REPUBLIC OF CAMEROON
MINISTRY OF AGRICULTURE

FEASIBILITY REPORT
ON
BAIGOM AGRICULTURAL DEVELOPMENT PROJECT

MAIN REPORT

SEPTEMBER 1986

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

REPUBLIC OF CAMEROON
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PREFACE

In response to the request of the Government of the Republic of Cameroon, the Japanese Government decided to conduct a feasibility study on the Baigom Agricultural Development Project and entrusted the study to the Japan International Cooperation Agency. J.I.C.A. sent to Cameroon a survey team headed by Mr. Kensaku Takeda, Nippon Koei Co., Ltd. from July to December, 1985.

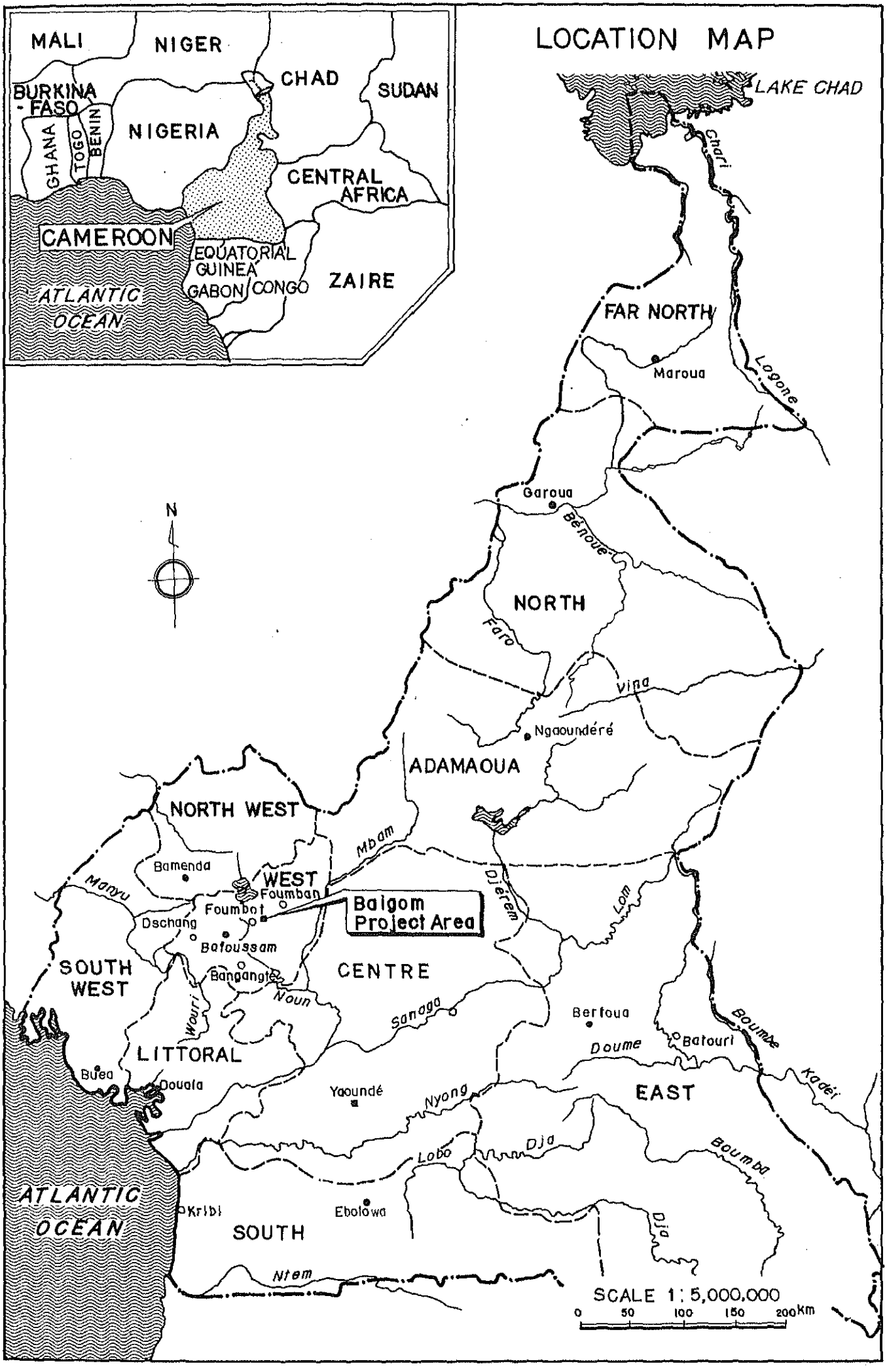
The team exchanged views on the Project with the officials concerned of the Government of Cameroon and conducted a wide scope of field survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Cameroon for their close cooperation extended to the team.

September, 1986

Keisuke Arita
President
Japan International Cooperation Agency


LOCATION MAP
MALI
NIGER
CHAD
SUDAN
BURKINA - FASO
NIGERIA
GHANA
TOGO
BENIN
CENTRAL AFRICA
CAMEROON
EQUATORIAL GUINEA
GABON
CONGO
ZAIRE
ATLANTIC OCEAN
LAKE CHAD
Chari
FAR NORTH
Maroua
Logone
Garoua
Benoue
N
NORTH
Faro
Vina
Ngaoundéré
ADAMAOUA
NORTH WEST
Mbam
Bamenda
WEST
Foumban
Manyu
Foumbot
Baigom Project Area
Djerem
Lom
Dschang
Bafoussam
SOUTH WEST
Bangangté
CENTRE
Noun
Sanaga
Wouri
Bertoua
Boumba
Doume
Batouri
LITTORAL
Buea
Douala
Yaoundé
Nyong
EAST
Kadéi
Lobo
Dja
Boumba
ATLANTIC OCEAN
Kribi
Ebolowa
SOUTH
Dja
Ntem
SCALE 1: 5,000,000
0 50 100 150 200Km

SUMMARY

1. The Republic of Cameroon has an area of 465,485 km^2 extending between Western Africa and Central Africa. The total population of Cameroon stood at around 9,578,000 as of June 1984, showing an annual growth rate of 2.83%. The population density is 20.6 persons per km^2, mostly concentrated in western and north-western regions. The Gross Domestic Product (GDP) in 1984 was CFA F 3,195 billion or US$6.8 billion equivalent, that means a GDP per capita of US$725. The GDP has increased at an annual rate of 9.95% during the period from 1979/80 to 1983/84.

2. Agriculture is a main economic sector in Cameroon. Since her independence in 1960, the Government of Cameroon has given a high priority to the agricultural development. At present, Cameroon is self-sufficient in food products. However, cultivation of such crops as rice, soybeans, tomatoes, etc. is being actively encouraged so as to meet the nation's food needs, to limit the import of foods and to increase the country's exports to neighbouring countries. The Baigom Agricultural Development Project has long been recognized as one of the highest priority projects in Cameroon, and also as a model scheme for agricultural development in the West Province.

3. The project area is located in the Baigom plain about 35 km north-east of Bafoussam, the capital of West Province. Access to the project area is very easy through the national road No. 2 connecting with Bafoussam and Foumban, the chief-town of Noun Division. The gross area of the Baigom plain is about 2,800 ha and administratively, it belongs to Foumbot Sub-Division and Koutaba District of the Noun Division in the West Province. In 1984, the population of the area within a radius of 10 km from the Baigom plain was estimated to be some 32,000, consisting of 15,000 in Koutaba District and 17,000 in Foumbot Sub-Division, which was about 12% of the total of the Noun Division.

4. The elevation of the Baigom plain ranges from 1,112 m to 1,125 m with an average slope of about 1.0%. Most of soils in the plain have good suitability for agricultural production. The climate in the plain is relatively mild throughout the year and two distinct seasons are observed: the rainy season from March to October and the dry season from November to February. The mean annual rainfall is about 2,016 mm, out of which 1,919 mm concentrates during the rainy season. The annual mean

temperature in the plain is about 21.6°C with the mean maximum of 27.8°C and the mean minimum of 16.8°C.

5. At present, most of the Baigom plain is covered with forests and grass, and inundated during about nine months of the year from March to November. The inundation in the plain is the major constraint in promoting the utilization of land for agriculture and is caused by poor drainage owing to the existence of the basaltic barrier on the Nkoup river near the Baigom bridge, insufficient flow capacities of three major rivers in the plain, namely Ndoup, Nja and Nkoup, lack of proper drainage canal systems other than the above three rivers, and growing of grass and forests which hinders the smooth flow of water.

6. Lack of water in the dry season is another major constraint in the plain. The Ndoup and Nja rivers are main water sources for irrigation in the plain but their available discharges are very small in the dry season. Possibility of irrigated agriculture in this season is very limited unless storage reservoirs are constructed in the upper reaches of the Ndoup and/or the Nja rivers.

7. The main objectives of the Project are to reclaim the Baigom plain and convert the existing swampy area into the new agricultural land, and to introduce the modern irrigated farming practices in the plain. The proposed development plan of the Project was formulated based on the assessment of the water resources, estimation of irrigation water requirements and the water balance study in relation to the scale of the Ndoup and Nja storage dams. The irrigation areas were proposed as shown below for the proposed cropping pattern with a two-year rotation.

Crops	1st Year		2nd Year	
	Rainy Season	Dry Season	Rainy Season	Dry Season
Paddy	1,000 ha	1,000 ha	1,000 ha	1,000 ha
Maize	1,000	-	500	-
Groundnuts	-	-	500	500
Soybean	-	500	-	-
Tomato	-	500	-	500
Total	2,000	2,000	2,000	2,000

8. The proposed project components would be two storage dams on the Ndoup and Nja rivers, irrigation and drainage canals and their related structures, farm road network and on-farm development works. The main features of the project works are summarized as follows:

(1) Storage Dams

1-1) Ndoup Dam

- Dam Type	:	Fill dam
- Dam Height	:	25.5 m
- Dam Crest Length	:	155.0 m
- Embankment Volume	:	180,900 m^3
- Gross Storage Capacity	:	8,760,000 m^3
- Active Storage Capacity	:	8,630,000 m^3

1-2) Nja Dam

- Dam Type	:	Fill dam
- Dam Height	:	26.0 m
- Dam Crest Length	:	260.0 m
- Embankment Volume	:	245,600 m^3
- Gross Storage Capacity	:	4,930,000 m^3
- Active Storage Capacity	:	4,770,000 m^3

(2) Irrigation Facilities

2-1) Ndoup Intake Weir

- Weir Type	:	Concrete fixed weir
- Weir Height	:	1.0 m
- Weir Crest Length	:	13.0 m
- Scouring Sluice Gate	:	H 1.5 m x W 1.0 m x 1 no.
- Intake Discharge	:	1.44 m^3/sec
- Intake Gate	:	H 1.0 m x W 1.0 m x 2 nos.

2-2) Irrigation Canals

- Ndoup Main Canal	:	3.7 km
- Nja Main Canal	:	4.4 km

- Ndoup Secondary Canals	:	7.9	km
- Nja Secondary Canals	:	10.3	km

2-3) Related Structures

- Turnouts	:	14	nos.
- Drops	:	3	nos.
- Culverts	:	3	nos.
- Checkgates	:	16	nos.
- Spillways	:	5	nos.

(3) Drainage Facilities

3-1) Drainage Canals

- Ndoup Main Canal	:	5.5	km
- Nja Main Canal	:	7.7	km
- Nkoup Main Canal	:	3.7	km
- Nkoup Secondary Canals	:	3.0	km
- Catch Drains	:	36.4	km

3-2) Related Structures

- Drops	:	15	nos.
- Culverts	:	8	nos.
- Drain Inlets	:	42	nos.
- Drainage Junction	:	1	no.
- Cross Drains	:	24	nos.

3-3) Diversion Flood Way

- Side Spillway	:	8.0	m
- Cross Drain	:	28.3	m
- Flood Canal	:	700.0	m

3-4) Regulating Gates

- Gate Type	:	Roller Gate
- Number of Gate	:	3 nos.
- Size of Gate	:	W 3.0 m x H 2.5 m

(4) Farm Roads

4-1)	Main Farm Roads	:	14.2 km
4-2)	Inspection Roads along Irrigation Canals	:	26.2 km
4-3)	Inspection Roads along Drainage Canals	:	20.0 km

(5) On-Farm Development

5-1)	Land Reclamation	:	2,000 ha in net
5-2)	Typical Size of a Farm Plot	:	0.3 ha (100 m x 30 m)
5-3)	Irrigation Canals		
	- Tertiary Canals	:	33.3 km
	- Quaternary Canals	:	50.0 km
	- Farm Ditches	:	100.0 km
5-4)	Drainage Canals		
	- Tertiary Canals	:	20.0 km
	- Quaternary Canals	:	37.5 km
	- Drainage Ditches	:	100.0 km
5-5)	On-Farm Roads		
	- On-Farm Roads	:	73.3 km
	- Inspection Roads	:	83.3 km

9. The implementation period of the Project was assumed to be 6 years from 1987 to 1992. The detailed design would be carried out in 1987 and actual construction works would be commenced in 1988 and continued for five years until 1992. The project cost comprises the direct construction cost, initial farm investment, administration cost, engineering cost, physical contingency and price contingency. The exchange rate used in the cost estimate was US$1.0 = CFA F 384.5 = ¥ 203 as of December, 1985. The total project cost was estimated at CFA F 15,533 million as shown below:

(Unit: CFA F 10^6)

Item	Foreign Currency	Local Currency	Total
1. Direct Construction Cost	4,135	3,293	7.428
1.1 Storage Dam Works	1,396	1,345	2,741
1.2 Irrigation Works	73	70	143
1.3 Drainage Works	1,248	694	1,942
1.4 Farm Road Works	505	344	849
1.5 On-Farm Works	913	840	1,753
2. Initial Farm Investment	475	408	883
2.1 Rice-Mill	228	38	266
2.2 Buying Center	123	184	307
2.3 Warehouse	22	33	55
2.4 Office	102	153	255
3. Administration Cost	-	596	596
4. Engineering Cost	1,002	133	1,135
5. Physical Contingency	561	443	1,004
6. Price Contingency	917	3,570	4,487
Total	7,090	8,443	15,533

10. The farming practices in the Project area would be performed by settled farm householders. The optimum farm size per household was determined to be 2.1 ha in due consideration of establishment of viable farm units and man-power demand for cultivation. The total number of households to be settled in the project area of 2,000 ha was, therefore, estimated to be 952. The priority of settlement would be given to the households living around the project area at the first stage and then to the young farmers in accordance with the Government's policy.

11. For the successful implementation, operation and management of the Project, it is proposed to establish a Development Authority (SODABA: Société de Développement Agricole de Baigom) by reinforcing the present Baigom Rice Cultivation Project Office. To undertake efficiently the operation and management of the developed area, the organization of SODABA would have to be strengthened progressively after the project implementation stage, and staff with adequate qualifications would be required. The number of staff required at the full development stage was estimated to be 193.

12. The annual crop production by the Project after full development would be expected as follows:

- Rice (Paddy)	10,000	ton
- Tomato	10,000	ton
- Maize	3,000	ton
- Soy bean	500	ton
- Groundnuts	1,000	ton

13. The economic cost of the Project was estimated to be CFA F 8,980 million by deducting both price contingency and transfer payments such as taxes and duties from the financial cost. On the other hand, benefit which would accrue from the net incremental production of crops, would reach around CFA F 1,795 million per annum at the full development stage. The economic internal rate of return (EIRR) was estimated at 12.1% and the benefit-cost ratio (B/C) was calculated to be 1.20 with the discount rate of 10%. It indicates that the Baigom Agricultural Development Project is and economically viable.

14. Various indirect benefits and socio-economic impacts would be expected from the realization of the Project such as (i) food supply to the Metropolis and commercial centers, (ii) foreign exchange saving, (iii) increase of employment opportunities, (iv) improvement of living standards and contribution to regional economy, (v) establishment of marketing systems and consolidation of farmers' associations, (vi) improvement of sanitary conditions, and (vii) settlement from densely populated areas and diminution of population drift from rural area.

15. In order to lead the Project up to the final goal smoothly, it would be desirable to establish a pilot scheme prior to the development of the whole project area. The main reasons for the necessity of the pilot scheme are as follows:

(1) Skilled engineers and technicians on the irrigation farming are not sufficient in Cameroon due to her rather short history especially for rice cultivation,

(2) The results of experiments obtained from the existing experimental plot still remain in a level of preliminary one mainly due to lack of engineers and facilities,

(3) Farmers are not familiar and skillful in a modern irrigation farming, and

(4) The executive body of the project operation is necessary to have experiments in a certain scale of settlement of farmers prior to the development of the whole area.

16. The location of the pilot scheme was selected on the north-eastern corner of the Baigom plain. The following works, facilities and equipments would be required for establishment of the pilot scheme:

(1) Land Reclamation 155 ha

- Experimental farms : 16 ha
- Demonstration and training farms : 29 ha
- Pilot model areas for farmers : 110 ha

(2) Irrigation and Drainage Facilities

- Intake weir : Concrete fixed weir
- Irrigation canals : 13.9 km
- Drainage canals : 20.7 km
- Related structures : turnouts, culverts, drops - 94 nos.

(3) Farm Roads

- Trunk road : 2.7 km
- Farm roads : 16.8 km
- Related structures : culverts - 2 nos

(4) Buildings

- Buildings for farm operation : 1,900 m^2
- Buildings for experiment and demonstration : 1,665 m^2
- Residences for staff : 1,825 m^2

(5) Utility Facilities

- Electric power supply system
- Water supply system

(6) Equipment

- Agricultural machinery
- Operation and maintenance machinery
- Vehicles
- Rice-mills
- Repair shop equipment
- Meteorological and farm observation equipment
- Experimental and training equiment

FEASIBILITY STUDY

ON

BAIGOM AGRICULTURAL DEVELOPMENT PROJECT

MAIN REPORT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF REPORTS

1. MAIN REPORT

2. ANNEX VOLUME 1

ANNEX	I	HYDROLOGY
ANNEX	II	GEOLOGY AND SOIL MECHANICS
ANNEX	III	SOILS AND LAND CLASSIFICATION
ANNEX	IV	SOCIO-ECONOMY
ANNEX	V	AGRICULTURE
ANNEX	VI	IRRIGATION AND DRAINAGE
ANNEX	VII	FARMERS SETTLEMENT PLAN AND FARMERS' ORGANIZATION
ANNEX	VIII	ORGANIZATION AND MANAGEMENT
ANNEX	IX	CONSTRUCTION PLAN AND COST ESTIMATE
ANNEX	X	PROJECT EVALUATION
ANNEX	XI	PILOT SCHEME

3. ANNEX VOLUME 2

ANNEX	XII	DRAWINGS

ABBREVIATIONS

(ABREVIATIONS)

A

ADRAO	Association pour le Développment de la Riziculture en Afrique de l'Ouest (West Africa Rice Development Association: WARDA)

B

BCD	Banque Camerounaise de Développement (Cameroon Development Bank)
BEAC	Banque des Etats de l'Afrique Centrale (Central Africa States Bank)
BIAO	Banque Internationale pour l'Afrique Occidentale (International Bank for Western Africa)
BICIC	Banque Internationale pour le Commerce et l'Industrie (International Bank for Trade and Industry)

C

CA	Catchment Area (Bassin Versant)
CAEFC	Chambre de l' Agriculture, de l'Elevage et des Forêts du Cameroun (Cameroon Chamber of Agriculture, Livestock and Forests)
CAMSEED	Cameroon Popcorn Company
CAPLABAM	Coopérative Agricole des Planteurs du Bamboutos (Agricultural Cooperative of Planters in Bamboutos)
CAPLAHN	Coopérative Agricole des Planteurs du Haut Nkam (Agricultural Cooperative of Planters in Haut Nkam)
CAPLAME	Coopérative Agricole des Planteurs de la Ménoua (Agricultural Cooperative of Planters in Ménoua)
CAPLAMI	Coopérative Agricole des Planteurs de la Mifi (Agricultural Cooperative of Planters in Mifi)
CAPLANDE	Coopérative Agricole des Planteurs du Ndé (Agricultural Cooperative of Planters in Ndé)
CAPLANOUN	Coopérative Agricole des Planteurs du Noun (Agricultural Cooperative of Planters in Noun)
CAPME	Centre National d'Assistance aux Petites et Moyennes Entreprises (National Center for Assistance to Small and Medium-size Enterprises)
CCCE	Caisse Centrale de la Coopération Economique (Central Fund for Economic Cooperation)
CEIPS	Centre d'Etudes, d'Instruction et de Production des Semences Légumières (Vegetable Seeds Research, Training and Production Centre)

CENADEFOR	Centre Nationale de Développement des Forêts (National Center for Forest Development)
CENEEMA	Centre National d'Etude et d'Experimentation du Machinisme Agricole (National Center for Studies and Experimentation of Agricultural Mechanization)
COOPAGAL	Coopérative Agricole des Pionniers de Galim (Agricultural Cooperative of Pioneers in Galim)
COOPAGRO	Coopérative Agricole de l'Ouest (Agricultural Cooperative of the West)
COOP COPEL	Coopérative de Commercialisation des Produits de l'Elevage à Bafoussam (Marketing Cooperative of Livestock Products in Bafoussam)
COOPEC	Coopérative d'Epargne et de Crédit (Saving and Credit Cooperative)

D

DGRST	Délégation Générale à la Recherche Scientifique et Technique (General Delegation for Scientific and Technical Research)

E

ENSA	Ecole Nationale Supérieure Agronomique (National Advanced School of Agriculture)

F

FAC	Fonds d'Aide et de Coopération (Assistance and Cooperation Fund)
FAO	Food and Agricultural Organization (Organisation des N.U. pour l'Alimentation et l'Agriculture: OAA)
FED	Fonds Européen de Développement (European Development Fund)
FIDA	Fond International de Développement Agricole (International Agricultural Development Fund)
FOGAPE	Fonds d'Aide et de Garantie des Crédits aux Petites et Moyennes Entreprises (Aid and Loan Guarantee Fund to Small and Medium-sized Enterprises)
FONADER	Fonds National de Développement Rural (National Fund for Rural Development)

G

GAM	Groupements d'Agriculteurs Modernes (Modern Farmers Groups)

I

IBRD	International Bank for Reconstruction and Development (World Bank) (Banque Internationale pour la Reconstruction et le Développement: BIRD)
IDA	International Development Association (Association Internationale de Développement: AID)
IFCC	Institut Français du Café, du Cacao et Autres Plantes Stimulantes (French Institute of Coffee, Cacao and Other Stimulative Plants)
IITA	International Institute of Tropical Agriculture (Institut International pour l'Agriculture Tropicale)
INADES	Institut Africain de Développement Economique et Social (African Institute of Economic and Social Development)
IRA	Institut de la Recherche Agronomique (Institute of Agricultural Research)
IRAT	Institut de Recherches Agronomiques Tropicales et de Cultures Vivrières (Research Institute for Tropical Agriculture and Food Products)
IRRI	Institut International de Recherches Rizicoles (International Rice Research Institute)
ITA	Institut des Techniques Agronomiques (Institute of Agricultural Technology)

J

JICA	Japan International Cooperation Agency (Agence Japonaise de Coopération Internationale)

M

MIDEVIV	Mission de Développement des Semences et des Cultures Vivrières (Seeds and Food Development Authority)
MESRES	Ministère de l'Enseignement Supérieur et de la Recherche Scientifique (Ministry of Higher Education and Scientific Research)
MINAGRI	Ministère de l'Agriculture (Ministry of Agriculture)
MINCI	Ministère du Commerce et de l'Industrie (Ministry of Trade and Industry)
NIMEPIA	Ministère de l'Elevage, des Pêches et des Industries Animales (Ministry of Livestock, Fisheries and Animal Industries)
MINEQ	Ministère de l'Equipement (Ministry of Equipment)
MINFI	Ministère des Finances (Ministry of Finance)
MINPAT	Ministère du Plan et de l'Aménagament du Territoire (Ministry of Planning and Regional Development)

MINTR	Ministère des Transports (Ministry of Transportaion)
MINUH	Ministère de l'Urbanisme et de l'Habitat (Ministry of Urbanism and Housing)

N

NCRE	National Cereals Research and Extension Project (Projet National pour la Recherche et la Vulgarisation des Céréales)

O

OC	Office Céréalier (Cereales Office)
OECF	Overseas Economic Cooperation Funds (Japan) (Fonds de Coopération Economique d'Outre-mer du Japon)
ONAREF	Office National de Regénération des Forêts (National Office of Reforestation)
ONCPB	Office National de Commercialisation des Produits de Base (National Produce Marketing Board)
ONDAPB	Office National de Développement de l'Aviculture et du Petit Bétail (National Office of Aviculture and Small Animals)
ONPD	*Office National de Participation au Développement* (National Office for Participation in Development)
ORSTOM	Office de Recherche Scientifique et Technique d'Outre-mer (Overseas Scientific and Technical Research Office)

P

PDRPO	*Projet de Développement Rural de la Province de l'Ouest* (Rural Development Project in the West Province)

R

RII	Redpath International Incorporated

S

SACTA	Société Agricole et de Collecte de Tabacs (Agricultural and Tobacco Collecting Company)
SCB	Société Camerounaise de Banque (Cameroonian Banking Company)
SEABA	Société d'Exploitation Agricole du Bamoun (Bamoun Agricultural Production Company)
SEDA	Société d'Etudes pour le Développement de l'Afrique (Study Company for African Development)

SEFN	Société d'Exploitation Forestière du Noun (Noun Forest Exploitation Company)
SEMRY	Société d'Expansion et de Modernisation de la Riziculture de Yagoua (Agency for Promotion and Modernization of Rice Cultivation, Yagoua)
SEPCAE	Société d'Engrais et de Produits Chimiques d'Afrique Equatoriale (Equatorial African Fertilizer and Chemical Products Company)
SEPCAM	Société d'Etudes pour la Promotion de la Culture et de l'Exploitation du Maïs (Study Company for the Promotion of Maize Culture and Production)
SNI	Société Nationale d'Investissement du Cameroun (National Investment Corporation)
SOCAF	Société de Conserverie Africaine (Ex-SAFEL) (African Canning Company)
SOCALEG	Société Camerounaise de Légumes (Cameroonian Vegetable Company)
SNEC	Société Nationale des Eaux du Cameroun (National Water Company of Cameroon)
SODERIM	Société de Développement de la Riziculture de la Plaine des Mbos (Mbo Plains Rice Development Corporation)
SONEL	Société Nationale d'Electricité du Cameroun (National Electric Corporation of Cameroon)
SPC	Société des Provenderies du Cameroun (Cameroon Feeds Company)

U

UCCAO	Union Centrale des Coopératives Agricoles de l'Ouest (Central Union of Agricultural Cooperatives in the West Provinciel)
UDEAC	Union Douanière et Economique de l'Afrique Centrale (Central African Customs and Economic Union)
UNVDA	Upper Noun Valley Development Authority (Société de Développement de la Haute Vallée du Noun)
USAID	United States Agency for International Development (USA) (Agence des Etats-Unis pour le Développement International)

V

VRD	Voirie et Réseaux Divers (Roads and Other Networks)

W

WADA	Wum Area Development Authority (Autorité de Développement de la Région de Wum)

UNITS OF MEASUREMENT
(UNITES DE MESURE)

Length (Longueur)	Kilometre	km
	metre	m
	centimetre	cm
	millimetre	mm
Area (Surface)	square metre	m^2
	hectare	ha
Velocity (Vitesse)	metre per second	m/s
	kilometre per hour	km/h
	million cubic meters	MCM
Volume (Volume)	cubic metre	m^3
	litre	l
Weight (Poids et Masse)	kilogramme	kg
	ton	t
Time (Temps)	hour	hr
	minute	min
	second	s
Power (Energie)	ampere	A
	volt	V
	kilovoltampere	kVA
	watt	W
	kilowatt	kW
Temperature (Température)	degree Celsius	°C

UNITS OF MONEY
(UNITES DE MONNAIE)

CFA Francs	CFA F / F CFA (or CFA)
US Dollar	US $ / $ EU
Japanese Yen	¥

US 1.0$ = CFA F 384.5 = ¥ 203 (as of Dec. 1985)

CHAPTER I INTRODUCTION

1.1 Authority

This Final Report was prepared in accordance with Article VI-3 of the Scope of Work for the Feasibility Study on the Baigom Agricultural Development Project in the Republic of Cameroon agreed upon between the Japan International Cooperation Agency (JICA) and the Government of Cameroon on 16th April, 1985.

The report presents the results of studies on the technical and economic feasibility on the Baigom Agricultural Development Project. It covers the present physical and economic conditions of the studty area, the proposed development plan including the pilot scheme plan, and economic and financial analyses of the Project. All comments on the Draft Final Report submitted previously to the Ministry of Agriculture were incorporated in this Final Report.

This Main Report is supported by the following Annexes:

Annex I	Hydrology
Annex II	Geology and Soil Mechanics
Annex III	Soils and Land Classification
Annex IV	Socio-Economy
Annex V	Agriculture
Annex VI	Irrigation and Drainage
Annex VII	Farmers Settlement Plan and Farmers' Organization
Annex VIII	Organization and Management
Annex IX	Construction Plan and Cost Estimate
Annex X	Project Evaluation
Annex XI	Pilot Scheme
Annex XII	Drawings

1.2 Background of the Study

Since her independance in 1960, the Government of the Republic of Cameroon has been steadily promoting the national economic development programmes with great emphasis being put on the development of the agricultural sector. As a result, the agricultural sector has become a predominant element in the country's economy, sharing

about 22% of the total GDP and about 50% of overall exports in 1983/84, and ensuring directly or indirectly the livelihood of three quarters of the population. Further, among African countries, Cameroon has reached a state of self-sufficiency in most food supply except for rice, wheat and flour.

In the Fifth 5-Year National Development Plan (1980/81-1985/86), priority is still given to the development of the agricultural sector in the national economy. Accordingly, the Government's policy is to promote "Integrated Rural Development Programmes" in order to attain self-sufficiency in food crops, to increase agricultural production in general and to improve farmers' living condition.

Based on the result of analysis of food crops forecast, it is estimated that in the short term, there would be no crucial problem with regard to the food supply and demand balance. However, it can be foreseen that after 1990, food shortage will increase at a quick pace as a result of the improvement of the living standard and the rapid growth of consumption. Cultivation of crops such as rice, maize, soybeans, tomatoes, cassava, etc., are being actively encouraged so as to meet the nation's food needs, to reduce imports of food and to increase the country's export capacity to neighbouring countries.

The study area located in the Baigom plain is regarded as one of the suitable regions for rice cultivation and is designated as a model area for rice production in the West province. Since 1975, a rice experimental farm was established by the Ministry of Agriculture and operated in the study area under the technical assistance of Korean experts. Researches on rice cultivation under irrigated and rain-fed condition and corns, beans cultivation, etc. are being carried out at the farm by the Ministry of Agriculture.

In 1980, SEDA (Société d'Etudes pour le Développement de l'Afrique, Yaoundé) conducted the first stage study covering a gross area of about 3,000 ha in the Baigom plain. Further in 1984, it executed the second stage study concentrating on 200 ha in the upper part of the plain. Under such circumstances, in December 1984, the Government of Cameroon which has always contemplated to implement the Baigom Agricultural Development Project as a model farm scheme for rice cultivation in the West Province, requested the Government of Japan to carry out a feasibility study on this project.

In response to the request of the Government of Cameroon, the Government of Japan has decided to conduct the Feasibility Study on the Baigom Agricultural Development Project. JICA was entrusted by the Japanese Government with the execution of the above study. A first JICA mission visited Cameroon at the end of 1984 to hold preliminary

discussions with the authorities concerned of the Government of Cameroon. Through these discussions, it was concluded by the mission that the Project will contribute to the increase of food production in the country, thus conforming to the national policy of self-sufficiency in food crops in the medium and long terms.

JICA then dispatched a second mission in April 1985 to conduct a preliminary study on the Project and recognized the necessity to develop agricultural infrastructures through the provision of irrigation and drainage systems and by establishing food crops farming systems in this region. Based on the result of the preliminary study, the second mission of JICA agreed with the Government of Cameroon on the Scope of Work for the Feasibility Study on the Baigom Agricultural Development Project.

1.3 Objectives of the Study and Summary of the Scope of Work

The objectives of the study are;

(i) to formulate a plan for the agricultural development in the Baigom area having about 3,000 ha in gross potential area by improving agricultural infrastructures to serve as a model agricultural center for the South-West region of Cameroon,

(ii) to verify the technical soundness and economic viability of the Project, and

(iii) to conduct on-the-job training to Cameroonian counterpart personnel during the study period.

The Scope of Work set forth for executing the Feasibility Study on the Baigom Agricultural Development Project was agreed upon between the Government of Cameroon and JICA on 16th April, 1985. The scope of the study is broadly divided into the following three major stages of the works;

Work I : Preparation of topographic maps with a scale of 1/5,000 (1 m contour intervals) covering the whole study area

Work II : Data collection, necessary field surveys and formulation of the basic concept for the Project

Work III : Formulation of a development plan for the Project including the pilot farm and preparation of the feasibility study report including the preliminary design of the pilot farm

The field survey for the preparation of topographic maps was carried out by the JICA Topographic Survey Team from June to August and the mapping with a scale of 1/5,000 was completed in December 1985. Work II and III were executed by the JICA Feasibility Study Team in Cameroon for about 4.5 months from July to December 1985 and in Japan for about 3 months from January to March 1986, respectively. The detailed "Scope of Work" is shown in the Attachment of this report.

1.4 Activities of the Study Team

JICA organized a study team composed of ten experts for the execution of the Feasibility Study of the Project as shown in Table 1. After the arrival of the first group of the study team in Douala on 30th July 1985, discussions on the draft "Plan of Operation for the Study" prepared by the study team were held on 31st July and 1st August between the staff of the Ministry of Agriculture and the study team at Yaoundé.

The study team moved to Bafoussam, the capital of the West Province, from Yaoundé on 2nd August and commenced data collection and field surveys. The Inception Report including the plan of operation for the whole study was prepared on the basis of the survey results for about one month after the commencement of the field works. It was submitted to the Ministry of Agriculture on 3rd September 1985.

The new topographic maps in draft form with a scale of 1/5,000 prepared by the JICA Topographic Survey Team became available at the end of September. They were fully utilized during the latter half of the field survey works. The field surveys were continued until the middle of November in cooperation of the counterpart personnel as shown in Table 1. The Interim Report which presented the interim results of the field works was prepared at the end of November 1985. A meeting on the Interim Report between officials of the Ministry of Agriculture and the Ministry of Planning and Regional Development, and the JICA study team was held on 28th November at Yaoundé.

Subsequent to the field works in Cameroon, further study was executed in Japan for about three months from January to March 1986, and the results of the field and home works were compiled into a Draft Final Report. Discussions on the draft report were held at the

beginning of July in Yaoundé and this Final Report was finalized based on the comments received from the Goverment of Cameroon on the Draft Final Report.

1.5 Acknowledgement

The JICA study team wishes to take this opportunity to acknowledge the gratitude to the staff of the Ministry of Agriculture, Ministry of Planning and Regional Development, and other agencies concerned for their cooperation and invaluable support during the study period. And of course, the team remains grateful to all who have helped during the field works, especially to the people in and around the study area.

CHAPTER II GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

2.1 Land and Population

The Republic of Cameroon has an area of 465,458 km^2 extending between Western Africa and Central Africa and bounded by Nigeria, Chad, Central Africa, Gabon, Congo, Equatorial Guinea and the Gulf of Guinea.

The country is called "Africa in miniature", for it is characterized by varied climate, vegetation and topography typical to various regions of the African Continent.

The total population of Cameroon stood at around 9,578,000 as of June 1984, showing an annual growth rate of 2.83% against the figure recorded during the 1976 national population census. The population density is 20.6 persons per km^2, mostly concentrated in western and northwestern regions. 63% of the population lives in rural area and 79.4% of the total working population - estimated to be 38.7% of the total population - is engaged in agricultural sector. It was observed however that there is a constant migration of rural people to urban areas at an annual rate of 5.5%.

2.2 Administrative Organization

The Cameroonian territory is administratively divided into 10 Provinces, 49 Divisions, 182 Sub-Divisions and 20 Districts under the leadership of Governors, Prefects, Sub-Prefects and District Chiefs, respectively. Table 2 shows the administrative division of Cameroon by provinces.

The Baigom Agricultural Development Project area covers about 3,000 ha of land in the Baigom plain, extending over the Koutaba District and Foumbot Sub-Division in the Noun Division, West Province.

Considering the geographical situation (high plateaux) and socio-economic and administrative units, the regional division for socio-economic study was defined as follows:

- Study region : West Province
- Project region : Koutaba District and Foumbot Sub-Division in Noun Division

- Project zone : Areas within a radius of 10 km from the Project site
- Project site : Baigom plain itself (about 3,000 ha)

2.3 National Economy

The Gross Domestic Product (GDP) of Cameroon in 1984 was CFA F 3,195 billion or US$6.8 billion equivalent, that means a GDP per capita of US$725. The GDP has increased at an annual rate of 9.95% during the period from 1979/80 to 1983/84.

Agriculture contributes a substantial share to the economy of Cameroon. Although it dropped from 28.7% of GDP in 1979/80 to 21.9% in 1983/84, it is still providing 50% of the country's export value. Petroleum and its products accounted for 36.7% of the total export value in 1984. Coffee and cacao are two other main products for exports.

As to imports, essential consumer goods and industrial equipment represent 32% of the total import value, and semi-finished products 21.7%. The inflating trade deficit was CFA F 14,972 million in 1979/80 and CFA F 22,263 million in 1982/83.

The soil and varied climate of the country are generally very favourable for agriculture. The principal crops cultivated are millet, sorghum, rice, groundnuts and cotton in the north, maize, plantains and various vegetables in the west, and yams, cassava and oil-palm in the south.

Cameroon is self-sufficient in most food products. However, the cultivation of such crops as rice, soybeans, tomatoes, etc. is being actively encouraged so as to meet the nation's food needs, to limit the imports of foods and to increase the country's exports to neighbouring countries.

Rice production in 1982 was 67,600 tons. The consumption of rice in Cameroon is constantly increasing. As shown in Table 3, rice is continuously imported at a rate of about 21,400 tons per year and an annual expenditure of CFA F 1.48 billion on an average during the past 16 years. To ensure self-sufficiency in rice, the Government set up some state corporations such as SEMRY, UNVDA, SODERIM, etc.

2.4 National and Regional Development Program

Since the independence in 1960, the Government of Cameroon has directed the economic, social and cultural development through successive national development plans. The Fifth 5-Year Economic, Social and Cultural Development Plan (1981-1986) is being implemented on the basis of the following four principles of the Cameroon development policy: 1) Planned liberalism, 2) Self-reliant development, 3) Balanced development and 4) Social justice.

The Government budget for the year 1985-86 which is the last year of implementation of the Fifth 5-Year Plan is estimated to be around CFA F 740 billion. The distribution of expenditures in the fiscal years 1984/85 and 1985/86 indicates that the Government has given priority to regional and agricultural development, infrastructure, education and public health.

The Government is working out the next Sixth Development Plan. According to the presidential note addressed to the authorities concerned, the rural development strategy which is one of the mainstays of the Plan is focused on the following three objectives: 1) maintaining or even exceeding the status of food self-sufficiency, 2) amelioration of nutrition level of the people, and 3) promotion and consolidation of commercial crops cultivation.

2.5 Regional Setting

The West Province covers an area of 13,890 km^2, corresponding to about 3% of the total area of the country. The population of the West Province in 1984 was estimated to be around 1,233,000 and the population density was about 89 persons per km^2. The population growth rate during the period of 1976-1984 was estimated to be 3.1% per annum.

The population in urban areas accounts for 24%, while 76% lives in rural areas. In 1984, the number of farm-households in the Province was 214,000 and the average household size was 5.6 persons. On the whole, the population of the Province is young: 52% of people is under 15 years old. The Province has a very high rate of migration: 41.3% of the country's migrants are from the West.

2.6 Regional Socio-Economy

The characteristics of the West Province are as outlined below. As to constraints to the harmonious regional development in the region, the problems in each sector are pointed out in Annex IV 2.2.

(1) Agriculture

Agriculture constitutes the principal activity of the population in the West Province. Owing to the fairly fertile soils and relatively mild climate, the West Province is developing a most diversified agriculture from cash crops to food and garden crops, and is one of the largest producers of market crops in Cameroon (maize and vegetables in particular). The average farm size in the region is only 1.5 ha.

(2) Livestock

The West Province which is known as one of the most prominent transit places of animals, is a main supplier of animal products to Littoral and Centre Provinces. It is however noticed that most of the cattle (96%) and almost half of the sheep (47.3%) in the region are reared by the Bororos.

In the Province, there exists the Kounden Station which serves as an animal breeding center in the western region.

(3) Fishery

As for fishery, it has only a marginal importance in the regional economy. To increase the output of fish in the Province, rational use of the Bamendjing reservoir as a fish pond is being promoted with assistance of UNDP and FAO. On the other hand the supply of sea fish remains insufficient.

(4) Forestry

The West Province constitutes a wooded savanna in degradation with trees along river banks. Most of the zones classified as forest reserves are, however, covered by coffee farms. Besides, forests in the region are suffering from degradation due to exploitation and burning of forest for farming.

(5) Industry

The industry in the West Province is still in its embryonic stage. Most of existing industries are light and home industries, mainly engaged in the processing and manufacturing of primary products and goods.

To absorb the potential labor force of the region, several agro-based industry development projects are expected to be realized in the near future.

(6) Electricity

The electric power supply is administrated by SONEL. The electricity of the region is supplied by a hydro-electric power station in Song-Loulou and Edea through the following transmission lines: Douala - Bafoussam (90 kV) and Bafoussam - Foumban (30 kV) via Foumbot.

(7) Transportation

There are mainly two transport means in the West Province, viz. land (road) and air transportation.

The road network in the West Province comprises 220 km of paved roads and 1,500 km of non paved roads. During the rainy season, most of the tracks become almost impassable. Communal and access tracks with a total length of 1,100 km are still insufficient for multiple agro-pastoral activities in the Province. Many fertile zones remain isolated.

In the West Province, there exist three airports: Koutaba, Bafoussam and Dschang. The Cameroon Airlines links Koutaba to Yaounde 8 times a week, using the Koutaba airrport which has been recently reopened after completion of the runway expansion work.

(8) Telecommunications

In the West Province, telecommunication infrastructure exists only in Bafoussam, Foumban, Dschang, etc. However, the communication by telephone is very difficult. A telephone system is now under construction in Foumbot. It is expected to be completed within the year of 1986 and can serve 100 subscribers.

(9) Socio-Cultural Features

Bestowed with a mild climate and fertile volcanic soil, the West Province attracted several surrounding clans and tribes to settle in the Province. The Bamileke tribesmen (about 1 million inhabitants) settled on the high plateaux extending over five Divisions of the West Province (Mifi, Bamboutos, Bangangté, Ménoua and Haut Nkam), while the Bamouns (about 254,000 inhabitants) occupied the "Noun" Division (ex-Bamoun) of which area represents more than a half of the total area of the West Province.

The population of the Province is characterized by a permanent exodus of active manpower to neighboring provinces (Littoral and Centre). The population distribution by religions in the Province is unknown, but there exist three main religions, namely Islam, Christianity (both Catholicism and Protestantism) and Animism. This diversity in terms of religion has an important effect upon the regional socio-cultural structure.

CHAPTER III PRESENT CONDITION OF THE STUDY AREA

3.1 Location

The study area is located in the Baigom plain about 35 km north-east of Bafoussam, the capital of the West Province. It is bounded both in the north and west by the national road No. 2, in the south by the Mbetpit mountain and in the east by the peneplain laying bare with gneiss outcrop. Administratively, the study area belongs to Foumbot Sub-Division and Koutaba District of the Noun Division in the West Province.

The gross area of the Baigom plain is about 2,800 ha with 5 km in the maximum width from north to south and 8 km in the maximum length from west to east. At present, most of the plain are covered with forest and grass, and are inundated during about nine months from March to November.

3.2 Physical Features

3.2.1 Topography

The elevation of the Baigom plain ranges from 1,112 m to 1,125 m with an average slope of about 1.0% westward except for the border of the plain. The average slopes in the upper, middle and lower parts of the plain are estimated as follows:

Upper part	(El. 1,125 m–1,118 m)	: 4.0%
Middle part	(El. 1,118 m–1,115 m)	: 1.0%
Lower part	(El. 1,115 m–1,112 m)	: 0.8%

In the center of the plain, there exists a volcanic island with the summit rising above the plain by about 70 m. The area located at elevation of more than El. 1,125 m of this island is about 120 ha and is covered with arbored savanna.

3.2.2 Climate and Meteorology

The climate in the study area is relatively mild throughout the year and two distinct seasons are observed: the rainy season from March to October and the dry season from November to February.

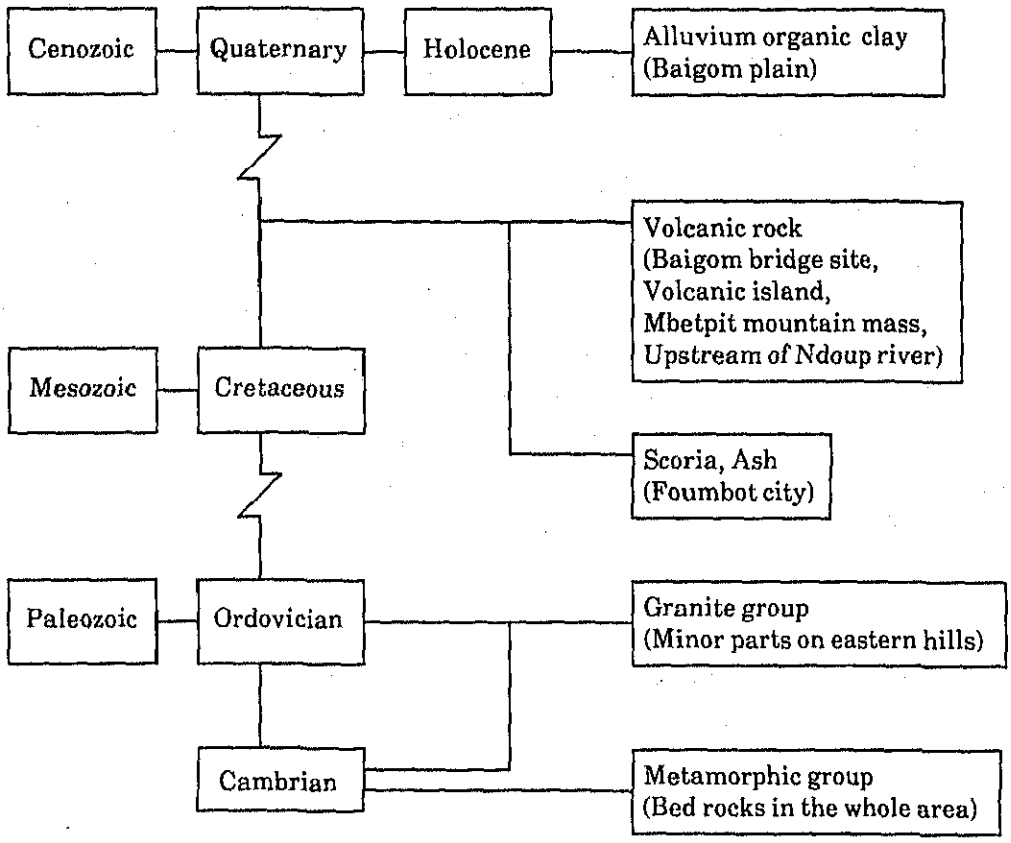
The meteorological condition of the study area is represented by the available records at the Koundja meteorological station. This station is situated very close to the study area and lies in the Nja catchment basin which is one of the two major external drainage basins providing the Baigom plain with water. The elevation of the station is 1,208 m, that is to say about 100 m above the plain. The mean monthly meteorological records for the recent 10 years from 1975 to 1984 at the Koundja station are summarized in Table 4.

The annual mean temperature in the plain is about 21.6°C with the maximum mean of 27.8°C and the minimum mean of 16.8°C. The maximum mean temperature in the dry season is higher than that in the rainy season, while the minimum mean temperature in the dry season becomes lower. Therefore, the difference between the maximum mean and the minimum mean becomes bigger in the dry season. The mean relative humidity varies between about 78% during the rainy season and about 61% during the dry season. The mean sunshine duration is 5.8 hours/day in the rainy season and 8.5 hours/day in the dry season. The annual mean A-pan evaporation is about 1,587 mm, which is equivalent to the daily mean of 4.3 mm/day. The mean pan evaporation in the dry and rainy seasons are 5.2 mm/day and 3.9 mm/day, respectively. The monthly mean wind velocity varies from 1.0 m/sec to 1.6 m/sec with the annual mean of 1.2 m/sec.

The mean annual rainfall for 34 years from 1951 to 1984 at the Koundja station is about 2,016 mm showing the maximum monthly mean of 351 mm in September and the minimum of 4.7 mm in January. The total rainfall during the rainy season is estimated to be about 1,919 mm or 95% of the annual rainfall. The annual mean rainy days during the recent 9 years from 1976 to 1984 is 174 days, of which 164 days or 94% are recorded during the rainy season. The maximum daily rainfall for the above period is 93 mm/day in May 1979 and every year high values of more than 50 mm/day are recorded.

3.2.3 Geology

The geology in and around the Baigom plain is chronologically classified as follows:



- Metamorphic group

  Metamorphic group consisting of mainly schist, gneiss, migmatite and phyllite, is found the whole area as bed rocks. Most of these bed rocks are weathered and are in an advanced stage of lateritization except for quartzite dikes which are observed in parts of the area.

- Granite group

  Granite group composed of highly weathered granite is found at minor parts on the eastern hills. Such weathered granite also exists at the right side hills of the Nja

river about 1.5 km downstream of the entrance point of the river into the plain, and its outcrop is found at the left side hills.

- Volcanic rock and Scoria

Volcanic rock is composed of mainly basalt and partly rhyolite. The outcrops are found at the downstream of the Nkoup river (Baigom bridge site), upstream of the Ndoup river, around the entrance of the Nja river into the plain, and in the volcanic island located in the centre of the plain. The peak of the Mbetpit mountain is formed of rhyolite. While, scoria and ash exist thickly in the western area of the Mbetpit mountain.

3.2.4 Soils

The soils in the study area were classified into seven soil units, according to the FAO/UNESCO soil classification system, i.e. Dystric Histosols (Od), Humic Gleysols (Gh), Mollic Andosols (Tm), Humic Andosols (Th), Humic Cambisols (Bh), Dystric Nitosols (Nd) and Lithosols (L).

Dystric Histosols (Od) extend over the swampy area in the lower flat lowland around the volcanic island. These soils are saturated with water through the year at present. The depth of histic horizon up to subsurface mineral layer ranges from 50 cm to over 2 m. This histic horizon contains about 80% of mineral clay. The drainage improvement and amendment of soil acidity are essential for agricultural use of these soils. These soils occupy 1,010 ha or 42.1% of the study area.

Humic Gleysols (Gh) are found on the flat lowland in north-western to south-western part of the swampy area. Surface layer is composed of dark brown organic soil. Underlying subsurface soils are derived from alluvial deposits. These soils will have good agricultural potential after improvement of the drainage condition. This soil unit occupies 760 ha or 31.6% of the study area.

Mollic Andosols (Tm) are found on the flat higher terraces in the eastern part of the volcanic island and south-western edge of the study area. These soils are derived from volcanic ash. For crop production, it is better to apply fertilizers, especially phosphorous. Mollic Andosols occupy 210 ha or 8.7% of the study area.

Humic Andosols (Th) extend over the flat higher terraces in the western part of the volcanic island. The land covered with these soils is imperfectly drained and amounts to 150 ha or 6.3% of the study area. These soils without storny phase has potential for crop production.

Humic Cambisols (Bh) develop on the slopes surrounding the flat lowland. These soils are formed on the residual deposits with shallow black surface layer. This soil unit is suitable for crop production if it is conserved from erosion.

Dystric Nitosols (Nd) are distributed over the undulating hilly area around the study area. These soils generally have agricultural potential for upland crops. However these are marginally suitable for irrigated rice cultivation.

Lithosols (L) cover the hilly portion of the volcanic island. These soils have almost no potential for agricultural production.

As the result of the present soil survey, the major parts of soils in the study area are suitable for cropping of rice as well as upland crops with irrigation and drainage development.

3.3 Human Resources

The study area is located in the Baigom plain extending over the Foumbot Sub-Division and the Koutaba District in the Noun Division. Foumban city is the chief town of the Noun Division. The administrative substructure centers (Sub-prefectures) of Koutaba District and Foumbot Sub-Division are located respectively in Koutaba and Foumbot cities.

The majority of the population in the region belongs to the ethnic group of Bamoun and about 85% of them are Muslims. The remainder (15%) is Christian, consisting of Protestants (10%) and Catholics (5%).

The population in last 8 years (1976–1984) is shown in Table 5 for whole Cameroon, West Province, Noun Division, Sub-Division & District and Project Zone. In 1984, the population of the project zone was estimated to be some 32,000, consisting of 15,000 in Koutaba District and 17,000 in Foumbot Sub-Division. The project zone comprises 10 villages within a radius of 10 km from the project site. The population in the project zone was

about 12% of the total of the Noun Division. The average population per household in the area was estimated to be 5.5 persons.

The population in the project zone is unevenly distributed due to its topography; it is dense in the villages located along the national road No. 2 and the main tracks. The population density in the project zone was about 100 persons per km^2 in 1984. The total population in the two villages of Baigom and Ngoundoup adjacent to the Baigom plain was estimated to be 6,331, consisting of 4,800 in Baigom and 1,531 in Ngoundoup.

The average growth rate in the project zone was 2.2% per annum during the period from 1976 to 1984, reflecting a slight outflow of the population to outside. This percentage is fairly low compared with 2.5% of the Noun Division.

Taking into consideration the present regional employment situation, the permanent exodus of active manpower and the tendency of land division into small holdings due to high population pressure, it is required to develop the Baigom plain which is mostly covered with undeveloped swamps and bushes.

Under such circumstances, it can be concluded that the Baigom Agricultural Development Project could find easily the manpower required for its implementation.

3.4 Water Resources

The Ndoup and Nja rivers are the main water sources for the development of the Baigom plain although many small streams flow into the plain from the northern hills and Mbetpit mountain mass on the south. The Ndoup river enters into the plain at the north-eastern corner and has a catchment area of 19.8 km^2. The Nja river having a catchment area of 17.1 km^2 flows into the plain at the eastern corner. The total area of the external drainage basins of the plain is about 62 km^2 and therefore, the catchment areas of both the Ndoup and Nja rivers occupy about 60% of the total drainage area.

There exist two water level staff gauges on the Ndoup river; one at a little downstream of the box culvert crossing the national road No. 2 installed by SEDA in 1980 and the other at the intake weir site for water supply to the Koundja military camp set by the JICA study team in August 1985. There is one gauge immediately at the entrance into the plain on the Nja river, a little upstream of a fall with several meters of difference in height, which was installed by SEDA in 1980. SEDA carried out measurements by use of these staff gauges to

collect data on discharges of the Ndoup and Nja rivers for about 15 months from March 1980 to May 1981. The JICA study team also carried out measurements during the field survey period from August to November 1985.

The monthly mean discharges of the Ndoup and Nja rivers are estimated as shown below by the simulation method of the hydrological analysis based on the available data on discharges and rainfalls:

(Unit: m^3/sec)

Month	Ndoup River (CA = 19.8 km^2)	Nja River (CA = 17.1 km^2)
Jan.	0.28	0.34
Feb.	0.20	0.26
Mar.	0.14	0.22
Apr.	0.14	0.21
May	0.28	0.33
Jun.	0.34	0.38
Jul.	0.62	0.60
Aug.	0.87	0.80
Sep.	1.06	0.96
Oct.	1.03	0.96
Nov.	0.68	0.74
Dec.	0.38	0.48
Average	0.50	0.52

3.5 Infrastructure

3.5.1 Transportation and Communications

Access to the study area can be made through the national road No. 2 running along the plain. This road (about 70 km) connects Bafoussam, the provincial capital of the West Province, and Foumban, the chief-town of the Noun Division.

Between these two administrative centers, there exist two important cities along the same national road; Foumbot and Koundja. The former (located 30 km from Bafoussam and 40 km from Foumban) is one of the biggest centers for market crops in Cameroon and the latter has a military base with an airport.

As regards to the access to the site (naturally the marginal area of the plain), the Baigom project has an advantageous position compared with other existing rice development projects such as SODERIM, UNVDA, SEMRY, etc.

Out of the national road, tracks or paths are used for daily traffic transportation of products and communications. These tracks often become impassable for ordinary vehicles in the rainy season. The access to the inside of the plain is very difficult, especially in the rainy season. Only the emerged marginal plain is partly exploited by farmers in the dry asason for production of food and garden crops.

In the project region, there is no telephone exchange. In Foumbot city, an automatic exchange is planned to be installed by the end of 1986. Mails are delivered twice a week to the subscribed P.O. boxes in the Post Office in Foumbot.

3.5.2 Electricity and Water Supply

Electricity in the region is supplied by SONEL through a 30 kV transmission line running along the national road No. 2 from Bafoussam to Foumban. The voltage for domestic use is dropped to 220-380 volts through several transformers.

Only about 35,000 households in such urban areas as Foumbot, Foumban, Koutaba, Koundja, etc. are supplied with electricity. The existence of an available transmission line along the project site makes the Baigom project more advantageous for implementation.

As for the water supply, only the big municipalities such as Foumbot and Foumban are served with piped water by SNEC in the Noun Division. Operation of the water supply system in Foumbot city was started just in 1980, using water from the Nkoup river. The present supply capacity of SNEC in Foumbot city is 2,880 m^3 per day (120 m^3 per hour). However, to meet the steady increase of water demand, SNEC is now planning to double the supply capacity (to 5,760 m^3 per day) before July 1986.

In the project region, the water source is mainly constituted by streams from hills or mountains, rivers and rain water. The military camp at Koundja has an independent drinking water supply system with an intake on the upper Ndoup river (supply capacity: 30 m^3 per hour) and supplies the Koundja village and the Koutaba airport with its surplus treated water.

The Baigom village (about 4,800 inhabitants) has also a drinking water supply system (capacity of water tower: 125 m^3) by tapping the spring from the Mbetpit mountain side on the south of the Baigom plain. The inhabitants settled in the villages along the national road No. 2 take directly the water coming down from neighbouring hills on the north and north-east of the Baigom plain. So, they often cannot get enough water in the dry season and have difficulty to secure clean drinking water.

3.6 Irrigation and Drainage

3.6.1 Irrigation Systems

In the study area, there are three experimental farms, i.e., zone 1, zone 2 and zone 3. At present, in the experimental farm zone 2 which is located at about 1.8 km south of the Ngoundoup village on the north-eastern part of the study area, about 6 ha of paddy fields are irrigated by getting water from a small natural stream. The irrigation system is, however, a very primitive one only provided with small scale earth canals without regulating and control facilities for water management. Except for this experimental farm, there exist no irrigation systems in and around the study area.

3.6.2 Drainage Condition

The Baigom plain is watered by two main rivers, namely Ndoup and Nja. However, after entering into the plain, these rivers split into many small arms which are hardly recognizable. Moreover they have irregular and insufficient flow capacities. In addition to the above two rivers, there are also a large number of small streams flowing into the plain from the northern hills and Mbetpit mountain mass on the south.

The Nkoup river which is named after joining the Ndoup and the Nja rivers, runs through a marshy prairie at the lower part of the plain. It crosses the national road No. 2 at

the Baigom bridge and flows down to the Foumbot city which is situated about 9 km downstream from the Baigom bridge. The existing flow capacities of the Nkoup river in the downstream of the Baigom bridge are estimated to be more than 40 m^3/sec in most parts but less than 10 m^3/sec in some parts, especially just downstream of the Baigom bridge.

At present, most of the Baigom plain is inundated during the rainy season, for that the following reasons are considered:

(1) existence of the basaltic shelf on the Nkoup river about 400 m upstream from the Baigom bridge, which dams up the river stream,

(2) insufficient flow capacities of the existing rivers, such as Nkoup, Ndoup and Nja, and lack of proper drainage canals other than the above three rivers, and

(3) presence of grass and forests in the plain which hinders the smooth flow of water.

3.7 Agriculture

3.7.1 Land Use

Since most of the study area are inundated particularly in the rainy season, agricultural activities are limited to narrow-sloping fringe lands of the area. The land use in the study area is classified into six main categories, comprising 1) forest, 2) grassland, 3) upland field, 4) rice field , 5) coffee plantation, and 6) others. The present land use in the study area is summarized below:

Land Use Category	Area (ha)	Proportional Extent (%)
1) Forest:	1,200	42.9
Common forest	270	9.6
Swampy forest	930	33.3
2) Grassland:	1,110	39.6
Common grass	370	13.2
Swampy grass	740	26.4
3) Upland field:	450	16.1
Year round cropping	340	12.2
Dry season cropping	110	3.9
4) Rice field	10	0.3
5) Coffee plantation	10	0.3
6) Others	20	0.8
Total	2,800	100.0

As shown in the above, most of the study area, about 2,310 ha or 82.5% of the total area, are covered with forests and grasslands. The cultivaed lands comprising upland field, rice field and coffee plantation amount to about 470 ha or 16.7% and are developed only in accessible western, eastern and southern edges of the study area where topographic conditions are gently slope and surface drainage conditions are well.

3.7.2 Land Tenure and Land Holding

Like other parts of Cameroon, the land tenure system in the region is in a transitional period with a juxtaposition of traditional practices and modern practices.

According to the traditional land tenure system, all lands are considered as the property of Mfon Pamoun (present Sultan of Foumban). The ownership of lands alloted to his vassals has been inherited from generation to generation. In this system, the selling and parcelling of lands are not allowed, but land leasing or tenancy is tolerated. The whole heritage belongs, in principle, to the control of the sole family chief.

As for the modern land tenure system, it was introduced by colonial regime by delivering land certificates to European planters. The ordinances No. 74-1, 74-2 and 74-3 of July 6th, 1974, the decree No. 77-399 of October 3rd, 1977 and the law No. 79-05 of June 29th,

1979, prescribe the land tenure, the state lands and the procedures of exploitation for public use and the indemnification modes.

According to the above-mentioned ordinances, the lands which are not yet exploited are categorized as state lands. To avoid eventual ulterior boundary troubles and disputes on landownership, citizens of Cameroon have nowadays the tendency to register the land owned by them and obtain a certificate to this effect.

To apply for the Land Certificate, the applicant has to pay for a fiscal stamp of CFA F 300. But, as to the procedure of dealing in real estates, he is required to pay registration fees in proportion to the selling prices. The land price in the project region is about CFA F 80 - 100 per m^2 in the rural zone and CFA F 150 - 500 per m^2 in the urban area.

3.7.3 Cropping Pattern and Farming Practices

The main food crops grown in and around the study area are maize, macabo (cocoyam), plantain, taro, cassava, groundnuts, etc. Coffee is cultivated as a main cash crop by some farmers while other farmers cultivate vegetables such as tomato, carrot, cabbage, irish potato, haricot beans, eggplant, lettuce, leek, etc. Farmers also plant fruit trees like mango, avocado, papaya, banana, oil palm, bush butter tree (Dacryodes edulis), guava, etc. Rice is cultivated as one of the cash crops in very limited areas by villagers near the experimental plot No. 2.

The cropping calendar for these crops is largely affected by the rainfall pattern because of the lack of irrigation and drainage facilities. Most of food crops are planted at the onset of the rainy season, and some vegetables such as tomato, irish potato, okra, etc. are cultivated during the dry season in the area where flood water is drained out naturally and soil moisture remains appropriate for vegetable cultivation.

Farming is mostly done by manpower. Mechanization or utilization of draught animals for farming are not common in the area. Most crops are planted on the ridges with the use of small quantity of chemical fertilizers. Plant protection, especially pests control is intensively carried out by spraying of agro-chemicals on vegetables and coffee,while no agrochemical application is practiced for most of food crops. Inter-cropping or mix-cropping methods are common in the area, such as maize with groundnuts, cassava, sweet potato, haricot beans, etc. In some places, three to four kinds of crops are planted together in the same field. Vegetables such as tomato, lettuce, haricot for green harvest, irish potato, etc. are

usually cultivated in pure stand. Rice is cultivated at the small area near the experimental plot No. 2 by ordinary transplanting method under irrigated condition, and the rainfed cultivation is not applied at present.

Major pests and diseases found in the area are stalk-eyed borer, plant and leaf hoppers case worm and bugs on rice, rust, leaf streak and leaf blight for maize, mildew on tomato, smuts on haricot, etc. Losses in rice production by predators such as rodents and birds are also observed.

3.7.4 Crop Yield and Production

Agricultural production in the study area is dependent mainly on crop cultivation, as livestock production is not the main line of agriculture in the area. Both the activities of pasturing in the grassland and logging in the forest are obstructed by the swampy condition in the area, and it is assumed that the amount of production obtained at present is negligible. In consideration of these conditions, agricultural production in the area was estimated on the basis of the crop farming.

The yield and production of major crops in the area under present condition were estimated on the basis of production data of the Sub-Division and District concerned of the Noun Division. The estimated yield and production of major crops are as shown below:

Land Use Category	Field Area (ha)	Planted Area (ha)	Crop/2	Unit Yield (t/ha)/3	Production (t)
1. Rice field	10/1				
2. Upland field:					
Year round cropping	170/4	170	Maize	2.0	340
		170	Groundnuts	1.0	170
		170	Haricot beans	1.7	290
Dry season cropping	70	35	Tomato	2.7	95
		35	Haricot (green)	1.3	45

Note: /1: Rice field is not used fully and the production is assumed negligible.
/2; These crops are selected as the representatives for the area.
/3; The unit yields used are of Foumbot, except for tomato for the Noun total.
/4; This field is used for mix-cropping system.

3.7.5 Marketing and Prices

Commercial activities of the region are remarkably diversified. The following three types of commerce can be distinguished:

- Export-oriented products
- Food and animal products
- Manufactured goods

The commerce of export oriented products involves the collection and selling of coffee, cacao, tobacco and so on. The marketing of coffee and cacao is carried out in accordance with the regulations to be fixed for each agricultural year. For the marketing of Arabica coffee, UCCAO and its member-cooperatives have a quasi-monopoly, while the activitiess of COOPAGRO are limited to the industrial plantations with an annual production of 1,000 tons. On the other hand, Robusta coffee is partly commercialized by UCCAO and mill owners.

As to the food and market crops and animal products for local consumption, they are bought from rural markets and resold in urban markets through middlemen who get a substantial profit.

The distribution of daily consumer goods produced locally or imported is assured by petty merchants who purchase these goods generally from wholesalers in Douala.

With a view to control the marketing and to stabilize the prices of basic products in Cameroon such as cacao, coffee, cotton, palm kernel, groundnuts, ONCPB (National Produce Marketing Board) was established in September 1976 under the tutelage of the Ministry of Commerce and Industry. The external marketing of coffee and cacao is monopolized by ONCPB, while the domestic marketing of these products is under the responsibility of UCCAO in the West Province.

In view of the importance of cereals supply to the population of Cameroon, the Cereals Board (Office Céréalier) was established in July 1975 under the tutelage of the Ministry of Commerce and Industry. However, due to inadequacy of the means made available to the Board, it can partially control the cereal marketing channels only, and as a matter of fact, it is difficult to control the increase in cereal prices during the period of shortage.

The role of marketing food and market crops is also entrusted to the Seed and Food Development Authority (MIDEVIV), a public corporation under the tutelage of the Ministry

of Agriculture. Near the Noun bridge in the study region, there exists a MIDEVIV regional station (established in 1976) where maize, plantains and fruit plants are produced in nursery farm (about 19 ha).

In the Noun Division, the marketing of export crops is duly assured by CAPLANOUN (Arabica, Robusta and cacao), COOPAGRO (Arabica) and mill owners. By contrast, food and garden crops are marketed in the anarchic conditions. As for manufactured goods, the same disorder induces price increase of the necessaries and construction materials. Although the market prices of the principal crops, goods and materials are fixed by the Provincial Ordinance, the prices fluctuate according to the rule of supply and demand.

In the Foumbot region which is known in all Cameroon for its production of garden crops, vegetables are sold on the markets such as Foumbot, Baigom, Mbankoup, Koundja, etc. Most of the major markets are held periodically one or twice a week.

All traders (wholesalers and retailers) in the markets are required to pay a market duty on all goods according to the capacity of their transportation means (CFA F 25 per cage to CFA F 5,000 per lorry) and all the duties collected belong to the each city and towns as these source of revenue. In addition, the owners of vehicles have to pay a parking toll to the each city and towns and a collecting permission fee to the prefecture .

Table 6 shows the situation of production, marketing and prices of the main agricultural products in the Noun Division on August 30th, 1984.

3.7.6 Storage and Processing Facilities

In addition to the poor organization of marketing channels for foodstuffs, the inadequacy of storage and processing facilities in the region constitutes one of the biggest problems restricting the increase in production of some of the foodstuffs.

Among perishable products, only French beans can be preserved thanks to the existence of several private companies such as SOCAF (ex-SAFEL), LACOUR-CAMEROUN, SOCALEG, FRIGO-CAM, AGRI-BAM, etc. which possess storage and processing facilities.

SAFEL which has been transformed into SOCAF in July 1984 started buisiness in 1972 as the first company installed in the West Province for the marketing of French beans and various vegetables. Its headquarter located in Foumbot until 1975 was transferred to

Bafoussam. With a capacity of about 1,200 tons of French beans per year, its turnover is estimated to reach about CFA F 1.8 billion in 1985. SOCAF generally makes verbal contracts with farmers cultivating in the neighbouring regions within a radius of 40 km from the Bafoussam center. SOCAF operates in two seasons: One is from April to June and the other from October to December. In addition to French beans, SOCAF is planning to process in the near future tomatoes for local markets, mangoes and papayas for exports to Europe (France in particular).

Among the aforesaid processing companies, only AGRI-BAM is based in Foumbot and handles fresh vegetables. However, the collected products are forwarded immediately to Douala to supply super markets or to be kept in cold storage for exports to France and UDEAC countries.

In the Noun Division, there exist 13 coffee hulling plants, of which 7 are owned by private parties and 6 by cooperatives (CAPLANOUN and COOPAGRO). But, most of these plants run only for three months a year.

Cameroon, as well as other member countries of UDEAC have no processing plant for concentrated tomato. Many studies have been made on a concentrated tomato plant construcction project which is regarded as one of the most promising agro-industrial projects in Cameroon. However, the project could not take shape because of the uncertainty of supply of fresh tomatoes.

In a recent feasibility study conducted by SNI (National Investment Corporation), the Foumbot region was selected as the most appropriate project site for the construction of a tomato concentrated plant.

3.7.7 Farm Household Economy

The present farm economy in and around the study area was analysed mainly based on the results of interviews obtained through the farm survey. It was observed that there was a relatively high tendency of polygamy as evidenced by the fact that 50% of farm household heads have 2 families or even more. One typical family holds about 7 ha of farm land and the farmer grows various crops. The results of the study on farm budget clarified that the farm-income is insufficient to cover living expenses and the farmers have to earn off-farm

income to supplement the subsistence living level. The farm budget of the typical family is summarized as follows:

(Unit: CFA F)

Item	Annual Budget of Standard Family
1) Gross Income	545,000
- Farm income	427,000
- Off-farm income	118,000
2) Gross Expenditure	545,000
- Production cost	146,000
- Living expenses	399,000
3) Net Revenue	0

3.8 Agricultural Supporting System

Fig. 1 shows the organization chart for the regional rural development comprising research and extension network, investment and credit services, rural development projects and agricultural production bodies and farmers' organizations.

3.8.1 Research and Extension

Under MESRES (Ministry of Higher Education and Scientific Research), there exists an educational institution: the University Campus at Dschang. Created by the decree of April 1977, the University Campus at Dschang is composed of two major establishments: ENSA (National Advanced School of Agriculture) and ITA (Institute of Agricultural Technology).

ENSA which had been at Nkolbisson near Yaoundé was transferred to Dschang on September 1st, 1985. In addition to about 500 students of ENSA, some 600 students of ITA are majoring in agricultural science.

Besides ENSA and ITA, there exist several training institutions in the study region. Institutions responsible for the training of planters and trainers at the same time include CEIPS (Vegetable Seeds Research, Training and Production Center) at Bafou near Dschang,

Training Center of the PDRPO (West Province Rural Development Project) and INADES (African Institute for Economic and Social Development).

The institutions which are in charge of agricultural researches and extension are the following (main activities of each institution are explained in detail in Annex IV):

1) Dschang University Campus,
2) IRA (Institute of Agricultural Research),
3) ONPD (National Office for Participation in Development),
4) Kounden Station (Animal Breeding),
5) National Aquaculture Center (Inland Fishery), and
6) CENEEMA (National Center for Studies and Experimentation in Agricultural Mechanization).

Regarding the agricultural extension services which are directly related to the Baigom Agricultural Development Project, they are decentralized through the provincial delegates, divisional delegates, sub-divisional delegates, chiefs of agricultural posts and agricultural monitors, as shown in Fig. 2.

As to the agricultural extension works around the study area, several extension workers of MINAGRI are assigned to each agricultural post, but their activities are mostly concentrated on the cultivation of coffee in cooperation with UCCAO.

3.8.2 Investment and Credit Services

Up to the mid-1970s, a number of public institutions were established to make more investment and credit available to local enterprises. These included BCD (Cameroon Development Bank), SNI (National Investment Corporation), FONADER (National Fund for Rural Development), etc.

(1) BCD (Cameroon Development Bank)

BCD participates in projects that are in line with the national economic and social development objectives. It finances local enterprises, commerce, agro-industry, small and medium size undertakings and large industrial projects.

(2) SNI (National Investment Corporation)

SNI, a para-public institution, was established in 1964 to enable the Government to mitigate the shortage of private domestic investment by promoting joint-ventures. It is responsible for some of the national development projects. As of June 1983, SNI participated in 63 undertakings with total investments amounting to CFA F 367 billion.

(3) FONADER (National Fund for Rural Development)

In order to intervene better in the rural sector, FONADER (established in 1973) was organized in 1977 as a farmer's bank. The Bafoussam Agency of FONADER was established in 1979 and is supporting agricultural production of the region by providing credits and finances for agro-pastoral operations (see Table 7).

With regard to credit operations, the following problems were pointed out:

- Complex procedure for credit application: it takes at least 2 months,
- Severe conditions for certain categories of borrowers (mortgage or guarantee),
- Poor rate of return of the financed projects (around 60%),
- Low credit recovery rate (less than 60%).

3.8.3 Rural Development Projects and Agricultural Production Bodies

In order to support the food self-sufficiency plan in Cameroon and to maintain the role of the West Province as a granary of the country, the following projects and undertakings are promoted in the Province:

(1) Baigom Agricultural Development Project

The rice cultivation experiment program in the Baigom plain started in 1976 with an irrigated paddy field of 7 ha. At present, about 9 ha of experimental farms divided into three zones (5.5 ha for irrigated paddy rice, 1.2 ha for food crop culture and 2.0 ha for garden crop culture) are run by the Baigom Rice Cultivation Project Office with some 50 staff including 10 temporary employees.

The organization chart of the Baigom Rice Cultivation Project Office is as shown in Fig. 3.

(2) Rural Development Project in the West Province (PDRPO)

From July 1984, PDRPO (ex-High Plateaux Project of the West) entered into the second phase. The principal objectives of the second stage project covering the whole West Province are to increase the yield and production of food crops and to ameliorate the quality of coffee through promotion of the various operations.

As one of the PDRPO's operations, a seed farm at Bafolé covering 380 ha (gross) produces mainly maize (about 600 tons in 1984/85) and some other crops such as soybeans, groundnuts, etc.

(3) Soybean Project

The Soybean Project (first stage) started in January 1981 with an experimental program for two years. The second phase carried out from 1983 aims to intensify the soybean cultivation and familiarize the population in the Province with the consumption of soybean. In the final year of the second stage (1985), a feasibility study was completed. In this study, it is expected that the following objectives will be realized from 1986 to 1991.

- Extension of soybean cultivation to 183,000 farmers
- Production of 14,500 tons of soybean in an area of around 12,000 ha

(4) Westcorn Project

The Westcorn Project envisaged in the 3rd plan by the Government of Cameroon was started in 1972 with an aim to increasing maize production. However, with repeated poor harvests due to poor soil conditions in the plateau, inadaptability of farming equipment, absence of partners and lack of fund, etc., SNI decided to stop the experiments in 1983 and finally dissolve this farm in March 1985.

(5) Seed and Food Development Authority (MIDEVIV)

Located in the Noun plain near Bafoussam, the MIDEVIV Station farm which started operation in 1976 produces fruit plants and banana sprouts. MIDEVIV plays now an important role in agricultural sector.

(6) Mbo Plain Rice Development Project (SODERIM)

In 1973, SODERIM (ex-MIDERIM) started with a view to producing 20,000–25,000 tons of paddy and 8,000–10,000 tons of soybean per year by developing a western part of the Mbo plain (6,000 ha). In 1983/84, SODERIM produced 1,150 tons of paddy in an area of 270 ha (170 ha under irrigated condition and 100 ha under rain-fed condition) at Santchou.

(7) SOCAMAIS

SOCAMAIS (Cameroon Maize Company) established in 1972 is a limited liability company with entirely private capitals. In 1984/85, SOCAMAIS produced about 6,500 tons of maize in a total area of 3,500 ha. The principal clients of SOCAMAIS are feed mills in Bafoussam, Douala, Yaoundé and EC countries which use the maize purchased from SOCAMAIS for food aid.

(8) CAMSEED

CAMSEED (succeeding SEABA) is located in Fosset on the road between Foumbot and Massangam (9 km from Foumbot). CAMSEED with 20 permanent staff now concentrates on popcorn cultivation (one cycle a year) on about 50 ha out of its total area of 500 ha.

(9) SEFN (Noun Forest Exploitation Company)

Main activities of SEFN (a limited liability company) are to fell trees, saw them into lumbers and market wooden products such as cases for transportation of food and garden crops. With 200 employees, SEFN produced 16,330 m^3 of rough timbers, of which 14,079 m^3 were dressed and 1,900 m^3 sold for exportation.

In connection with the future development of the Baigom plain where considerable timber resources are available, there exist two public bodies: ONAREF (National Office of Reforestation) and CENADEFOR (National Center for Development of Forests). ONAREF is in charge of reforestation in the savanna for production of woods. On the other hand, CENADEFOR is responsible for forest inventory.

3.8.4 Cooperatives and Credit Unions

In the West Province, there exist 19 cooperatives registered with the Provincial Service of Cooperation and Mutuality.

(1) COOPAGRO

COOPAGRO was established by regrouping 17 industrial plantations in Noun Division (14) and in Bamboutos Division (3). The cultivated total area of COOPAGRO is around 2,500 ha, but the total production in 1983/84 was 687 tons only accounting for merely 6% of the total production of the Province.

(2) UCCAO and its Member-Cooperatives

UCCAO,established in 1958, was officially authorized in July 1971. From March 1978, it has six cooperatives. UCCAO and its six member-cooperatives play a very important part in the regional rural development. Activities of the UCCAO group are essentially concentrated on the marketing of Arabica and Robusta coffee and cacao. However, they became in recent years multi-functional by taking part in rural development projects such as PDRPO, production and extension of soybeans, etc.

CAPLANOUN based in the Noun Division produced 1,953,511 tons of Arabica coffee and 1,274,435 tons of Robusta coffee in 1984, accounting for 16.6% and 27.0% respectively of the total production.

(3) Popular Credit Unions (Caisses Populaires)

Popular Credit Unions are the savings and credit cooperatives. In the West Provinnce, the Unions started in 1978 with a view to use the savings as investment funds for rural development. At present, there exist 13 Popular Credit Unions in the West Province. The total savings of 1,777 members of the Unions amount to some CFA F 100 million. The interest rate applied for the loans by the Popular Credit Unions is relatively low at 12% per year.

CHAPTER IV PROSPECTIVE DEVELOPMENT PLAN

4.1 Major Constraints for Development

Some of the constraints in agriculture for the development of the Baigom plain are mentioned in the foregoing chapters. The major problems faced in formulating the basic concept and strategy for the future development of agriculture in the plain are explained below:

(1) Inundation in the Baigom plain constitutes the major contraint in the utilization of land for agriculture. The Baigom plain was shaped by a recent basaltic flow probably from the Mfou crater to the south of the plain, and it formed a barrier on the Nkoup river about 400 m upstream from the Baigom bridge. As the river is the only outlet from the plain, water from the watershed, mostly rain water, is retarded in the plain and causes inundation particularly in the rainy season.

(2) The Ndoup and Nja rivers are the main drainage channels in the plain. After entering into the plain from their external drainage basins, these rivers form many small streams, some of them hardly recognizable with irregular and insufficient flow capacities. In addition, the plain is covered with grass and forests which hinder smooth water flow in the plain.

(3) Lack of water in the dry season is another major constraint in the plain. The Ndoup and Nja rivers are main water sources for irrigation in the plain but their available discharges are very small in the dry season. Possibility of irrigated agriculture in this season is very limited unless storage reservoirs are constructed in the upper reaches of the Ndoup and/or the Nja rivers.

(4) The climate in the plain is moderate throughout the year, but the minimum temperature is a little low for the satisfactory growth in the important generative stage of rice plants. This may have some restriction for determining the cropping calendar.

(5) As for the soil condition of the plain, Dystric Histosols having about 2.0 m depth of histic horizon are found in the south-eastern part of the plain, where trees are blighted

at present. The area covered with the deep histic layer is estimated at about 300 ha, and this is one of the constraint in promoting the utilization of land for agriculture.

4.2 Needs of Project and Basic Concept for Development

The Baigom Agricultural Development Project has been contemplated as a model farming scheme for agricultural production in the West Province by the Government of Cameroon. After implementation of the Project, it will contribute to the increase of food production in the region, thus conforming to the national policy of self-sufficiency in food crops in the medium and long terms.

The major constraints which hinder agricultural development in the Baigom plain are inundation in the rainy season and shortage of irrigation water in the dry season as mentioned above. The main objectives of the proposed Project are to reclaim the Baigom plain, and convert swampy area into agricultural land, and introduce modern irrigation farming practices.

To reach the above objectives, the basic concept for development is formulated as follows:

a) to improve the existing rivers and to establish a drainage network consisting of secondary, tertiary drainage canals, catch drains, etc.,

b) to provide a new irrigation system with the storage dams,

c) to establish an adequate farm road network,

d) to settle farmers and to improve farmers' living and working environment,

e) to improve the present agricultural support services,

f) to improve processing of agricultural products and marketing system, and

g) to establish an organization consistent with the management and operation of the Project.

4.3 Project Formulation

4.3.1 Available Water Resources

The main water sources in the Baigom plain are the Ndoup and Nja rivers. The Ndoup river enters into the plain at the north-eastern corner with the catchment area of 19.8 km^2, and the Nja river having the catchment area of 17.1 km^2 flows into the plain at the eastern corner.

The base year for irrigation plan was determined based on the drought year with a five-year return period and therefore, the assessment of available irrigation water was made for discharges of the Ndoup and the Nja rivers in the drought year with a five-year recurrence.

The 10-day mean discharges of both rivers in the drought year with a five-year return period were estimated by the simulation method of the hydrological analysis based on the available data on discharges and rainfalls. They are shown below:

(Unit: m^3/sec)

Month	10-day	Ndoup R. (CA = 19.8 km^2)	Nja R. (CA = 17.1km^2)	Month	10-day	Ndoup R. (CA = 19.8 km^2)	Nja R. (CA = 17.1km^2)
Jan.	1	0.306	0.391	Jul.	1	0.428	0.440
	2	0.277	0.324		2	0.539	0.526
	3	0.274	0.301		3	0.593	0.566
Feb.	1	0.221	0.279	Aug.	1	0.651	0.620
	2	0.190	0.256		2	0.716	0.674
	3	0.166	0.237		3	0.779	0.782
Mar.	1	0.142	0.220	Sep.	1	0.918	0.836
	2	0.130	0.210		2	0.922	0.843
	3	0.121	0.202		3	0.925	0.858
Apr.	1	0.120	0.197	Oct.	1	0.950	0.878
	2	0.123	0.191		2	0.920	0.860
	3	0.127	0.195		3	0.851	0.815
May	1	0.176	0.248	Nov.	1	0.745	0.742
	2	0.250	0.301		2	0.581	0.629
	3	0.245	0.303		3	0.436	0.514
Jun.	1	0.234	0.300	Dec.	1	0.371	0.428
	2	0.269	0.325		2	0.332	0.386
	3	0.318	0.360		3	0.290	0.326

4.3.2 Water Balance Study

In order to clarify the optimum scale of the irrigation area and storage dams, a water balance study was made on a 10-day basis in the drought year with a five-year return period based on the available discharges of the Ndoup and the Nja rivers, and the irrigation water demands estimated on the proposed cropping pattern.

(1) Irrigable Area

Out of the gross area of about 2,800 ha in the study area, the irrigable area was estimated to be 2,000 ha in net area based on the topographic maps with a scale of 1/5,000 taking into account the proposed irrigation canal alignment and topographic condition.

(2) Cropping Pattern

The following two cropping patterns were taken into consideration for the water balance study based on the natural and socio-economic conditions in and around the study area, and the policy of agricultural development programs at the national and regional levels:

i) Paddy : 50%
Upland crops : 50%
(Maize, Groundnuts, Soybean, Tomato)

ii) Paddy : 75%
Upland crops : 25%
(Maize, Groundnuts, Soybean, Tomato)

(3) Irrigation Water Requirement

Based on the proposed cropping pattern, the irrigation water requirements were estimated on a 10-day basis by using meteorological data around the study area. The effective rainfalls were estimated by the daily water balance method, and the diversion water requirements were obtained as the overall irrigation efficiency of 50%.

(4) Storage Dam

Two dam sites were found in the upper reaches of the Ndoup and Nja rivers. They are suitable sites from the topographical and geological viewpoints. From the available

discharges of the Ndoup and Nja rivers, the maximum scale of the dams on the respective rivers was estimated as follows:

i) Ndoup Dam

- Drainage area : 16.7 km^2
- Gross storage capacity : 10,500,000 m^3
- Dead storage capacity : 130,000 m^3
- Dam type : fill dam
- Dam embankment volume : 200,000 m^3

ii) Nja Dam

- Drainage area : 20.8 km^2
- Gross storage capacity : 12,800,000 m^3
- Dead storage capacity : 160,000 m^3
- Dam type : fill dam
- Dam embankment volume : 800,000 m^3

(5) Alternative Plan

In the water balance study, the following five alternative plans were taken into consideration for optimization of the irrigation area:

Case	Crops		Storage Dam
1	Paddy	: 50%	None
	Upland crops	: 50%	
2	Paddy	: 50%	Ndoup & Nja Dams
	Upland crops	: 50%	
3	Paddy	: 50%	Ndoup Dam only
	Upland crops	: 50%	
4	Paddy	: 75%	None
	Upland crops	: 25%	
5	Paddy	: 75%	Ndoup & Nja Dams
	Upland crops	: 25%	

(6) Result of Water Balance Study

The water balance study was made for the above five cases and the relation between the irrigation area and the dam scale is summarized as shown below:

Description	Case 1	2	3	4	5
1. Irrigation Area	(ha)	(ha)	(ha)	(ha)	(ha)
a) Rainy Season					
- Paddy	1,000	1,000	1,000	1,500	1,500
- Maize	750	750	750	375	375
- Groundnuts	250	250	250	125	125
Sub-total	2,000	2,000	2,000	2,000	2,000
b) Dry Season					
- Paddy	180	1,000	650	210	1,500
- Soybean	45	250	162.5	17.5	125
- Groundnuts	45	250	162.5	17.5	125
- Tomato	90	500	325	35	250
Sub-total	360	2,000	1,300	280	2,000
Total	2,360	4,000	3,300	2,280	4,000
2. Storage Dam		($x10^3m^3$)	($x10^3m^3$)		($x10^3m^3$)
a) Ndoup Dam					
- Gross storage capacity	-	8,760	8,110	-	8,650
- Dam embankment volume	-	181	165	-	173
b) Nja Dam					
- Gross storage capacity	-	4,930	-	-	12,530
- Dam embankment volume	-	246	-	-	800

4.3.3 Optimum Scale of Development Plan

A comparison of the alternatives was made based on the Internal Rate of Return (IRR) and Benefit-Cost Ratio (B/C) with rough estimation of cost and benefit.

The results of the alternative study are shown as follows.

Description	Case				
	1	2	3	4	5
IRR (%)	9.0	12.1	11.8	9.0	8.4
B/C	0.89	1.25	1.22	0.88	0.82

Note: B/C was estimated at a discount rate of 10%.

From the above, Case 2 was selected as the best economic alternative with the highest IRR, and in this case, the whole potential area can be irrigated not only in the dry season but also in the rainy season.

Thus, the optimum scale of the Project was determined as follows:

(1) Storage Dam

a) Ndoup Dam

- Crest elevation : El. 1,175.5 m
- Full water level : El. 1,171.5 m
- Low water level : El. 1,156.0 m
- Gross storage capacity : 8,760,000 m^3
- Active storage capacity : 8,630,000 m^3
- Dam height : 25.5 m
- Dam crest length : 155.0 m
- Dam embankment volume : 180,900 m^3

b) Nja Dam

- Crest elevation : El. 1,145.0 m
- Full water level : El. 1,141.0 m
- Low water level : El. 1,127.0 m
- Gross storage capacity : 4,930,000 m^3
- Active storage capacity : 4,770,000 m^3
- Dam height : 26.0 m
- Dam crest length : 260.0 m
- Dam embankment volume : 245,600 m^3

(2) Irrigation Area (average of two year rotation)

(Unit: ha)

Crops	Rainy Season	Dry Season
Paddy	1,000	1,000
Maize	750	-
Groundnuts	250	250
Soybean	-	250
Tomato	-	500
Total	2,000	2,000

4.4 Agricultural Development Plan

4.4.1 Basic Principles for Agricultural Development

In conformity with the Government's agricultural development policy and taking into consideration the socio-economic and natural conditions in and around the project area, the fundamental agricultural development plan was conceived as follows:

- introduction of diversified cropping patterns particularly with rotation of rice and upland crops,
- increase and stabilization of yield and production of crops through supply of irrigation water, proper drainage management, and introduction of irrigation farming system,
- achievement of a successful settlement of farmers through effective training and with thorough agricultural support services,
- establishment of processing and marketing facilities especially for rice, and
- promotion of improvement of living condition of farmers and increase in employment opportunities to support the growing rural population, particularly young active farmers.

4.4.2 Proposed Land Use

The proposed land use was formulated taking into consideration the natural conditions, distribution of land in the plain, and the following land use concepts:

1) Cattle pasturing should not be allowed in the plain in order to avoid troubles which may occur between farmers and nomadic cattle breeders,

2) Flat plain will be used as cultivated land, the area with deep histic layer located in the south-eastern part of the plain will also be used, but it will take several years for stabilization of the land.

3) The volcanic island will be used for:

   - crop production in the lower part,
   - coppice and plantation of useful trees,
   - building area such as office, rice mill, warehouses, etc.

According to the above conditions and concepts, the land use was proposed as follows:

(Unit: ha)

Land Use Category	Present Land Use	Proposed Land Use
1. Forest:	1,050	10
Common	240	10
Swampy	810	0
2. Grassland:	1,100	160
Common	360	160
Swampy	740	0
3. Rice field	10	0
4. Upland field	240	10
Year round cropping	170	10
Dry season cropping	70	-
5. Irrigated field for rotational cropping	0	2,220
Total	2,400	2,400

The above total area of 2,400 ha is the gross area surrounded by the proposed irrigation canals and includes the volcanic island.

4.4.3 Proposed Cropping Pattern

The proposed cropping pattern was formulated with rice as the main crop and with upland crops like maize, soybean, groundnuts, and tomato as the representative crops. In the

proposed cropping pattern, rice cultivation will use in 50% of the area and the remaining area will be used for upland crops. These upland crops will be cultivated in rotation with irrigated rice two. The rotation system is aimed to provide a stabilized farm management through maintenance and improvement of soil fertility, prevention of of soil-borne diseases, pests and weeds, dispersion of risks from crop failures, etc. The proposed cropping pattern is shown in Fig. 4. The cropping pattern will rotate every two years as shown in the figure, but each land will be cultivated in rotation every four years.

In this pattern, two crops of rice a year will be practiced, namely the rainy season crop and the dry season crop. The rainy season crop will be sown during the last 10 days of June to the first 10 days of August, and harvested during the middle of November to the end of December, while the dry season crop will be sown during the last 10 days of December to the middle of January, and harvested during the beginning of May to the middle of June. The cropping season of the upland crops will mostly coincide with the rice cropping seasons.

The cultivated area of each crop under the proposed cropping pattern is summarized as follows:

(Unit: ha)

Crops	Dry Season	Rainy Season	Year Total
Rice	1,000	1,000	2,000
Tomato	500	0	500
Maize	0	750	750
Soybean	250	0	250
Groundnuts	250	250	500
Total	2,000	2,000	4,000

4.4.4 Proposed Farming Practices

The proposed farming practices were formulated under the following principles:

1) The manual labour force will be fully used for such works as sowing, transplanting, weeding, harvesting and drying.

2) Mechanization will be introduced in such heavy tasks as soil preparation, plant protection by chemical spraying, rice threshing in order to obtain high quality in production and prevent harvest losses.

Farming practices to be introduced should be aimed at rationalizing farm works in conformity to the cropping calendar for higher productivity and to provide employment opportunities to farmers. In this context, it was proposed to introduce light agricultural machinery such motorcultivators or tillers, automatic threshers, portable engine sprayers and others in farming works.

According to the above mentioned principles, the labour balance was examined between the required labour for farming and the available family labour. The required annual labour force for farming of a unit farm with 2.1 ha of net cultivation area was estimated at about 740 man-day in total. Out of 740 man-day of labour, 650 man-day will be provided by family labour, and 90 man-day will be covered by hired labour mainly during the end of May to the end of June. The total number of labourers to be hired in the area was estimated at about 900–1,500.

4.4.5 Anticipated Crop Yield and Production

The unit yield of crops would substantially increase and stabilize through the introduction of the irrigated farming system under the project. The anticipated crop yields were projected with referring to the actual results obtained at the Bafole Seed Farm for maize, soybean and grounduts, and at the Baigom Rice Cultivation Project Office for rice. Regarding vegetables and other crops, the target yields were projected through the examination of the climate and soil conditions. The projected target yields of the representative crops are as shown below:

Crops	Unit Yield (ton/ha)	
	Present	Target
Rice (Paddy)	1.7	5
Maize	2.0	4
Groundnuts	1.0	2
Soybean	-	2
Haricot bean	1.7	2
Haricot bean (green)	1.3	5
Tomato	2.7	20

The anticipated annual crop production at the full development stage was estimated based on the projected crop yields and the planted areas as follows:

Crops	Planted Area (ha)	Unit Yield (ton/ha)	Production (ton)
Rice	2,000	5 (paddy)	10,000
Tomato	500	20	10,000
Maize	750	4 (shelled seed)	3,000
Soybean	250	2	500
Groundnuts	500	2 (shelled seed)	1,000

The annual production of rice was estimated about 10,000 tons of paddy. The average annual productions of upland crops, like maize, soybean and groundnuts were estimated at 3,000, 500 and 1,000 tons, respectively. The production of tomato was estimated at about 10,000 tons per annum.

4.4.6 Operation Facilities and Equipment

For the achievement of a profitable operation of agriculture in the area, it is necessary to establish agricultural operation facilities such as farm machinery services and paddy buying centers, and rice mill.

(1) Farm machinery service

In the present situation, prospects to use farm machinery or draught animals are rather remoted. On the other hand, it is necessary for farmers to introduce some kinds of mechanization to increase their productivity and to improve their living standard. Mechanization in farming is also needed to realize farming works in time according to the envisaged cropping calendar. Not only that, it will also help farmers to improve farm management and save operation costs. In view of the prevailing financial situation of most farmers in the area, it would be difficult for them to purchase the necessary farm machinery during the initial years of the project operation. To compensate this gap, it would be necessary to establish a service system in which farm machinery will be loaned to farmers at least during the early stage of the operation of the project. This will also enable to provide technical guidance and training for the operation of the equipment. Moreover, to allow

farmers to purchase necessary machinery, the provision of loans should be considered by using farmers' credits facilities through, for instance, FONADER and the likes.

(2) Paddy buying centers

Paddy buying centers will be established by the Authority in the project area to facilitate collection of paddy from farmers. Three buying centers will be constructed at selected sites in the area. Each buying center will be equipped with receiving, inspection and grading, weighing, drying floor and winnowing, and storing facilities. The paddy will be inspected at the receiving line and laboratory, graded and weighed by quality of paddy. A total amount of 5,000 tons of paddy will be received by the three buying centers for 65 days, i.e. 26 tons of paddy will be received every day by each center during the harvest season. The outlines of the buying centers are as follows:

Facilities	Specification
Receiving	Inspection line; 2 lines per each center, Paddy inspection equipment; 2 sets per each center, Weighing scale of 500 kg; 2 sets per each center.
Storage	1,200 tons of sacked paddy for 2 places, 300 tons for one place.
Drying floor	300 m^2 for each center
Winnowing shed	40 m^2 for each center
Inspection laboratory	40 m^2 for each center
Managing office	32 m^2 for each center
Loading & unloading	Lump sum

(3) Rice mill

The proposed rice mill will have all the main equipment to realize such operations as receiving and cleaning, milling, grading and sorting, blending, weighing and packing. The milling capacity of the rice mill plant was estimated based on the amount of 5,000 tons of paddy to be processed with a working period of 120 days in each season. The capacity of machinery for each section is summarized as follows:

Machinery	Specification or Capacity
Intake hopper	200 kg
Paddy cleaner with stoner	3.5 t/hr.
Rice dehuller	3.5 t/hr.
Paddy separator	2.4-3.1 t/hr.
Stoner	3.5 t/hr.
Rice whitener	2.0-2.4 t/hr.
Rice pearler	2.4 t/hr.
Color sorter	2.0 t/hr.
Rice grader	1.5 t/hr.
Bin for head rice	700 kg
Bin for broken rice (large)	400 kg
Bin for broken rice (small)	400 kg
Bin for blended rice	2,000 kg
Bagging scale with filled bag closing machine	600 kg/hr.

4.4.7 Market and Price Prospects

(1) Market prospects

In order to estimate the marketable surplus of farm products with project condition, a demand and supply balance study on the farm products was made with the target year of 1997. The expected marketable surplus products would be about 8,900 tons of paddy, 2,100 tons of maize, 1,600 tons of soybean and 9,000 tons of vegetables (tomato) as shown below:

(Unit: ton)

Item	Paddy	Maize	Soybean	Vegetables (Tomato)
Total production	10,000	3,000	2,000	10,000
Seed and waste requirement	500	300	200	1,000
Consumption in the area	600	600	200	100
Marketable surplus	8,900	2,100	1,600	8,900

(2) Price prospects

The economic and financial prices of farm outputs and inputs were forecasted in order to evaluate the expected monetary benefits and effects of the project. The standard conversion factor (SCF) of 0.77 determined by the World Bank was applied for the shadow exchange rate. Thus the current exchange rate of US$1.0 = CFA F 384.5 (as of the beginning of December 1985) in terms of the financial price was converted to US$1.0 = CFA F 499 in terms of economic price. The conversion between international market prices and farm gate prices was made by referring to "The Price Prospects for Main Primary Commodities" prepared by the World Bank, July 1985. Non trade products as vegetables, etc. were valued at their financial prices. The economic prices of paddy, maize, and soybeans were estimated at 150, 103 and 190 CFA F/kg, respectively. The estimated prices are as summarized in Table 8.

4.4.8 Farm Household Economy

A farm budget analysis was made on the typical farm household of 2.1 ha of net cultivation area under with project condition. The annual farm budget was estimated based on the crop budget and the planted area by crop. There are small differences in amount of gross incomes, production costs and net incomes between the 1st and 2nd crop rotations. The annual gross agricultural income, production cost and net income were estimated at about CFA F $2,060 \times 10^3$, CFA F 800×10^3 and CFA F $1,260 \times 10^3$ for the 1st rotation, and CFA F $2,205 \times 10^3$, CFA F 835×10^3 and CFA F $1,370 \times 10^3$ for the 2nd rotation, respectively. The average annual agricultural net income of the typical farm household was estimated at about CFA F $1,300 \times 10^3$.

4.5 Irrigation Development Plan

4.5.1 General

The optimum irrigation development plan was formulated based on the assessment of water resources, estimation of irrigation water requirements and the water balance study. The assessment of water resources was made through the hydrological analysis of the Ndoup and Nja rivers. The irrigation water requirements were calculated for the proposed cropping pattern after selecting the most beneficial crops for the Project. Based on the available

irrigation water sources and irrigation water requirements, the water balance study was made to estimate the guaranteed irrigation area in relation with the scale of the proposed Ndoup and Nja storage dams. The proposed irrigation system was determined taking into account the topographical condition of the project area on the basis of the formulated development plan.

4.5.2 Irrigation Water Requirements

Rice will be the principal crop in the project area and upland crops such as maize, groundnuts, soybean and tomato are also recommended as consumable and profitable crops for the Project. Therefore, the study of irrigation water requirements was made for these crops.

The irrigation water requirements were calculated for the proposed cropping pattern on a 10-day basis for the drought year with a five-year return period. The consumptive use of water by crop was estimated as a product of potential evapotranspiration with crop coefficients to crop growth stages. The potential evapotranspiration was calculated by the Pan Evaporation Method using meteorological data at the Koundja station. The effective rainfall was estimated by the daily water depth balance method.

The diversion water requirement is defined as the farm water requirement plus allowances for farm waste, conveyance and operation losses. The overall irrigation efficiency was assumed to be 50% consisting of on-farm efficiency of 75%, conveyance efficiency of 80% and operation efficiency of 85%.

The annual diversion water requirement by each crop for the drought year with a five-year return period is shown below:

Paddy	Rainy season	:	1,298	m^3/ha
	Dry season	:	16,060	m^3/ha
Maize	Rainy season	:	34	m^3/ha
Groundnuts	Rainy season	:	596	m^3/ha
	Dry season	:	3,580	m^3/ha
Soybean	Dry season	:	3,880	m^3/ha
Tomato	Dry season	:	1,537	m^3/ha

4.5.3 Irrigation Area

The gross area of the Baigom plain is 2,800 ha and the irrigable area was estimated to be 2,000 ha in net based on the new topographic maps with a scale of 1/5,000 taking into account the proposed irrigation canal alignment and topographic condition.

The optimum irrigation areas were determined by the water balance study in relation to the scale of the Ndoup and Nja storage dams as discusssed in the previous paragraph. Based on the result of studies on the water balance and economic evaluation, the irrigation areas were proposed as shown below for the proposed cropping pattern with a two-year rotation.

(Unit: ha)

Crops	1st Year		2nd Year	
	Rainy Season	Dry Season	Rainy Season	Dry Season
Paddy	1,000	1,000	1,000	1,000
Maize	1,000	-	500	-
Groundnuts	-	-	500	500
Soybean	-	500	-	-
Tomato	-	500	-	500
Total	2,000	2,000	2,000	2,000

4.5.4 Proposed Irrigation System

Based on the result of study on the optimum scale of the development plan, the following irrigation works were proposed:

1) Construction of two storage dams, i.e. Ndoup and Nja dams,
2) Construction of an intake weir on the Ndoup river, and
3) Establishment of an irrigation canal network to comprise main and secondary irrigation canals, and related structures.

The total irrigation area of 2,000 ha in net is divided into two irrigation systems as shown below according to the topographic condition and available irrigation water supplied by the two storage dams.

Ndoup irrigation system - 1,110 ha

Nja irrigation system - 890 ha

The irrigation diagram is illustrated in Fig. 5 and the general layout of the proposed irrigation system is shown in Fig. 6. The general features of the proposed irrigation works are described below (see Tables 9 and 10).

(1) Ndoup Dam

The Ndoup dam would be constructed on the Ndoup river at about 1.6 km upstream from the culvert crossing the national road No. 2. The active storage capacity of the Ndoup dam is 8.63 MCM and water stored in the reservoir during the rainy season would be released to the downstream of the Ndoup river for irrigation in the dry season.

The elevation-capacity and -area curves of the reservoir were prepared as shown in Fig. 7 based on the 1/50,000 topographic map. The full water level was determined to be El. 1,171.5 m for the gross storage capacity of 8.76 MCM and the high water level was estimated at El. 1,173.0 m by adding the overflow depth at the spillway to the full water level. The low water level was determined to be El. 1,156.0 m on the basis of the deposit sediment in the reservoir. The design sediment load was assumed to be about 80 m^3/km^2/year from the geological viewpoint in the watershed of the river. The useful life of the reservoir is considered to be 100 years and thus the total sediment volume was estimated to be 130,000 m^3.

Considering the proposed dam scale, availability of materials for dam embankment nearby the dam site, geological condition at the site, etc., the homogeneous type fill dam was selected as the most optimum dam type. The freeboard for the dam was determined to be 4.0 m including the overflow depth of 1.5 m at the spillway above the full water level. The width of dam crest was determined to be 8.0 m taking into account the practicability of construction. The embankment slopes were designed to be 1:2.5–2.7 and 1:2.3–2.5 for upstream and downstream respectively based on the stability analysis of the dam. The typical section of the Ndoup dam is shown in Fig. 8.

(2) Nja Dam

The Nja dam with an active storage capacity of 4.77 MCM would be constructed on the Nja river at about 1.5 km downstream of the staff gauge installed by SEDA. Irrigation water

will be taken directly from the Nja reservoir without release to the downstream of the river, and be transported to the fields through main, secondary and tertiary irrigation canals.

The elevation-capacity and -area curves of the reservoir are shown in Fig. 9 based on the 1/5,000 topographic map. The full water level was determined to be El. 1,141.0 m for a gross storage capacity of 4.93 MCM, and the high water level was estimated at El. 1,142.5 m by adding the overflow depth at the spillway to the above full water level. The low water level was determined to be El. 1,127.0 m based on the design sediment volume of 160,000 m^3.

The homogeneous type fill dam was proposed as the most optimum dam type taking into consideration the dam scale, availability of dam embankment materials, geological condition at the site, etc. The elevation of the dam crest was determined to be El. 1,145.0 m with a freeboard of 4.0 m above the full water level, and the crest width was designed to be 8.0 m. From the results of the stability analysis, the embankment slopes for upstream and downstream were determined to be 1:2.5–2.7 and 1:2.3–2.5 respectively. Fig. 10 shows the typical section of the Nja dam.

(3) Ndoup Intake Weir

The Ndoup intake weir would be constructed at about 250 m downstream of the Ndoup river from the national road No. 2 to divert irrigation water to the fields. The fixed type concrete weir was proposed and the crest elevation of the weir was determined to be El. 1,125 m considering the elevation of the irrigation area. The scouring sluice would be provided at the right side of the river where the intake structure would be constructed. The design intake discharge was estimated to be 1.44 m^3/sec for covering the Ndoup irrigation area of 1,110 ha.

(4) Irrigation Canals and Related Structures

The major irrigation canal system consists of two main canals and four secondary canals. The total lengths of the main canals and secondary canals are 8.07 km and 18.13 km, respectively. All irrigation canals would be of earth canals with trapezoidal sections. For effective functioning of the canal system, the following related structures were proposed:

- turnouts for distribution of irrigation water
- drops and checkgates for regulation of water level
- culverts for conveyance of water under roads
- spillways for protection of canals

4.6 Drainage Development Plan

4.6.1 General

As mentioned in the previous chapter, most of the Baigom plain are inundated especially during the rainy season. To solve these existing problems, firstly the basaltic shelf on the Nkoup river would be excavated, and the three major rivers of the Nkoup, Ndoup and Nja would be improved through provision with sufficient flow capacities to drain the design discharges so that they would function as the main drainage channels in the project area. After that, the proper drainage network consisting of secondary and tertiary drainage canals and catch drains would be established to convey excess water from each catchment area to the main drainage channels. As a matter of course, grass and forests in the plain would be cleared to enable a smooth water flow in parallel with establishment of the new drainage network.

4.6.2 Drainage Water Requirements

The drainage water requirements for the proposed drainage system were estimated for transporting the runoff from the external drainage basin of the Baigom plain and for removing excess rainfall in the plain on the basis of the design daily rainfall with a five-year return period of 73 mm/day.

The external drainage basins are broadly divided into three basins, namely Ndoup basin, Nja basin and the other small basins, and the runoff from each basin was estimated by the simulation method of the hydrological analysis usisng available records of rainfall and discharge.

After the implementation of the Project, the Baigom plain would be developed into agricultural lands consisting of paddy fields and upland fields. The drainage water requirements in the paddy field and the upland field were calculated using the following formulas:

- For paddy field

$$Q = \frac{R_{24} \times 10^{-3} \times A \times 10^{4}}{T \times 60 \times 60}$$

where, Q : Drainage water requirement in the paddy field (m^3/sec)
R_{24} : Design daily rainfall (mm/day)
T : Drainage period (hours)
A : Drainage area (ha)

- For upland field

MC Math formula (U.S.B.R. Drainage Manual)

$$Q = 9.15 \times 10^{-3} \times C \times i \times S^{1/5} \times A^{4/5}$$

where, Q : Drainage water requirement in the upland field (m^3/sec)
C : Runoff coefficient
i : Rainfall intensity (mm/hr)
S : Average slope
A : Drainage area (ha)

From the above results, the drainage water requirements at the major points in the project area are summarized below:

- At the entrance into the Baigom plain from the Ndoup drainage basin (CA = 19.8 km^2) : Q = 15.0 m^3/sec
- At the entrance into the Baigom plain from the Nja drainage basin (CA = 17.1 km^2) : Q = 8.0 m^3/sec
- At the point about 1.8 km downstream of the entrance into the Baigom plain from the Nja drainage basin (CA = 22.2 km^2) : Q = 10.0 m^3/sec
- At the confluence of the Ndoup and Nja rivers (CA = 65.6 km^2) : Q = 30.7m^3/sec
- At the Baigom bridge (CA = 88.5 km^2) : Q = 42.9 m^3/sec

The drainage diagram is illustrated in Fig. 11.

4.6.3 Proposed Drainage System

The following works were proposed for the establishment of the proper drainage system in the project area:

1) Excavation of the basaltic shelf at the downstream of the Nkoup river
2) Improvement of the existing three major rivers, namely the Nkoup, Ndoup and Nja rivers
3) Establishment of drainage canal network such as secondary drainage canals, catch drains and their related structures
4) Construction of the diversion flood way at the south-eastern corner of the project area
5) Installation of regulating gates at the outlet of the Baigom plain

The general layout of the proposed drainage system is shown in Fig. 6 and the general features of the above drainage works are described below (see Table 11).

(1) Excavation of Basaltic Shelf

The basaltic shelf on the Nkoup river about 400 m upstream of the Baigom bridge hinders smooth water flow from the project area. Therefore, this basaltic shelf would be firstly removed by dynamites. The excavated volume was estimated to be about 30,340 m^3.

(2) Drainage Canals and Related Structures

The existing Nkoup, Ndoup and Nja rivers would be improved so as to fulfill their functions as the main drainage canals in the project area. The total length of main drainage canals was estimated to be 16.95 km consisting of 3.69 km of Nkoup, 5.54 km of Ndoup and 7.72 km of Nja. The secondary drainage canals of 3.00 km in total length would be newly constructed to convey the excess water to the main drainage canals, and the catch drains of 36.40 km in total length would also be provided to catch the drainage water from the external drainage basins along the boundaries of the project area and the surrounding hills. All drainage canals would be of earth canals with trapezoidal sections. In relation to the above drainage canals, the related structures such as drops, culverts, drain inlets, cross drains and drainage junction, would be provided for protection of canals and for conveyance drainage water under roads and irrigation canals.

(3) Diversion Flood Way

The diversion flood way would be constructed at the narrow ridge on the south-eastern corner of the project area to divert the flood discharge from the Nja main drainage canal to adjacent basin. The proposed diversion discharge was estimated to be about 5.8 m^3/sec which was equivalent to half of the design drainage discharge of the Nja main canal. The flood way would consist of the side spillway on the Nja main drainage canal, the cross drain under the Nja irrigation canal and the diversion canal of 700 m in total length. This diversion flood way would be useful in reducing the flood discharge in the downstream reaches of the Nkoup river.

(4) Regulating Gates

The existing flow capacities of the downstream reaches of the Nkoup river are not sufficient for the design drainage discharge in some parts, about 2.0 km between the Baigom bridge and the confluence with the Chanké river. Therefore, some river improvement works may be required if the design drainage discharge flows down directly without regulation from the project area. In order to mitigate the flood damage in the downstream parts of the Nkoup river, the regulating gates would be installed at the outlet of Baigom plain, just upstream of the Baigom bridge. Three steel roller gates are proposed and the size of each gate would be 2.5 m in height and 3.0 m in width.

4.7 Farm Road Development Plan

For operation and maintenance of the project facilities and effective agricultural activities after implementation of the Project, establishment of the proper farm road network is of vital importance. The proposed road network consists of main farm roads and inspection roads. The main farm roads would be provided to link the project area and the national road No. 2, and between the inspection roads in the project area. The inspection roads would be constructed along main and secondary irrigation and drainage canals for inspection, operation and maintenance of canals. These roads would also be used for the farm operation.

The total length of the above roads were estimated as follows:

Name of Road	Total Length (m)
1. Main Farm Roads	14,170
2. Inspection roads for main and secondary irrigation canals	26,200
3. Inspection roads for main and secondary drainage canals	19,955
Total	60,325

The effective width of each road was designed to be 4.0 m with the gravel pavement for the proper operation and maintenance of the project facilities and for the smooth agricultural activities.

4.8 On-Farm Development Plan

The gross area of the Baigom plain is 2,800 ha comprising 1,200 ha of forests, 1,110 ha of grasslands, 470 ha of cultivated lands and 20 ha of others. For introduction of the modernized farming method in the plain, most areas should be reclaimed and provided with the proper irrigation and drainage facilities.

The average slope of the area is about 1/1,000 with the elevation of 1,118 m to 1,125 m. The useful soil depth for plowing layer was estimated at about 30 cm based on the soil survey. The typical size of a farm plot was determined to be 0.3 ha (100 m x 30 m) taking into consideration the above topography, soil condition and efficient farming practices. The farm plot would be generally reclaimed in parallel to the contour line and to be of rectangular shape in order to minimize the earth moving volumes and the cutting depth as small as possible.

The net irrigation area of 2,000 ha would be divided into 17 tertiary irrigation blocks in consideration of the topographic condition, canal alignment, water management, etc. Each tertiary block would be served with irrigation water by one turnout. At the on-farm level, the following facilities were proposed:

1) Irrigation canals

i)	Tertiary irrigation canals	:	33.3 km (16.7 m/ha)
ii)	Quaternary irrigation canals	:	50.0 km (25.0 m/ha)
iii)	Main farm ditches	:	100.0 km (50.0 m/ha)

2) Drainage canals

i)	Tertiary drainage canals	:	20.0 km (10.0 m/ha)
ii)	Quaternary drainage canals	:	37.5 km (18.7 m/ha)
iii)	Main drainage ditches	:	100.0 km (50.0 m/ha)

3) On-farm roads

i)	On-farm roads	:	73.3 km (36.7 m/ha)
ii)	Inspection roads for tertiary and quaternary irrigation canals	:	83.3 km (41.7 m/ha)

In relation to the above canals, many structures such as division boxes, quaternary outlets, culverts, drops and drainage junctions would be provided to divide and convey water and to protect the canals.

4.9 Farmers' Settlement Plan and Farmers' Organization

4.9.1 General

The active work force in the villages surrounding the Baigom plain is estimated to be about 1,800 persons at present. To introduce an intensive farming practice in the area, it would be essential to transmigrate farm households around the project area.

4.9.2 Land Distribution and Population to be Settled

To determine the optimum farm size, a study was conducted on the following alternatives: 1.5 ha, 1.8 ha and 2.1 ha per household, in due consideration of man-power demand for the cultivation, and income for farmers.

As a result of the comparative study, a farm size of 2.1 ha per household would be appropriate in order to enable a rational use of familial and marginal labour force. The total number of households to be settled in the proposed area of 2,000 ha was estimated to be 952. At the first stage, the priority of migration will be given to the households living around the project area.

4.9.3 Selection of Farmers for Settlement

Selection of farmers would be carried out on the basis of the following qualifications:

General Conditions

- Ability of reading and writing,
- Good health and mental conditions,
- Capability of satisfying adequately the conditions fixed by the Development Authority (SODABA), and
- Having no other wage-earning occupations.

For Local Farmers
(residing in the radius of 10 to 20 km from the site)

- Inhabitants of one of the Sub-Divisions in the project zone,
- Aged 20-55 years, and
- Married and having at least 2 other family members of over 15 years old who can help cultivate the alotted land.

For Young Farmers

- Aged 20-35 years,
- Having at least 2 other family members of over 15 years old who can help cultivate the alotted land, and
- Trained by the National Civic Service Center for Participation in Development (preferably) or having participated in other similar training programs.

Applications for settlement will be submitted by the interested farmers to the Development Authority or the Divisional Agricultural Delegation Office, and a selection committee composed of representatives of the authorities concerned will pick out the most appropriate candidate farmers after examining the application documents.

4.9.4 Settlement Schedule

The settlement schedule would mainly follow the project construction schedule. A total of 952 farm households would be transmigrated into the project area during a period of 4 years from the 3rd year after the commencement of construction works. The settlement schedule is summarized below:

Year	Developed Area (ha)	Number of Households Settled		Total Number of Settled Farmers
		Local Farmers	Young Farmers	
1990	200	76 (80%)	19 (20%)	95
1991	300	114 (80%)	29 (20%)	143
1992	500	167 (70%)	71 (30%)	238
1993	1,000	333 (70%)	143 (30%)	476
Total	2,000	690	262	952

As to the residence area of settled farmers, it will be prepared by the government outside and, if possible, near the project area so as to ensure practical use of the developed area to a maximum extent. More detailed regulations relating to the settlement will be stipulated by the Board of Directors of SODABA.

4.9.5 Government Support and Settlement Procedure

Generally, farmers (especially young farmers) have no own financial means to cover necessary expenses for settlement and cultivation. Thus, the Government would have to assist them by providing agricultural grants or credits according to the clauses of the Order No. 88/MINAGRI, relating to the public aids to settled farmers through the National Office for Participation in Development.

A total assistance amount of CFA F 360,000 will be allocated by the Government to each young farmer, as broken down below:

Grants		CFA F 160,000
- Settlement premium	:	CFA F 100,000
- Subsistence premium	:	CFA F 60,000
Advances		CFA F 200,000
- Fund for construction of house	:	CFA F 60,000
- Fund for preparatory works	:	CFA F 140,000

The amount of agricultural loans or credits to be extended by the Government to the settled young farmers was estimated to be CFA F 94.3 million. The reimbursement of the above-mentioned advances will be made in 6 years without interest, starting from the 2nd year of cultivation.

Besides, as to the general fund that farmers need for agricultural investment, the Development Authority (SODABA) would arrange with FONADER to provide them with farmers' credits. The initial fund requirement per farm household was estimated to be about CFA F 2.4 million.

The farmers who desire to cultivate in the developed area commanded by SODABA will, first of all, sign a contract with the Authority for a 3-year rent of land for cultivation and for residence. At the expiration of the 3-year contract, the Board of Directors of SODABA will examine the adaptability of each farmer to decide to renew or to terminate the contract. The term of the second contract will be 5 years and renewable by tacit agreement as far as the farmer continues to fulfill the following obligations:

- Respect of the technical standards and farming calendar fixed by the Authority,
- Commercialization of products through the farmers' organization designated by the Authority,
- Reimbursement of advances and credits granted through the Authority,
- Attendance to the agricultural extension programs and farmers' meetings organized by the Authority and the farmers' associations,
- Participation in the cooperative and community works required by the sectional association to which the farmers belong, and
- Other reasonable requirements by the Authority.

All problems related to the principles of operation and management of SODABA would be discussed and resolved with a majority of two thirds or more of the members of the Board of Directors.

4.9.6 Farmers' Organization

For rational management, operation and maintenance of the irrigation and drainage systems in the developed areas of the Baigom plain, it is recommended to set up associations of the settled farmers as shown in Fig. 12.

As a first step, Farmers' Groups (FG) will be organized in each quaternary irrigation block (24 ha). FG would later be incorporated into Farmers' Associations (FA) at the rate of about one association for every 360 ha. At the final stage, FA would be integrated into a Federation of Farmers' Associations (FFA).

The organization of FG, FA and FFA would be implemented within a period of 8 years from 1990 to 1997 after preparation of parcellary maps of the developed areas.

To assure the smooth setting-up of farmers' organization and communication among the authorities concerned and the farmers, a "Village Community Center" will be established near or in the Administration Office of SODABA.

CHAPTER V IMPLEMENTATION SCHEDULE AND COST ESTIMATE

5.1 Construction Plan

The project comprises the construction of the Ndoup and Nja storage dams, irrigation and drainage canal systems, farm road networks and on-farm facilities. As these construction works involve mainly earth works, due attention should be paid to the characteristics of earth materials which directly affect earth moving plan, selection of *construction equipment, etc.*

Major construction works having a large amounts of earth volume would be executed by heavy construction equipment but the remaining minor works would be implemented by manpower to increase employment opportunities for local people in and around the project area. Earth works can be affected by rainfall. The annual workable days were estimated to be 213 days for earth works and 264 days for concrete works based on the daily rainfall records of the Koundja meteorological station.

Most of the embankment materials of the Ndoup and Nja dams would be obtained from the dam sites, but drain materials should be purchased since they can not be found around the dam sites. Embankment materials would be spread by bulldozer and compacted by tamping roller and vibrating roller. Drainage works would commence from the downstream of the Nkoup river. Excavation works would be made by swamp bulldozers and back-hoe shovels, and excavated soils would be used for embankment of farm roads and for reclamation of farm lands. The basaltic shelf on the Nkoup river would be removed by use of dynamites and some of them would be used as rip-rap materials of the Ndoup and Nja dams. The Ndoup irrigation system would be constructed firstly and then the Nja irrigation system be implemented according to the progress of the drainage works. Farm road works would be executed by using excavated materials of canals in parallel with the irrigation and drainage works. Concrete works for structures related to the canals would mainly be carried out by manpower with the use of concrete mixers. In on-farm works, cutting of trees would be made by chain saws and grubbing be executed by swamp rakedozers. Levelling of farm lands would be made by swamp bulldozers. Construction of on-farm facilities such as tertiary canals, farm ditches and their related structures would mainly be done by manpower as they involve minor works.

5.2 Implementation Schedule

The implementation period of the Project was assumed to be 6 years from 1987 to 1992 as shown in Fig. 13. The detailed design would be carried out in 1987 and actual construction works would commence in 1988 and be continued for five years until 1992.

Considering the present swampy condition of the area, drainage works should be realized in the first instance for about 3 years from 1988 to 1990. Dam construction including the diversion structure, excavation and embankment, appurtenant structures, etc., would need about 3.5 years in all. The irrigation works would take about 2.5 years from 1989 to 1991 according to the progress of the drainage works.

5.3 Cost Estimate

5.3.1 General

The project cost comprises the direct construction cost, initial farm investment, administration cost, engineering cost, physical contingency and price contingency.

The following considerations were taken into account for the cost estimate of the Project:

(1) The exchange rate used in the estimate was US$1.0 = CFA F 384.5 = ¥ 203 as of December, 1985.

(2) The construction works would be executed on a contract basis. The construction machinery and equipment required for the construction works would be provided by the contractors. Therefore, depreciation costs of machinery and equipment were included in the construction unit costs.

(3) The construction cost consists of foreign currency and local currency portions. The local currency portion was estimated on the basis of the current prices in Cameroon in December 1985 and the foreign currency portion was estimated on the CIF prices at Douala.

(4) The physical contingency related to the construction quantities was set at 10% of the direct cost. The price contingency was assumed to be 12% for the local currency portion and 3% for the foreign currency portion, respectively.

5.3.2 Project Cost

The project cost was estimated at CFA F 15,533 million, comprising CFA F 7,090 million of foreign currency and CFA F 8,443 million of local currency as shown below.

(Unit: CFA F 10^6)

Item	Foreign Currency	Local Currency	Total
1. Direct Construction Cost	4,135	3,293	7,428
1.1 Storage Dam Works	1,396	1,345	2,741
1.2 Irrigation Works	73	70	143
1.3 Drainage Works	1,248	694	1,942
1.4 Farm Road Works	505	344	849
1.5 On-Farm Works	913	840	1,753
2. Initial Farm Investment	475	408	883
2.1 Rice-Mill	228	38	266
2.2 Buying Center	123	184	307
2.3 Warehouse	22	33	55
2.4 Office	102	153	255
3. Administration Cost	-	596	596
4. Engineering Cost	1,002	133	1,135
Sub-total	5,612	4,430	10,042
5. Physical Contingency	561	443	1,004
Total	6,173	4,873	11,046
6. Price Contingency	917	3,570	4,487
Grand Total	7,090	8,443	15,533

5.3.3 Annual Disbursement Schedule

The annual disbursement schedule was prepared based on the construction time schedule and is summarized as follows:

(Unit: CFA F 10^6)

Financial Year	Foreign Currency	Local Currency	Total
1987	444	175	619
1988	1,053	1,253	2,306
1989	1,861	2,000	3,861
1990	1,476	1,829	3,305
1991	1,249	1,692	2,941
1992	1,007	1,494	2,501
Total	7,090	8,443	15,533

5.3.4 Operation and Maintenance Cost

The annual operation and maintenance cost covers the salaries of administrative and technical staff, material and labor costs for repair and maintenance of project facilities, costs for operation and maintenance of the rice-mill. The operation and maintenance cost annually required for the Project was estimated at CFA F 363 million.

5.3.5 Replacement Cost

Some of the facilities installed or constructed in the Project will have a shorter useful life than the project life and will require replacement within the project useful life. The replacement costs of steel gates, stoplogs and rice-mill were estimated as shown below.

Item	Useful Life	Replacement Cost
Steel gates	25 years	CFA F 153.00 million
Stoplogs	10 years	CFA F 0.24 million
Rice-mill	10 years	CFA F 228.12 million

CHAPTER VI ORGANIZATION AND MANAGEMENT

6.1 Organization for Project Implementation

At the project implementation stage, the present Baigom Rice Cultivation Project Office will be reinforced and transformed into the Baigom Agricultural Development Authority (SODABA) to undertake the project implementation and management under the control of the Directorate of Studies and Projects, Ministry of Agriculture (see Fig. 14).

For the successful implementation of the Project, it is proposed to establish as soon as possible at the initial stage a Development Authority (SODABA) under an establishment agreement with the Government of the Republic of Cameroon, similar to in the case of similar projects such as SODERIM, UNVDA, SEMRY, etc.

To ensure the administrative cooperation from the local authorities at provincial, divisional and sub-divisional levels, it is recommended to create a "Board of Directors" to control the above Project Office. The Board will consist of the representatives of the authorities concerned.

The Project Office will consist of three working sections, i.e., 1) Administrative & Financial Section, 2) Construction Supervision Section and 3) Operation and Maintenance Section. The Construction Supervision Section will be progressively transformed into Operation and Maintenance Section with the progress of construction works.

6.2 Organization for Operation and Maintenance

To undertake efficiently the operation and management of the developed area, the organization of SODABA (Project Office) will have to be strengthened progressively after the project implementation stage (see Fig. 15).

The Project Office of SODABA will consist of a Secretariat and five Departments: Financial Department, Administrative Department, Operation and Maintenance Department, Production and Marketing Department, and Farmers Organization Department.

In proportion to the work volumes, the Administrative & Financial Section at the project implementation stage will be reinforced by dividing it into two Departments :

Administrative Department and Financial Department. The Construction Supervision Section and Operation and Maintenance Section will be transformed into the Operation and Maintenance Department. On the other hand, a Production and Marketing Department and a Farmers Organization Department will be newly created to ensure profitable and rational O&M of the Project.

6.3 Agricultural Support System and Staffing

It will be essential in the first place to use rationally the existing agricultural support agencies and institutions in charge of researches and extension, investment and credit services, cooperatives and farmers' organizations, etc. (see Fig. 2).

As the present agricultural support institutions in the region are not yet well developed, the Project could not expect, for the time being, a full assistance from these organizations.

To ensure a smooth implementation of the Project, it is recommended to assign staff with adequate qualifications. The number of staff required at each stage - Project Implementation and Operation and Maintenance - is given in Table 12.

To cope with the shortage of experienced personnel in Cameroon, some foreign specialists would have to be recruited, especially in each initial period. The personnel expenses of SODABA were calculated on the following conditions:

a) All remunerations including base salaries and allowances will be in principle borne by the SODABA. However, following the case of similar projects, the base salaries for national officials might be paid by the Government according to the stipulations of the agreement concluded between the Government and SODABA. The total amounts of personnel expenses for both cases without and with the government subsidy are given in Annex VIII.

b) Project allowances equal to 20% to 40% of the base salary will be paid to national officials according to their responsibility, technical level, diligence and for their transportation, etc.

c) The amounts appropriated for local staff as Project Allowances (added by 10%) will cover overtime payments and so on.

d) Social charges (estimated to be about 15% of the base salary) will be paid by SODABA. In case the government subsidy available, SODABA will bear only social charges for the local staff.

e) Travelling allowances at each of the two stages were calculated by applying the following percentages to those in the target year of 1995:

- 20%–65% for the project implementation stage
- 80%–100% for the operation and maintenance stage

f) For members of the Board of Directors or Committee of Selection of Candidate Farmers, only travelling allowances will be borne by SODABA.

It is quite indispensable to assign the right staff to the right post so as to ensure a smooth operation and management of the Project. The qualifications and requirements of the staff are given in detail in Table 13.

CHAPTER VII PROJECT EVALUATION

7.1 General

Project evaluation is performed to ascertain the viability of the Project in the economic, financial and socio-economic aspects.

The economic viability of the Project is evaluated in terms of the internal rate of return (IRR), benefit-cost ratio (B/C) and benefit minus cost (B-C). Further, sensitivity analysis is made to evaluate the economic viability of the Project in case of eventual changes in the estimated project costs and benefits.

The financial analysis is aimed at evaluating the capacity to pay of farmers and the repayment schedule of the project capital cost. Calculation of the capacity to pay is to confirm the soundness of the Project from the farmer's viewpoint. A repayment schedule is prepared to estimate the Government annual subsidy based on the estimated fund requirements with the assumed financial terms of conceivable loans and the expected revenue from the Project.

Intangible benefits of the Project are briefly assessed in the consideration of the effects of the Project on the regional development.

7.2 Economic Evaluation

7.2.1 Economic Cost

The economic costs of the Project would consist of the construction cost, replacement cost and operation and maintenance (O&M) cost, and are obtained by deducting both price contingencies and transfer payments such as taxes and duties (estimated to be 15% for the foreign currency portion). The above economic costs were estimated based on the December 1985 price level. The standard conversion factor (SCF) determined by the World Bank to be 0.77 for Cameroon was applied to the domestic portion of all costs to bring them to the border price equivalents.

The economic construction cost would amount to CFA F 8,980.1 million as shown in Table 14. Steel gates to be installed in the development area will be replaced once during the entire project life time,while stoplogs will be renewed every 10 years. As for the O&M

equipment,it will be replaced every 10 years. The O&M cost of the Project will be initially disbursed in 1990 when partial operation will commence, and will reach the full amount of CAF F 269.6 million in 1997. The price contingencies were excluded from the economic cost.

7.2.2 Economic Benefit

The project benefits would accrue primarily from increased crop production thanks to land development works and for establishment of a suitable irrigation and drainage system. The benefit was estimated from the difference of the annual net production values under future situation "with" and "without" project. The project benefit would amount to CAF F 1,794.6 million per annum at the full development stage as shown in Table 15. This benefit from agricultural development will start to accrue from 1990, and would gradually increase up to the maximum in 1997.

As for forest exploitation subsequent to land development in the Baigom plain, the benefit to be derived from wood production within the project area was computed in the economic evaluation as well as in the financial evaluation.

7.2.3 Evaluation

(1) Internal rate of return

On the basis of the economic cost and benefit estimated as described in the preceding sections, the internal rate of return (IRR) of the Project was calculated for the entire project.

Calculation of the IRR was made based on a project life of 50 years. The result indicated that the Project is quite feasible with an IRR of 12.1% for the entire project as shown in Table 16.

In addition, the B/C and B-C were also estimated at the discount rates of 10%, 12% and 15% as follows:

Discount Rate	10%	12%	15%
B/C	1.206	1.006	0.788
B-C (CFA F 10^6)	1,829.76	52.03	-1,557.14

(2) Sensitivity analysis

In order to further evaluate the soundness of the Project in case of possible changes in economic condition in future, sensitivity analyses were made under the following conditions:

a) Cost increase of 10%,
b) Cost increase of 20%,
c) Benefit decrease of 10%,
d) Benefit decrease of 20%,
e) Combination of the above cases, and
f) Delay in reaching project objective (1 year).

The results of the sensitivity analyses on the above cases are shown in Fig. 16 and are summarized below:

Cost	Benefit			Delay in Reaching Project Objective (1 year)
	0%	-10%	-20%	
0%	12.1	10.9	9.7	10.9
+10%	11.0	9.9	8.7	10.0
+20%	10.0	9.0	7.8	9.2

As seen in the table, the project feasibility would not sensitively fluctuate even under critical condition: The IRR would stand at 7.8% under the most adverse condition caused simultaneously by a 20% price decline and a 20% cost overrun.

7.3 Financial Evaluation

7.3.1 Capacity to Pay

In order to evaluate the project viability from the financial aspect of farmers, an average farm budget analysis was made for the future situation of "with" and "without" project as outlined below:

(Unit: CFA F 10^3)

Item	Without Project/*	With Project
1) Gross Income	545	2,130
2) Gross Expenditure	545	1,516
- Production cost	146	816
- Living expenses	399	700
3) Capacity to Pay	0	614
4) O&M Service Fee	-	222
5) Net Reserve	0	392

Remarks: /* For the future situation "without project", the present condition of farm budget was directly applied.

As seen in the above table, the capacity to pay expected under the "with project" condition would be CFA F 614,000 per farm household.

7.3.2 Repayment Capability

For the repayment capability analysis, it was assumed that the investment requirement would be arranged under the following conditions:

(a) Foreign currency portion: This will be financed by bilateral financing agencies at an interest rate of 3.5% per annum. The repayment period will be 30 years including a grace period of 10 years.

(b) Local currency portion: This will be financed from allocation through government budgets.

Based on the above assumption, the O&M service fee to be charged to the settled farmers was estimated to be about CFA F 222,000/year per farm household corresponding to about 10.4% of gross income. Generally, the charge to be collected from the settled farmers

should be reasonably within their capacity to pay so as to give them sufficient incentive to increase agricultural production. In this view, it is anticipated that the farmers would be in a position to bear the annual operation and maintenance cost as well as the replacement cost of the project facilities.

The financial cash flow at the project level was calculated for the whole project life as shown in Table 17, in which the O&M and replacement costs were temporarily assumed to be borne by the beneficiary farmers and all other costs including amortization of the loan are to be provided by the Government as subsidy to the Project.

7.4 Indirect Benefit and Socio-Economic Impact

Various indirect benefits and socio-economic impacts are expected from the realization of the Project as mentioned below:

(1) Food supply to the Metropolis and commercial centers

Since demand for rice and vegetables in the Metropolis and commercial centers continue to increase along with the population growth, the project area will be called to become a supply base to these centers.

(2) Foreign exchange saving

It is expected upon completion of the Project that marketable rice would be about 5,798 tons after deducting the home consumption amount. Thus, the estimated foreign exchange saving would amount to about CFA F 517 million per annum as a result of substitution for imported rice.

(3) Increase of employment opportunities

Employment opportunities to local people would increase along with the project implementation. The workers participating in the Project will be able to gain more experience, technical know-how and skill in various working fields. This accumulation of knowledge would be useful for future development in the region.

(4) Improvement of living standards and contribution to regional economy

After the realization of the Project, the income of the farmers around the project area is expected to increase considerably as a direct result of the increase in crop production and consequently to improve the living standards of the local people. This fact would benefit the development of the regional economy as a whole.

(5) Establishment of marketing systems and consolidation of farmers' associations

With anticipated higher agricultural production, market facilities in the project region are expected to be improved with the support of the Authority. Through the marketing of farm inputs and outputs, farmers' organizations in and around the project area would be also consolidated.

(6) Improvement of sanitary conditions

The Project would have a positive effect on the overall ecology of the project area. The health and sanitary conditions in the region will become better with the introduction of improved drainage systems.

(7) Settlement from densely populated areas and diminution of population drift from rural areas.

About 2,000 ha of arable land would be newly created through the realization of the Project. If the people from the densely populated areas are settled in this new land, the population drift from the region will be considerably reduced.

CHAPTER VIII ENVIRONMENTAL IMPACT ASSESSMENT

8.1 General

The Baigom Agricultural Development Project aims to create 2,000 ha of new farm lands in the Baigom plain by means of reclamation of the swamp plain through construction of irrigation and drainage systems. Major facilities to be provided for the Project are storage dams on the Ndoup and Nja rivers, irrigation and drainage canals and their related structures.

The development works may affect the environmental resources of the area in and around the Baigom plain. In this chapter, the principal environmental impacts of the Project are considered, and the assessment of the potential impacts are given on the basis of information available from the existing sources.

8.2 Physical Environment

After the implementation of the Project, the hydrological regime in the downstream area in the plain would be changed as a consequence of the water control effect of the Project. A tendency in the change is that a peak flood discharge would increase in the rainy season. In order to minimize the effect of such change in the downstream basin, the regulating gates would be provided at the outlet of the project area, just upstream of the Baigom bridge, as described in Chapter IV.

Some water pollution resulting from human waste and use of various agro-chemicals in the project area would occur. The effects to the downstream, especially for water supply to the Foumbot city would be very small, because dilution by discharges from additional watershed in the downstream and natural purification of the flow in the river channel are expected. In order to minimize the effect of the Project on water quality, it is recommended to use the least toxic fertilizers and agro-chemicals such as those which are used in Japan as shown in Table 18.

Periodical observation of water quality of the Nkoup river at the outlet of the Baigom plain and at the intake point of SNEC (Foumbot city) is recommended in order to confirm the

change in water quality which may be caused by the project execution. It is recommended to enact a law or regulation on the water pollution control in the country.

8.3 Ecological Enviroment

No detailed ecological studies have been made so far on the Baigom plain. The vegetation in the plain consists of swampy forests and grass, and the typical flora at present are rapial, carex, reed, etc. Although the floras in the plain could change with the progress of development works, no serious problems would occur.

It is reported that several decades ago, there were some hippopotamuses in the Baigom plain, however at present no such animals can be seen.

8.4 Aesthetic and Cultural Environment

From the field observation, it would appear that there are no geological, historical, archeological or scenic sites to be affected by the Project.

CHAPTER IX PILOT SCHEME PLAN

9.1 Objective

The project area covered with grass and forests is mostly inundated at pressent. After the implementation of the Project, the project area would be reclaimed and developed with the appropriate irrigation and drainage facilities. Most of the reclaimed fields would be distributed to the newly settled individual farm household. In order to lead the Project up to the final goal, it is recommended to establish a pilot scheme with a proper executive organization prior to the development of the whole project area.

The main reasons for the necessity of the pilot scheme are as follows:

(1) Skilled engineers and technicians on irrigation farming are still few in Cameroon due to her rather short history in rice cultivation. In order to operate successfully the Project, engineers and technicians should be trained through the pilot scheme within the framework of the Project.

(2) The results of experiments obtained from the existing experimental plot remains at a preliminary level mainly due to the lack of engineers and facilities. It is essential to carry out various experiments through the introduction of suitable varieties, cropping calendar, plant protection, high-yielding farming method, proper irrigation method, harvest and post-harvest technology to acquire high quality products with reduction of production losses and so on.

(3) Farmers are not familiar and skillful in a modern irrigation farming. It is very important to train the leading farmers and extension workers in order to extend proper irrigation farming practices all over the project area.

(4) The executive body of the project operation is necessary to have experiments in a certain scale of settlement of farmers prior to the development of the whole project area. Through the experiments in the pilot scheme, the executive body would acquire sufficient trained staff in the field and proper organization of the farmers for the operation of the whole project area.

To achieve the principal objectives of the pilot scheme, the following activities are required:

- To operate the experimental and demonstration farms for carrying out experiments and demonstration in modernized irrigation farming,
- To train engineers, technicians, extension workers and farmers,
- To promote farmers cooperative activities for the smooth supply of farm inputs, effective extension of farming technics and to produce uniform high quality of production,
- To operate rice processing facilities, and
- To operate a farm machinery center for the smooth operation in the initial stage of the Project.

9.2 Location and Scale

The location of the pilot scheme was selected on the north-eastern corner of the Baigom plain as shown in Fig. 17 for the following reasons:

(1) Easy access to the proposed area which is close to the national road No. 2, and the demonstration would be effectively achieved.

(2) Irrigation water can be easily obtained by gravity from the Ndoup river.

(3) Topographically the area is situated on the relatively higher land of the plain so as to enable drainage improvement works economically without any radical measures in the downstream of the plain.

(4) Soil condition in the area is favourable for agricultural production consisting of Humic Gleysols, Humic Cambisols, and Dystric Nitosols which are the main soil units in the project area.

(5) The existing experimental plot in which rice cultivation is practiced, is included in the area.

The gross area of the pilot scheme would be about 170 ha. The average slope of the area is about 1/300 at elevations ranging from 1,118 m to 1,125 m. At present, the area consists of 33 ha of arable land, 90 ha of grass land and 47 ha of forest. From the geological viewpoint, the area is composed of black organic soils of about 30 cm in depth as top-layer and laterite as foundation intervening partly with organic clay. The cone index of the foundation

measures more than 2.0 kg/cm^2, which shows enough bearing capacity for the use of agricultural equipment.

The pilot scheme would be established with 45 ha of experimental and demonstration farms, 110 ha of pilot model areas and 15 ha of lands for buildings and facilities as shown below:

Gross area : 170 ha

(1) Experimental and Demonstration Farms : 45 ha

i) Experimental Farms : 16 ha

ii) Demonstration and Training Farms : 29 ha

(2) Pilot Model Areas for Farmers : 110 ha

(3) Lands for Buildings and Facilities : 15 ha

The general layout of the pilot scheme is shown in Fig. 18.

9.3 Farm Development Plan

9.3.1 Land Reclamation Plan

In the pilot scheme, a gross area of 155 ha of farm lands would be newly developed and provided with proper irrigation and drainage facilities. The breakdown of the farm lands is summarized as follows:

Farm		Gross Area (ha)		Net Area (ha)	
Experimental Farms	16.2	Paddy Field - 10.7 Upland Field - 5.5	14.6	Paddy Field - 9.6 Upland Field - 5.0	
Demonstration & Training Farms	28.8	Paddy Field - 19.3 Upland Field - 9.5	25.9	Paddy Field - 17.4 Upland Field - 8.5	
Pilot Model Areas	110.0	–	99.0	–	
Total	155.0		139.5		

The typical size of a farm plot was determined at 0.3 ha (100 m x 30 m) by taking into consideration the topographic and soil conditions, and efficient farming practices. The farm

plot would be generally reclaimed following the contour line and be of rectangular shape to minimize earth moving volumes and cutting depth as far as possible.

9.3.2 Irrigation Plan

An intake weir would be constructed on the Ndoup river at about 250 m downstream of the culvert crossing the national road No. 2 to draw irrigation water from the river. The irrigation canal network would consist of two main irrigation canals, five secondary irrigation canals and many farm ditches. These canals would be of earth canals with trapezoidal sections. The required structures related to the above canals consist of turnouts for distribution of irrigation water and culverts for conveyance of water under the roads.

The general features of the irrigation facilities are shown below.

Intake Weir	Type	:	Fixed type concrete weir		
	Crest Elevtion	:	El. 1,125 m		
	Crest Length	:	13.0 m		
	Scouring Sluice Gate	:	W 1.0 m x H 1.5 m x 1 no.		
	Intake Discharge	:	0.25 m³/s		
	Intake Gate	:	W 1.0 m x H 1.0 m x 1 no.		
Canal		Discharge (m³/s)	Length (m)	Bed Width (m)	Water Depth (m)
Main Irrigation Canal	Right	0.19	1,180	0.70	0.80
	Left	0.06	1,600	0.50	0.70
Secondary Irrigation Canal	No. 1	0.09	1,590	0.50	0.70
	No. 2	0.06	940	0.50	0.70
	No. 3	0.02	570	0.40	0.50
	No. 4	0.01	170	0.40	0.40
	No. 5	0.01	270	0.40	0.40
Farm Ditch		0.01	7,595	0.40	0.40
Related Structure	Turnout	: 38 nos.			
	Culvert	: 22 nos.			

9.3.3 Drainage Plan

The Ndoup river would be the main drainage channel in the area. As the existing condition of the river is not adequate for smooth drainage, the river would be improved to