95	214	129	136	171.3	148.0	233.2	123.1	169.0
J	94	106	153	134	122	161.8	70.0	117.8	78.9	107.1
J	96	174	117	120	127	50.3	168.5	86.5	96.0	100.3
A	86	160	150	155	138	135.9	161.8	172.5	111.2	170.4
S	137	104	121	-	121	153.8	55.1	121.1	-	110.0
O	171	101	180	-	151	206.6	139.7	221.6	-	189.3
N	151	112	145	-	136	14.2	72.5	188.2	-	125.0
D	144	111	125	-	127	20.9	44.8	10.1	-	25.3
Year	---	1590	1137	---	1662	----	1121.7	1617.7	---	1312.0

Table IV - 4

Air Temperatures

Month	Benga Aver Daily Max	Aver Daily Min	Aver Daily	Maji Aver Daily Max	Aver Daily Min	Aver Daily	Bako (Jinca) Aver Daily Max	Aver Daily Min	Aver Daily
J	28.7	10.5	19.6	24.4	10.7	17.5	29.2	14.6	21.9
F	29.4	11.3	20.3	24.2	10.8	17.5	29.9	15.3	22.6
M	29.1	12.2	20.6	23.6	10.6	22.1	30.7	16.4	23.4
A	29.8	12.8	21.3	22.6	10.5	16.5	27.1	16.8	21.9
M	27.1	12.7	19.9	23.7	10.8	17.2	25.6	16.2	20.9
J	25.5	12.4	19.0	21.2	11.1	16.1	24.8	15.7	20.3
J	24.2	12.5	18.3	21.4	11.2	16.3	24.7	15.5	19.9
A	24.4	12.5	18.5	20.6	10.9	15.7	24.5	15.4	19.9
S	25.5	11.8	18.6	21.3	11.6	16.5	25.6	15.3	20.4
O	27.3	11.5	19.4	22.7	10.7	16.7	25.6	15.8	20.7
N	27.7	10.7	19.2	25.9	11.4	18.7	26.2	13.9	20.1
D	28.1	10.4	19.3	23.2	10.4	16.8	28.1	13.1	20.4

Note: Air temperatures at lower elevations in the valley would be higher than those listed above.

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published data of a dependable nature are water fluctuations reported for Lake Rudolf from 1949 to 1953.[1] Based on these measured water levels and mean lake rainfall, a tentative water budget analysis was prepared as an indication of the magnitude of contribution to the lake's volume by the Omo River, its principal source. This analysis, shown in Table IV-5, indicates a low-flow of 190 cubic meters per second (occuring in April) at the Omo mouth. This figure may be high and subject to some dispute, but is perhaps more accurate than attempting a basin-wide runoff analysis for such a large catchment area, based on scattered data from a few rainfall stations.

Synthesized Project Area Climate

For the Omo River Basin, data for area runoff, river flows and stages, sediment discharge, and groundwater are not available with respect to either quantity or quality. There is great need for such dependable hydrometerological data before detailed engineering and agro-socio-economic planning can proceed, as the synthesized average monthly rainfall probabilities preclude agricultural production without irrigation.

Rainfall - There are no rainfall gauges within the project area. The nearest stations are Kalam (El. 565), Beko (El. 2260) Maji (El. 2316) and Lokitaung (El. 535, in Kenya).

A rainfall pattern has been synthesized based on known patterns and probabilities and adjusted for elevations 600 to 750 meters at valley latitudes. For computing consumptive use and irrigation diversion requirements, a total annual rainfall of 600 millimeters is assumed with a monthly distributional pattern as shown in Table IV-6.

1/ "Recent History of an Ethiopian Delta." 1971, Karl W. Butzer, University of Chicago Research Paper No. 136.

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Table IV- 5

Runoff - Omo River

First of Month Water Level of Lake Rudolph, (1)

	J	F	M	A	M	J	J	A	S	O	N	D	
1949	2.17	2.03	1.90	1.72	1.54	1.43	1.42	1.63	1.89	2.20	2.36	2.42	
1950	2.40	2.26	2.11	1.97	1.88	1.74	1.84	2.10	2.28	2.53	2.61	2.50	
1951	2.41	2.07	1.99	1.91	1.84	1.60	1.79	1.90	1.99	2.09	2.10	2.00	
1952	1.85	1.84	1.97	1.82	1.70	1.82	1.69	1.84	2.00	2.19	2.24	2.32	
1953	2.19	2.09	1.79	1.67	1.56	1.47	1.39	1.41	1.45	1.53	1.53	1.47	
Change in level, meters													
1949	-.14	-.13	-.18	-.18	-.11	-.01	+.21	+.26	+.31	+.16	+.06	-.02	
1950	-.14	-.15	-.14	-.09	-.14	+.10	+.26	+.18	+.25	+.08	-.11	-.09	
1951	-.34	-.08	-.08	-.07	-.16	+.19	+.11	+.09	+.10	+.01	-.10	-.15	
1952	-.01	+.13	-.15	-.12	+.12	-.13	+.15	+.16	+.19	+.05	+.18	-.13	
1953	-.19	-.21	-.12	-.11	-.09	-.08	+.02	+.04	+.08	.00	-.06	-.14	
Average 1949 - 1952 (meters)													Net
	-.16	-.06	-.14	-.12	-.07	+.04	+.18	+.17	+.21	+.07	-.02	-.10	0.00
Average 1949 -1952 (mm)													
	-160	-60	-140	-120	-70	+40	+180	+170	+210	+70	-20	-100	0.00
Assumed rain on lake (mm)													Total
	20	10	39	61	37	12	12	5	0	14	67	32	+308
Assumed evaporation and percolation (mm)													
	269	250	308	264	245	220	230	250	218	271	245	230	3000
Evaporation less rainfall (mm)													
	249	240	269	203	208	208	218	245	218	257	178	198	2692
=Runoff (mm)													
	89	180	129	83	138	248	398	415	428	327	158	98	2691
Omo @ 80% (mm) (2)													
	71	144	103	66	110	198	318	331	343	261	126	78	2149
Omo runoff in million cubic meters													
	530	1080	770	490	830	1480	2380	2470	2560	1960	940	580	16,070
Omo runoff in cubic meters per second													Aver.
	200	450	290	190	310	570	880	930	990	730	360	220	510

(1) From "Recent History of an Ethiopian Delta", Butzer.

(2) Omo River is assumed to contribute 80% of total runoff to Lake Rudolf.

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Table IV - 6

Synthesized Project Area Climate

	Rainfall (1) (mm)	Rainfall (1) (% of Ann.)	Temperature (2) (°C)	Evaporation (3) (mm)
Jan	29	4.4	27.1	156
Feb	26	44.3	27.3	145
Mar	108	18.0	26.9	179
Apr	134	22.3	25.9	153
May	70	11.7	25.9	143
June	19	3.1	25.4	128
July	29	4.8	25.2	133
Aug	13	2.2	24.8	145
Sep	8	1.4	25.0	127
Oct	44	7.4	26.3	159
Nov	95	15.8	25.8	143
Dec	25	4.1	25.3	133
	600	100.0	26.0	1744

(1) from % annual distribution at Lokomakingang Station
(2) from Elev. - Teng Curve.
(3) from pan evaporation at Bako adjusted to 600-750m elevations.

This pattern identifies the peak wet season from March through April when 23 percent would occur.

It is noted that, according to a 1968 NWRC map showing existing and proposed hydrology and meteorology stations in the Omo River Basin, a third-class weather station is proposed on the Omo River near the center of the selected study area. This station, in addition to meteorological recordings, would also be equipped with an automatic river level recorder, a bank operation cableway and a staff gauge. It is hoped that this station will be installed and equipped prior to undertaking detailed studies in this area as such data is prerequisite to feasibility grade analyses.

Temperature - Project area temperatures have been constructed from mean monthly values reported from Lokitaung, Kalam and Daboloo, at elevations 535, 565 and 1280 meters, respectively. Monthly amounts from these stations were adjusted for a mean annual of 26.0°C to satisfy an Elevation-Teng Curve for the project's assumed elevation. The synthesized values are included on Table IV-6.

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Evaporation - The nearest station with a class A pan is Bako, 60 kilometers due east of the valley center at 1980 meters elevation. Mean monthly values for over three years of record from this station have been used to construct monthly evaporation values considered valid for the project area. The synthesized amounts shown on Table IV-6 total 1,744 millimeters. Taking evaporation at 70 percent pan evaporation, the mean annual amount would be about 1,220 millimeters.

Soils

The soils in the Omo Valley, in particular the lower deltaic fans and the mid-valley plains, have been described by Butzer as Vertisols. The contemporary soils of the delta and floodplains are alluvial with weak diagnostic horizons. Organic matter is low, rarely exceeding two percent. Soil properties are dominated by the typical deep cracking traits, shallow humification and limited gleying. The flooded silts generally are brown with poorly defined A and B horizons of silty clay loam. The structure may be defined as massive, blocky and prismatic with occasional fine limolitic mottling in the subsoil. These soils are interspersed with basic deposits and clay plugs of deep cracking, dark gray clays with moderate to intense mottling.

The mid-valley plain soils found on the floor of the central basin commonly have impeded drainage after rains, and deep cracking patterns may develop during the drier parts of the year as the water-table lowers. Some dark cracking clay soils of intrazonal type are associated and such vertisols show considerable variation in response to facies changes or surface drainage.

In general, the soils are characterized by a high content of expanding lattice clay with cracks from one to 25 centimeters wide that reach to the middle of any solum present. They are developed from montmorillonitic parent material derived from either limestone, basic igneous rocks or granite. Climatic conditions favoring the formation of vertisols vary from sub-humid to arid but with seasonal sources of water adequate to thoroughly saturate the soil, with consequent swelling and closing of the cracks. The massive movements within the upper strata limits the use of these soils.

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Building foundations may be seasonally broken, and roadbeds may be tilted or severed. Plowing and cultivation must be done within limited periods following softening of the clays and before saturation makes farming operations difficult. The structure can be gradually improved as humus is plowed into the upper layers.

Population and Social Conditions

Population - CSO population estimates (1974) for Gofa Awraja are as follows:

Area(Km^2)	Population	Population per Km^2
11,500(1)	226,300	19.7

(1) includes 416,000 hectares of government owned grazing lands.

The aerial inspection of the Omo Valley clearly showed that this population was concentrated in the northern highlands of the awraja. The actual study area appeared to be deserted and dry at the time of the overflights (July/August, 1974). No villages or grazing camps (active or abandoned) were visible from low altitude observations.

Land Tenure and Farm Size - Land tenure data from Gemu Gofa Province are available at the awraja level and serve to indicate prevailing conditions. The National Sample Survey (CSO, 1968) report includes the following sampling results for Gofa Awraja: There are approximately 98,000 distinct cultivated fields in the awraja. Some 38,500 households are estimated with 83 percent, or 32,000, being farm families having on the average 3 fields each with a combined total of slightly more than half a hectare in cultivation. It is estimated that 30 percent of the holdings are farmed by owners and 64 percent by renters with six percent having both rented and owned portions.

Data published by the MLRA[1] confirms that the entire area under study lies within a 3,744-square kilometer (374,000-hectare) block of government owned land presently without settlement, grants or ownership claim disputes.

The People - According to Butzer, the Omo Basin is inhabited by three main tribal groups: the Dasanech, Bume and Murle. The

[1] "A Policy Oriented Study of Land Settlement," Vol. II, "The Resource Inventory," MLRA, 1969.

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Dasanech, estimated at about 8,000 people form the largest delta tribal organization and are becoming semi-sedentary, living primarily in villages near Lake Rudolf that vary in size from a few huts to nearly a hundred. Their economy is based on stock raising, agriculture and fishing; crops raised include millet, maize, beans, gourds and tobacco. Cultivation is limited to small widely dispersed fields which are seasonally flooded by the Omo. They rely on crude forms of basic agriculture and do not practice irrigation. Millet, the principal food, and other crops are sown upon recession of the flood waters, and mature from residual moisture held by the clay soils. Rainfall is too unreliable and too limited during the dry season to be of more than occasional value. Stock raising centers around Zebu-type cattle, goats, sheep and a few camels.

The Bume, also known by many other names, may number under 5,000. They grow similar crops as the Dasanech on the delta alluvial flats, but keep no cattle in this area. Their livestock are grazed over a wide area in both Kenya and Ethiopia depending upon the range conditions and available stock water. No estimated herd sizes could be obtained. The Murle tribes also raise similar crops but, with the exception of a few domestic animals, do not keep livestock. They are known to be hunters (primarily illegal elephant hunters) and depend on hunting and fishing throughout the delta for supplemental food.

PRESENT CONDITIONS

Existing Land Use

The selected project area is, for all practical purposes, barren and devoid of population. The land is sparsely covered with low thorn bushes and drought resistant succulents. Cattle are grazed by semi-nomadic herdsmen, mainly from the Bume tribe, following the main rainy season when forage is available.

Existing Agricultural and Livestock Production

Agricultural Production - The aerial surveys of the study area showed conclusively that present agricultural production is nil. No signs could be seen of abandoned fields and precipitation is insufficient for rain-fed agriculture.

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Livestock Production - The predominant grasses in the area are probably Thomeda, Cenchrus and Cynodon with an estimated carrying capacity of only 110 to 130 kilograms of live weight per year. This estimate, however, does not reflect the seasonal nature of the pasturage value which would be higher during and immediately following the wet season and greatly reduced in the drier months. In the dry season, water is available only from the Omo River.

Zebu-type cattle in this area are of small to medium size averaging 200 to 240 kilograms in the highlands and between 240 to 260 kilograms in the lowlands at maturity. Throughout the Hamer Bako and Gofa Awraja lowlands, migratory herds are grazed by Bume tribesmen whose range extends far south into Kenya and northward into the Dencia River basin, where higher rainfall provides more abundant pasture. As a consequence, there is considerable migration according to the season. Water supply becomes critical at places during the dry season and some cattle are watered only every second or third day.

The total cattle population for Gemu Gofa Province is reported to be slightly over 300,000 head. However, several successive years of less than average rainfall, have probably reduced this number considerably.

It has been impractical to estimate the value of livestock offtake which could be assigned to the periodic grazing time of livestock within the selected project area. Thus, the value of existing livestock production is taken to be nil.

Health

Livestock Diseases and Veterinary Services - The following diseases are known to exist in Gemu Gofa Province: Trypanosomiasis, Rinderpest, CBPP, FMD, Blackleg, Anthrax, Liverflukes, Helminth parasites of the digestive tract and external parasites (ticks, leeches, etc.). Brucellosis, Pasteurellosis, Tuberculosis, Piroplasmosis, Anaplasmosis, Heartwater and Rabies probably occur but have not yet been confirmed.

The Veterinary Services Division of the MOA maintains a well equipped veterinary clinic in Arba Minch staffed by a veterinarian, one animal health assistant and three vaccinators. In addition,

there are two animal health assistants and four to six vaccinators in each awraja where microscopes and stains for diagnostic purposes are present. The animal health center and laboratory nearest the project area is at Bako, about 60 kilometers away.

The JP-15 Rinderpest Control Program has been active in the Province for the past two years, and this disease is nearing control status.

Human Health - Human Trypanosomiasis probably exists but has not been positively confirmed. Malaria is endemic and the incidence is extremely high in the lower plains near Lake Rudolf. No data has been obtained concerning the location of health clinics near the project area, but it is likely that the closest available services are at Bako.

Communications

Existing Road Access - There is at present no road access to the project area. A track of sorts exists between Maji and Bako which crosses the area, but which is practically indistinguishable from the air. There are no bridges across the lower Omo River and it is extremely doubtful that the river could be forded anywhere along the southern portion even in the driest months. Maji can be reached in the dry season via an extremely difficult track leading south from Mizan Tefari, and an indistinct trail connects Bako with Arba Minch through Gidole. Livestock trails lead northward from Lake Rudolf into grazing areas along the western banks of the Omo but are less well defined on the project's eastern bank.

The future construction program of IHA and preliminary schedules have been discussed in Part I of this report and will not be repeated here.

Other Services - Scheduled airline services to Arba Minch, Bulki and Bako are available thrice weekly via Ethiopian Air Lines, and Maji is served twice a week. There are numerous small landing strips in the province, many of them at various mission stations and large private farms, which can accommodate small aircraft. Postal, telegraph and telephone services are available at Bako and at other centers in the province.

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Markets

Agricultural Markets - A well-developed market exists in Arba Minch which includes several retail merchants with established trades and a daily operated open air market. Smaller markets are found in Bako, Gardula and Bulki, nearer to the project area. Once the project area is connected by all weather road to Arba Minch, via Bako and Gardula, all surplus products would flow along this route. Gemu Gofa is a food importing province and the yields from 25,000 irrigated hectares of land along the Omo River could easily make up the existing deficit and provide surpluses for shipment to Addis Ababa and abroad. The extent of the effective market demand cannot be quantified without a detailed survey of the area during feasibility investigations.

Livestock Markets - There are 11 known cattle markets in Gemu Gofa Province. The one nearest to the project area is at Bako which handles from 500 to 600 animals per year, all for slaughter. Some cattle from Hamer Bako and Gofa Awrajas are marketed at Otolo, but the vast majority are sold in Kenya and Sudan where many of the herds are pastured during the dry seasons. The average prices for cattle quoted in the province are E$120 to E$140 for a good quality slaughter animal, E$60 to E$80 for low quality, and around E$100 to E$140 for draft and breeding stock.

DEVELOPMENT STRATEGY

One of the primary objectives of development would be the settlement of indigenous people into a pattern of productive agricultural and possibly livestock operations combined with the introduction of farmers from the nearby highlands or from drought stricken areas. The 50,000 hectares selected for appraisal would be divided into 25,000 hectares of farmlands on the more productive soils and possibly 25,000 hectares of controlled grazing on lands of lower potentiality.

As rainfall is insufficient to meet evapotranspiration requirements, even in the principal wet season, irrigation and drainage facilities would be required. Thus, two or more crops per year could

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be harvested since temperatures favor year-around cultivation.

It is provisionally planned to provide irrigation water by pumping from unregulated Omo River flow. It is essential that the proposed gauging station in the project area be operative for a sufficient time prior to implementation to accumulate accurate low flow data. Should such data indicate that low flows would be insufficient for dry season irrigation, storage sites in several Omo tributaries should be investigated.

An internal feeder road network would be constructed to all weather standard to provide the area with convenient access to the proposed IHA highway improvements, linking the area to the awraja and provincial capitals. Other required infrastructure would include a demonstration and seed multiplication farm, veterinary and extension services, and the necessary community and public services.

Conservation

A primary objective in a development scheme should be the conservation and, where possible, the improvement of the environment within the project area. While the ecology of the Omo project area would be altered by irrigated agriculture and possibly livestock development, the alterations in several instances would be for the better.

Soil Conservation - As mentioned in Part I, the soil loss from annual erosion has been estimated to range from 40 to 200 tons per square kilometer. Considering the gentle slope of the terrain on the project, it is unlikely that the annual soil loss in this area would greatly exceed the minimum (40 tons per square kilometer).

Implementation of an irrigation and drainage project would serve to reduce erosion in the valley. Roadways, irrigation canals, and drainage ditches, constructed on calculated gradients, would control local surface runoff and effective channel all waters into the Omo River. Controlled grazing in the livestock area would allow for a cover of perennial grasses to provide a measure of erosion control.

Forest Conservation - The presently forested strip along the Omo River would be left in an undisturbed state. The western

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boundary of the project would be located about a kilometer landward for Tsetse control. The scattered low brush and shrubs would be removed from the project during the Tsetse fly eradication program. However, on each of the 2,500 ozen farms, one hectare has been set aside for residence and other farm structures, home gardens, and the establishment of a small woodlot or forested area. Wood is consumed daily as it is the principal material used for cooking fires. Without woodlots, the farm families would quickly consume the remaining trees on the project and then seek timber in the riverine forest and the escarpment to the east of the area, thus hastening the destruction of the remnants of natural forests and greatly increasing the rate of erosion.

Quick-growing tree seedlings, especially tall straight species which would not harbor Tsetse flies, could be provided each family through the extension services included in the project's budget. In addition to firewood, such trees would be a source of building poles and fence posts. Fruit trees, such as mangoes, avocadoes, citrus and papayas, would provide the farm family with supplemental food and a more nutritious diet. The balance of forest conservation thus favors the establishment of the project.

Wildlife Conservation - As mentioned in Part I, it is impossible to eradicate or effectively maintain a low incidence of livestock disease unless wild animals can be prevented from entering the area. It is likely that the construction of dikes, the excavation of canals and drainage ditches, and the increase of population would serve as a partial barrier to the intrusion of some wild animal species. However, the availability of water throughout the year, over all of the project, would attract others. Measures would have to be adopted to eliminate or reduce the risks of infected wildlife invading the developed area.

It is noted that the Wildlife Conservation Organization proposed a wildlife reserve from the Omo River eastwards into the

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hilly land. While the many species of wildlife located in this area should be protected, it is believed that such can be accomplished by demarcating and controlling much smaller areas in the Omo River vicinity. The areas noted above comprise almost all of the prime irrigable lands along the lower river reaches which will be needed in the future to feed a growing national population, provide settlement areas, and possibly produce export crops to earn foreign exchange.

Resettlement

The strategy is to settle 2,500 families on irrigated five-hectare oxen-powered farm units. Every effort must initially be made to induce the semi-nomadic tribes who consider the entire lower Omo River plains as tribal and communal territory to accept settled agriculture. If they cannot be settled into the farming units, they should be convinced to pasture their livestock within the 25,000 hectare controlled grazing area provided they accept the conditions of control imposed.

Other families would primarily be drawn from the overcrowded highland areas of Gemu Gofa Province, but could also be partially recruited from the drought stricken areas in the country. In addition to the 2,500 settlement units, many additional families would be permanently employed on the larger tractor farms being considered.

It is estimated that in Gofa Awraja alone, there are some 10,000 families presently occupying less than 0.3 hectare of cultivated rented land, that could provide the bulk of new settlers. By moving families from the nearby upland plateaus, dual benefits could be realized. Relocation costs would be minimized and the remaining farm units in the highlands could be increased to a more profitable size.

The present condition of the proposed beneficiaries is one of subsistence farming and nomadic livestock raising. On the average, about one half of their cultivated fields are planted with maize and the balance with teff, sorghum, barley and beans. The yields are mainly used for home consumption with only minimum amounts sold at low harvest time prices on local markets for cash needs.

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Land Capability

Based on known soils information, topographic maps, aerial photographs and aerial inspections, the land capability has been tentatively classified as to capability. The most promising 25,000 of the 50,000 hectares selected for this study would be utilized for settled irrigated agriculture development.

Class I lands cannot be identified without more detailed studies. The tentative distribution of land in the other arable categories is as follows:

Class II - 8,750 hectares or 35 percent
Class III - 12,500 hectares or 50 percent
Class IV - 3,750 hectares or 15 percent

Class II Lands - roughly between elevations 600 and 650 meters are Vertisols with a relative higher percentage of silts and sands from quaternary and more recent alluvium than lands at higher elevation away from the river. They are uniquely suited for a wide range of crops if irrigated, but are presently limited by poor surface drainage resulting from periodic waterlogging. They have structural defects common to Vertisols but less severe than the flooded deltaic lands at lower elevations.

These lands could support the cultivation of superior quality Virginia-type tobaccos, garden vegetables, cotton, beans, groundnuts (peanuts), as well as cereals.

Class III and IV Lands - interspersed and occur between about 600 and 700 meters elevation on intermediate terraces which roughly parallel the river at distances varying from five to 10 kilometers. They are similar in texture and structure but differ primarily in topographic limitations and development costs. Class III lands would not require leveling for irrigation; however, the closely associated Class IV lands have localized slopes, small gullies and broken topography which are not severe enough to be separated from Class III lands, so may be developed as part of the project. These lands, if levelled and provided with dependable irrigation, could produce long staple cotton and a wide variety of cereals, including rice, maize, sorghum, oats, millet and sesame.

Cropping Patterns

For purposes of this prefeasibility report and comparative analysis with the other three projects, a simplified pattern of crops has been assumed for the entire project area which considers the availability of irrigation for sustained double cropping. The adopted patterns for both the five and 250-hectare model farms, during the wet and dry seasons, are given in Table IV-7.

Table IV - 7

Cropping Patterns - Omo Plains

	Model Five-Hectare Oxen Farms	Model 250- Hectare Tractor Farms
Wet Season		
Maize	2	-
Sorghum	2	250
Dry Season		
Cotton	2	250
Pulses	1	-
Sorghum	1	-

Model Farm Budgets

Model Five-Hectare Oxen Farms - Table IV-8 gives the basic direct parameters adopted for financial analysis of the smaller oxen farms. Yields are believed to be conservative and consider the capability of the soil, favorable climatic conditions, the availability of inputs and the ability of the prospective farmers. Yields are somewhat higher than were used for the Gambela Project (Part II) to account for the effect of lower percentage of cloud cover in the Omo area. Prices used were discussed in Part I of this report.

The estimated indirect costs, also utilized in computing the financial analysis of the model farm units, are given in Table IV-9.

Model 250-Hectare Tractor Farms - Table IV-10 gives the basic direct parameters used for crops on the larger model 250-hectare tractor farm units. Cropping patterns have been simplified to show border-to-border sorghum in the wet season and cotton in the

Table IV - 8

Basic Direct Parameters for Crops on 5 Hectare Oxen Farms
Omo Project - Irrigated

Item	Units	Wet Season		Dry Season		
		Maize	Sorghum	Pulses	Cotton	Sorghum
Returns						
Yield	qq/ha	32	28	16	19	28
Price	E$/qq	12	14	20	55	14
Sales	E$/ha	384	392	320	1045	392
Direct Inputs						
Seed and Seed Treatment	E$/ha	11	6	26	18	6
Fertilizer	E$/ha	32	23	-	77	23
Insecticide	E$/ha	32	32	32	80	32
Bags	E$/ha	-	-	-	12	-
Total	E$/ha	75	61	58	187	61
Labor	hrs/ha	785	665	560	850	690
Oxen	hrs/ha	90	90	90	90	90

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Table IV - 9

Indirect Costs for Model Five-Hectare Oxen Farm
Omo Project - Irrigated

Item	Annual Costs(E$)
Oxen Maintenance (1)	10
Goats, Sheep etc Maintenance (1)	2
Repairs and Maintenance	44
Land Tax	9
Family cash expenses (2)	240
Hired labor (3)	125
Home Consumption - Maize (4)	84
Home Consumption - Sorghum (5)	42
Home Consumption - Pulses (6)	20
Total	576

(1) minerals, Tick control and medical
(2) assumes family of six
(3) assumes 1000 hours annually
(4) 7 quintals @ E$12 per quintal
(5) 3 quintals @ E$14 per quintal
(6) 1 quintal @ E$20 per quintal

Table IV - 10

Basic Direct Parameters for Crops on 250 Hectare Tractor Farms
Omo Project - Irrigated

Item	Units	Wet Season Sorghum	Dry Season Cotton
Returns			
Yield	qq/ha	32	26
Price	E$/qq	14	55
Sales	E$/ha	448	1430
Direct inputs			
Preharvest			
Machine	E$/ha	11	16
Labor	E$/ha	35	40
Seed & Seed Treatment	E$/ha	6	24
Fertilizer	E$/ha	23	77
Food-labor	E$/ha	4	6
Insecticide	E$/ha	32	80
Subtotal		111	243
Harvest			
Machine	E$/qq	0.20	0.30
Labor	E$/qq	1.50	5.20
Materials	E$/qq	1.90	1.40
Subtotal	E$/qq	3.60	6.90
Subtotal	E$/ha	115	179
Total	E$/ha	226	422

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dry season under-irrigated agriculture. Somewhat higher yields were used than for the Gambela Project for reason stated above under oxen farms.

The estimated indirect costs for the model 250-hectare tractor farm, are given in Table IV-11.

Table IV - 11
Indirect Costs for Model 250-Hectare Tractor Farm
Omo Project

Item	Annual Costs (E$)
Salaries	3,100
Repairs and Maintenance (buildings)	700
General Transportation	700
Management - Imputed	4,200
Land Tax	500
Total	9,200

Financial Analyses of Model Farms

Cash flow projections were worked out for the model farms based on the cost and revenue data derived in the preceding paragraphs and on investment expenditures presented hereinbelow.

Model Five-Hectare Oxen Farm - The investment and replacement schedule adopted for the five-hectare oxen farm is given in Table IV-12.

The cash flow analysis is presented in Tables IV-13. Loan repayment (at 12 percent interest) was assumed over a period of four years with a one-year grace period. Short term interest for production loans was assumed at 14 percent. Buildup to full production was taken to be five years. Water charges were derived from amortization of capital costs for water control facilities and the annual operation and maintenance costs thereof (see the section, Infrastructural Development Plan). Agricultural income tax is based on the official Imperial Ethiopian Government Tax Schedule (Negarit Gazeta, 27th year, No. 4, November 23, 1967).

The resulting cash flow, even with considerable water charges, is indicative of a viable oxen-farm operation.

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Table IV - 12

Investment Requirements for Model Five-Hectare Oxen Farm
Omo Project (E$)

Item	Units	Life (Year)	Year 1	Year 5	Year 9	Year 11	Year 16	Year 17
Oxen	1 pair	5	360	240(1)	-	240	240	--
Donkey	1	10	25	--	--	25	--	--
Sheep, Goats, Chickens	set	--	100	--	--	--	--	--
Plow	1	8	50	--	50	--	--	50
Plow-rider	1	8	50	--	50	--	--	50
Harrow	1	8	50	--	50	--	--	50
Back-Pack Sprayer	1	5	70	70	--	70	70	--
Miscellaneous	1 set	5	50	50	--	50	50	--
Tukul	1	10	150	--	--	150	--	--
Store	Materials	10	75	--	--	75	--	--
Thresher-hand	1	10	75	--	--	75	--	--
Total	--	--	1055	360	150	685	360	150

(1) Assumes sales price of E$120 for old pair or net replacement cost of E$240 per pair.

Table IV - 13

Cash Flow for Model Five-Hectare Oxen Farm
Omo Project - Irrigated
(Ethiopian Dollars)

Years	1	2	3	4	5	6	7-8	9	10-12
Cash Inflow									
Sales (1) (2)	435	1306	2612	3919	4354	4354	4354	4354	4354
Less Home Consumption	146	146	146	146	146	146	146	146	146
Loan	1295	--	--	--	--	--	--	--	--
Total	1584	1160	2466	3773	4208	4208	4208	4208	4208
Cash Outflow									
Direct Expenses (2)	77	230	459	688	765	765	765	765	765
Indirect Expenses (3)	56	56	181	181	181		181	181	181
Land Tax	9	9	9	9	9	9	9	9	9
Income Tax (4)	2	35	79	114	171	171	171	171	171
Investment	1055					360		150	--
Short-Term Interest	6	13	27	38	42	42	42	42	42
Family Expenses	240	240	240	240	240	240	240	240	240
Total	1445	583	995	1270	1408	1768	1408	1558	1408
Cash Balance	139	577	1471	2503	2800	2440	2800	2650	2800
Debt Service	80	469	469	389	389	--	--	--	--
Cash Balance	59	108	1002	2114	2411	2440	2800	2550	2800
Water Charge	--	--	--	1452	1452	1452	1452	1452	1452
Cash Balance	59	108	1002	662	959	988	1348	1198	1348

(1) Assumes Buildup of 10, 30, 60, 90 and 100 percent for years 1 through 5
(2) Full development based on 2 hectares each of maize and sorghum in wet season and 1 hectare each of pulses and sorghum and 2 hectares of cotton in the dry season.
(3) Annual maintenance and repairs for years one and two; plus hired labor thereafter.
(4) Taxable income computed as sales less land taxes less ¼ sales representing costs.
(5) Assumes B$240 food allowance interest free.

Model 250-Hectare Tractor Farm - The investment and replacement schedule assumed for the model 250-hectare tractor farm is given in Table IV-14. It was assumed that 70 percent of the initial outlays would be financed at 12 percent interest.

The cash flow analysis is presented in Table IV-15. Loan repayment (at 12 percent interest) was assumed over three years with no grace period. Short term interest for production and harvest loans was assumed at 14 percent. Buildup to full production was taken to be four years. Water charges and income tax were derived as stated above for the oxen farm.

The resulting cash flow is indicative of a very viable commercial operation.

LIVESTOCK DEVELOPMENT PLAN

The viability and economic feasibility of a livestock operation is dependent upon the identification of constraints and the possibility of minimizing their effects.

The principle constraints to livestock production in the Omo project area are:

- livestock diseases, particularly Trypanosomiasis which hampers any serious attempts to develop a livestock project in the southwest lowland (other viral, bacterial and parasitic diseases, unless controlled will also limit livestock production);
- critical shortage of water during the dry season;
- lack of an existing cattle market in the immediate area;
- a low population of cattle in the immediate area;
- an almost complete lack of infrastructure (roads, etc.);
- use of non-selective breeding practices;
- lack of an extension and education program; and
- a lower animal carrying capacity on the grazing area.

Potentials for development of a livestock program are:

- a population of nomadic pastoralists that might be induced to settle given the opportunity and if disease constraints are minimized and water supply is assurred;
- although not the usual type in the area, cattle of the

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Table IV - 14

Investment Requirements for Model 250-Hectare Tractor Farm
Omo Project
(thousnad E3)

Item	No Units	Life (yrs)	Year 1	Year 9	Year 11	Year 17
Tractor-70ph	2	8	30.0	30.0	--	30.0
Widelevel -15'	2	8	13.6	13.3	--	13.6
Drill - 12'	2	8	12.0	12.0	--	12.0
Sprayer - 32'	1	8	6.0	6.0	--	6.0
Trailer - 3T	2	8	4.8	4.8	--	4.8
Land development	-	--	2.5	--	--	--
Tukuls	3	10	1.8	--	1.8	--
Pole shed	1	10	4.8	--	4.8	--
Total			75.5	66.4	6.6	66.4

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Table IV - 15

Cash Flow for Model 250-Hectare Tractor Farm
Crop Project - Irrigated
(Thousand D$)

Years	1	2	3	4-8	9	10	11	12
Cash Inflow								
Sales (1) (2)	281.7	375.6	422.6	469.5	469.5	469.5	469.5	469.5
Loan	52.8	--	--	--	--	--	--	--
Total	334.5	375.6	422.6	469.5	469.5	469.5	469.5	469.5
Cash Outflow								
Direct Expenses (2)	97.2	129.6	145.8	162.0	162.0	162.0	162.0	162.0
Indirect Expenses	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Land Tax	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Income Tax (3)	53.3	72.2	81.6	91.2	91.2	91.2	91.2	91.2
Investment	75.5	--	--	--	66.4	--	6.6	--
Short-Term Interest	5.2	6.4	7.2	8.0	8.0	8.0	8.0	8.0
Total	240.4	217.4	243.8	270.4	336.8	270.4	277.0	270.4
Cash Balance	94.1	158.2	178.8	199.1	132.7	199.1	192.5	199.1
Debt Service	22.0	22.0	22.0	--	--	--	--	--
Cash Balance	72.1	136.2	156.8	199.1	132.7	199.1	192.5	199.1
Water Charge	90.7	90.7	90.7	90.7	90.7	90.7	90.7	90.7
Cash Balance	(18.6)	45.5	66.1	108.4	42.0	108.4	101.8	108.4

(1) assumes buildup of 60, 80, 90 and 100 percent for years 1 through 4
(2) full development assumes 250 hectares each of cotton and sorghum
(3) taxable income computed as sales less land taxes less ¼ of sales representing costs.

may be lacking when a humic A horizon, thicker than 25 centimeters, is present and are not saline, at least within the upper 125 centimeters. They lack an aridic moisture regime as well as hydromorphic properties within 50 centimeters of the surface. Humic Cambisols do possess an umbric A horizon which is thicker than 25 centimeters when the cambic horizon is lacking. The requirements of the umbric A horizon may be summarized as follows:

1) soil structure sufficiently strong that the horizon is neither massive nor hard when dry;
2) has color with chroma of less than 3.5 when saturated, over 3.5 when moist, and 5.5 when dry;
3) has organic matter content of at least one percent throughout the thickness of the mixed soil; and
4) has a base saturation of less than 50 percent.

Horizons that have acquired the above characteristics through slow additions of materials under cultivation are excluded from the umbric category.

Population and Social Conditions

Population - The project area includes portions of Limu Awraja of Kefa Province and Bedele Awraja of Ilumabor Province. The estimated population of these two awrajas is as follows:[1/]

Awraja	Rural	Urban	Total
Limu	282,500	14,700	297,200
Buno Bedele	214,800	2,500	217,300
Total	497,300	17,200	514,500

The above figures are valid indicators of total nearby population from which project settlers could be drawn. The vast majority of inhabitants live in overpopulated highland areas

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1/ Sources: "The Demography of Ethiopia", Results of the National Sample Survey, 1974, SCO.

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surrounding the valley, having been driven from the lowlands by Tsetse flies and malarial mosquitos. By aerial inspection, it can be determined that, with the exception of two large farms, the entire project area is devoid of signs of habitation. In a Phase II study, the legal status of these farms would be determined and they could be incorporated into project planning and assisted, as required, to reach full productivity in order to serve as an early demonstration of the area's potential.

There are no villages, schools or other infrastructural facilities in the valley. Development plans would provide for public services during the project implementation stage.

Land Tenure - CSO data[1/] are available at the awraja level only, but are indicative of prevailing farm patterns surrounding the valley.

Awraja	Farm Families	Hectares in Cultivation/Family	Average No. of Parcels/Family
Buno Bedele	52,000	0.69	2.5
Limu	78,000	0.90	2.5

The apparent overcrowding would be more acute if it could have been broken down further to show those areas, within each awraja, which were sparcely, or not at all, populated.

Land tenancy patterns for the two awrajas are summarized as follows:

Land Tenure on Farm Lands (in percent)

Awraja	Fully Owned	Rentals	Mixed Rental/Owned
Buno Bedele	25	73	2
Limu	38	59	3

As mentioned earlier, the valley itself is practically devoid of habitation. The MLRA estimates that there are 26,600 hectares of government land in the area adjacent to the Bedele-Arjo road and some 5,500 hectares scattered upstream. However, since the balance of the area is unoccupied and no tax revenues have ever been received therefrom, there are no valid private ownership

1/ "National Sample Survey", CSO, revised 1970.

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The annual maintenance cost of the above road network is estimated to be in the order of E$ 50,000.

Water Control Facilities

In order to implement a two (or more) crop development, irrigation, drainage, and flood prevention facilities would be required. Preliminary, schematic layouts of these facilities are shown on Figure IV-1, following page IV-1.

It is envisaged that the irrigation water supply would be provided by a multiple-unit pumping plant lifting water from the Omo River into a gravity irrigation canal system.

Drainage canals would flow by gravity into the several water courses within the project area, thence through control structures in the flood prevention dike back into the Omo River.

Overbank flooding would be prevented by constructing a low dike along the Omo River (behind the riverine forest), thence inland to ground lying above flood level.

Irrigation Water Requirements - The consumptive uses of the various crops were estimated by the Blaney-Criddle method, modified to fit the climatic conditions of the area.

The amount of precipitation that is effective for irrigated crops was estimated on the basis of a method presented in "Technical Release No. 21" of the Soil Conservation Service (SCS) of the United States Department of Agriculture (USDA), 1964.

The net irrigation amounts at the field have not been modified by water requirements that may be required for tillage and seeding and by changes in soil moisture at the beginning, during, and at the end of cropping seasons.

For purposes of this pre-feasibility study, overall irrigation efficiencies have been taken conservatively as 50 percent for all crops.

The diversion requirements at the pumping plant, in liters per second per hectare for the individual crops are summarized in Table IV-17.

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Table IV - 17

Mean Monthly Irrigation Requirements at Pumping Plant
Omo Project (liters/sec/ha)

Month	Crop			
	Cotton	Maize	Sorghum	Pulses
January	1.58			
February	1.32			
March	0.27			
April	0.00			
May		0.48	0.26	
June		1.14	1.97	
July		1.25	1.22	
August		1.14	0.37	
September	0.10		0.48	0.48
October	0.10		1.46	1.46
November	0.33		0.80	0.80
December	1.33		0.31	0.31

On the bases of the unit irrigation requirements summarized in Table IV-17 and the cropping patterns discussed in a previous section, the overall project irrigation water requirements were estimated and are summarized in Table IV-18.

Estimated Costs - The estimated order-of-magnitude costs of water control facilities for the Gambela irrigated agriculture project are summarized in Table IV-19.

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Table IV - 18

Monthly Irrigation Water Requirements
Omo Project (cubic meters per second)

Crop	Area(ha)	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Wet Season													
Maize	5,000	-	-	-	-	2.4	5.7	6.3	5.7	-	-	-	-
Sorghum	17,500	-	-	-	-	4.6	34.5	21.4	6.5	-	-	-	-
Dry Season													
Cotton	17,500	27.7	23.1	4.7	-	-	-	-	-	1.8	1.8	5.6	23.3
Sorghum	2,500	-	-	-	-	-	-	-	-	1.2	3.7	2.0	0.8
Pulses	2,500	-	-	-	-	-	-	-	-	1.2	3.7	2.0	0.8
Totals		27.7	23.1	4.7	-	7.0	40.2	27.7	12.2	4.2	9.2	9.6	24.9

Table IV - 19

Estimated Capital Costs - Water Control
Omo Project - Irrigated (Thousand E$)

	Project Years					
	-1	1	2	3	4	Total
Pre-Construction	810	-	-	-	-	810
Pumping Plant	-	2,140	2,150	2,150	2,150	8,590
Main Canal	-	1,440	1,600	980	980	5,000
Lateral Canals	-	3,750	4,500	5,250	4,900	18,400
Distribution System	-	5,250	6,750	7,500	7,500	27,000
Drainage System	-	3,750	6,350	6,300	6,300	22,700
Flood Prevention Dike	-	6,800	-	-	-	6,800
Control Structures	-	1,500	3,300	2,150	2,050	9,000
Land Development	-	1,370	1,350	1,670	2,310	6,700
Totals	810	26,000	26,000	26,000	26,190	105,000

The order-of-magnitude annual operation and maintenance costs for the complete water control system were estimated at roughly E$ 3,240,000.

To provide provisional figures for water charges in the model farm cash flow analyses, presented earlier in this part, the total order-of-magnitude capital cost was amortized over a period of 40 years at 3½ percent interest. The resultant annual amount was E$ 4,917,000. Adding the annual operation and maintenance costs to this amount and dividing by the total cultivated area (22,500 hectares) resulted in a provisional water charge of E$ 363 per irrigated hectare.

PRELIMINARY ECONOMIC ANALYSIS

Economic Costs

To determine the order-of-magnitude economic costs of the Omo Project, the methodology described in Part I of this report was applied to the capital and recurring costs estimated for roads; water control facilities; and farm investment costs, in this part, and for mapping and surveys; credit, marketing and storage; resettlement

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allowances; and management, testing and extension services, presented in Part I. The resulting economic cost stream over a 20-year period of analysis is given in Table IV-20.

Net Project Benefits and Internal Economic Rate of Return.

To determine the gross benefit margin, model farm costs were converted to economic costs, using the factors presented in Part I of this report, and subtracted from sales. These figures were aggregated according to the assumed rate of buildup (500 oxen farms per year over a five year period and 10 tractor farms in project year 2 and 20 each in project years 3 and 4). The resulting benefit stream is given in Table IV-21.

The gross project cost stream (Table IV-20) was then subtracted from the gross benefit stream to yield the net project benefit stream (also shown in Table IV-21). The preliminary internal economic rate of return from the project was found by discounting this net benefit stream. The preliminary rate of return on total project investments is 16 percent.

Table IV - 20
Economic Costs of Omo Project - Irrigated
(Million E$)

Project Year	Water Control	Roads	Mapping & Surveys	Credit, Marketing & Storage	Resettlement Allowance	Public Services	Management, Testing, Training & Estension	Total Farm Investment	Gross Project Costs
-1	0.73	0.09	0.04	--	--	--	--	--	0.86
1	23.34	0.63	0.04	0.17	0.21	0.12	0.75	0.51	25.77
2	24.71	0.63	--	0.26	0.21	0.14	0.54	1.82	28.31
3	25.40	0.63	--	0.15	0.21	0.14	0.49	3.32	30.34
4	26.09	0.04	--	0.18	0.21	0.14	0.42	3.64	30.72
5	2.75	0.04	--	0.29	0.21	0.14	0.42	1.30	5.15
6	2.75	0.04	--	0.19	--	0.12	0.50	0.73	4.33
7	2.75	0.04	--	0.19	--	0.13	0.45	0.52	4.08
8	2.75	0.04	??	0.30	--	0.14	0.42	0.25	3.90
9	2.75	0.04	--	0.19	--	0.15	0.47	0.91	4.51
10	2.75	0.04	--	0.31	--	0.16	0.42	1.55	5.23
11	2.75	0.04	--	0.20	--	0.16	0.52	1.73	5.40
12	2.75	0.04	--	0.20	--	0.16	0.45	0.46	4.06
13	2.75	0.04	--	0.20	--	0.16	0.42	0.46	4.03
14	2.75	0.04	--	0.20	--	0.16	0.42	0.30	3.87
15	2.75	0.04	--	0.20	--	0.16	0.42	0.30	3.87
16	2.75	0.04	--	0.20	--	0.16	0.50	0.18	3.83
17	2.75	0.04	--	0.20	--	0.16	0.50	0.91	4.56
18	2.75	0.04	--	0.20	--	0.16	0.42	1.57	4.14
19	2.75	0.04	--	0.20	--	0.16	0.42	1.57	5.14
20	2.75	0.04	--	0.20	--	0.16	0.42	(5.53)	(1.96)

Table IV - 21

Derivation of Net Project Benefits

and Basic Internal Economic Rate of Return

Omo Project - Irrigated

(Million E$)

Project Year	Gross Benefit Margin 0-5	T-250	Total	Gross Project Costs	Net Project Benefits
-1	-	-	-	0.86	(0.86)
1	0.16	-	0.16	25.77	(25.61)
2	0.36	2.00	2.36	28.31	(25.95)
3	1.75	6.68	8.43	30.34	(21.91)
4	3.36	12.41	15.77	30.72	(14.95)
5	5.15	14.86	20.01	5.15	14.86
6	6.78	16.32	23.10	4.33	18.77
7	8.05	17.08	25.13	4.08	21.05
8	8.77	17.08	25.85	3.90	21.95
9	8.95	17.08	26.03	4.51	21.52
10	8.95	17.08	26.03	5.23	20.80
11	8.76	17.08	25.84	5.40	20.44
12	8.57	17.08	25.65	4.06	21.59
13	8.38	17.08	25.46	4.03	21.43
14	8.19	17.08	25.27	3.87	21.40
15	8.00	17.08	25.08	3.87	21.21
16	8.00	17.08	25.08	3.83	21.25
17	8.00	17.08	25.08	4.56	20.52
18	8.00	17.08	25.08	5.14	19.94
19	8.00	17.08	25.08	5.14	19.94
20	8.00	17.08	25.08	(1.96)	27.04
				NPW @ 15%	+2.50
				IERR	16%

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PART V

SAGAN PROJECT

DESCRIPTION OF PROJECT AREA

Location

Two potential project areas were investigated in the Sagan River Basin. Both were mentioned in the Interministerial Sub-Committee's Reconnaissance Report, and also had been identified by the former USAID pilot, Mr. Temple, in his aerial observation report (1973) to the Soil and Water Conservation Department, MOA.

One area begins approximately 30 kilometers south of Lake Chamo where the Sagan emerges into an undulating, eroded and sparcely populated valley. The irrigable lands in the valley extend for some 25 kilometers along the Sagan River at widths up to ten kilometers or more.

The second area lies due north of the confluence of the Sagan with its major tributary, the Galana Dulei River, some 50 kilometers north of Chew Bahir. From the junction of these two streams, an almost unsettled but level valley extends northward (upstream) for some 60 kilometers along both banks of the Galana Dulei and considerable areas of arable lands extend both eastward and westward into smaller tributary basins.

This latter area has been chosen for preliminary economic analysis for the following reasons:

1) The saline content of the Sagan River is reported to be quite high with values ranging between 1.1 millimhos at 25°C (at road bridge) to 0.9 millimhos at 25°C (at Upper Valley).[1/] Both readings give these waters a USBR classification for irrigation purposes of C_3S_2 (very poor for most crops).

[1/] "Development Prospects in the Southern Rift Valley," Ethiopia. 1974 by Mabin, Kingham, et. al., Overseas Development Administration, Foreign and Commonwealth Office, U. K.

2) Tobacco leaf damage, related to overhead sprinkling using waters from Lake Abaya has been reported.[1]

3) An examination of aerial photographs and aerial observations showed that irrigation of the Upper Valley would require storage and either high level pumping or lengthy canals from the dam site through extremely difficult terrain. The lift required on Galana Dulei would be considerably less.

4) A potential storage site was identified on the Bala River, a tributary of the Galana Dulei, east of Bako, which could effectively store about 40 million cubic meters of water for irrigation releases; storage sites are believed to exist on other tributaries but have not been identified yet.

As the Sagan River is fed by overflow from two reported saline lakes (in turn fed partly by hot mineral springs) there is reason to delay plans to use this water for irrigation purposes until sufficient data are available for the evaluation of the long term risks involved.

The selected project area is shown on Figure V-1. It lies approximately between latitudes 5°20' and 5°50'N, and longitudes 36°50' and 37°5'E. The lands studied for settled agricultural development lie within Hamer Baro and Gardula Awrajas.

Climatology and Hydrology

Climatological and Hydrological Stations - For the general area under consideration, climatological stations have been operated for a moderately long period only at Bako (Mission), northwest of the area in the Omo Basin, and at Arba Minch to the northeast and east. Short period peripheral stations exist at Cambo, Pera, Colmo, Giresso and Tortellia.

The Sagan River Basin rises far to the northeast with much of the basin draining to Lake Abaya, which in turn drains into Lake Chamo. Until recently, Lake Chamo was considered to have no outlet but in reality spills into the Sarmallo River which, at about latitude 5°-30', becomes the Sagan River. Water level recorders exist at the

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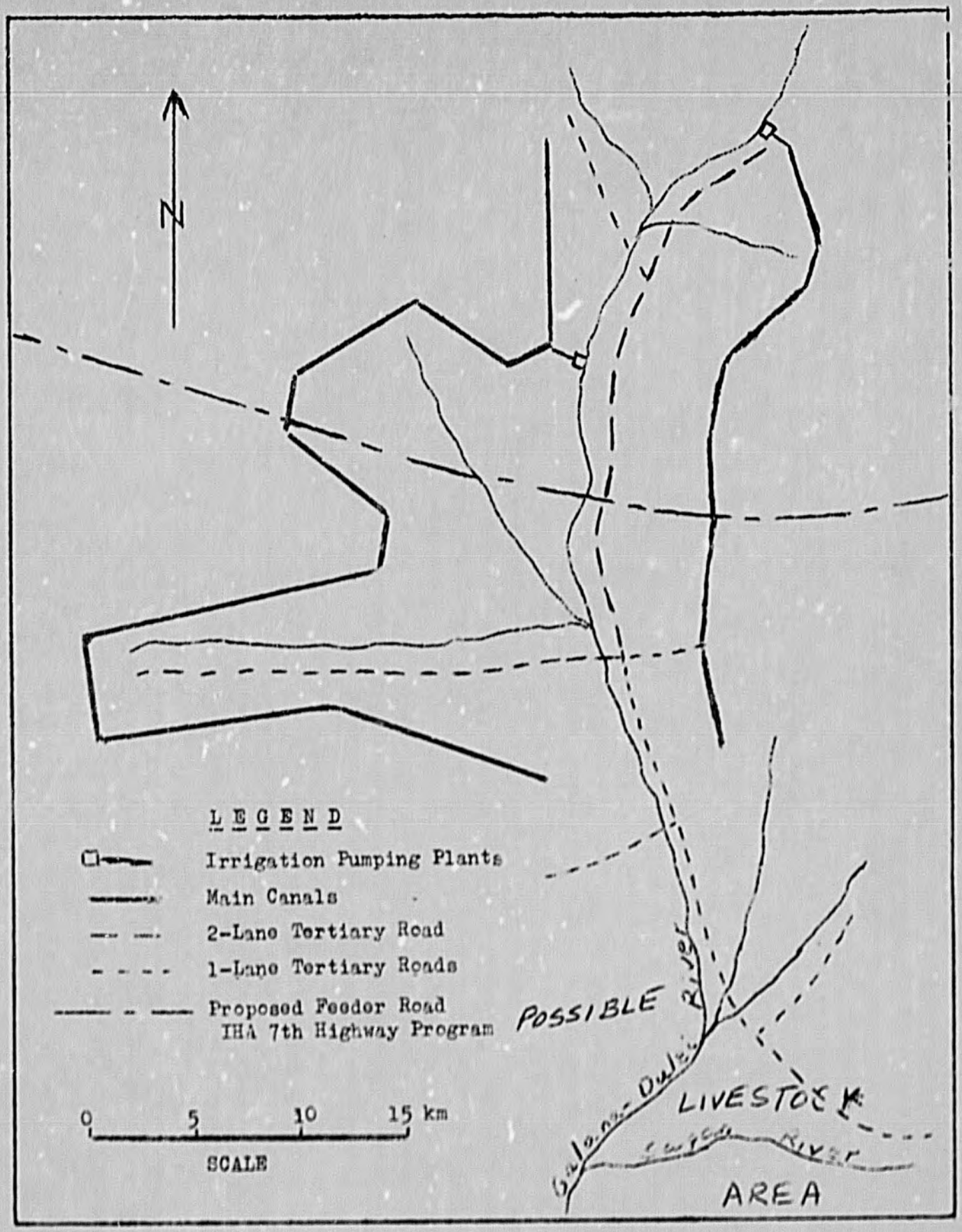
[1] Tobacco Monopoly Board (unpublished).



SAGAN PROJECT AREA FIG. V-1

outlet of Lake Abaya and at the inlet to Lake Chamo. A discharge measurement station should be installed at the outlet of Lake Chamo. A gauging station exists on the Sagan River near the bridge on the roadway southeast of Konso and another is proposed for the confluence with the Galana Dulei where the project area begins. The Konso station has not been rated and no discharge records exist. A staff gauge is proposed for recording levels on Chew Bahir where the Sagan River empties. Chew Bahir (meanin Salt Lake) has no outlet and by the end of the dry season is often greatly reduced in size because of the low yield of the basin and high evaporation losses.

Precipitation - Mean annual precipitation, according to a 1973 isohyetal map of the NWRC, increases from less than 600 millimeters at Chew Bahir to about 1,200 millimeters at the northern divide of the area under consideration. Monthly mean precipitation at Tortellia, Gidole and Arba Minch are given in Table V-1.

Precipitation at Tortellia (which most closely relates to project area conditions) during the spring and fall wet periods ranged in a 4-year period from 0 to 146 millimeters in March 1962 to 267 millimeters in April, 82 to 182 millimeters in May, 9 to 54 millimeters in June, 29 to 87 millimeters in September, 49 to 180 millimeters in October and 3 to 150 millimeters in November. With such a variable occurance, rainfed agriculture cannot be considered.

Temperature - Air temperature data are available from the Arba Minch station and are given in Table V-2.

Hydrology - One source for an irrigation supply which might be allocated to the lower Sagan basin would be the control of Lake Chamo's outflow by use of a low dam; however the quality of this source is highly suspect. Fluctuations of lake elevations from tables of daily observations, are summarized in Table V-3 for the 1st, 11th and 21st days of each month. The range of levels has been from about 0.3 to 1.0 meter. Insofar as the lake area is about 500 square kilometers, the change in storage of 0.7 meter represents a volume of some 350 million cubic meters, equivalent to a depth of one meter of water over 35,000 hectares.

Table V - 1

Mean Precipitation
(mm)

Station	Tortellia	Gidole		Arba Minch
Lat.N.	5°-02'	5°-37		6°-05'
Long. E.	37°-02'	37°-29		37°-38'
Elev. m		2550		1300±
Period	1970-3 (1)	1937-40 (2)	1954-70 (1)	1960-70 (1)
J	61.3	10.1	11.8	31.1
F	25.1	34.0	63.4	0.1
M	56.9	102.8	148.3	95.4
A	167.8	177.6	192.4	141.2
M	128.6	174.8	130.0	88.4
J	32.4	60.5	83.4	52.8
J	9.8	111.2	78.2	14.4
A	20.4	105.9	98.5	56.6
S	58.4	100.2	99.1	100.4
O	111.3	83.6	155.8	109.9
N	64.4	41.9	41.3	58.8
D	13.0	13.5	56.3	25.5
Year	749.4	1018.7	1158.5	774.6

(1) From Files, NWRC
(2) From "Contribututo Alla Climetologica Dell Ethiopia", Fantoli, 1965.

Table V - 2

Air Temperature at Arba Minch :
(°C.)

Month	Average Daily Maximum Temperature	Average Daily Minimum Temperature	Average Daily Temperature
J	31.0	14.4	22.7
F	31.7	15.0	23.3
M	31.1	14.4	22.8
A	29.9	15.4	22.7
M	28.6	14.2	21.4
J	27.8	13.8	20.8
J	28.3	14.0	21.2
A	28.2	13.9	21.0
S	29.3	14.4	21.9
O	28.9	15.2	22.1
N	28.6	14.3	21.5
D	30.6	12.2	21.4

Table V - 3

Water Levels on Lake Chamo (M)

Month	Date	1969	1970	1971	1972	1973
J	1	-	0.38	0.70	0.82	0.77
	11	-	0.33	0.65	0.80	0.74
	21	-	0.33	0.63	0.77	0.73
F	1	-	0.54	0.62	0.74	0.69
	11	-	0.43	0.61	0.71	0.62
	21	-	0.45	0.58	0.74	0.59
M	1	-	0.54	0.54	0.71	0.57
	11	-	0.54	0.50	0.68	0.49
	21	-	0.59	0.48	0.68	0.50
A	1	-	0.66	0.47	0.68	0.43
	11	-	0.68	0.45	0.66	-
	21	-	0.68	0.51	0.68	-
M	1	-	-	0.51	0.75	-
	11	-	0.78	0.56	0.78	-
	21	-	0.82	0.64	0.76	0.49
J	1	-	0.80	0.72	0.88	0.54
	11	-	0.80	0.72	0.88	0.52
	21	-	0.77	0.70	0.83	0.53
J	1	0.80	0.76	0.68	0.80	0.51
	11	0.76	0.74	0.72	0.81	0.64
	21	0.80	0.69	0.76	0.83	0.64
A	1	0.77	0.65	0.76	0.78	0.61
	11	0.69	0.65	0.73	-	0.62
	21	0.64	0.65	0.72	0.73	0.63
S	1	0.60	0.68	0.75	0.72	0.66
	11	0.71	0.67	0.79	0.74	0.68
	21	0.63	0.72	0.78	0.74	0.70
O	1	0.63	0.70	0.74	0.71	-
	11	0.76	0.70	0.74	0.74	-
	21	0.74	0.74	0.91	0.78	-
N	1	0.77	0.82	0.91	0.78	-
	11	0.78	0.93	-	0.80	-
	21	0.74	0.88	-	0.92	-
D	1	0.55	0.82	0.94	0.90	-
	11	0.49	0.76	0.88	0.86	-
	21	0.43	0.74	0.82	0.82	-

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Other possibilities for irrigation are by storage in either the Sagan or in the Galana Dulei basin (one site identified) providing suitable sites can be located. Lending agencies are hesitant to consider such projects until rainfall and runoff characteristics are determined by data collected from within the basin. But with such storage schemes, an irrigation project could eventually be considered provided that water quality and storage quantity would permit.

The available chemical analysis suggests that Sagan water is of doubtful value which may be expected as both Lake Abaya and Lake Chamo are somewhat saline. Sediment discharges of the streams have not been measured and groundwater supplies have not been tested for either quality or quantity.

One analysis of Lake Chamo water (1967) indicated a highly mineralized water with the following contents (expressed in milligrams per liter); HCO_3 - 624; F - 14; heavy metal oxides - 208; Na^+ - 488; K^+ - 82; Ca^+ - 52; with pH - 8.8 and with spectographic highs for Si, Ca, Al, Mg, B, Fe and Cu.

Soils

There are two dominant soils in the selected project area. Around Lake Chew Bahir and bordering the southernmost portion of the combined Sagan and Galana Dulei rivers, are found calcaric Fluvisols associated with Orthic Solonchaks, including eutric inclusions of Histosols and Regosols. The broad, arid and sparcely covered valley lands upstream in the Galana Dulei valley are principally Lithic or Haplic Yermosols occuring in association with Lithosols, with notable inclusions of Vertisols and, nearer to the river, Fluvisols.

While no data can be found regarding chemical and physical analysis of typical soils from this region, some information exists for relatively similar soils in southern Sidamo Province. In general, it may be said that these soils are slightly to moderately alkaline, low in organic matter and total nitrogen and high to very high in potash, calcium and magnesium. They range in texture from silty clay to clay and in color from dark reddish brown to reddish brown.

In the Southern Rift Valley Development Report, the pedology in the southern lowlands between Lake Chamo and the floor of Chew Bahir basin is described as being characterized by soils formed on materials recently deposited by rivers and lakes. These include fans, deltas and floodplains which are variable in morphology and,

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in many places, influenced by sediment deposits. Soil fertility, structure and drainage are believed to be favorable for agricultural purposes provided suitable sources of irrigation water can be economically provided.

Based on this meager data it is felt that this area urgently requires a more detailed soils survey - if only at a reconnaissance level - which would also include a sampling program to determine water quality in the Sagan River and its principal tributaries (and groundwater if possible). The Solonchak soils mentioned above are usually heavily saline and require leaching prior to planting any except the most salt tolerant crops.

Population and Social Conditions

Population - Gemu Gofa Province covers about 39,500 square kilometers with an estimated population of 850,000 for an overall population density of 21.5 per square kilometer. The project area includes portions of both Gardula and Hamer Bako Awrajas whose population densities are taken to be 30 and three per square kilometer, respectively. In Gardula, fully 85 percent of the people are concentrated in about 25 percent of the awraja - mainly the highland areas around Gidole and the lower Rift Valley lake region.

The project area is not inhabited by settled farmers, but seasonally provides support for the transhumant nomadic herdsmen seeking temporary pasturage for their livestock. These tribesmen range throughout the southern portions of Gemu Gofa and Sidamo provinces in Ethiopia and far into the northern regions of Kenya.

Farm Size and Land Tenure - Data concerning the number of holdings and size of fields are not available for Hamer Bako Awraja; however, for Gardula, some approximations are possible which are indicative of conditions adjacent to the project area.

In Gardula, there are about 38,400 households distributed as follows:

Type of Holding	Percent	Numbers
Resident owners	54	20,700
Tenants	31	12,000
Mixed owners/tenants	3	1,100
Non-agricultural	12	4,600
	100	38,400

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A total of 94,500 fields have been estimated for Gardula (by sample survey) whose average cultivated area per field is taken at 0.20 hectare. As 33,800 households represent farm families (38,400 total holdings less 4,600 non-agricultural) the average farm would contain 2.8 fields comprising 0.56 hectare of cultivated land. No data are available to indicate the average size of pasture, forest or non-agricultural land controlled by the holdings.

Data for the entire province show that about one half of the total holdings are limited to one parcel each and only two percent contained five or more fields. While this information is inconclusive insofar as the semi-arid portions of Gordula and Hamer Bako are concerned, it is indicative of the restrictive subsistence (or sub-subsistence) level of agriculture practiced by the vast majority of farm families in this region.

The inventory of government owned land [1] shows that a 491.2 square kilometer block (49,120 hectares) of government owned lands occupies the southwest corner of the awraja and would include a sizeable portion of the project area. The entire southern portion of Hamer Bako Awraja (from about latitude 5°30'N) is government owned. According to information received from the MLRA, there are no claims or owners of record on the remainder of the project area lands.

The People.- Many tribes have been identified among the residents of the province and have intermingled in most areas without difficulty. In the semi-arid lowlands are several small nomadic tribes which seasonally migrate throughout southern Sidamo and Gemu Gofa and into northern Kenya. Among these are the Amaro, Burgi, Gugi, Kalme and Konso tribes. The highland areas of denser population and concentrated farming, are chiefly occupied by Gemu people with smaller numbers from the Amhara, Mako, and Melezo tribes.

1/ "A Policy Orientated Study of Land Settlement," 1969, MLRA.

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PRESENT CONDITIONS

The highlands of Hamer Bako and Gardula Awrajas in Gemu Gofa Province and Arero Awraja in Sidamo Province fall away to the south to extensive plains around Lake Chew Bahir at about 400 meters elevation. The selected project area (completely in Gemu Gofa Province) lies at the upper limit of this plain between 600 and 1,000 meters elevation.

There are no agricultural research stations or training institutions in Gardula or Hamer Bako Awrajas, but a state farm and a small settlement scheme do exist at Arba Minch, the provincial capital on the west shore of Lake Abaya.

Existing Land Use

The Ethiopian Rift Valley terminates in Gemu Gofa Province, and its southernmost lakes, Abaya and Chamo, are on the northern provincial boundary at approximately 1,250 meters elevation. West of the lakes, high mountains rise to over 3,800 meters, before giving away to the semi-arid southern lowlands. Much of the highlands is unsuited for agriculture, consisting of steep slopes and rugged, broken terrain. The broad plateaus and gently rolling slopes of the central highlands are lacking. Only near the lakes can the combination of dependable rainfall and arable soils be found in any quantity. These uplands are, nevertheless, relatively densely populated. Lands unsuited for cultivation are being intensively farmed and consequently, the steep slopes are heavily eroded. The lowland plains have irrigation potential, but are remote from markets and lack roads and other means of communication. At present, they are occasionally used by nomadic pasturalists, but the presence of Trypanosomiasis and Rinderpest diseases are major constraints to full utilization of their potential. Thus, the existing land use is limited to periodic grazing of livestock with severe disease limitations.

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Agricultural and Livestock Production

Existing Agricultural Production - Reliable data covering existing crop production in the province are not available. It has been estimated that no more than 45,000 hectares are under cultivation in the four awrajas, divided as follows: 1) 26,000 hectares in maize and sorghum; 2) 17,000 hectares in teff, wheat and barley; and 3) 2,000 hectares in other crops including small areas in cotton, coffee and vegetable crops. The agricultural pattern is aimed at subsistence production; however, the province is considered to be deficit in total food supplies and depends upon imports from elsewhere in Ethiopia to balance market demands.

The selected project area in the Galana Dulei basin is, for purposes of preliminary economic analysis, presently devoid of agricultural production.

Existing Livestock Production - The total livestock population for the province was reported in 1968 to be about 300,000 head, with approximately 63,000 in Gardula Awraja. However, recent years of lower than average rainfall and drought have no doubt considerably reduced herd sizes.

The lowland cattle are, in general, of moderate size, weighing between 240 and 260 kilograms at maturity. Highland cattle are somewhat lighter and range from 200 to 240 kilograms when mature.

The valley areas in the lower Sagan River Basin probably have an Acacia-Themeda cover with an anticipated carrying capacity of 150 to 180 kilograms of live weight per hectare. Stock water supplies are limited during the dry season and available only from the few perennial streams.

Cattle normally move from the nearby highlands and from the drier regions of northern Kenya into the Sagan valleys and delta in April when water is more abundant, then return to their origin in September when the water holes dry and the pastures have been grazed barren.

Indications are that livestock are marketed in Kenya, and to a lesser extent in Gardula and Arba Minch.

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Health

Animal Health - The following diseases have been confirmed to exist in the province: Trypanosomiasis, Rinderpest, CBPP, FMD, Blackleg, Anthrax, liverflukes (highland areas), Helminth parasites of the digestive track and external parasites (ticks, leeches, etc.). Brucellosis, Pasteurellosis, Anaplasmosis, Piroplasmosis, Heartwater and Rabies probably occur but have not been confirmed.

The Veterinary Service Division maintains a well equipped veterinary clinic in Arba Minch staffed by a veterinarian, one animal health assistant and three vaccinators. In addition, there are two animal health assistants and four to six vaccinators in Gardula Awraja. Microscopes and stains for diagnostic use are available at the laboratory in Gidole, the one nearest the project area.

The JP-15 Rinderpest program has made impressive gains in the past two years. This program is scheduled to continue through the 1974/75 season, but its continuance beyond 1975 is presently unclear.

Human Health - Much of Gemu Gofa Province, including all the project area, lies below 2,000 meters and must be considered endemic for malaria. The incidences of parasites, malnutrition and respiratory diseases are reported to be high throughout the province. The presence of Schistosomiasis and Cherocercisis is suspected but not yet confirmed.

Communications

The only all weather road in the entire province links Arba Minch with Addis Ababa via Shashemenne. The section between Addis Ababa and Shashemenne (220 kilometers) is paved and the stretch between Shashemenne and Arba Minch (255 kilometers) is gravelled and well maintained. Under the Fourth Highway Program of IBRD, it was planned to extend this gravelled portion to Gardula; however, this construction has been delayed. A dry weather track presently connects Arba Minch to Gidole (60 kilometers) and Yabelo (215 kilometers) in Sidamo and beyond. These dry weather tracks are best suited to four-wheel drive vehicles at average speeds of approximately 20 kilometers per hour. There are additional tracks and foot trails in the province, one extending from Gidole to Waita via Bekewle, thus

touching the project area, but its present utility, even for four-wheel drive vehicles, is doubtful.

The only operating air field in the province for regular passenger and freight service is at Arba Minch which is served on regular schedule by Ethiopian Air Lines. There are several landing strips maintained by missions in the lowlands and large commercial farms in the lakes region, but these are only occasionally used by light aircraft.

Markets

Agricultural Markets - Effective demand for consummable produce in Gardula, as well as in Gemu Gofa Province, is relatively small and cash markets are underdeveloped. The province is deficit in grain, however, and population continues to increase at a higher rate than agricultural production. The farmers generally consume what they produce and only sell small amounts at harvest time to local markets for immediate cash requirements. The non-agriculturalists and the urban dwellers must depend on other markets for a considerable portion of their basic intake.

Livestock Markets - There are eleven known small cattle markets in Gemu Gofa. The nearest market to the project area is at Gidole where from 2,500 to 3,000 head are sold annually. There is a secondary market at Konso (2,000 to 2,500 head annually) south of the project area. Approximately 90 percent of the cattle sold at Gidole are for slaughter, while at Konso the same percentage are sold to other traders or farmers for breeding stock, with only ten percent being slaughtered. The peak market months are September through April. The Gidole market is connected by road to Arba Minch (60 kilometers) in the dry season only, but Konso cannot be reached by vehicles, even in the dry season, without great difficulty and risk.

DEVELOPMENT STRATEGY

Development planning in Gemu Gofa Province considers: 1) the present deficit food situation; 2) the unbalanced distribution of population between uplands and lowlands; 3) the constraints deterring

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livestock production; 4) the necessary conservation measures; 5) the remoteness from major markets; 6) the low annual precipitation; and 7) the apparent low priority for road construction in that section of the country. Objectives are: 1) to provide settlement opportunities on five-hectare irrigated farm units mixed with commercial development on mechanized farms; 2) to provide disease-free and improved pastures for livestock grazing; and 3) to protect the natural resources of the area insofar as possible.

Tentatively, the 50,000 hectare project selected for study would be divided into 25,000 hectares for intensive irrigated agriculture and 25,000 hectares for controlled pastures. Regulated storage releases would provide supplemental irrigation water for harvesting two crops per year and irrigation return flow would be channeled into the grazing area to improve the pasture lands. Water control facilities and other infrastructure would be essentially as described in Part II for the Gambela Project.

Conservation

Soil Conservation - The project lands have been subject to considerable erosion from flash runoffs from the surrounding escarpments. Many small streams enter the valley, some of them via spectacular waterfalls which last for a few hours following heavy rains in the highlands. These streams have cut deep gullies into the valley floor seeking the Galana Dulei channel. Overgrazing, especially in the southern portion of the valley which receives the least precipitation, has resulted in sheet erosion and the Galana Dulei carries a heavy silt load as it merges with the Sagan and thence into the shallow Chew Bahir. It is likely that total erosion from the valley floor may exceed 40 tons per hectare per year.

The implementation of an irrigation project in the upper portion of the valley would serve to reduce erosion in that portion. Roadways, irrigation canals and drainage ditches on calculated gradients would control local surface runoff and effectively channel all waters into the river. Controlled grazing in the livestock area would allow for a cover of perennial grasses to provide a measure of erosion control. During more detailed studies, the feasibility of contouring the grazing area at regular intervals could be investigated as well as the advisability of complete protection from outside

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flash runoff by excavating collector drainage ditches along each side of the valley near the escarpment.

Forest Conservation - The project area is practically devoid of trees at present except for small shrubs and thorn bushes. As previously mentioned in this report, each five-hectare farm family would be assisted in planting a woodlot containing trees for firewood, poles and fruit thus notably increasing the present tree population in the area. Having such a source of wood within the farm boundary, would eliminate the necessity of clearing the sparcely covered slopes and almost denuded nearby escarpments of their remaining trees. A reforestation project on these surrounding steep slopes would have the additional benefit of aiding in controlling erosion while, at the same time, providing for the needs of the people.

Wildlife Conservation - There is considerable game in the valley which would be displaced should an irrigation and settlement project be implemented in the area. However, there are vast plains between the project and Chew Bahir and up the Sagan River towards its source in Lake Chamo which provide even better wildlife forage. A game preserve is planned in the area between Lake Abaya and Lake Chamo which would offer protection for wildlife from hunters.

Resettlement

As previously mentioned, the project lands lie adjacent to a populated and over-exploited highland region. The highlanders, especially those tenants restricted to minimal farm units, could provide a ready source of immigrants who would form the nucleus of a resettlement movement. There are an estimated 10,000 farm families now renting small cultivated areas (many of these farms are located on marginally arable soils) within Gardula and Gofa Awraja uplands, who should be given primary consideration in resettlement planning. Alternatively, families from the drought-stricken provinces, should be given an opportunity to resettle on five-hectare farms with irrigation facilities available.

These potential settlers from the nearby highlands are included in the lower subsistence or sub-subsistence category. They currently

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depend on occasional labor on larger farms for cash income. Erosion continually reduces their land capability. The economic condition of the stricken families in the northern drought areas is even more critical. They are presently depending on Government and multinational food donations for survival.

Settlement plans must also provide for the needs of those migrants who may be induced to settle on either irrigated farms or on improved pasture lands if given ample opportunity and financial assistance.

Land Capability

This area is similar in many ways to the Omo project area (see Part IV) insofar as soils and topography are concerned. It lies within a relatively small drainage basin, however, and must depend upon storage for irrigation water supply. A study of aerial photographs supplemented with aerial inspections permits a variation in capability class distribution. Should this area be selected for more detailed analysis, a reconnaissance level soil survey and land use classification would establish more precise capability mapping boundaries. Based on present, limited knowledge, the following distribution has been assumed for the 25,000 hectares considered in the development strategy for settled agriculture:

Class II - 30 percent or 7,500 hectares
Class III - 50 percent or 12,500 hectares
Class IV - 20 percent or 5,000 hectares

The soils and land characteristics are similar to those conditions described in Part IV for the Omo project area with the exception that Class IV lands are more easily identifiable. Class II lands occur near the Galana Dulei River course and into the micro deltas of the smaller tributary streams that abound. Class III lands comprise intermediary terraces and are relatively better drained than Class II lands but have structural and textural defects which may be alleviated or improved by future cultural practices. Class IV lands approach the escarpment slopes on both sides of the river and are also found on the more eroded soils with steeper slopes than the valley floor. They are restricted by topographic

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and structural defects but are well drained. If leveled and combined with Class III, they can form viable lands for agricultural exploitation. The same crops as discussed for the Omo River valley plains would be relevant for consideration here. However, final selection would require more indepth studies into local, regional and national markets, as well as the prospects for exporting produce into northern Kenya. For preliminary economic analysis, however, a simplified pattern of crops has been chosen for pre-feasibility comparison with the three other areas under study.

Cropping Patterns

The tentative cropping patterns for the model five-hectare oxen and model 250-hectare tractor farms are shown in Table V-4. Sorghum would be planted in both cropping seasons on the smaller farms for domestic consumption and local sales. Maize, rotated with sorghum in the wet season, would provide a cash crop which would be in heavy demand, particularly after the Southern Rangeland Project becomes operative. Cotton and pulses would be rotated with sorghum in the dry season as these crops are becoming increasingly more important in both national and export trading.

The larger tractor farmers would aim for regional, national and foreign markets by planting the full hectarage in sorghum during the wet season and in cotton during the dry months.

These patterns could well be altered on the basis of more detailed examination. They do, however, provide a logical model for establishing the basic parameters required for comparative analysis with the other projects studied.

Table V - 4

Tentative Cropping Patterns - Gagan Project
(in hectares)

	Model Five-Hectare Farms	Model 250-Hectare Tractor Farms
Wet Season		
Maize	2	-
Sorghum	2	250
Dry Season		
Cotton	2	250
Pulses	1	-
Sorghum	1	-

Model Farm Budgets

Shown in Tables V-5 and V-6 are the basic direct parameters adopted for financial analyses on the model five-hectare oxen farms and the model 250-hectare tractor farms, respectively. As climatic conditions, soils, and elevations in this area resemble so nearly those conditions prevailing in the Omo project, identical yields, prices, direct inputs and labor requirements have been used for both areas, Discussions in Part IV covering these topics in Part IV are applicable here and are not repeated.

The estimated indirect costs, also utilized in computing the financial analyses of the model farm units, are given in Tables V-7 and V-8 for the oxen and tractor models, respectively.

Financial Analyses of Model Farms

Cash flow projections were worked out for both model farms based on the cost and revenue data derived in the preceding paragraphs and on investment expenditures presented hereinbelow.

Model Five-Hectare Oxen Farm - The investment and replacement schedule adopted for the five-hectare oxen farm is given in Table V-9. The results of the cash flow analysis are presented in Table V-10. Loan repayment (at 12 percent interest) was assumed over a period of four years with a one-year grace period. Short term interest for production loans was assumed at 14 percent. Buildup to full production was taken to be five years. Water charges were derived from amortization of capital costs for water control facilities and the annual operation and maintenance costs thereof (see the section, Infrastructural Development Plan). Agricultural income tax is based on the official Imperial Ethiopian Government Tax Schedule (Negarit Gazeta, 27th year, no. 4, November 23, 1967).

The resulting cash flow, even with the considerable water charges, is indicative of a viable oxen-farm operation.

Model 250-Hectare Tractor Farm - The investment and replacement schedule assumed for the model 250-hectare tractor farm is given in Table V-11. It was assumed that 70 percent of the initial outlays would be financed at 12 percent interest.

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Table V-5

Basic Direct Parameters for Crops on Oxen Farms

Sagan Project - Irrigated

Item	Units	Wet Season		Dry Season		
		Maize	Sorghum	Pulses	Cotton	Sorghum
Returns						
Yield	qq/ha	32	28	16	19	28
Price	E$/qq	12	14	20	55	14
Sales	E$/ha	384	392	320	1045	392
Direct Inputs						
Seed and seed Treatment	E$/ha	11	6	26	18	6
Fertilizer	E$/ha	32	23	--	77	23
Insecticide	E$/ha	32	32	32	80	32
Bags	E$/ha	--	--	--	12	--
Total	E$/ha	75	61	58	187	61
Labor	hrs/ha	785	665	560	850	690
Oxen	hrs/ha	90	90	90	90	90

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Table V-6

Basic Direct Parameters for Crops on Tractor Farms
Sagan Project-Irrigated

Item	Units	Wet Season Sorghum	Dry Season Cotton
Returns			
Yield	qq/ha	32	26
Price	E$/qq	14	55
Sales	E$/ha	448	1430
Direct inputs			
Preharvest Costs			
Machine	E$/ha	11	16
Labor	E$/ha	35	40
Seed and Seed Treatment	E$/ha	6	24
Fertilizer	E$/ha	23	77
Food for labor	E$/ha	4	6
Insecticides	E$/ha	32	60
Subtotal		111	243
Harvest Cost			
Machine	E$/qq	0.20	0.30
Labor	E$/qq	1.50	5.20
Materials	E$/qq	1.90	1.40
Subtotal	E$/qq	3.60	6.90
Subtotal	E$/ha	115	179
Total	E$/ha	226	422

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Table V-7

Indirect Costs for Model Five-Hectare Oxen Farm
Sagan Project-Irrigated

Item	Annual Costs(E$)
Oxen maintenance (1)	10
Goats, sheep, etc. maintenance (1)	2
Repairs and maintenance	44
Land tax	9
Family cash expenses (2)	240
Hired labor (3)	125
Home consumption-maize (4)	84
Home consumption-sorghum (5)	42
Home consumption-pulses (6)	20
Total	576

(1) Minerals, Tick control and medical
(2) Assumes family of six
(3) Assumes 1000 hours annually
(4) 7 quentals @ 12 per quintal
(5) 3 quintals @ 14 per quintal
(6) 1 quintal @ 20 per quintal

Table V-8

Indirect Costs for Model 250 - Hectare Tractor Farm
Sagan Project

Item	Annual Costs(E$)
Salaries	3100
Repairs and Maintenance (buildings)	700
General Transportation	700
Management - Imputed	4200
Land tax	500
Total	9,200

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Table V - 9

Investment Requirements for Model Five-Hectare Oxen Farm
Sagan Project (E$)

Item	Units	Life (Year)	Year 3	Year 8	Year 11	Year 13	Year 18	Year 19
Oxen	1 pair	5	360	240(1)	-	240	240	--
Donkey	1	10	25	--	--	25	--	--
Sheep, Goats, Chickens	set	--	100	--	--	--	--	--
Plow	1	8	50	--	50	--	--	50
Plow-ridger	1	8	50	--	50	--	--	50
Harrow	1	8	50	--	50	--	--	50
Back-Pack Sprayer	1	5	70	70	--	70	70	--
Miscellaneous	1 set	5	50	50	--	50	50	--
Tukul	1	10	150	--	--	150	--	--
Store	Materials	10	75	--	--	75	--	--
Thresher-hand	1	10	75	--	--	75	--	--
Total	--	--	1055	360	150	685	360	150

(1) Assumes sales price of E$120 for old pair or net replacement cost of E$240 per pair.

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Table V - 10

Cash Flow for Model Five-Hectare Oxen Farm
Sagan Project - Irrigated
(Ethiopian Dollars)

Years	3	4	5	6	7	8	9-10	11	12-14
Cash Inflow									
Sales (1)(2)	435	1306	2612	3919	4354	4354	4354	4354	4354
Less Home Consumption	146	146	146	146	146	146	146	146	146
Loan	1295	--	--	--	--	--	--	--	--
Total	1584	1160	2466	3773	4208	4208	4208	4208	4208
Cash Outflow									
Direct Expenses (2)	77	230	459	688	765	765	765	765	765
Indirect Expenses (3)	56	56	181	181	181	181	181	181	181
Land Tax	9	99	9	9	9	9	9	9	9
Income Tax (4)	2	35	79	114	171	171	171	171	171
Investment	1055	--	--	--	--	360	--	150	--
Short-Term Interest	6	13	27	38	42	42	42	42	42
Family Expenses	240	240	240	240	240	240	240	240	240
Total	1445	583	995	1270	1408	1768	1408	1558	1408
Cash Balance	139	577	1471	2503	2800	2440	2800	2650	2800
Debt Service	80	469	469	389	389	--	--	--	--
Cash Balance	59	108	1002	2114	2411	2440	2800	2650	2800
Water Charge	--	--	--	1792	1792	1792	1792	1792	1792
Cash Balance	59	108	1002	322	619	648	1008	858	1008

(1) Assumes Buildup of 10, 30, 60, 90 and 100 percent for project years 3 through 7
(2) Full development based on 2 hectares each of maize and sorghum in wet season and 1 hectare each of pulses and sorghum and 2 hectares of cotton in the dry season.
(3) Annual maintenance and repairs for years one and two; plus hired labor thereafter.
(4) Taxable income computed as sales less land taxes less ¼ sales representing costs.
(5) Assumes E$240 food allowance interest free.

Table V - 11

Investment Requirements for Model 250-Hectare Tractor Farm
Sagan Project
(Thousand E$)

Item	No Units	Life (yrs)	Year 3	Year 11	Year 13	Year 19
Tractor-70ph	2	8	30.0	30.0	--	30.0
Widelevel -15'	2	8	13.6	13.3	--	13.6
Drill - 12'	2	8	12.0	12.0	--	12.0
Sprayer - 32'	1	8	6.0	6.0	--	6.0
Trailer - 3T	2	8	4.8	4.8	--	4.8
Land development	-	--	2.5	--	--	--
Tukuls	3	10	1.8	--	1.8	--
Pole shed	1	10	4.8	--	4.8	--
Total			75.5	66.4	6.6	66.4

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The cash flow analysis is presented in Table V-12. Loan repayment (at 12 percent interest) was assumed over three years with no grace period. Short term interest for production and harvest loans was assumed at 14 percent. Buildup to full production was taken to be four years. Water charges and income tax were derived as stated above for the oxen farm.

The resulting cash flow is indicative of a very viable commercial operation.

LIVESTOCK DEVELOPMENT PLAN

The principle constraints to livestock production in the Sagan project include:

- livestock diseases, particularly Trypanosomiasis in the valley;
- critical shortage of water during the dry season;
- low population of indigenous cattle in the area;
- small type and number of indigenous animals available for the project;
- a relatively low carrying capacity of the ranges;
- use of non-selective breeding practices;
- lack of an extension program; and
- small markets that probably meet the local demand.

Positive factors for development of a livestock program in the Sagan Project area include:

- market at Gidole that could be expanded as an all weather road is proposed that may encourage export from the area;
- demand for stocker cattle (1½ to 2 years old) that would develop upon activation of the Southern Rangeland Development Project (this would particularly be true upon implementation of an acceptable disease control and prevention program within the project area);
- well-staffed veterinary services within the area with a laboratory at Gidole;
- apparent control of Rinderpest as a result of the JP-15 program activities.

Table V - 12

Cash Flow for Model 250-Hectare Tractor Farm
Sagan Project-Irrigated
(Thousand B$)

Years	3	4	5	6-10	11	12	13	14
Cash Inflow								
Sales (1) (2)	281.7	375.6	422.6	469.5	469.5	469.5	469.5	469.5
Loan	52.8	--	--	--	--	--	--	--
Total	334.5	375.6	422.6	469.5	469.5	469.5	469.5	469.5
Cash Outflow								
Direct Expenses (2)	97.2	129.6	145.8	162.0	162.0	162.0	162.0	162.0
Indirect Expenses	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Land Tax	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Income Tax (3)	53.3	72.2	81.6	91.2	91.2	91.2	91.2	91.2
Investment	75.5	--	--	--	--	--	--	--
Short-Term Interest	5.2	6.4	7.2	8.0	8.0	8.0	8.0	8.0
Total	240.4	217.4	243.8	270.4	336.8	270.4	277.0	270.4
Cash Balance	94.1	158.2	178.8	199.1	132.7	199.1	192.5	199.1
Debt Service	22.0	22.0	22.0	--	--	--	--	--
Cash Balance	72.1	136.2	156.8	199.1	132.7	199.1	192.5	199.1
Water Charge	112.0	112.0	112.0	112.0	112.0	112.0	112.0	112.0
Cash Balance	(39.9)	24.2	44.8	87.1	20.7	87.1	80.5	87.1

(1) Assumes buildup of 60, 80, 90 and 100 percent for project years 3 through 6
(2) Full development assumes 250 hectares each of cotton and Sorghum
(3) Taxable income computed as sales less land taxes less ⅔ of sales representing costs.

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Components of the Program

As with the other projects, livestock development is closely allied to but not directly associated with, the irrigation scheme.

A series of development activities would be initiated to reduce the constraints inherent to livestock production in the area, such as:

- implementation of the disease control program previously outlined for both draft oxen and the production herd;
- provision of water on a year-around basis;
- development of continuing extension services in agriculture and livestock production;
- initiation of a pasture management and improvement scheme to protect and increase the carrying capacity of the grazing areas; and
- construction of access roads into the project area.

Location and Size of Livestock Grazing Areas - Approximately 25,000 hectares of valley area would be available for cattle production. This area should support from 10,000 to 12,500 livestock units. If a larger type is brought into the area (e.g., Borana), the capacity would be reduced to from 7,500 to 9,500 livestock units.

Available Stock - Although the number of local cattle available is limited, there may be a supply adequate to stock the area. If, however, a market with the Southern Rangelands Development Project appears feasible, cattle of the Borana type should be imported.

Disease Control - The disease control program previously described would be established including a routine vaccination program for FMD. Vaccinations for Rinderpest and CBPP would be continued until the area could be declared to be free from these diseases. This control program would be dependent on the availability of adequate personnel from the Veterinary Services Division. It is considered that at least the following additional personnel would be required to serve this project - one Animal Health Assistant, one vaccinator, two dip-spray attendants and casual labor as needed.

Waterpoints - Waterpoints would be established throughout the grazing area to provide water to livestock and human populations.

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These would be arranged so that no animal has to travel more than five to seven kilometers for water.

Extension Services - As with the other project areas, a system would be established to impart knowledge concerning disease control, animal breeding and selection, pasture management and animal nutrition.

Pasture Management - A scheme for management and improvement of the pasturelands would be developed when the precise nature of the vegetation is established.

Benefits - Qualitative

As this area does not now serve as a major livestock producing zone, the establishment of such a program would yield direct benefits. Improvements in livestock production capacity would occur as a consequence of: 1) reduction of disease incidence; 2) improvement of the grazing areas by altering pasture management; 3) upgrading of livestock quality; 4) provision of a local market for offtake of stocker cattle; and 5) education of the pastoralists in improved methods of agriculture.

The culmination of these activities should be a restructuring of the herd as follows:

- Increase the percentage of females in the herd.
- Increase the number of females of reproductive age.
- Increase the calving rate.
- Reduce the mortality rate among cattle of all ages.
- Increase annual offtake providing owners with greater financial returns.
- Increase the weight and quality of cattle.

In view of the negative net benefit stream resulting from the preliminary economic analysis of a cow-calf operation for the Gambela Project (see Part II), no analysis was made for the Bagan Project area where the pasture carrying capacity is lower and infrastructure development costs would be about the same. As was recommended for Gambela, however, detailed feasibility investigations here should also include a livestock component.

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INFRASTRUCTURAL DEVELOPMENT PLAN

Included in this section are: 1) internal roads; and 2) irrigation, drainage and flood control facilities. Other infrastructure, including: 1) management, testing and extension services; 2) credit, marketing and storage; and 3) public services, common to all four projects studied, were presented in Part I of this report.

Internal Roads

The preliminary criteria, design standards, and estimated unit (per kilometer) costs for the internal road networks for all projects studied were given in Part I of this report.

The preliminary layout of one and two-lane tertiary roads for the Sagan Project is shown on Figure V-1, following page V-2. Summarized in Table V-13 are the approximate lengths and order-of-magnitude costs of these tertiary standard roads.

Table V - 13

Estimated Cost Internal Roads
Gambela Project

Item	Length(Km)	Unit Cost(US$/Km)	Cost(1,000US$)
2-Lane Tertiary	27	23,800	643
1-Lane Tertiary	78	18,800	1,467
Bridges	-	-	290
Total Cost			2,400

The annual maintenance cost of the above road network is estimated to be in the order of US$ 50,000.

Water Control Facilities

In order to implement a two (or more) crop development, storage, irrigation and drainage facilities would be required. Preliminary schematic layouts of these facilities are shown on Figure V-1 following Page V-2.

It is envisaged that the irrigation water supply would be provided by two multiple-unit pumping plants lifting water into gravity irrigation canal systems.

Drainage canals would flow by gravity into the several water courses and depressions within the project area. It may be found

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necessary, during future detailed studies, to provide some flood prevention works.

Storage would be required on the tributary system. In the absence of streamflow data, precise storage requirements cannot be determined. One site has been tentatively identified on the Bala River; and others would be needed on the other tributaries. Only very rough provisional costs for storage are included in this report.

Irrigation Water Requirements - The consumptive uses of the various crops were estimated by the Blaney-Criddle method, modified to fit the climatic conditions of the area.

The amount of precipitation that is effective for irrigated crops was estimated on the basis of a method presented in "Technical Release No. 21" of the Soil Conservation Service (SCS) of the United States Department of Agriculture (USDA), 1964.

The net irrigation amounts at the field have not been modified by water requirements that may be required for tillage and seeding and by changes in soil moisture at the beginning, during, and at the end of cropping seasons.

For purposes of this pre-feasibility study, overall irrigation efficiencies have been taken conservatively as 50 percent for all crops.

The diversion requirements at the pumping plants, in liters per second per hectare for the individual crops are summarized in Table V-14.

Table V - 14
Mean Monthly Irrigation Requirements at Pumping Plants
Sagan Project (liters/sec/ha)

Month	Crop			
	Cotton	Maize	Sorghum	Pulses
Jan	1.58			
Feb	1.32			
Mar	0.27			
Apr	0.00			
May		0.48	0.26	
June		1.14	1.97	
July		1.25	1.22	
Aug		1.14	0.37	
Sep	0.10		0.48	0.48
Oct	0.10		1.46	1.46
Nov	0.33		0.80	0.80
Dec	1.33		0.31	0.31

On the basis of the unit irrigation requirements summarized in Table V-14 and the cropping patterns discussed in a previous section, the overall project irrigation water requirements were estimated and are summarized in Table V-15.

Estimated Costs - The estimated order-of-magnitude costs of water control facilities for the Sagan irrigated agriculture project are summarized in Table V-16.

Table V - 16
Estimated Capital Costs - Water Control
Sagan Project - Irrigated (Thousand E$)

Item	Project Years							
	-1	1	2	3	4	5	6	Total
Pre-Construction	1,200	-	-	-	-	-	-	1,200
Storage Dams	-	7,000	7,000	7,000	9,000	9,000	-	39,000
Pumping Plants	-	-	-	4,000	2,000	2,000	4,000	12,000
Main Canals	-	-	-	2,000	600	600	2,000	5,200
Lateral Canals	-	-	-	5,130	4,070	4,070	5,130	18,400
Distribution System	-	-	-	6,250	5,070	5,070	8,610	25,000
Drainage System	-	-	-	5,000	4,000	4,000	5,000	18,000
Control Structures	-	-	-	2,250	2,250	2,250	2,250	9,000
Land Development	-	-	-	1,300	1,300	1,300	1,300	5,200
Totals	1,200	7,000	7,000	32,930	28,290	28,290	28,290	133,000

The order-of-magnitude operation and maintenance costs for the completed water control system were estimated at roughly E$ 3,700,000.

To provide provisional figures for water charges in the model farm cash flow analyses, presented earlier in this part, the total order-of-magnitude capital cost was amortized over a period of 40 years at 3½ percent interest. The resultant annual amount was E$ 6,380,000. Adding the annual operation and maintenance costs to this amount and dividing by the total cultivated area (22,500 hectares) resulted in a provisional water charge of E$ 488 per irrigated hectare.

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Table V - 15

Monthly Irrigation Water Requirements
Sagan Project (cubic meters per second)

Crop	Area(ha)	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Wet Season													
Maize	5,000	-	-	-	-	2.4	5.7	6.3	5.7	-	-	-	-
Sorghum	17,500	-	-	-	-	4.6	34.5	21.4	6.5	-	-	-	-
Dry Season													
Cotton	17,500	27.7	23.1	4.7	-	-	-	-	-	1.8	1.8	5.6	23.3
Sorghum	2,500	-	-	-	-	-	-	-	-	1.2	3.7	2.0	0.8
Pulses	2,500	-	-	-	-	-	-	-	-	1.2	3.7	2.0	0.8
Totals		27.7	23.1	4.7	-	7.0	40.2	27.7	12.2	4.2	9.2	9.6	24.9

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PRELIMINARY ECONOMIC ANALYSIS

Economic Costs

To determine the order-of-magnitude economic costs of the Bagan Project, the methodology described in Part I of this report was applied to the capital and recurring costs estimated for roads; water control facilities; and farm investment costs, in this part, and for mapping and surveys; credit, marketing and storage; resettlement allowances; and management, testing and extension services, presented in Part I. The resulting economic cost stream over a 20-year period of analysis is given in Table V-17.

Net Project Benefits and Internal Economic Rate of Return

To determine the gross benefit margin, model farm costs were converted to economic costs, using the factors presented in Part I of this report, and subtracted from sales. These figures were aggregated according to the assumed rate of buildup (500 oxen farms per year over a five-year period starting with project year 3; and 10 tractor farms in project year 4 and 20 each in project years 5 and 6). Settlement of farms in this project would start two years later than the other projects studied since one of the storage reservoirs must be completed to provide water for irrigation before farming can commence.

The gross project cost stream (Table V-17) was then subtracted from the gross benefit stream to yield the net project benefit stream (also shown in Table V-18). The preliminary internal economic rate of return from the project was found by discounting this net benefit stream. The preliminary rate of return on total project investments is 11 percent.

Table V - 17

Economic Costs of Sagan Project - Irrigated
(Million B$)

Project Year	Water Control	Roads	Mapping & Surveys	Credit, Marketing & Storage	Resettlement Allowance	Public Services	Management Testing, Training & Extension	Total Farm Investment	Gross Project Costs
-1	1.08	—	—	—	—	—	—	—	1.08
1	6.30	—	—	—	—	—	—	—	6.30
2	6.30	0.09	0.04	—	—	—	—	—	6.43
3	29.64	0.72	0.04	0.17	0.21	0.12	0.75	0.51	32.16
4	27.60	0.72	—	0.26	0.21	0.14	0.51	1.82	29.39
5	25.58	0.72	—	0.15	0.21	0.14	0.39	3.32	30.61
6	26.36	0.04	—	0.18	0.21	0.14	0.42	3.64	30.99
7	3.11	0.04	—	0.29	0.21	0.14	0.42	1.30	5.51
8	3.11	0.04	—	0.19	—	0.12	0.50	0.73	4.69
9	3.11	0.04	—	0.19	—	0.13	0.45	0.52	4.44
10	3.11	0.04	—	0.30	—	0.14	0.42	0.25	4.26
11	3.11	0.04	—	0.19	—	0.15	0.47	0.91	4.87
12	3.11	0.04	—	0.31	—	0.16	0.42	1.55	5.59
13	3.11	0.04	—	0.20	—	0.16	0.52	1.73	5.76
14	3.11	0.04	—	0.20	—	0.16	0.45	0.46	4.42
15	3.11	0.04	—	0.20	—	0.16	0.42	0.46	4.39
16	3.11	0.04	—	0.20	—	0.16	0.42	0.30	4.23
17	3.11	0.04	—	0.20	—	0.16	0.42	0.30	4.23
18	3.11	0.04	—	0.20	—	0.16	0.50	0.18	4.19
19	3.11	0.04	—	0.20	—	0.16	0.50	0.91	4.92
20	3.11	0.04	—	0.20	—	0.16	0.42	(3.97)	(0.04)

Table V - 18

Derivation of Net Project Benefits

and Basic Internal Economic Rate of Return

Sagan Project - Irrigated

(Million E$)

Project Year	Gross Benefit Margin U-5	T-250	Total	Gross Project Costs	Net Project Benefits
-1	-	-	-	1.08	(1.08)
1	-	-	-	6.30	(6.30)
2	-	-	-	6.43	(6.43)
3	0.16	-	0.16	32.16	(32.00)
4	0.36	2.00	2.36	28.49	(26.13)
5	1.75	6.68	8.43	30.61	(22.18)
6	3.36	12.41	15.77	30.99	(15.22)
7	5.15	14.86	20.01	5.51	14.50
8	6.78	16.32	23.10	4.69	18.41
9	8.05	17.08	25.13	4.44	20.69
10	8.77	17.08	25.85	4.26	21.59
11	8.95	17.08	26.03	4.87	21.16
12	8.95	17.08	26.03	5.59	20.44
13	8.76	17.08	25.84	5.76	20.08
14	8.57	17.08	25.65	4.42	21.23
15	8.38	17.08	25.46	4.39	21.07
16	8.19	17.08	25.27	4.23	21.04
17	8.00	17.08	25.08	4.23	20.85
18	8.00	17.08	25.08	4.19	20.89
19	8.00	17.08	25.08	4.92	20.16
20	8.00	17.08	25.08	(0.04)	25.12
			NPW @ 10%		+7.10
			IERR		11%

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PART VI

FINDINGS AND RECOMMENDATIONS

COMPARATIVE ANALYSIS

Project Components

The components included for each of the four areas studied and which formed the bases for preliminary evaluations were as follows:

Gambela Project - Irrigated Agriculture Alternative -

Location	:	In Gambela Awraja, Ilubabor Province, within latitudes 7° - 57' and 8° - 14'N and longitudes 33° - 05' and 34° - 25'E.
Area	:	25,000 hectares to intensive agriculture and possibly 25,000 hectares to livestock development.
Resettlement	:	2,500 smallholders on five-hectare, oxen-powered units; 50 (or more) larger holders on 250-hectare (or smaller) tractor-powered units; and possibly about 400 small livestock development units.
Crop Patterns	:	For smallholders, two hectares each of sorghum and maize during wet season cultivation and two hectares of cotton and one hectare each of pulses and sorghum during the dry season; for mechanized farmers, 250 hectares of sorghum during wet season cultivation and 250 hectares of cotton during the dry season.
Yields	:	(In quintals per hectare) for smallholders, sorghum - 27, maize - 30, cotton - 18 and pulses - 15; for mechanized farmers, sorghum - 30 and cotton - 25.

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Production : In metric tons, full-production assumed in project year 9, sorghum - 57,750, maize - 15,000, cotton - 40,250 and pulses - 3,750.

Infrastructure: Water control including pumping plant, gravity irrigation and drainage system, flood prevention dike, and project land development; internal tertiary standard project roads; grain storage and weighing facilities; offices, housing, and equipment for project management, testing, credit, and extension services; test, demonstration, and seed multiplication project farm; and public services including health, education, malarial mosquito and Tsetse fly control, and police.

Gambela Project - Rainfed Agriculture Alternative -

Location : In Gambela Awraja, Ilubabor Province, within latitudes 7° - 57' and 8° - 14'N and longitudes 34° - 05' and 34° - 25'E.

Area : 25,000 hectares to intensive agriculture and possibly 25,000 hectares to livestock development.

Resettlement : 2,500 smallholders on five-hectare, oxen-powered units; 50 (or more) larger holders on 250-hectare (or smaller) tractor-powered units; and possibly about 400 small livestock development units.

Crop Patterns : For smallholders, two hectares of cotton and one hectare each of sorghum and maize during the wet season; for mechanized farmers, 125 hectares each of cotton and sorghum during the wet season.

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Yields : (In quintals per hectare) for smallholders, sorghum - 22, maize - 24 and cotton - 14; for mechanized farms, sorghum - 24 and cotton - 20.

Production : (In metric tons) full production assumed in project year 8, sorghum - 20,500, maize - 6,000 and cotton - 19,500.

Infrastructure: Water control including a drainage system and flood prevention dike; internal tertiary standard project roads; grain storage and weighing facilities; offices, housing, and equipment for project management, testing, credit, and extension services; test, demonstration, and seed multiplication project farm; and public services including health, education, malarial mosquito and Tsetse fly control, and police.

Didesa Project - Rainfed Agriculture -

Location : In Ilubabor and Kofa Provinces, within latitudes 8° - 30' and 8° - 42'N and longitude 36° - 23' and 36° - 36'E.

Area : 25,000 hectares to agriculture.

Resettlement: : 2,500 smallholders on five-hectare, oxen-powered units; 50 (or more) larger holders on 250-hectare (or smaller) tractor-powered units.

Crop Patterns : For smallholders, two hectares of maize and one hectare each of sorghum and pulses; for mechanized farmers, 125 hectares each of sorghum and pulses.

Yields : (In quintals per hectare) for smallholders, sorghum - 24, maize - 27 and pulses - 14; for mechanized farms, sorghum - 27 and pulses - 16.

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Production : (In metric tons) full production assumed in project year 8, sorghum - 22,875, maize - 13,500 and pulses - 13,500.

Infrastructure: Water control comprising surface drainage works; internal tertiary standard project roads; grain storage and weighing facilities; offices, housing, and equipment for project management, testing, credit, and extension services, test, demonstration, and seed multiplication project farm; and public services including health, education, malarial mosquito and Tsetse fly control, and police.

Omo Project - Irrigated Agriculture -

Location : In Gemu Gofa Province, within latitudes 5° - 30' and 6° - 20'N and longitudes 35° - 55' and 36° - 15E.

Area : 25,000 hectares to intensive agriculture and possibly 25,000 hectares to livestock development.

Resettlement : 2,500 smallholders on five-hectare, oxen-powered units; 50 (or more) larger holders on 250-hectare (or smaller) tractor-powered units; and possibly from 200 to 300 small livestock development units.

Crop Patterns : For smallholders, two hectares each of sorghum and maize during the wet season and two hectares of cotton and one hectare each of pulses and sorghum during the dry season; for mechanized farmers, 250 hectares of sorghum during the wet season and 250 hectares of cotton during the dry season.

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Yields : (In quintals per hectare) for smallholders, sorghum - 28, maize - 32, cotton - 19 and pulses - 16; for mechanized farmers, sorghum - 32 and cotton - 26.

Production : (In metric tons) full production assumed in project year 9, sorghum - 61,800, maize - 16,000, cotton - 42,000 and pulses - 4,000.

Infrastructure: Water control including pumping plant, gravity irrigation and drainage system, flood prevention dike, and project land development; internal tertiary standard project roads; grain storage and weighing facilities; offices, housing, and equipment for project management, testing, credit, and extension services; test, demonstration, and seed multiplication project farm; and public services including health, education, malarial mosquito and Tsetse fly control, and police.

Sagan Project - Irrigated Agriculture -

Location : In Gamu Gofa Province, within latitudes 5° - 20' and 5° - 50'N and longitudes 36° - 50' and 37° -05'E.

Area : 25,000 hectares to intensive agriculture and possibly 25,000 hectares to livestock development.

Resettlement : 2,500 smallholders on five-hectare, oxen-powered units; 50 (or more) larger holders on 250-hectare (or smaller) tractor-powered units; and possibly from 200 to 300 small livestock development units.

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Crop Patterns : For smallholders, two hectares each of sorghum and maize during the wet season and two hectares of cotton and one hectare each of pulses and sorghum during the dry season; for mechanized farmers, 250 hectares of sorghum during the wet season and 250 hectares or cotton during the dry season.

Yields : (In quintals per hectare) for smallholders, sorghum - 28, maize - 32, cotton - 19 and pulses - 16; for mechanized farmers, sorghum - 32 and cotton - 26.

Production : (In metric tons) full production assumed in project year 9, sorghum - 61,800, maize - 16,000, cotton - 42,000 and pulses - 4,000.

Infrastructure: Water control including storage, two pumping plants, gravity irrigation and drainage system; and project land development; internal tertiary standard project roads; grain storage and weighing facilities; offices, housing, and equipment for project management, testing, credit, and extension services; test, demonstration, and seed multiplication project farm; and public services including health, education, malarial mosquito and Tsetse fly control, and police.

Initial Capital Costs

The estimated order-of-magnitude initial capital costs for agricultural development of the four areas studied are given in Table VI-1.

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Table VI - 1

Initial Capital Costs for Agricultural Development
(Million Br)

Item	Gambela Project		Didesa Project	Omo Project	Dagan Project
	Irrigated	Rainfed	Rainfed	Irrigated	Irrigated
Water Control	70.0	22.5	5.0	105.0	133.0
Roads	2.0	2.0	1.0	2.1	2.4
Mapping and Surveys	0.1	0.1	0.1	0.1	0.1
Credit, Marketing and Storage	0.7	0.7	0.7	0.7	0.7
Resettlement Allowance	1.3	1.3	1.3	1.3	1.3
Public Services	0.3	0.3	0.3	0.3	0.3
Management, Testing and Extension	0.7	0.7	0.7	0.7	0.7
Total	75.1	27.6	9.1	110.2	138.5

Annual Recurring Costs

The estimated order-of-magnitude annual recurring costs for the four projects at full development and full production are given in Table VI-2.

Table VI - 2 .

Annual Recurring Costs
(Thousand Br)

Item	Gambela Project		Didesa Project	Omo Project	Dagan Project
	Irrigated	Rainfed	Rainfed	Irrigated	Irrigated
Water Control	2,700	800	185	3,240	3,700
Roads	50	50	25	50	50
Credit, Marketing and Storage	231	231	231	231	231
Public Services	183	183	183	183	183
Management, Testing and Extension	448	448	448	448	448
Total	3,612	1,712	1,072	4,152	4,612

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Internal Economic Rates of Return

The net economic benefit streams for the four projects are given in Table VI-3, and derived internal economic rates of return are as follows:

Gambela Project - Irrigated Alternative	21 percent
Gambela Project - Rainfed Alternative	26 percent
Didesa Project - Rainfed	21 percent
Omo Project - Irrigated	16 percent
Sagan Project - Irrigated	11 percent

Table VI - 3

Net Economic Benefit Streams
(Million E$)

Project Year	Gambela Project		Didesa Project	Omo Project	Sagan Project
	Irrigated	Rainfed	Rainfed	Irrigated	Irrigated
-1	(0.86)	(0.31)	(0.18)	(0.86)	(1.08)
1	(17.75)	(6.19)	(3.21)	(25.61)	(6.30)
2	(17.87)	(5.14)	(3.03)	(25.95)	(6.43)
3	(14.02)	(2.77)	(1.84)	(21.91)	(32.00)
4	(7.35)	0.60	0.31	(14.95)	(26.13)
5	13.93	1.75	0.97	14.86	(22.18)
6	17.62	7.18	2.96	18.77	(15.22)
7	19.76	7.76	3.31	21.05	14.50
8	20.61	7.89	3.35	21.95	18.41
9	20.17	7.55	2.99	21.52	20.69
10	19.45	7.11	2.55	20.80	21.59
11	19.10	6.85	2.30	20.44	21.16
12	20.26	7.50	2.97	21.59	20.44
13	20.12	7.45	2.92	21.43	20.08
14	20.10	7.52	3.01	21.40	21.23
15	19.92	7.44	2.93	21.21	21.07
16	19.96	7.48	2.97	21.25	21.04
17	19.23	7.05	2.54	20.52	20.85
18	18.65	6.77	2.26	19.94	20.89
19	18.65	6.77	2.26	19.94	20.16
20	25.75	11.23	5.22	27.04	25.12

RECOMMENDED PROJECTS FOR PHASE II STUDIES

The two projects recommended for Phase II feasibility studies are, in order of suggested priority: 1) the Gambela Project; and 2) the Didesa Project. Reasons for this selection are as follows:

1) The respective internal economic rates of return were considerably higher than for the Omo and Sagan Projects.

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2) Long-term streamflow and precipitation records exist for the Gambela area; nearby climatological stations are in operation which would permit close approximations of conditions in the Upper Didesa Valley. There is a complete absence of basic streamflow and climatic data for the Omo and Sagan Projects; field measurements carried out during the short period covered by Phase II studies would be inconclusive and inadequate for feasibility grade investigations.

3) There do not appear to be any overriding social aspects which would rate one project over the other. With the exception of the Didesa Project, which appears to be completely uninhabited except for two recent farms, all project areas are scantily utilised seasonally by semi-nomadic herdsmen. Land tenure is not expected to be an unsolvable constraint in either the Gambela area (all lands classified as Government owned) or the Upper Didesa Valley (reported to have neither communal claims nor current disputes). The Gambela area offers the unique opportunity of settling indigenous peoples together with farmers from overcrowded highland and drought areas elsewhere.

4) The Gambela area offers the potential to expand agricultural and livestock development, in stages, to an ultimate area well in excess of one million hectares, thus providing unique opportunities for resettlement, increased agricultural production, and large-scale processing industries.

5) A detailed study of the Baro River, in conjunction with the Gambela Project feasibility investigations would provide indications of river development potentials for flood control, inland navigation, irrigation, and power generation, possibly in an international Nile Basin context.

6) The Didesa Project comprises the only possibility found in the vicinity of the Bedele-Motu road area having appreciable potential for resettlement.

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7) The areas recommended for detailed studies are anticipated to have minimal adverse affects on the ecology of the area. Both areas consist of grasslands with some scattered trees and brush; therefore, forests would not be destroyed. The Upper Didesa Valley does not appear to have a large wildlife population; and there exists ample area in Gambela Awraja to support a wildlife reserve in addition to eventual large scale agricultural and livestock development. Both developments would provide beneficial soil and water conservation.

8) Both recommended areas are scheduled by IHA to have all-weather feeder road access during the Sixth Highway Program.

RECOMMENDED SCOPE OF WORK FOR PHASE II STUDIES

Field Surveys

Soil Surveys and Land Use Classification - To identify the precise areas in the two selected projects suitable for both irrigated (Gambela) and rainfed (Gambela and Didesa) agriculture development and livestock development (Gambela only), soil surveys and land capability classification are required. The work required is as follows:

- Reconnaissance soil surveys of the two areas. Since the soils in both cases are relatively uniform, a sampling density of one soil profile per 400 hectares will probably be sufficient. However, the final density of soil sampling should be determined by the survey teams after ground inspection of the areas.
- Profile descriptions will normally be by auger borings to a depth of two meters. However, about 50 soil profile pits two meters deep should be dug throughout each project area, and 25 of these should supply samples from each discernible horizon for laboratory analysis.

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- The physical and chemical analyses of the soil samples collected from the representative soil pits should include:

Mechanical Analysis:	Chemical Analysis:
percent stones and gravel	pH
coarse sand	soluble salts (anions and cations)
fine sand	organic N
silt	percent organic matter
clay	C/N ratio
	percent $CaCO_3$
	total exchangeable bases
	cation exchange capacity
	base saturation
	HCl extractable P and K (surface samples only)

In addition, samples from each of the profile sites should be hand textured in the field and at least 50 of them should have field determinations of their pH made, as well as full morphological descriptions on an horizon basis.

The numbers of profile pits, soils samples collected and the precise range of physical and chemical testing may be adjusted during the work as may be mutually agreed to suit the field soils conditions encountered.

From the results of the soil surveys and terrain evaluations, a land capability map will be produced. Classification should be in accordance with the systems used by either the USDA Soil Conservation Service or the USBR, modified where necessary to take account of local conditions and land use requirements.

The soil survey report should include all data on soils, and the ecology and land use capabilities of the area. The following maps of the area suitable for agricultural development should be included:

- soil map, scale 1:20,000
- land use and classification map, scale 1:20,000

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Agro-Socio-Economic Survey - To determine the existing conditions of both the indigenous rural population and would-be resettled beneficiaries from other sections of the country, the following information should be obtained: (Note: In the case of farmers who would be resettled from other provinces, this information may be qualitative.)

- Religion, tribal groups, family sizes, usual places of residence, occupations, and sources of income.
- Indebtedness, sources of credit and repayment terms and purpose of loans.
- Work done for others and payments received.
- Family purchases insofar as this is possible to determine.
- Distance of markets from farms or usual places of residence, how often visited, what is purchased, and what is sold.
- Tribal or religious customs which may form a constraint to settlement.
- Existing farming systems of beneficiary farmers to include area of holdings, crops, planting and harvesting dates, cultural practices, types of equipment, yields, inputs, production costs, source of seeds, etc.
- Livestock owned, where grazed, and use of stock (i.e., for food, sale or work).
- Land tenure situation.
- Permanent improvements, i.e., housing, buildings, water supply, etc.

Transportation Survey - The following work will be undertaken to obtain data essential for project planning studies:

- Inspection and evaluation of the existing roads within the areas and the highway connections between the areas and other points in Ethiopia.
- Determination of traffic volume on existing roads in the areas.
- Identification of suitable sites for road construction materials.

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- Obtaining information regarding road construction plans and schedules of the Imperial Highway Authority and the Rural Roads Administration.
- Determination of present water transport volume along the Baro River.
- Determination of present transport rates.

Topographic Surveys - To provide the necessary topography to enable planning, layout and preliminary designs of project works (irrigation, drainage, flood control, farm plans, roads, etc.), ground surveys will be required. Maps at a scale of 1:20,000 with one meter contour interval are considered adequate for feasibility grade purposes.

Water Resources and Climate - Existing data will be collected, reviewed and analyzed, including:

- Stream flow; including gauge heights, discharge measurements, sediment content, water quality, floods, dependable yield, and potentials for development.
- Precipitation, including frequency distribution of rainfall, rainfall intensity, and effective rainfall.
- Other climatological factors, such as temperature, evaporation, relative humidity, and wind speed.

Credit - The existing sources and methods of supplying short, medium and long-term credit will be reviewed.

Marketing - The current and prospective internal and world markets for cotton, maize, sorghum, groundnuts, pulses, rice, sugar, livestock, and other produce as may be found adaptable to the project areas, will be examined and analyzed.

Processing - The present capacities and locations of crop processing facilities in Ethiopia, such as cotton gins, sugar refineries, oil mills, canneries, meat packing plants, and others, will be determined.

Livestock - The present role of livestock in the project areas will be determined and numbers will be estimated.

Ecology - The ecology of the areas will be determined, including plant species, ecological zoning, carrying capacities of pastures, forest density and value (if applicable), and wildlife.

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Planning Studies

Water Control - The following planning and preliminary design activities will be carried out to provide the necessary water control infrastructure to enable implementation of proposed agricultural, livestock and resettlement schemes:

- Determination of irrigation water requirements on the bases of effective rainfall, evapotranspiration requirements of the proposed crops, and irrigation efficiencies (Gambela irrigated alternative).
- Preliminary layout and design of irrigation (Gambela irrigated alternative), and drainage (Gambela rainfed alternative and Didesa) systems, including necessary pumping facilities and control structures.
- Preliminary layout and design of flood prevention dike for both Gambela alternatives, including necessary control structures.
- Determination of sources of construction materials.
- Preliminary cost estimates and annual operation and maintenance costs.

Transportation - The following planning and preliminary design activities will be carried out to provide for the transportation facilities necessary to accommodate project development:

- Estimation of the growth of future travel (goods and people) within the project areas and to outside centers.
- Preliminary layout and design of internal project roads and bridges; selection of standards and design criteria will be coordinated with the IHA and Rural Roads Administration.
- Methods of construction and locations of construction materials.
- Preliminary cost estimates and annual operation and maintenance costs.
- Review of the IHA's highway programs and the Rural Road Administration's planned activities, as they affect external access to the project areas, and suggestions as to scheduling and alignments thereof.

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- Consideration of a possible river transport route via the Baro River and White Nile system.

Farming Systems - Alternative farming systems will be examined to include:

- Alternative farm sizes.
- Degree and extent of mechanization.
- Cultural practices with and without irrigation.
- Cropping patterns and rotations.
- Seed varieties, fertilizers, pesticides.
- Production and equipment costs.

On the basis of the above, representative model farms will be determined (in close coordination with MOA and within existing or pending land tenure legislation) and cash flow analyses will be made including complete farm budgets, production costs, investment costs, taxes, credit requirements, yields, sales, debt service, water charges (if applicable), net returns, and internal rates of return.

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Credit - The existing situation in the project areas is such that locally-available credit sources are virtually non-existent. Consequently, credit requirements for the projects will be estimated and recommendations made for the development and maintenance of credit institutions and funds at the project level, including preliminary cost estimates.

Markets and Processing Facilities - Estimates will be made of existing and projected demands for the proposed project area crops, both domestic and international, taking into account production in other areas of the country and the impacts of population growth and increased incomes. The location and seasonal characteristics of demands will also be considered as these will influence transportation and storage requirements. The potential markets for rice and sugar cane will also be investigated.

The requirements for crop storage will be determined and preliminary cost estimates made.

The viability of crop processing facilities, such as cotton gins, rice mills, and sugar refineries, will be investigated and recommendations made.

The nature and magnitude of the market for farm supplies will be identified and described.

Recommendations on the organization and role of cooperatives will be made.

Management, Testing and Extension Services - Project organization and management requirements will be determined and recommendations made for each project, including the establishment of a demonstration and seed multiplication farm, the training of extension agents, and the provision of extension services for both agricultural and livestock (if applicable) development. Preliminary estimates for buildings and equipment and annual recurring costs will be made.

Settlement Plans and Land Tenure - Settlement plans will be prepared for the two areas, to include source of settlers, location of farmsteads and siting of villages which will probably appear to support the farm population (not to include actual village layouts). Recommendations will be made as to how best to

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fit the maximum number of indigenous rural population into the settlement scheme.

Systems of land tenure, which will have a profound affect on settlement planning, will be carefully analyzed and taken into account and recommendations made as to farm boundary marking, land registration, land taxes, etc. Constraints will be identified and recommendations made for removing them.

Livestock - The potential role of livestock, specifically in the Gambela Project area, will be investigated and evaluated including the eradication or control of disease. Various alternatives, including cow-calf operations, stocker programs, and possibly a project feed-lot, will be investigated and preliminary cost estimates made.

Forestry - Insofar as neither project area selected has appreciable forest cover, there is no scope for either control or utilization of this resource. However, as a measure of conservation and to protect nearby forested areas, the advisability of providing for farm woodlots will be studied and recommendations made.

Ecology and Environmental Impact - An ecological overview will be made of the effect the two projects will have on the interelation of plant and animal life in their environment.

Wildlife population and the presence of prehistoric sites (if any) will be assessed and recommendations made for their protection and possible controlled exploitation in connection with tourism development.

Particular attention will be given to soil and water management. The possibility of planting more nutritious grasses in pasturelands will be considered.

An outline environmental impact statement will be prepared.

Public Services - The nature of other services to support the populations of the project areas, and the settlements therein, will be indicated. Included will be health, education and police. Based on standards of the Ministries concerned and on their cost data, general requirements and approximate costs of these services will be determined.

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Project Proposals

The individual planning studies in the previous section will all form elements of the project proposals for implementation by the Imperial Ethiopian Government. The balance between these elements, their interrelation, and their ultimate presentation as components of a plan will be achieved through a continuous process of synthesis leading to a coordinated plan document.

The project proposals will define and describe the implementation plans. The choice of components of a recommended proposal will be influenced by such criteria as soils, size of area suitable for development, location relative to transportation, the present status of farming and livestock production in the area, the relationship between expansion into new agricultural areas to the development of lands adjacent to existing farms, and other factors. There will be considerable economic choice in identifying broad areas for sequential land development activities.

Based on the planned phasing of the projects, recommendations for the timing of the development of supporting infrastructure, principally roads, irrigation water supplies, marketing and storage facilities, and extension services, will be made.

The projects selected will be described in detail, including all of their relevant components, together with their estimated costs and phasing. The project descriptions will set out the anticipated farm production and financial analyses of farm models. Costs and returns from model farms, together with the requirements for supporting infrastructure, other services and the relationship to livestock production will then be aggregated to provide results for the project proposals as a whole.

Specifications for operation and management of the projects and definition of the required support of government agencies will be included.

A comprehensive financial analysis of each project, including financial costs, financing requirements, estimated government cash flow and foreign exchange cash flows, will be made.

The economic analyses will include economic valuations of costs and benefits and their aggregations, and derivation of the internal economic rates of return.

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The project proposals will serve as bases for deriving the requirements, costs, benefits, returns and the primary and secondary impacts which would result from the aggregate development of areas. The economic and social benefits to the regions, the national economy and foreign trade will also be identified.

The project proposals will be drawn up to meet requirements of international financing agencies.

Reports

Monthly progress reports will be prepared covering staff assigned, description of work under way, identification of matters requiring special attention or possibly change in work scope, estimates of progress on work items and summary data on project costs and budget performance.

Final feasibility reports will be submitted at the end of the Phase II Feasibility Study.

MANPOWER REQUIREMENTS FOR PHASE II STUDIES

Contractor's Staff

In order to carry out the work outlined in the previous section, it is estimated that a total of 55 man-months of professional time will be required for the following positions:

Position	Man-Months In Ethiopia	Man-Months In USA
Team Leader	9	-
Land Use Specialist (Deputy Team Leader)	9	-
Agricultural Economist	6	-
Hydrologist	3	-
Transportation Planner	3	-
Soils Scientist	3	-
Livestock Specialist	3	-
Marketing Specialist	2	1
Ecologist (local hire)	6	-
Rural Sociologist (local hire)	6	-
Principal Advisors (home office)	2	2
Totals	52	3

The proposed scheduling of the above staff is shown on Figure VI-1.

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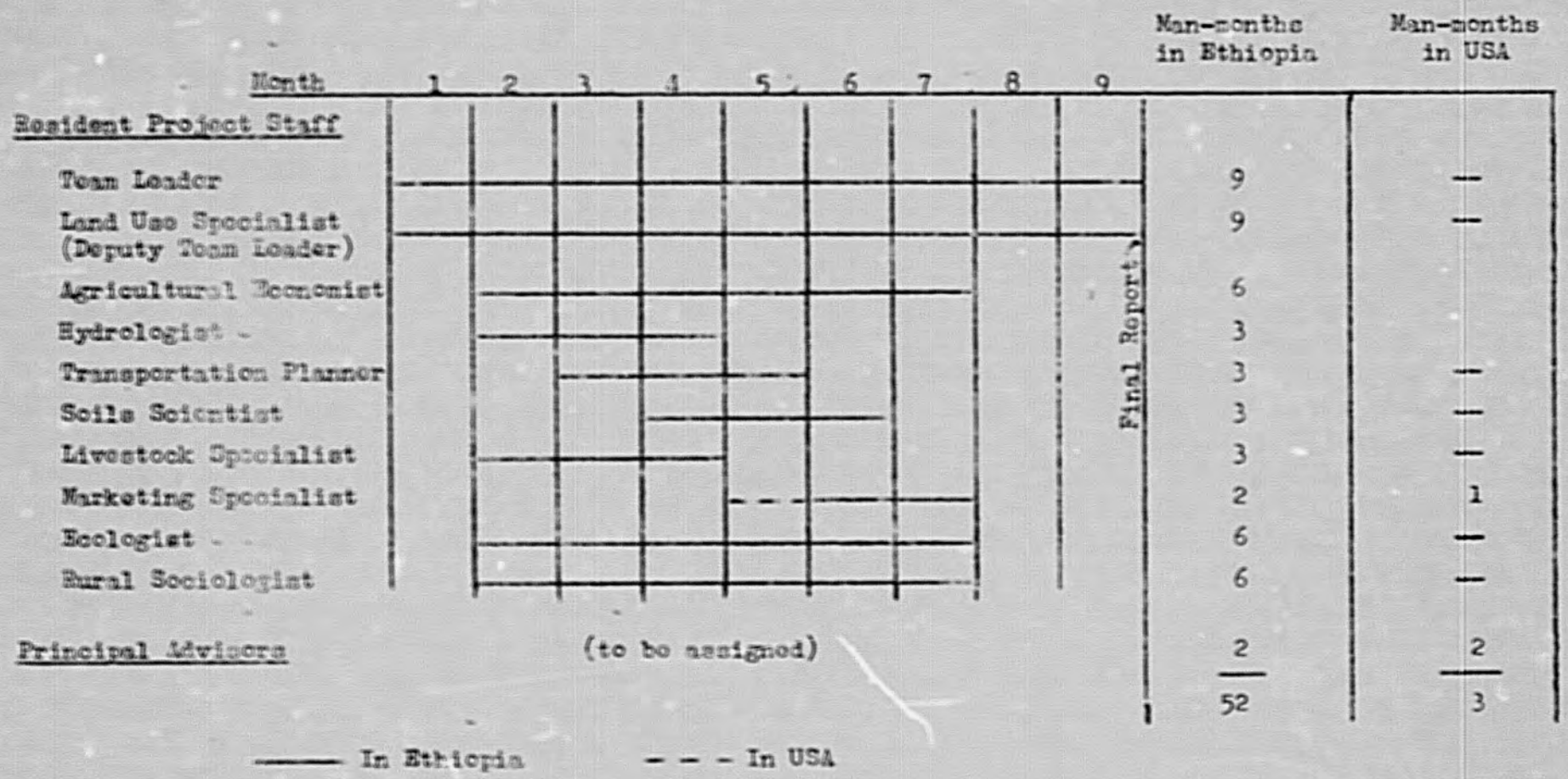

Figure VI-1

PROPOSED STAFF SCHEDULE
PHASE II STUDIES

Ethiopian Counterpart Staff

The process of carrying out the Phase II studies in the limited time scheduled will require professional assistance from the Ethiopian Government in the form of counterpart personnel assigned to work directly with the Contractor's staff. Such arrangement will also provide an opportunity for the training of counterpart personnel. It is recommended that the following counterpart staff be assigned:

Position	Man-Months
Economist	9
Civil Engineer	8
Agronomist	8
Road Engineer	3
Hydrologist	3
Veterinarian	3
Assistant Soils Surveyor	6
Assistant Soils Surveyor	6
Total	46

ESTIMATED COST FOR CARRYING OUT PHASE II STUDIES

The cost to carry out Phase II studies is estimated as follows:

	Estimated Cost (U.S. Dollars)
Salaries	
U. S. Personnel	
Home Office Professional	7,000
Field Staff Professional	83,990
Total U. S. Salaries	90,990
Cooperating Country Nationals	
Field Staff Professional	12,000
Overhead	
Home Office	8,050
Field Staff	67,190
Total Overhead	75,240

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Travel and Transportation	
U. S. Travel	1,000
International Travel	27,750
Other Personnel Travel	4,000
Transportation of HHE and Vehicles	24,200
Total Travel and Transportation	56,950
Allowances	
Post Differential	8,400
Quarters	9,000
Temporary Lodging	3,360
Education	7,000
Educational Travel	2,400
Per Diem	22,020
Total Allowance	52,180
Other Direct Costs	
Mobilization	4,000
Communications	1,800
Report Reproduction	10,000
Total Other Direct Costs	15,800
Equipment, Vehicles, Materials and Supplies	
Equipment	2,000
Materials and Supplies	1,800
Resale Loss on 2 Vehicles	4,000
Total Equipment, Vehicles, Materials and Supplies	7,800
Subtotal	310,960
Fixed Fee	31,100
Grand Total	342,060

SERVICES, EQUIPMENT AND PERSONNEL TO BE PROVIDED

The following items are not included in the cost estimate and it is assumed that they will be furnished in local currency or in kind by the Ethiopian Government or by USAID. If not provided by the Government or USAID, they will be reimbursable to the Contractor by additions to the cost of the contract and to the fee. Costs will be in accordance with USAID standards where applicable.

- Adequate office space in Addis Ababa as required by resident and short-term staff.
- Competent secretarial, accounting, clerical and drafting personnel, topographic survey crews, translators and drivers

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and other local supporting services specifically assigned to the Contractor's team.

- Office equipment and furnishings, utilities and supplies, including typewriters, adding machines, calculators, drafting equipment and other furniture and fixtures required.
- Field vehicles as required, POL, and vehicle maintenance.
- Maps, aerial photographs, survey and field equipment, and other supporting services and equipment of a technical nature.
- Laboratory analyses of soil, water and plant samples.
- Assistance in procuring visas and arranging trips.
- Routine innoculations and medical services required by the Contractor's team.

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Borana breed are found in the adjoining provinces and might be available for stocking the project;

- well-staffed and moderately well equipped veterinary services in the province which could be expanded to provide project services;
- Rinderpest vaccination under auspices of the JP-;5 program appears to be controlling this disease as well as reducing the incidence of CBPP; and
- the possibility that stocker animals produced here could find a market in the Southern Rangelands Development Project.

Components of a Livestock Development Program

General - As with the Gambela project area (Part II), this program could be allied to the proposed irrigation project previously discussed. A series of positive actions would be required to overcome the constraints and take advantage of the potentials. Actions required include:

- initiation of an extension program for pastoralists with respect to selection, feeding, and health protection for cattle;
- implementation of disease control as previously outlined (for draft and production herds);
- establishment of year-around waterpoints;
- construction of access roads to the project area; and
- inauguration of a pasture management scheme to protect and up-grade the grazing area.

Location and Size of Livestock Project Area - An area of approximately 25,000 hectares on the east bank of the Omo River adjacent to and south of the irrigation project could be designated. This area should support from 11,000 to 13,000 head of mature indigenous cattle. If the larger Borana is brought in, however, the number would be reduced to 8,000 or 9,000 mature animals.

Stock - Cattle for a livestock production phase of the project could be either local breeds or, as previously suggested, importation of the Borana type. Undoubtedly, some local pasteralists would take advantage of the opportunity to obtain grazing rights in the area and this should be encouraged.

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Disease Control - Institution and maintenance of the system of disease control outlined in Part I would be dependent on the availability of adequate personnel from the Veterinary Services Division. Although the Gemu Gofa area is fairly well provided with such personnel, the following should be added to serve a project - one Veterinarian, one animal health assistant, two vaccinators, two dip-spray attendants and casual labor as needed during vaccination and tick-prevention operations.

Waterpoints - As a constant water supply is required, waterpoints would be established throughout the grazing area. These would also serve the needs of the human population living in or near the grazing areas. Water would be derived in part from irrigation return flow and partly as specifically designed waterpoints fed from the river. These would be arranged so that no animal would have to travel more than five to seven kilometers for water.

Extension Services - As there are only a few agriculturalists now providing extension education in Gemu Gofa, and none in the project area, additional extension staff would be required. Consideration should be given to establishment of a demonstration livestock production unit within the project. Realistic extension education in the fields of animal breeding, nutrition, disease prevention and control, and pasture management would be required.

Pasture Management - Only when the precise ecologic character of the project area has been determined during more detailed studies, can a logical scheme of management be introduced. A systematic schedule for burning of the grazing area may be required unless controlled continual grazing can prevent the proliferation of undesirable species. Consideration should also be given to pasture improvement by introduction of new species.

Benefits - Qualitative

Improvement of the carrying capacity of the rangelands would occur as a result of reduction of disease incidence; alteration of management practices; upgrading of animal quality; and education of pastoralists in newer methods of livestock production. As all of these factors come into play, there would be a graded restructuring of the herd to include:

- The percentage of females in the herd would increase.
- The number of females of reproductive age would increase.
- The calving rate would increase.
- The mortality rate among cattle of all ages would be reduced.
- Average animal weight would be increased.
- The annual off-take would increase.
- Annual financial return to individual owners would increase.

In view of the negative net benefit stream resulting from the preliminary economic analysis of a cow-calf operation for the Gambela Project (see Part II), no analysis was made for the Bagun project area where the pasture carrying capacity is lower and infrastructure development costs would be about the same. As was recommended for Gambela, however, detailed feasibility investigations here should also include a livestock component.

INFRASTRUCTURAL DEVELOPMENT PLAN

Included in this section are: 1) internal roads; and 2) irrigation, drainage and flood control facilities. Other infrastructure items, including: 1) management, testing and extension services; 2) credit, marketing and storage; and 3) public services, common to all four projects studied, were presented in Part I of this report.

Internal Roads

The preliminary criteria, design standards, and estimated unit (per kilometer) costs for the internal road networks for all projects studied were given in Part I of this report.

The preliminary layout of one and two-lane tertiary roads for the Gambela Project is shown on Figure IV-1, following page IV-1. Summarized in Table IV-16 are the approximate lengths and order-of magnitude costs of these tertiary standard roads.

Table IV - 16
Estimated Cost Internal Roads
One Project

Item	Length (Km)	Unit Cost(E$/Km)	Cost(1,000E$)
2-Lane Tertiary	48	21,400	1,025
1-Lane Tertiary	71	15,200	1,075
Total Cost			2,100

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