MINISTRY OF ECONOMIC PLANNING
GOVERNMENT OF THE REPUBLIC OF GHANA

FEASIBILITY REPORT ON THE AVEYIME SUGAR PRODUCTION PROJECT IN ACCRA PLAINS

MAIN REPORT

JUNE 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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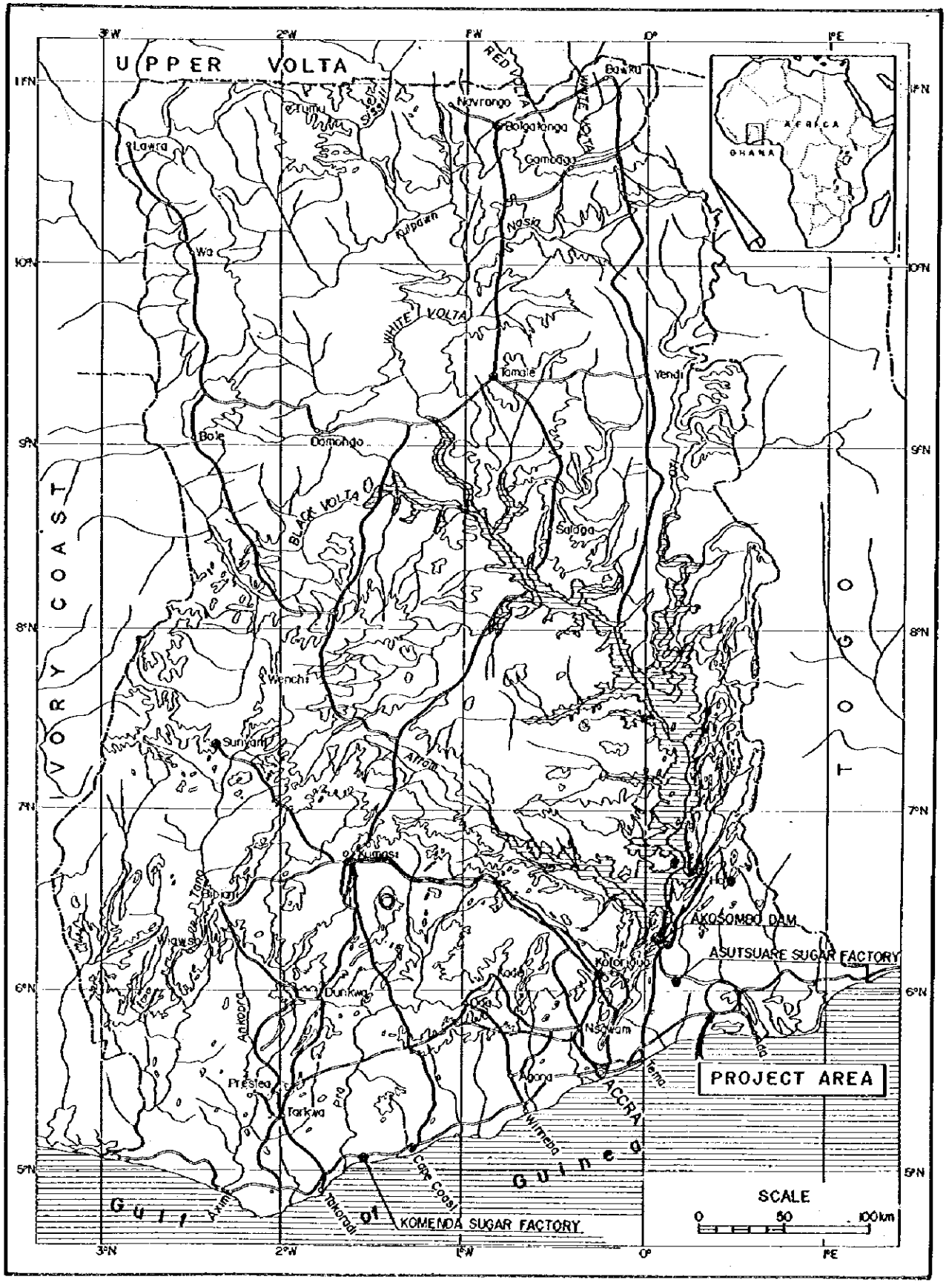
LOCATION MAP



PREFACE

In response to the request of the Government of the Republic of Ghana, the Government of Japan has decided to undertake a feasibility study on the Aveyime Sugar Production Project in the Accra Plains and the Japan International Cooperation Agency executed the study.

The Agency dispatched a survey team consisting of five experts headed by Mr. I. Kuno, chief of irrigation and drainage department, Nippon Koei Co., Ltd. to Ghana over a period from June 26 to July 25, 1975. The survey team conducted the field investigation in close cooperation with the Ghanaian authorities concerned. After its return to Japan, the team made various studies and analyses of data, materials and opinions obtained in Ghana. As a result, the feasibility report has been completed and it is herewith submitted to the Republic.

I sincerely hope that this report will contribute to the implementation of the project for the further economic growth in Ghana, and will serve in promoting friendly relations between Ghana and Japan.

Finally, I wish to take this opportunity to express my heartful gratitude to the officials in the authorities concerned of the Government of Ghana, and the Ambassador of Japan to Ghana and his staff, for the wholehearted support and cooperation extended to the team throughout the survey period.

Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

We have the pleasure of submitting herewith the feasibility report on the Aveyime Sugar Production Project in the Accra Plains in compliance with the Terms of Reference agreed between the Government of Japan and the Government of the Republic of Ghana.

In the course of the field investigation, we held several meetings for discussion with the officials of the Government of Ghana. All the findings and comments raised during the meetings are studied and fully incorporated in this report.

The purpose of the project is a land and water development of the Aveyime area in the Accra Plains, with particular emphasis on the production of refined sugar. The net irrigable area taken up in this project is 7,500 hectares in the northeastern part of the Accra Plains. In addition to the irrigation development, included in the scope of the project is to establish a sugar plant with a processing capacity of 3,000 tons of sugar cane per day. The estimated annual output from this sugar plant is about 45,000 tons of granulated refined sugar entirely for domestic consumption.

It is our sincere hope that the project will be implemented as soon as possible, based on the detailed site-investigation along the suggestions presented in this report.

In submitting this report, we wish to express our sincere appreciation and gratitude to personnels of your agency, the Embassy of Japan to Ghana and the authorities concerned of the Government of Ghana for the courtesies and cooperations afforded during our field survey and home office work.

Our recongnition is also extended to the Ministry of Foreign Affairs and the Ministry of Agriculture and Forestry of Japan.

Very truly yours,

I. Kuno.

I. Kuno
Team Leader,
JICA Survey Team

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ABBREVIATIONS

km	kilometer	kW	kilowatt
m	meter	MW	megawatt
cm	centimeter	kVA	kilovolt ampere
mm	millimeter	V	volt
kg	kilogramme	Hz	hertz
g	gramme	mho	reciprocal of ohm
mg	milligramme	$\mu\mho$	micro mho
meq	milligramme equivalent	PS	Horse power
km^2	square kilometer	pH	potential of Hydrogen
m^2	square meter	^oC	degree centigrade
cm^2	square centimeter	%	percent
ha	hectare	ppm	part per million
kℓ	kiloliter	ft.	foot
ℓ	liter	lb	pound
mℓ	milliliter	no(s).	number(s)
m^3	cubic meter	rpm	revolution per minute
hr(s)	hour(s)	dia.	diameter
ℓ/sec/ha	liter per second per hectare	ϕ	diameter
kg/ha	kilogramme per hectare	approx.	approximately
g/ha	gramme per hectare	max.	maximum
ℓ/ha	liter per hectare	min.	minimum
ton(s)/hr	ton(s) per hour	IRR	internal rate of return
m^3/hr	cubic meter per hour	O&M	operation and maintenance
cm/hr	centimeter per hour	M	man-year
cm/min	centimeter per minute	Fig.	Figure
ℓ/min	liter per minute	US$	U.S. dollar
m^3/sec	cubic meter per second	US¢	U.S. cent
Nm^3/min	normal cubic meter per minute	¢	Cedi
mm/day	millimeter per day	¥	Japanese yen
cals/cm^2	calories per square centimeter	L.S.	lump sum
El(s)	Elevation(s) above mean sea level		
mg/100g	milligramme per 100 gramme		
meq/100g	milligramme equivalent per 100 gramme		
kg/cm^2G	kilogramme weight per square centimeter		
ISO	International Sugar Organization		
ISC	International Sugar Council		
CIF	Cost, Insurance and Freight		
FAO	Food and Agriculture Organization of the United Nations		
IBRD	International Bank for Reconstruction and Development		

CONVERSION TABLE

Length

1 mile	=	1.609 km
1 yard	=	0.914 m
1 foot	=	0.305 m
1 inch	=	0.0254 m

Area

1 square mile	=	2.59 km^2
1 acre	=	0.405 ha
1 square foot	=	0.093 m^2
1 square yard	=	0.836 m^2

Volume

1 acre foot	=	1,233.5 m^3
1 cubic yard	=	0.765 m^3
1 cubic foot	=	0.0283 m^3
	=	28.3 ℓ
1 gallon (Imperial)		
	=	4.546 ℓ

Weight

1 ounce	=	28.35 g
1 pound	=	453.59 g

CURRENCY EQUIVALENT

Currency unit

Cedi (¢), Pesawa (p)

¢ 1.00	=	100 p
¢ 1.00	=	US$0.87
US$ 1.00	=	¢ 1.15
US$ 1.00	=	¥ 300
¢ 1.00	=	¥ 261

S U M M A R Y

BACKGROUND

1. The greatest asset of Ghana is the water resources of the Volta river system. The physical and economic utilization of the resources was hampered by the large seasonal fluctuation of the river discharge. With the completion of the Akosombo dam, the flow of the Volta has been regulated and the extensive flat land, which had been subject to periodical inundation in the past, has been made available for a great increase of agricultural production.

2. The agricultural production in Ghana makes up about 40 % of the National Domestic Products. However, it is not yet attained to keep up with the growing demand for foods, and a considerable amount of agricultural products has been imported. Sugar is by far an important item among the imported agricultural products.

3. Ghana has imported more than 80 % of the total national requirement of sugar annually, and the burden on the national economy caused by this sugar import has sharply increased as the result of the recent international sugar price raise.

4. It is estimated that Ghana consumes about 90,000 tons of sugar annually, as compared with the total present production by the existing two factories of about 11,000 tons. The present sugar production is far behind the installed capacity of the factories. It is anticipated that with the ongoing rehabilitation programme of the existing factories the domestic sugar production will gradually increase up to its maximum production capacity of 45,000 tons per annum. Even with this achievement, Ghana will still have to import a large amount of sugar, unless more factories be constructed. Under such circumstances and in view of the anticipated continuation of high international sugar price in future, the Government intends to strive its effort to enlarge sugar production by means of a new project in the lower Volta flood plain.

THE PROJECT AREA

5. The project area is located on the northeastern part of the Accra plains and extends over about 9,400 ha of fertile land along the lower reaches of the Volta. It is an alluvial plain gently sloping toward the north. The population of the project area is about 18,000, most of which are engaged in agriculture. The lands are mostly covered with scrub and grass. Climate is equatorial; there are two rainy seasons every year, the major rainy season being from mid-April to end of June and the second rainy season from mid-September to early November. Annual rainfall averages 949 mm, largely varying from year to year. The average air temperature is 27.4°C. Seasonal temperature change is not conspicuous throughout the year. Soil conditions in the project area are generally recognized to be fertile with thick effective soil depth and adequate permeability.

6. The present intensity of agricultural land use in the project area is very low, as densely cultivated lands share only about 2 % of the whole area. Main crops are cassava, maize, groundnuts and vegetables. Average yields of these crops are also very low mainly due to the absence of adequate irrigation facilities, farming technique and farm inputs. The present scale of the average farm household economy is very small and the living standard is quite low with average annual net reserve of US$320 per farm household.

THE PROJECT

7. The project is planned with particular emphasis on production of sugar cane with possible inclusion of other crops to form rotative crop system on the net area of 7,500 ha. The plan also includes to establish a complex of sugar plant with processing capacity of 3,000 tons of sugar cane per day.

8. Construction cost of a sugar factory is now very high and is anticipated to increase still further. High investment is only justified if high production of sugar cane can be assured. In this view, sugar cane will have to be grown under irrigation in the project area. Dependable source of irrigation water is the regulated flow of the Volta river. Irrigation development of the project area requires the pumping up.

9. The proposed size of sugar cane farm will consist of 4,300 ha of the estate farm managed by the governmental organization and 3,200 ha of the settlement farm collectively managed by the local farmers. All the farming practices will be mechanized in order to meet the systematic work-flow from soil preparation to harvest-to-mill process and to save the labour requirement. The estimated production of sugar cane is 450,000 tons a year when it comes to the full operation.

10. A sugar plant will be established to produce the granulated refined sugar. The estimated annual output of the proposed plant is 45,000 tons of refined sugar entirely for domestic consumption.

PROJECT FACILITIES

11. The principal features of the project facilities are summarized below:

(1) Pumping Station

No. 1 Pumping Station	; 433.0 m^3/min
No. 2 Pumping Station	; 357.8 m^3/min
No. 3 Pumping Station	; 20.6 m^3/min
No. 4 Pumping Station	; 33.6 m^3/min
No. 5 Pumping Station	; 16.4 m^3/min
No. 6 Pumping Station	; 33.6 m^3/min
No. 7 Pumping Station	; 31.0 m^3/min
No. 8 Pumping Station	; 21.2 m^3/min
No. 9 Pumping Station	; 41.6 m^3/min

(2) Gate Structure

No. 1 Gate: 5 m wide x 2.0 m high	; 4 nos.
No. 2 Gate: 3 m wide x 2.5 m high	; 2 nos.

(3) Irrigation Canals

Concrete-block-lined canals

Main canal: 0.123-4.333 m^3/sec	; 47 km
Secondary canal: 0.055-0.996 m^3/sec	; 18 km

Earth canals

Main canal:	0.036-0.676 m^3/sec	; 21 km
Secondary canal:	0.075-0.229 m^3/sec	; 4 km
Distribution canal:	0.011-0.265 m^3/sec	; 173 km

(4) Drainage Canals

Main drain:	0.112-52.0 m^3/sec	; 69 km
Collector drain:	0.089-1.281 m^3/sec	; 143 km

(5) Roads

Main road: 8 m wide	; 60 km
Secondary road: 6 m wide	; 91 km
Tertiary road: 4 m wide	; 140 km

(6) Related Structures

Turnout	; 154 nos.
Syphon	; 7 nos.
Culvert	; 11 nos.
Cross regulator	; 40 nos.
Drop	; 16 nos.
Side spillway	; 15 nos.
Wasteway	; 18 nos.
Drain culvert	;1430 nos.
Cross drain	; 39 nos.
Bridge	; 13 nos.
Farm pond	; 36 nos.

(7) Buildings

Office and quarters

Project office	; 800 m^2
Co-operative office	; 600 m^2
Rest house, Guest house, Clinic, etc.	; 2,150 m^2
Staff quarter	;14,750 m^2

Sugar factory

Main factory building	; 8,820 m^2
Factory office and laboratory	; 200 m^2
Garage, Chemical storage, Sugar warehouse, etc.	; 2,780 m^2

(8) Sugar Factory

Processing capacity	; 3,000 tons of cane per day
Annual net operation days	; 150 days
Products	; Granulated refined sugar
Annual production	; 45,000 tons

COST

12. The construction cost estimated at the price level of July 1975 is US$74.78 million equivalent including US$31.26 million equivalent of local currency component and US$43.52 million equivalent of foreign currency component as shown below:

Description	Foreign currency (US$1,000)	Local currency (US$1,000)	Total (US$1,000)
a. Infrastructures	13,160	23,960	37,120
b. Sugar plant	22,110	5,380	27,490
c. Initial farm investment	8,250	1,920	10,170
Total	43,520	31,260	74,780

13. The construction work will be carried out on the contract basis. The construction of the civil work will be commenced in the 1977/78 dry season and span over four major dry seasons; completion of all the civil works is expected to be at the end of the 1982/83 dry season. The sugar plant will be completed by the beginning of the 1981/82 dry season when the first factory operation will start.

ORGANIZATION

14. The project has an important role in the governmental economic plan as a pioneer project in the Accra plains. As its essential part, the project includes a programme for farm settlement on the land of 3,200 ha. In consequence, the project will bring about strong influence on the economy at national level as well as at regional level. It is therefore recommended that the project be implemented and operated by a government agency.

15. The settlement farm will be collectively managed by the local farmers through cooperative activity. It is recommended, however, that the government agency be responsible for the management of the settlement farm at the initial stage of the settlement, in view of farmers' lacking in experience of sugar cane cultivation.

ECONOMIC ASPECT

16. The economic analysis of the project is made based on the imported refined sugar pirce. Under the wide variation of the international sugar price at present, the imported refined sugar price is estimated to be in the range of US$400/ton and US$620/ton.

17. The benefit attributable to the project is calculated on the basis of the estimated sugar cane yield of 80 ton/ha and sugar yield of 10 % on an average. The following table is an estimate of the project benefit for the sugar price of US$510/ton which is the center value of the above-mentioned price range.

(a) Production (ton)

Sugar cane (3 crops in 4 years)	; 450,000
Fallow crops	; 3,800
Refined sugar	; 45,000

(b) Project output (US$1,000)

Gross output	; 23,734
Production cost	; 7,270
Net output	; 16,464

(c) Net production value
without project (US$1,000) ; 168

(d) Incremental benefit; (b)-(c)
(US$1,000) ; 16,296

18. The internal rate of return of the project is estimated to be 11 % for the sugar price of US$400/ton, 15 % for the sugar price of US$510/ton and 18 % for the sugar price of US$620/ton, respectively. These figures are considered to be high enough to endorse the economic feasibility of the Aveyime Sugar Production Project and in addition to that, the success of the project will be an effective initiator for the forthcoming development of the neighbouring potential areas.

19. The project will produce 45,000 tons of refined sugar annually at the full operation stage. If this amount of sugar is assumed to be imported wholly at the price of US$510/ton, the foreign exchange needed will be US$23.0 million equivalent. While, the foreign currency portion of the annual expenses totals about US$9.3 million equivalent for the foreign capital repayment, fertilizers, agri-chemicals, machinery and tools, etc. The balance about US$13.6 million equivalent between the gross foreign exchange saving and the total foreign expenses is considered to be the net foreign exchange saving of the project. It corresponds to about 3 % of the total import value in Ghana.

CHAPTER I INTRODUCTION

1.1 General

In May 1975, the Government of Japan, in response to the request by the Government of the Republic of Ghana, decided to carry out a feasibility study on the Sugar Production Project in the Accra plains, and entrusted the implementation of the study to the Japan International Cooperation Agency (JICA), an executing organization responsible for the international cooperation programme of the Government of Japan.

The Agency made a contract for the study with Nippon Koei Co., Ltd., Tokyo, and dispatched a field investigation team comprising five experts, headed by Mr. I. Kuno, chief of irrigation and drainage department of Nippon Koei, to the Republic of Ghana over a period from June 26 to July 25, 1975.

The objective of the study requested by the Government of Ghana was the updating of the "Feasibility Report on Sugar and Rice Production Project in the Accra Plain" prepared by Nippon Koei in 1967 with emphasis on the sugar production.

1.2 Scope of the Project and Its Importance

The proposed project is a land and water development programme for the sugar production in the Aveyime area in the Accra plains extending along the lower reaches of the Volta river. The scope of the project, therefore, includes the implementation of infrastructural facilities necessary for a large-scale sugar cane production together with the installation of a sugar plant which will produce the granulated refined sugar. As its essential scope, the project also includes the establishment of a programme for family farm settlement in a half of the area, in accordance with the government policy for the rural development.

The irrigable area of this project is 7,500 ha. It will play an important role in the economic development plan as the first stage of the Accra Plains irrigation development programme which is accorded with the highest development priority by the Government. The project will produce about 45,000 tons of refined sugar at its full operation

stage. This production is almost comparable to the current sugar import in quantity, and it will substantially reduce the drift of foreign exchange spent on imported foodstuff.

1.3 Past and Present Status of the Project

Blessed with the favourable natural conditions for agricultural development, the Accra plains have long been marked with the highest priority in Ghana. A series of efforts have been made by various authorities concerned, among which major studies and works made until now are summarized below:

- In 1959, Netherlands Engineering Consultants (NEDECO) made a reconnaissance in the Angaw basin which is located adjacent to the Aveyime area, and indicated the possibility of cropping over 19,500 acres (7,800 ha). They suggested that holding of 8 acres (3.2 ha), each managed with bullock power, is suited for local families in the area. Besides, large completely mechanized plantations for sugar cane cultivation was also recommended.

- During 1960 - 63, the United Nations Food and Agriculture Organization (FAO) conducted a detailed survey of the lower Volta floodplain and revealed a possibility of irrigated cropping on total area of 21,000 acres (8,400 ha). The selected irrigable lands are mainly located in the upper reaches from the Agbo river along the Volta. The Aveyime area was also studied at a preliminary level as one of the "Sketch Design Schemes". The report favoured a large scale sugar cane plantation over 8,000 acres (3,200 ha). For peasant farms, an area of 5 acres (2 ha) was considered enough to utilize the family labour fully.

- In 1964, Kaiser Engineers and Constructors, Inc. surveyed the entire Accra plains and prepared the Feasibility Report on the Accra Plains Irrigation Project. This report proposed to irrigate about 440,000 acres (176,000 ha) out of the 828,000 acres (331,000 ha) of the whole Accra plains. It was contemplated that the irrigation water would finally be taken at an intake to be constructed at the Akosombo dam. The report favoured the

establishment of large farm units with highest degree of mechanization and it suggested several rotations of crops including sugar cane, rice, etc.

- During 1965 - 67, Nippon Koei Co., Ltd. carried out the detailed survey and investigation of the Aveyime area including two-year operation of a 200-acre pilot farm and prepared a feasibility report for the irrigation development of 21,000 acres (8,400 ha) of land near Aveyime. In the report, an area of 10,000 acres (4,000 ha) was suggested to be used for sugar cane plantation to support a sugar plant of economical size, whereas the remaining lands would be used mainly for growing rice in combination with maize and groundnuts.

- In 1973, H.V.A. International B.V. being sponsored by IBRD made an overall study on future supply and demand for sugar in Ghana and made recommendations for taking up the Aveyime area for the Ghana's third sugar complex.

CHAPTER II BACKGROUND

2.1 General Geography of Ghana

The Republic of Ghana lies almost in the centre of the countries along the Gulf of Guinea, having a territory of 238,000 km^2. It is located between the latitudes $4^{\circ}44'$ and $11^{\circ}11'$ north and the longitudes $1^{\circ}12'$ east and $3^{\circ}15'$ west, being bounded by Ivory Coast in the west, Upper Volta in the north and Togo in the east. The whole land is divided into nine administrative regions.

Topographically, Ghana is characterized by two lines of high ground and the plains developed in the Volta valley. One of the high ground is the Togo-Akwapin mountains, with peaks up to nearly 1,000 m, running northeast to southwest, and the other is the Ashanti-Kwahu uplands, with the highest elevation of about 700 m, running from northwest to southeast. They meet, some 80 km from the coast northeast of Accra, at the gap through which flows the Volta river. The plains which spread along the Volta river occupy nearly two-thirds of the land of Ghana. Generally, they consist of swamps, floodplains and gently sloping lowlands, having elevations not over 300 m.

The drainage of Ghana is dominated by the Volta river system. This river runs through several countries, and it drains an area of 400,000 km^2, of which 160,000 km^2 lies within the territory of Ghana. There are a number of rivers and streams in the southern part of the country, but most of them are seasonal.

Ghana is situated in the tropical zone, and its climate is largely influenced by two air masses. One of them is the northeast trades or the Harmattan, hot and dry winds blowing from the Sahara desert, and the other is the monsoon with cool and moist winds blowing from the Gulf of Guinea. The two air masses meet in and around the territory of Ghana throughout the year. As a result, the southern half of the country receives rainfalls of more than 1,500 mm a year on an average, while the northern half receives less rainfall ranging from 900 to 1,200 mm a year. The coastal plains are relatively dry, and receive rainfall of less than 1,100 mm a year. Temperature is generally high

and has little variation throughout the year. Annual mean temperature of the whole country ranges from 26° to 29°C.

There are three main types of vegetation in Ghana, i.e., savannah, forest, and coastal scrub and grassland. About two-thirds of the country in the north is open savannah, with vegetation gradually scarcer towards the border with Upper Volta. The coastal scrub and grassland form a narrow strip along the coast, widening toward the Togo border. The dense rain forest covers the southern third except the strip of the coastal grassland.

According to the 1970 census, the population of Ghana is about 8.6 million, and the density of population is about 36 per km^2. Ghana is not densely populated at present. However, the population is increasing at a rate of 2.7 % per annum. The estimated population in 1975 is about 9.8 million.

About two-thirds of the population live in the southern regions, which are the centre of all the economic activities of Ghana. The northern part of Ghana is sparsely populated, mainly due to river blindness, but Tamale is a secondary centre of economic activities being located in the north. The population density in and around Accra, the capital of Ghana, is about 1,500 per km^2, and the population in the Accra-Tema metropolitan area is growing at a rate of 5.6 % per annum.

2.2 General Economic and Agricultural Situations

The economy of Ghana has experienced intermittent stagnations and declines. The Gross Domestic Products (GDP) grew at an average rate of only 2.5 % per annum over the decade of the 1960's, as against the annual population growth of 2.7 %. The rate of the GDP growth has been behind the fast growing population increase, and the real per capita income appears to have become lower.

The mainstay of the Ghanaian economy is agriculture. About 60 % of the population is engaged in agriculture and the contribution of this sector to the Gross Domestic Products (GDP) has been estimated

to be about 40 %, which is far greater than any other branch of the economic activities in Ghana. The agricultural land in Ghana is approximately 2.6 million ha that occupies about 11 % of the total land. The average size of cropped area per farming family is estimated at about 3.2 ha.

Ghana is the world largest exporter of cocoa. Cocoa is widely grown in the southern forest areas. In 1973, Ghana produced about 353,000 tons of cocoa or about 26 % of the world cocoa production. The agricultural products such as hardwoods, palm oil and kernels, cassava, maize, etc. form other major commodities in Ghana.

The mining sector ranks second to agriculture in terms of its contribution to the national economy. Mineral resources are mainly found in the southwestern areas. Mineral products of economic importance at present are gold, diamond, manganese and bauxite. The total production of gold in 1973 amounted to 729,000 ounces. The productions of diamond, manganese and bauxite in 1973 were 2.3 million carats, 313,000 tons and 349,000 tons, respectively.

In the external trade, manufactured goods and foodstuffs make up about 80 % of the imports, and almost all of the exports are occupied by such primary products as cocoa, timber and minerals. In 1973, Ghana exported about 368,000 tons of cocoa valued at about US$345 million equivalent, accounting for about 55 % of the total export earnings. As to mineral products, their total export value was about US$121 million equivalent which corresponded to about 20 % of the total value of exports in 1973. Besides, the timber products amounted to US$113 million equivalent or about 19 % of the total export value. On the other hand, the imports of the manufactured goods amounted to about US$281 million equivalent corresponding to about 61 % of the total value of imports in 1973. The imported foods amounted to about US$103 million equivalent or about 21 % of the total value of the Ghana's imports in 1973.

In recognition of the structural unbalance and weakness in the monocultural economy, the Government made an entirely new focus of

development policy in which the principle of Self-Reliance was established as its cornerstone and launched the Operation Feed Yourself Campaign in 1972, aiming at the increase of food production for internal consumption and possibly for export as well as of the production of industrial raw materials particularly for the agro-based industries. With this new policy, the Government intends to diversify the country's agricultural activities with a view to taking off from the cocoa monocultural economy as well as to satisfy the nation's demand for other agricultural products which the country has been importing.

Sugar is by far important item among the imported agricultural products. Ghana has imported about 80 % of the total national requirement of sugar annually. In 1973, the foreign exchange spent on the imported sugar amounted to about US$18 million equivalent, and the burden on the national economy caused by this sugar import has sharply increased as a result of recent world sugar crises. Under such circumstances and in view of the anticipated continuation of high international sugar price in the coming future, the Government seriously wishes to increase the domestic sugar production.

2.3 Present Status of Sugar Industry

2.3.1 Present sugar production

Ghana has two sugar complexes at Asutsuare and Komenda. The sugar factory at Asutsuare was put into operation in 1966. It has a rated capacity of 30,000 tons of sugar per annum, and is provided with a double sulphitation system for producing plantation white sugar. It is scheduled to be further equipped with an adequate size of refinery plant in the near future. The factory is fed by the estate of 1,400 ha and the outgrower's land of 2,200 ha. The sugar plant at Komenda started operation in 1967. It has half the capacity of the Asutsuare plant; 15,000 tons of sugar per annum. It is also equipped with a double sulphitation process, and has no refinery. The Komenda factory is supplied cane from the estate of 960 ha and the outgrower's field of 1,120 ha. Generally, sugar cane is grown under rain-fed condition with little farm requisite.

The production of sugar by the existing two factories in the recent years amounted to:

Year	Asutsuare (tons)	Komenda (tons)	Total (tons)
1971/72	2,000	3,500	5,500
1972/73	3,200	3,500	6,700
1973/74	3,600	4,300	7,900
1974/75	5,000	6,300	11,300

Source: Ghana Sugar Estates Limited

The present sugar production is far behind the installed capacity of both the factories (45,000 tons of sugar per annum). The major constraints which keeps the sugar production at low level are (1) low average cane yields: Asutsuare; 28 tons/ha, Komenda; 45 tons/ha on an average, (2) insufficient acreage of the cane field, (3) inadequate transportation to the factory, (4) insufficient labour supply for harvesting operations, and (5) inadequate maintenance of the factory.

To ensure the maximum productivity of both sugar factories, a 5-year rehabilitation programme was started in late 1972 with the financial assistance of the International Development Association (IDA)/1. It is anticipated that, with the success of this rehabilitation programme, the sugar production by the two factories will gradually increase and reach their maximum production capacity of 45,000 tons per annum by the end of 1978.

2.3.2 Needs for a new sugar project

The Institute of Statistical, Social and Economic Research of the University of Ghana made a study/2 on actual sugar consumption in Ghana based on a sampling survey and concluded that Ghana consumed about 93,600 tons of white sugar in 1970. The estimated sugar consumption consists of: (1) 52,600 tons for domestic use, (2) 23,000 tons for industrial uses producing sweets, drinks and drugs, and (3) 18,200 tons for local

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/1: World Bank Report; Appraisal of the Sugar Rehabilitation Project, Ghana, 1972

/2: University of Ghana, Technical Publication Series No.21, Structure and Prospects of the Sugar Industry in Ghana, 1972 Vol. 1, pp 18-35

spirit distilling. The domestic consumption of 52,600 tons which corresponds to per capita consumption of 5.91 kg or two spoonful of sugar per day, is not considered large and is anticipated to increase still further.

According to the satistical data adjusted by H.V.A[/1], the per capita consumption of sugar in Ghana over the past years was as follows:

Year	Population (millions)	Consumption	
		Total (tons)	Per capita (kg)
1955	5.85	31,000	5.30
1960	6.80	60,000	8.80
1965	7.75	63,900	8.25
1970	8.90	93,800	10.54

As mentioned in Chapter 2.3.1, the present level of sugar production is about 11,000 tons per annum. In order to meet the domestic demand for sugar, Ghana has been importing a large quantity of sugar as shown below[/2]:

Year	Population (millions)	Import of sugar	
		Total (tons)	Per capita (kg)
1955	5.85	31,430	5.35
1960	6.80	62,130	9.15
1965	7.75	61,180	8.00
1970	8.90	141,585	15.90

The future production of sugar by the existing sugar factories in Ghana is anticipated to gradually increase and will amount to:

Year	Population* (millions)	Production	
		Total** (tons)	Per capita (kg)
1975	9.82	30,000	3.05
1980	11.23	45,000	4.01
1985	12.82	45,000	3.51

* projected on the assumption that the population growth rate is 2.7 % per annum

** Source: Ghana Sugar Estate Limited

/1: H.V.A. International B.V., Memorandum with reference to a third cane sugar project in Ghana, June 1973, p.2.

/2: The details are given in Table 2.1.

Comparison of these figures clearly demonstrates that Ghana will have to continue the import of sugar to meet the local demand even if the per capita consumption would remain unchanged at the 1970 level of 10.54 kg.

Based on the past sugar consumption mentioned above, the Institute of Statistical, Social and Economic Research of the University of Ghana[/1] made detailed projections of latent demand for sugar in Ghana for the years of 1975, 1980 and 1985, taking into account the price elasticity, income elasticity, distribution of income, increases in population and income. The results of the studies are summarized as follows:

	Total (tons)		Per capita (kg)	
Year	Maximum	Minimum	Maximum	Minimum
(1) Domestic use				
1975	79,600	71,800	8.11	7.31
1980	120,200	94,700	10.70	8.43
1985	178,000	127,200	13.88	9.92
(2) Industrial uses				
1975	33,800	32,300	3.44	3.29
1980	49,700	45,200	4.43	4.02
1985	73,000	63,500	5.69	4.95
(3) Local spirit distilling				
1975	21,100	20,100	2.15	2.05
1980	24,500	22,200	2.18	1.98
1985	28,300	24,500	2.21	1.91
(4) Total				
1975	134,500	124,200	13.70	12.65
1980	194,400	162,100	17.31	14.43
1985	279,300	215,200	21.78	16.78

/1: University of Ghana, Technical Publication Series No.21, Structure and Prospects of the Sugar Industry in Ghana, 1972 Vol. 1, pp 36-47

The import requirements would be approximately:

Year	10.54 kg per capita	Minimum forecast	Maximum forecast
1975	75,000	95,000	105,000
1980	80,000	115,000	145,000
1985	100,000	160,000	230,000

These figures clearly indicate that there is an urgent and pressing need for the country to establish more sugar complexes as well as extension of the existing factories to increase the domestic sugar production. If such sugar projects would be materialized, Ghana could save a considerable amount of foreign exchange.

2.3.3 Priority area for future sugar production

Ghana is divided into three ecologically different areas:

- northern open-savannah area
- central rain-forest area
- coastal scrub and grassland

The northern open-savannah area is characterized by relatively dry climate with a long dry season from November to April. The long dry season is considered suitable for the establishment of cane sugar industry in general, but sugar cane growing in this area obviously requires irrigation practices particularly during the long dry season. The water resources for irrigation in this area are the Oti, White Volta and Black Volta rivers. These rivers convey an abundant volume of water during the rainy season, but virtually no water for irrigation during the dry season. This means that storage dam construction is indispensable for large scale irrigation in this area. Construction of dams on such big rivers calls for a tremendous amount of fund and it would not to be expected in the near future.

The central rain-forest area has relatively wet climate and short dry season which lasts from 3 to 5 months only. The annual average rainfall varies from 1,250 to over 2,000 mm. This area is not generally suitable for a commercial sugar production, because of the short dry season which means the short duration of factory operation.

The country's two major agricultural products, cocoa and timber, are mainly produced in this area. Under the present condition, it is unlikely that the changes in land use in this area are economically justified.

The coastal scrub and grassland has generally long dry season lasting from November to April, being favorable for a commercial sugar cane production. In this area several sugar projects have been conceived so far, including the existing sugar complexes. This area consists of two deferrent areas, i.e., the coastal narrow plains and the Accra plains. The coastal narrow plains where the Komenda factory is located, have very limited possibility of the extension of the sugar industry due to the restricted availability of irrigation water during the dry season. The Accra plains extend east of Accra with the total area of about 3,300 km^2, of which about 1,800 km^2 have been classified as suitable for irrigated agriculture. The lower Volta floodplain extending along the Volta river, is most important among the Accra plains because of its favourable location for pumping the river water. Since the Akosombo dam was completed in 1965, the regulated river flow of about 1,090 m^3/sec is available throughout the year. In 1963, FAO completed detailed surveys of the floodplain and designed 8 rice and sugar cane production schemes, scattered along both sides of the river. Among them the Asutsuare scheme was taken up and it was put into operation in 1966. There are more lands suitable for sugar cane growing south and east of Asutsuare.

In due consideration of these natural conditions in the three different areas, the Ghana Government decided that a new sugar project should be located in the southeastern part of the lower Volta floodplain. The Aveyime Project is located in this high priority area.

2.3.4 Institutional framework for sugar production

In order to unify the various activities regarding sugar industry, the Sugar Industry Board was established in 1973. Its function is to monitor the sugar industry and advise the Government on (1) the price of sugar cane to be paid to the grower, (2) the prices of sugar and its

by-products, (3) extension of the sugar industry including size and location of new factories, (4) the import and export of sugar and the coordination of production and distribution, (5) the protection of the local sugar industry by means of duties, levies, licencing and other necessary measures, (6) the promotion and coordination of research activities on sugar cane growing and processing, (7) the promotion and encouragement of extension services to the sugar cane farmers, and (8) any other matters affecting the sugar industry. The Board is made up of the following personnels:

- Principal Secretary, Ministry of Industries
- Managing Director, Agricultural Development Bank
- Managing Director, Ghana Sugar Estates Limited
- Principal Secretary, Ministry of Agriculture
- National Secretary, Sugar Cane Planters Association
- Principal Commercial Officer, Ministry of Trade
- Senior Budget Officer, Ministry of Finance
- Representative of Crop Research Institute, University of Ghana
- Representative of Institute of Statistical, Social and Economic Research, University of Ghana

The primary objective of the on-going 5-year rehabilitation programme is to increase sugar production up to 45,000 tons which is the full capacity of the existing two factories, by the end of 1978. In order to make this possible, the existing two factories and estates were incorporated into Ghana Sugar Estates Limited (GHASEL), a limited liability company, in 1973, as an executive body of the project. The Government of Ghana has 95 % of shares in GHASEL. H.V.A. International B.V., Amsterdam, has been entrusted with actual day-by-day management of the company. GHASEL has carried out various types of resarch regarding sugar cane growing so as to attain high cane yield. A training programme for the Ghanaian staff is being devised to ensure adequate management and skills in the future years. A substantial portion of sugar cane is supplied by independent sugar cane growers who sell their product to the factories. The sugar cane farmers certified by GHASEL are eligible for obtaining the credit from the Agricultural Development Bank (ADB) and the company's technical assistance. The usual loan condition for the sugar cane farmers is 4 years of maturity

period including the grace period of 6-9 months at the interest rate of 9 % per annum. In the existing two sugar cane areas, about 80 % of the growers are benefited from the bank loan.

CHAPTER III THE PROJECT AREA

3.1 General Condition

The area envisaged under the Aveyime Sugar Production Project (hereinafter refered to as the project area) occupies the northeastern part of the Accra plains and extends over about 9,400 ha of mostly flat land along the lower reaches of the Volta river (see Drawing No. 000-01) This area is administratively one of the six "sub-districts" of the Tongu Local Council with its headquarters at Sogakope, in the Volta Region of Ghana.

The major villages in and around the project area are Aveyime, Battor and Mepe. They are connected each other by a fairly good laterite-paved road, which links to the Accra-Tefle asphalt-paved highway at a point of about 18 km south from Aveyime. Using this road, the distance from Aveyime to Accra is about 120 km. Private buses ply regularly on this road. There are regular ferry services on the Volta river and a certain amount of trading is carried out at places such as Akuse, Aveyime, Adidome, Sogakope and Ada, where roads reach the Volta river. Within the project area, there are many footpaths, but many of them are presently impassable for vehicle.

The total population of the project area is about 13,000, with possibly about an additional 5,000, now living elsewhere, who regard the area as their ancestral land. Generally, the riparian lands are intensively populated, in contrast with the scanty population on most of the interior lands. There are about 1,800 families in the project area. Average size of family consists of 10.2 persons. Almost every family follows more than one occupation. Crop production is the most common and major occupation in the area. More than 90 % of the families are engaged in crop production which is generally carried out in the form of shifting cultivation. The main crops are cassava, groundnut, maize and vegetables. Sugar cane is not grown in the area. Subsidiary occupations are fishing, livestock raising, trading. etc.

The scale of farming is rather small, i.e., the average cropped area per family is about 1.5 ha. The amount of labour needed for the present farming practices is estimated as low as about 200 man-days per annum in total, despite that the average size of family keeps about 2.5 adult men equivalent labour or about 650 man-days per annum. Under the present farming condition in the project area, most of the farmers appear to be in the condition of under-employment in general.

According to a preliminary farm budget resulted from this time's survey, a typical household earns about US$1,140 of disposable income annually, of which about US$820 are allocated for living expenses. Such a living condition of farmers could not be considered favourable.

3.2 Topography

The project area is broadly divided into two areas from topographic point of view. They are herein called the lowland area and upland area.

The lowland area develops along the Volta, and descends gradually from an elevation of 7 to 9 m near the Agbo river to an elevation of about 1.5 m near Tefle. This area has rather complicated relief due to irregular arrangement of flood channels and permanent lagoons. Most of the lowland area had often been inundated because of poor drainage condition of the flood channels and of high water levels of the Volta river during the rainy season. With the completion of the Akosombo dam, however, the area has become free from the damages by floods.

The upland area adjoining the lowland area comprises gently undulating lands with elevations of 9 to 45 m. The slopes of land are less than 3 % on an average. Streams carry water only occasionally.

3.3 Climate

The climate of the project area is equatorial. There are two rainy seasons each year, the major rainy season being from mid-April to the end of June and the second rainy season from mid-September to early November. However, considerable variations occur from year to

year with regards to the time of onset, duration and strength of monthly rainfall becuase the project area is affected by the shiting influence of the northward-blowing equatorial trade winds which carry moisture from the Gulf of Guinea and the tropical rain belts, and the southward-moving winds from the Sahara deserts which are extremely hot and dry. The average annual rainfall at Aveyime, the nearest meteorological station, during the 22-year period (1953-1974) is 949 mm.

Temperature and relative humidity have little variation throughout the year. The mean annual temperature is 27.4°C at Aveyime. The mean maximum and minimum temperatures range between 22.7°C and 32.0°C. The daily range of temperature is seldom more than 3 to 4°C. Relative humidity varies from 74 to 86 %. Average monthly data on rainfall, temperature and humidity at Aveyime are presented in Table 3.1.

3.4 Vegetation

The project area is basically grassland. Lagoon areas near the Volta river are covered with a thick growth of moisture-loving plants and scattered trees. The elongated areas along the Volta are generally bush of fairly high density. The sloping areas which extend behind the lowlands are grassland with scattered trees and clumps, and in the valley bottoms there are swamps and small pools covered with thick clumps.

3.5 Geology

The geological formations within the project boundaries consist mainly of acidic gnesses and shists, with a belt of tertiary red continental deposits in the southeast, and recent unconsolidated clays, sands and gravels along the line of the Volta river and in the valleys of its tributaries. The Volta alluvial tract increases in width from about 3 km at its upstream limit to more than 8 km near Tefle, beyond which begins the old delta of the Volta river.

3.6 Soil Survey and Land Classification

Based on the results of the semi-detailed soil survey carried out by Nippon Koei Co., Ltd. in 1965-66, the remarkable features and capability of soils for agricultural use are summarized as follows:

The soils of the project area are broadly classified into 4 great soil groups, i.e., (1) Acid gleisols, (2) Savannah ochrosols, (3) Tropical grey earth and (4) Regosolic groundwater laterite.

Acid gleisols cover the nearly flat lowland with elevations between 3 and 10 m in general, and they are mostly the imperfectly matured or inmatured fluvial deposits transported by the Volta and its tributaries. These soils extend over 4,140 ha corresponding to about 43.9 % of the project area. They have large effective soil depth composed of various textural surface soils with an average depth of 40 cm overlying fine textured clayey subsoils in general. As for their chemical properties, the soils have weakly acid soil reaction (pH 5.4-6.5), low to moderate cation exchange capacity (7-20 meq/100g) and medium base saturation degree (50-70 %). These soils have moderate to low basic intake rate (I; about 10^{-3}cm/sec) and relatively high water holding capacity (about 12 % by volume) which are fairly favourable for irrigation practices. However, they are not always blessed with drainability because of their topographical conditions and textural features. In view of the land capability, most soils of this group can be graded as 2nd class according to the criteria of U.S. Bureau of Reclamation.

Savannah ochrosols develop on very gently sloping and slightly elevated lowland with elevations ranging from 6 to 20 m. These soils extend over the area of 250 ha or 2.6 % of the project area. They have large effective soil depth composed of loamy sand to loam textured surface soils with an average depth of 25 cm and loam textured subsoils with an average depth of 30 cm overlying very thick sub-stratum of silty clay texture. With regard to their chemical properties, these soils have weak acidity (pH 5.8-6.5), generally low cation exchange capacity (3-10 meq/100g) and moderately high base saturation degree (50-80 %). As for their physical nature and hydrological characteristics, these soils have favourable irrigability and drainability as well as

tillability. Most of these soils are graded as 1st class of the land capability.

Tropical grey earth develops on gently sloping upland with elevations ranging from 6 to 29 m. These soils cover large area of about 4,450 ha or 47.2 % of the project area. They generally have rather large soil depth consisting of sandy textured surface soils with an average depth of 15 cm and clay or loamy clay subsoils with an average depth of more than 80 cm overlying very thick substratum with clayey texture. However, hard clay pan layers are sometimes found in the illuvial horizons at relatively shallow depth (less than 50 cm). As to their chemical properties, these soils have rather weak acidic reaction (pH 5.8-6.8). It is noteworthy that the substrata of these soils often show alkaline reaction (about 8.5 in pH value). The cation exchange capacity of these soils is not high (5-15 meq/100g), whereas the base saturation degree is rather high (70-95 %). These soils have relatively low basic intake rate (I; 10^{-4}cm/sec) and medium water holding capacity (about 8 % by volume). Most of these soils are graded as 3rd class of the land capability classification by U.S. Bureau of Reclamation.

Regosolic groundwater laterites widely cover the gently undulating upland with elevations of more than 12 m. These soils extend over an area of 590 ha, or 6.3 % of the project area. They have rather deep effective solum composed of sandy textured surface soils with an average depth of 30 cm and gravelly clay loam textured subsoils with an average depth of 25 cm overlying loamy textured substratum with depth of more than 80 cm. The soils have almost neutral reaction (pH 6.6-7.5), low cation exchange capacity (6-13 meq/100g) and fairly high base saturation degree (65-92 %). As to their physical nature, these soils have rather high basic intake rate (I; 10^{-2}cm/sec) and low water holding capacity (about 6 % by volume). These soils are graded as 4th class in the land capability classification.

The above-mentioned soil groups are further subdivided into 8 soil series, 14 soil types and 20 soil phases in the lower categories of soil classification. These sub-groups are described in detail in

Annex II. The soil map and land capability classification map are shown in Drawing Nos. 000-02 and 000-03, respectively.

3.7 Present Land Use and Cropping Pattern

Only a minor part of the arable land in the project area is used for crop production. Most of the area are covered with scrub and grasses forming the general landscape known as tropical savannah.

The present land use in the area is summarized as follows. The details are given in Table 3-2. The land use classification map is given in Drawing No. 000-04.

Land categories	Area (ha)	Proportional extent (%)
1. Settlement and associated non-agricultural land	30	0.3
2. Densely cultivated land	150	1.6
3. Variable mixture of cultivation and fallow	1,490	15.8
4. Scrub and grassland	6,250	66.3
5. Forest	1,510	16.0
Total	9,430 ha	100.0 %

Densely cultivated land which occupies only 1.6 % of the project area, is found mainly along the Volta river within 3 km from its bank. A dense forest lies in the northeastern part of the project area. Smaller patches of forests occur further along the small streams. These forest lands occupy about 16 % of the project area. The upland area which extends behind the alluvial tracts is mainly grassland occupying about 66 % of the project area. The remaining area consists mainly of variable mixture of cultivation and fallow.

Shifting cultivation is the most popular type of farming in the project area. Generally, under the shifting cultivation, only one crop of cassava, maize, groundnuts, beans and some vegetables is planted each

year during the major rainy season. After about three years of cropping, the land is usually left fallow for two or three years to regain its soil fertility. Perennial crops such as plantain, papaya and pineapple are grown mainly in the areas near Battor and Mepe. Tree crops such as coconut, kapok, oil palms and mangoes are scattered among the bush. The present cropping calendar of major crops is shown in Fig. 3.1.

The Aveyime pilot farm of 80 ha was established by Nippon Koei and therein experiments were carried out for the cultivation of rice and sugar cane during 1966-67 period. The farm is provided with irrigation system. It was later taken over by the Ministry of Agriculture and about 30 ha of it is presently used for rice cultivation by settlers.

Crops depend upon the rain. There is neither irrigation nor drainage facilities, except for the Aveyime pilot farm. Cultivation is mostly done by hand. The equipment consist of hoes and cutlasses only. No certified seeds are used and the farmers are ignorant about more promising varieties of crops. Chemical fertilizer is not generally used. There is no control of pests, diseases and rodents.

3.8 Agricultural Production

The cultivated area and production of major crops in the area are summarized in the following table, based on the results of this time's land use survey and the interviews with the community representatives of several villages.

Crop	Cultivated area (ha)	Unit yield (ton/ha)	Production (ton)
Cassava	230	6.0	1,380
Maize	150	1.5	240
Groundnuts	100	0.8	80
Rice	30	2.0	60
Vegetables	150	4.8	720
Total	660	-	-

There are additional cropped lands of about 2,100 ha mainly along the river, which are outside the project area. The farmers in and around the project area use also these alluvial tracts for agricultural production.

Most of the food crops are grown principally for self-consumption. The food products used in the greatest quantity are cassava, maize and groundnuts.

The yield of crops is generally low. The main natural constraint which keeps the crop yield at a low level is uneven distribution of the rainfall. The low yield is also attributable to the lack of fertilizer application and plant protection against pests and diseases. The present crop yield could be greatly improved by introducing modern irrigation farming system.

Animal husbandry is insignificant in the area. Only a very limited number of beef cattle is raised mainly on the upland area of undulating open savannah. The principal feed for the cattle is wild grass of low nutritious value.

3.9 Land Distribution and Tenure

Every land belongs to a "family", a group of certain kinship in the project area. There is no chieftain's land, nor does belong to individuals. All members of the "family" have a right to use the land. Land can be leased to outsiders with the approval of the "family head" concerned. The customary rent paid to the land owner is generally low (about US$2-10/ha/year). Most of the farmers in the area use the land for agricultural production. The average size of cultivated area is estimated at about 1.5 ha (3.75 acres) per family.

In view of the public interest, the Government could designate all of such open land for irrigation development and the creation of large commercial farming units.

3.10 Farm Budget of Typical Farm

The agro-economic survey of the present farm income and expenditure of a typical farm was carried out in the project area. Information on the present farm budget was also obtained from the District Agricultural Extension Office at Sogakope. The survey results are summarized as follows.

Description		Amount (US$ equivalent)
(1)	Gross income	
	Farming income	810
	Off-farm income	670
	Total	1,480
(2)	Gross expenditure	
	Farming expenses	280
	Taxes and public imposts	60
	Total	340
(3)	Net farm income, (1) - (2)	1,140
(4)	Living expenses	820
(5)	Net reserve, (3) - (4)	320

A typical farm would have an average annual balance of US$320 equivalent, but there is little evidence of any saving. The balance appears to be spent on the customary ceremony related to marriage, funeral, child birth, etc. The small farm income indicates the nature of subsistence agriculture in the project area.

3.11 Marketing

Aveyime is the largest rural market in the project area. The neighbouring markets of Adidome and Sogakope also serve the people living in the area. The bulk of the farm products is consumed in the village where they are produced and the surplus is disposed of in the above-mentioned markets which are usually held twice a week. The

distance of villages from the nearest market ranges from 1 to 10 km. The marketed volume of the products is estimated at about 30 % of the total production. Through these markets various manufactured goods are brought into the project area. The prices of farm products fluctuate considerably both seasonally and yearly. The current prices of major crop products are shown in Table 3.3.

3.12 Agricultural Support Services

No research institution exists in the project area, except the Aveyime pilot farm where the trial cultivation of irrigated rice has been carried on by the Ministry of Agriculture. The reliable agronomic data on sugar cane cultivation can be obtained mainly from the Agricultural Irrigation Research Station of the University of Ghana at Kpong, about 40 km northwest of Aveyime.

Agricultural extension services are carried out by the Division of General Agriculture in the Ministry of Agriculture. Only 6 extension workers are presently engaged in the services to cover the total area of 130,000 ha under the District Agricultural Extension Office at Sogakope. The major activities of the office are: (a) to advise farmers on improved methods of farming of all crops except cocoa, and (b) to provide farming requisites such as improved seeds and seedlings, fertilizers and insecticides to the farmers. Only a limited number of the farmers, however, are benefited from the services because of the shortage of the extension cadres and the lack of adequate financial support.

The Agricultural Development Bank (ADB) is only the institute to provide credits to the farmers in the project area. The nearest branch office of ADB is located at Somanyo. The farmers utilizing the ADB loan are very few in the project area.

There is no definite farmers cooperative organization in the area, but mutual exchange of family labour for farm operations is being extensively carried out.

CHAPTER IV THE PROJECT

4.1 Development Concept

The area envisaged under the project was selected among the Accra plains in the previous investigation by Nippon Koei, in view of the soil condition and availability of water from the Volta river. It was, at that time, proposed to provide the project area with irrigation facilities for the rice and sugar cane production. Demand for rice was increasing due to expansion of urban population, while domestic production was quite limited. The price of imported sugar was very low. The Asutsuare sugar factory was in operation and another factory was nearly completed at Komenda. Under these circumstances, the establishment of a new sugar factory was proposed only indicatively.

In the pass of eight years from the previous feasibility report, circumstances have changed, though the physical and socio-economic situations in the project area have not much altered except a more drift of young people to Accra, Tema and other urban places.

The domestic production of rice is remarkably increasing, because irrigated rice culture has been promoted in the northern regions in recent years. The shortage in rice is no longer critical. The domestic sugar factories have continued quite a low productivity compared with their capacity The present sugar consumption in Ghana is largely confined by the shortage of supply, as stated in chapter 2.3.2. No sugar could be found in the retail market during our survey in 1975. They say that most sugar is traded in black market at more than three times the official price. The on-going rehabilitation may increase the domestic sugar production in the future, but Ghana will still have to import a large amount of sugar, unless more factories be constructed. More foreign currency must be spent for import of sugar from now on, because the rise in the international sugar price poses that a low price like those before 1972 is no longer expected. It is clear that the rehabilitation of the existing factories should be accelerated and more sugar production projects should be developed.

The contemplated project is the establishment of a new sugar complex with the maximum use of land in the project area. It involves the development of sugar cane farm and sugar factory.

4.1.1 Irrigation development

The construction cost of sugar factory has remarkably increased in recent years. High investment for the construction can only be justified if high production of sugar cane can be assured. Irrigation is obviously required for growing sugar cane in the project area.

The land in the project area is not intensively used at present except for the narrow belt along the Volta river. The land rent is very low. Thus main consideration is made on the soil condition and topography in selection of irrigable area.

Sugar cane prefers fertile, deep and permeable soils. Most lowland is occupied by acid gleisols, which are fertile having thick effective depth. Poor drainage stimulating from fine texture is the constraint for cultivation on acid gleisols, but it can be improved by providing adequate surface drainage channels. Tropical grey earth is predominant on the upland area. It is well drained but it has less fertile and shallower surface soils compared with acid gleisols. Adequate fertilization and deep plowing will be requisite for high productivity on tropical grey earth. Acid gleisols and tropical grey earth together covering 80% of the project area are proposed for sugar cane growing.

Irrigation water for the project will be entirely pumped up from the Volta river. Irrigation of higher land involves higher cost of pump facilities. On the other hand, part of low-lying land may be inundated by the Volta river when a large flood would occur. With these considerations, the irrigation area was selected between 3 m and 20 m in elevation.

The gross irrigable area based on the above-mentioned criteria is 9,400 ha. Deducting 20 % of the area for the canals, roads and buildings, the net irrigable area is estimated to be 7,500 ha.

4.1.2 Introduction of mechanized farming

All the steps of farming should be systematically arranged and be effectively carried out for sustaining a high yield of sugar cane. This requirement must mean tremendous number of labourers, if hand labour is sticked to as the main force. The introduction of mechanized farming to the maximum extent is proposed, in view that the project area is sparsely populated.

4.1.3 Introduction of settlers

In the "Guideline for the Five-Year Development Plan (1975-80)", clear recognition is made of need for improving the income and conditions for living in the rural areas to reduce the drift of the population to urban centres. It states that the Government is anxious to ensure that the development of industrial crops is not left only to the large-scale estate farms and that as many small farmers as possible are involved in the exercise as a means of increasing the incomes of the rural people.

The Government has recently raised the price of sugar cane from ¢10/ton to ¢20/ton to encourage outgrowers of existing sugar complexes. As will be explained in Chapter VIII, the project can bare the cost of ¢20/ton and sugar cane growing at this price in the project area will yield farming income much more than the cultivation of other crop.

A failure in material supply may spoil the feasibility of the whole project, once a factory is constructed. In this sence, it is desirable that a certain area of farms be undividedly managed by a single body which is responsible to the operation of factory.

In consideration of the above-mentioned conditions, it is proposed that the farms developed in the initial half of construction be operated as an estate farm and another half be appropriated to farmers as the settlement farms.

4.1.4 Refined sugar production

The taste of Ghanaian people is largely inclined to the refined sugar. It is planned that refining section will be installed in the Asutsuare sugar factory in the near future.

Under these circumstances, the proposed factory configulation will produce refined granulated sugar packed in a polyethylene laminated paper bag of 50 or 100 kg each.

The cube sugar manufacturing process is not annexed in the proposed sugar factory, though the consumption of cube sugar is high at the moment in Ghana. This proposal is made for the purpose of saving the initial investment cost. For instance, a cube sugar plant processing 1 ton/hour requires a construction cost of about US$350,000.

4.2 Plan of Sugar Cane Production

The plan of sugar cane farming for the project is proposed and the production is estimated hereunder. More detailed explanation on these aspects is given in Annex III.

4.2.1 Crop variety

Based on the investigation carried out by the Agricultural Research Station (ARS) at Kpong and by the Asutsuare sugar factory, some varieties of sugar cane were tested by Nippon Kopi at Aveyime in 1965-66. Among them, B41227, B34104, PR980 and POJ2878 showed an yield ranging between 84 tons/ha and 103 tons/ha with available standard sugar of 14.3 - 15.1 %. These varieties will be employed in the initial stage of the project.

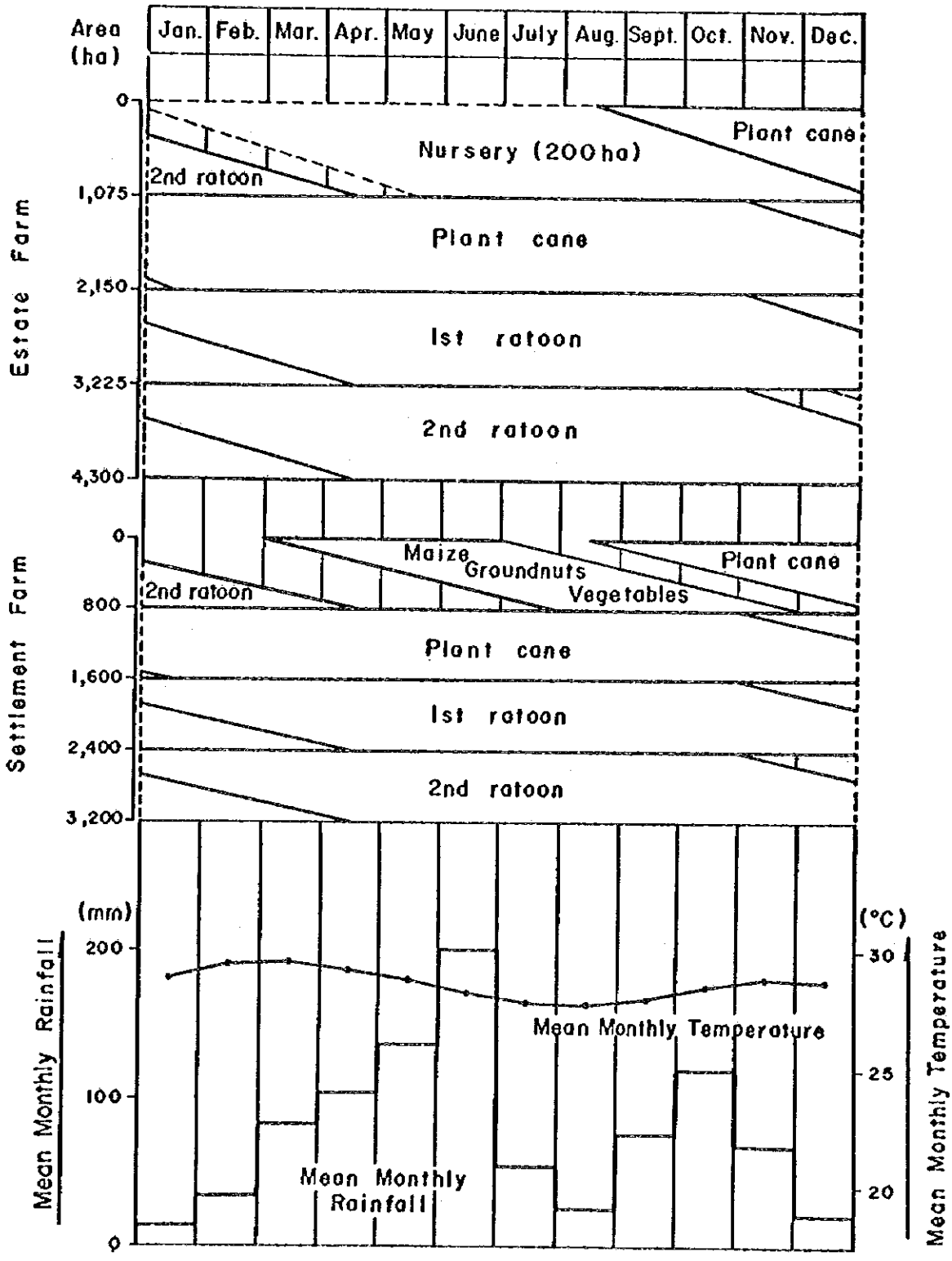
4.2.2 Cropping pattern

The sugar cane is harvested in the dry season, in which the sucrose content shows the maximum. The harvesting period is set in the major dry season from early November to mid-April. The optimum growing period of the varieties proposed in chapter 4.2.1 is 14-16 months. Therefore, the planting period is from mid-August to mid-January.

Ratooning is the technique normally employed to save the soil preparation in the sugar cane farming. The crop yield, however, declines as the ratoon crop is repeated. The number of ratoons involved in a crop rotation is determined depending on the balance of increments of farming cost and yield. The crop is maintained for more than five years in the existing sugar cane farms at Asutsuare and Komenda, i.e., the ratoon is repeated three times or more under the rainfed condition. A rotation pattern of four years comprising a plant crop, two ratoons and one-year fallow is recommended for the project, based on a economic comparison of several alternatives.

The proposed sugar cane field consists of 4,300 ha of estate farm managed by the government organization and 3,200 ha of the settlement farm collectively managed by the local farmers. In the 4-year rotative cropping, only 75% of the total cane area will carry a crop annually. The remaining 25% of the land will partly be used as a nursery on the estate farm and for the cultivation of some short-term cash crops on the settlement farm.

PROPOSED CROPPING PATTERN



4.2.3 Farming practices and mechanization

The proposed cropping pattern requires proper farming practices throughout the year together with efficient water management. It is planned that all the farming practices will be mechanized in order to meet the systematic work-flow from soil preparation to harvest-to-mill process. The mechanized work schedule is illustrated on Fig. 4-1. Brief description regarding the mechanized farm operations is as follows:

- Preparation of seed cane: There will be two types of nursery. One will be pure-line reserved nursery which will be established with an area of 30 ha (see Chapter 4.2.6). On this nursery, the strains of the excellent varieties selected will be carefully maintained under the control of sugar cane agronomist. The other is ordinary nursery on which the seeds maintained on the pure-line reserve farm are planted for multiplication. A part of the fallow land in the estate farm will be used as the ordinary nursery.

- Sub-soiling: The cane field will be sub-soiled immediately after harvesting of second ratoon crop for improving the drainability of subsoils, which would have been compacted by heavy tractor operations. The 140 PS class crawler type tractor will be employed for this operation.

- Ploughing and harrowing: After sub-soiling, the cane field will be ploughed up to 40-50 cm and harrowed as thoroughly as possible to break down clods remaining on the field. The 80 PS class wheel type tractors will be used for these operations.

- Furrowing and ditching: Furrows of 150-cm in width will then be prepared by using 3-row ridger attached to the 80 PS class wheel type tractor. After making furrows, several ditches will be made on the furrows by hand to ensure the perfect distribution of irrigation water.

- Pre-treatment of seed cane: The seed cane will be sterilized with agri-chemicals prior to the planting. The fungi are thereby prevented, and the treatment also has the advantage of quick and regular sprouting.

- Planting and basic fertilizer application: The cutter-planter will be used for planting. This machine can be accurately adjusted for varying depths of furrow, amount of cover, length of seed cane and spacing in the row. The basal fertilizer will be applied at the same time from an attachment of the planter.

- Gap-filling: The gap-filling will be carried out two weeks after planting by hand. The expected germination rate is 90 % on an average.

- Weeding: Eradication of weed will be delayed until the cane shoots are clearly visible so that young cane will not be injured in the process of weeding. The operation of weeding will be done with spring tooth cultivator to be drawn by the 60 PS class type tractor.

- Plant protection: First application of insecticide (Fenitrothion) will be carried out soon after weeding, and the second application will be 1.5 month later. Swath sprayer attached to the 60 PS class high clearance type tractor will be employed for this operation.

- Top dressing: Only nitrogeneous fertilizer will be additionally applied two times within 3 months after planting, by using fertilizer distributor. The 60 PS class tractor with high clearance will be used for the top dressing.

- Earthing: Earthing will be carried out immediately after the top dressing. Disc type cultivator will be employed for the earthing.

- Pre-harvest burning and harvesting: Harvesting is also mechanized. The self-propelled chopper type harvester is recommended for cane harvesting in the project area. For the purpose to ensure the smooth harvesting, the cane field will be burned prior to the harvesting. The harvester simultaneously cuts the top and bottom of the cane stalks. The cane harvested is lifted by the elevator attached and cut into pieces of 30 cm in length. These chopped stalks are loaded onto the trailer-truck running aside the harvester.

The lodged cane, which is estimated to be less than 20 % of the whole quantity of cane to be harvested, cannot be properly harvested by the mechanical power. They will be harvested and bound into bundles of each about 30 kg by man-power, and will be loaded onto the trailer-truck by the grab-loader.

- Hauling: The cane thus harvested will be transported to the factory by the trailer-truck. The average hauling distance is 13 km.

- Ratooning: Before ratoon cultivation starts, the discarded stalks and the top of cane will be collected and taken out of the field to avoid disturbance to the subsequent works. After clearing of the field, the cane field will be off-barred by a cultivator as close as possible along the rows, and the bank will be opened up to help stubbles sprout easily; then most of old roots are cut off and the soil is well-aerated to give the buds in the lower soil layer an opportunity to sprout.

  All the cane above the ground should be harvested, but "high-cutting" of stalks is often observed with the harvesters. New shoots that emerge from the buds on the old stumps are always weak and usually are shaded out by more vigorous shoots that emerge from the buds lower in the soils. This results in lost growing time, but can be prevented by using mechanical stubble shaver. Fertilizer can be applied at the same time from an attachment of the stubble shaver.

  The second fertilizing and earthing will be done one month after the opening of banks. As the ratoons grow up early in ratoon fields, the times of the second fertilizing, earthing up and banking should be decided according to the growth of the stalks.

The selection of type of machinery is made upon due consideration of the climatic and soil conditions of the project area. Table 4-1 shows the proposed types of machinery for each farm operations. The required number of farm machinery is shown in Table 4-2. In order to make these mechanized farming practices possible, large farm plotting with a unit area of 4 ha (400 m x 100 m) will be realized in the project area.

At the initial stage of operation, all the machinery will belong to the estate farm and the farmers (settlers) will be trained in various fields of the mechanized sugar cane cultivation on the estate farm, using "learn-by-doing" technique. The cultivation of sugar cane on the settlement area will be carried out by the farmers themselves with the technical assistance of the estate farm.

Although the farm operation will be mechanized as much as possible, the proposed farming will still require much labour force. The labour requirement for the entire cane field of 7,500 ha is estimated at about 1,950 adult-men equivalent on an average as shown in Table 4-3, whereas total available labour force in the project area is estimated at about 4,500 adult-men equivalent. This means that almost half of the present working population will be engaged in the sugar cane production.

4.2.4 Farm input

The soils in the project area are fertile to a certain extent. In order to sustain high yield of sugar cane, however, it will be essential to apply the basic elements of fertilizers, especially nitrogen and phosphate, in large quantities. The fertilizers requirements are estimated on the basis of results of fertilizer trials carried out by Nippon Koei at the Aveyime pilot farm in 1965-66, and are summarized as follows:

Fertilizers	Plant cane (kg/ha)	Ratoon cane (kg/ha)	Fallow crops (kg/ha)
Nitrogen (N)	80	70	50
Phosphate (P_2O_5)	80	75	25
Potasium (K_2)	20	15	25

The factory waste such as filter cake, bagasse ash, etc. may also be used as fertilizers. It is recommended that, before large scale application of fertilizers is begun, trials should be made of the effects of fertilizers on different type of soils in the project area.

In the experimental plots at the Aveyime pilot farm, damages by pests and diseases were negligible. Only some damages by termites were observed on crops planted on newly reclaimed land, probably due to old tree roots left in the soil. Application of Aldrin emulsion put an end to the

trouble. The damages caused by pests and diseases may increase with the introduction of large scale sugar cane cultivation by the project. In this case, it will be necessary to use adequate amount of pesticides and fungicides. Under the present state of cropping, serious damages by rodents are extensively observed in the area. Rodenticide (Zinc phosphide) will be used to prevent the crop from this cause.

A successful plantation primarily depends on the availability of strong, healthy and freely sprouting seed cane. To ensure the success, a pure-line reserved nursery will be established as proposed in Chapter 4.2.6, and the seed cane therein produced will be multiplied on the fallow area in the ordinary cane fields.

The details of the farm inputs required are given in Table 4-4. The requirements of farm inputs will be confirmed through the field trials and experiments to be made at the pilot farm.

4.2.5 Anticipated yield and production programme

There are several sugar cane cultivation trials in the Accra Plains. Average yields of sugar cane and sugar observed on these trials are summarized in Table 4-5. From the results of these trials on the fields, it is estimated that the yield as an average of plant crop, first ratoon and second ratoon is 80 tons of sugar cane per ha per crop. The cane yield will gradually increase proportionately to the increase of land productivity and the improvement of farming techniques. With this view, the anticipated yield and production of sugar cane during the build-up period are estimated as summarized below:

Year	Cane area harvested (ha)	Unit yield (ton/ha)	Cane production (1,000 tons)
1976/77-1979/80	(Design and Construction)		
1980/81	1,450	72.0	104.4
1981/82	3,100	68.3	211.6
1982/83	5,200	65.0	338.0
1983/84	5,460	63.5	346.5
1984/85	5,625	68.0	382.4
1985/86	5,550	74.2	411.6
1986/87 and after	5,625	80.0	450.0

These estimated rates are contingent upon a continuous research work and the cane cultivation by experienced growers under efficient management. The detailed sugar cane production programme is given in Table 4-6.

4.2.6 Pilot farm

The provision of a pilot farm well equipped and staffed, working in close co-ordination with the management of the estate farm, is one of the essential conditions for the success of the project. The proposed pilot farm will be established at a part of the existing pilot farm/1 at Aveyime. The proposed size of the pilot farm is about 50 ha.

The proposed works to be carried out in the pilot farm will be (1) research on mechanized irrigation farming of sugar cane, (2) training of the technical staff and leading farmers in various fields of mechanized sugar cane cultivation, and (3) multiplication of the improved seed cane.

The research work will cover all aspects of growing of sugar cane, including testing of existing and new varieties, ratooning trials, application of fertilizers, control of pests and diseases, methods of mechanized sugar cane farming and effective water management. Particular emphasis will be laid on the testing of new varieties.

The large scale mechanized sugar cane cultivation under the irrigated condition is not familiar for the local farmers as well as the technical staff in Ghana. The staff and leading farmers (settlers) will be intensively trained for mastering the mechanized sugar cane farming by means of the "learn by doing" technique.

The project area covering 7,500 ha will annually require about 11,000 tons of strong and healthy seed cane for planting. The pilot farm, functioning as a pure-line reserve farm, will produce adequate amount of seed cane which will thereafter be multiplied on the nurseries of ordinary farm. The area proposed for the pure-line reserve farm is 30 ha.

/1: The Aveyime pilot farm was originally established by Nippon Koei Co., Ltd. in 1965 with an area of 80 ha. The Aveyime farm is now being used as a rice demonstration farm. The area under the cultivation of rice is about 30 ha. The remaining land of 50 ha is not presently used for any purpose.

For the successful operation of the pilot farm, the technical assistance by foreign experts is essential for the initial stage of operation. The key staff required are sugar cane agronomists, irrigation engineers and farm machinery experts.

4.3 Infrastructures

4.3.1 General

The proposed infrastructures for the production of sugar cane are described hereunder. The major facilities to be constructed under the project are the irrigation facilities, drainage facilities, road system and buildings. The plan and preliminary design of them are presented hereunder. The transmission and distribution lines of electricity and settlers' houses will not be the project facilities, but they are necessary for the operation of the project. Some comments are also made on these facilities.

The general layout of the project facilities is shown in Drawing No. 000-01.

4.3.2 Irrigation facilities

(1) Irrigation water source

The streams running in the project area are not suitable for the irrigation use because they are often dried up, especially for a long time in the dry season. The Volta river, carrying 1,090 m^3/sec of perennial flow, only can be sighted as the source of irrigation water. The proposed irrigable area is located in the elevations between 3 m and 20 m, while the Volta river normally keeps its water level at the elevations from 0.6 m and 0.8 m beside the project area. The pump irrigation is inevitable.

(2) Irrigation blocks

Due to the inundation and consequent sediment of the Volta river, the lowland in the project area is dissected by west-east-running streams and lagoons. The irrigation areas therein proposed are accordingly divided into four blocks (Block 1 to 4) by streams and lagoons. Each block is supplied by an isolated irrigation system. On the other hand, the irrigation area in the upland area will be supplied by a single irrigation

system but it is, for convenience, divided into three blocks (Blocks 5 to 7) by the low ridge of regosolic groundwater laterite, between the Bla and Keli lagoons, and the Taliba river. The irrigation water is directly lifted from the Volta river for Blocks 1, 3 and 4. For the other blocks, water is once pumped from the Volta river into the Bla lagoon and lifted further. The gross and net irrigation area of each block are as follows:

Block No.	Gross Irrigation Area (ha)	Net Irrigation Area (ha)
1 (Estate farm)	500	400
2 (Estate farm)	820	650
3 (Estate farm)	810	650
4 (Estate farm)	750	600
5 (Estate farm)	2,500	2,000
6 (Settlement farm)	1,920	1,500
7 (Settlement farm)	2,100	1,700
Total	9,400	7,500

(3) Irrigation water requirement

The assumptions and results of estimate of irrigation water requirement are summarized hereunder. Details are presented in Annex IV. The amount of evapo-transpiration needed for the sound growth of a crop is called the consumptive use, which is usually assumed as the product of a parameter representing the meteorological condition and a factor determined by the kind of crop. In this report, the standard pan evaporation in the project area is regarded as representing the meteorological condition. The seasonal crop coefficient for sugar cane is estimated based on experiment results in Taiwan and Hawaii and those used for the other proposed crops are Hargreaves' seasonal crop factors.

Little rain can not wet the effective root zone and excessive rain is lost as surface flow. Therefore only a part of rainfall contributes to the soil moisture. Such part of rain is called effective rainfall. The effective rainfall was estimated based on the monthly rainfall record at Aveyime. The net irrigation requirement is the consumptive use less effective rainfall. It is the net amount of water to be applied from outside on every spot of a farm.

There is a certain loss in applying water to a farm plot. It consists of the spill to the outside of the farm and deep percolation unavoidable in maintaining the soil moisture at a required level. This loss is considered in the application efficiency which is assumed to be 65 % for the lowland area and 50 % for the upland area, respectively.

The water loss due to percolation, evaporation and spillout between the intake and farm gate is called the conveyance loss. The main and secondary canals in the lowland area are designed as the earth canals while those in the upland area are concrete-block-lined taking into account the soils and canal length as will be explained later. The loss in the main and secondary canals in both the lowland and upland areas are assumed to be 10 %; that means the main and secondary canal efficiency is 90%. The distribution canal branching off either the main or secondary canal also shows a water loss. This loss is assumed to be 10 % or the distribution efficiency is 90 %.

The product of application efficiency, main canal efficiency and distribution efficiency is herein called the project efficiency. The net farm irrigation requirement being divided by the project efficiency is the diversion requirement which is the water quantity to be taken in at the headworks.

The dimensions of irrigation facilities are determined by the maximum water requirement. The energy required for pumping water is, on the other hand, determined by the annual average water requirement.

The diversion requirement estimated for the proposed cropping pattern is as follows:

	Diversion Requirement (l/sec/ha)		
	Estate Farm (Lowland)	Estate Farm (Upland)	Settlement Farm (Upland)
Maximum	0.86	1.11	1.17
Average	0.39	0.51	0.52

Based on the maximum diversion water requirements obtained above, the design water requirement in each irrigation block is calculated as follows:

Irrigation blocks	Net irrigation area (ha)	Design water requirement (m^3/sec)
Lowland		
1 (Estate farm)	400	0.34
2 (Estate farm)	650	0.56
3 (Estate farm)	650	0.56
4 (Estate farm)	600	0.52
Upland		
5 (Estate farm)	2,000	2.22
6 (Settlement farm)	1,500	1.76
7 (Settlement farm)	1,700	1.99
Total	7,500	7.95

(4) Pumping stations

The criteria employed in the design of pumping station are summarized hereunder. Every pumping station is provided with a farm pond at the delivery end, assuming 24-hour pumping at the time of peak irrigation requirement. Each pumping station is installed with regular pumps and a stand-by pump. The number of pumps is determined based on the variation of irrigation requirement and economic considerations. The principal features of the proposed pumping stations are listed in Table 4-7. The design of pumping station are shown in Drawings No. 200-01, -02 and -03.

No. 1 pumping station will be constructed just upstream of the existing pumping station for the Aveyime pilot farm to lift water from the Volta river to the Bla lagoon through a headrace. The site for this station is shifted 900 m upstream from the original site, because the landscape at present indicates that the new site is more stable against the side erosion than the previously proposed.

No. 2 pumping station will be constructed at the upstream end of the Bla lagoon which would be dammed up by No. 1 gate as will be explained later. This station will supply Blocks 5, 6 and 7 which will be all located in the upland area.

No. 3 pumping station will supply Block 1 being located near Battor. No. 4 pumping station will take water from the elevated Bla lagoon to feed Block 2. No. 5 pumping station will be the booster station being located in the middle of Block 2.

No.6 pumping station will be located in a deep channel connected with the Volta river at a distance of 1 km near Zawtiro and it will supply Block 3.

No.7 pumping station will be located at the eastern end of the project area. It will take water from the Volta river and divert it to Block 4. No.8 pumping station is the booster station in Block 4.

(5) No.1 gate

The Bla lagoon is located to the south of the Aveyime pilot farm. It collects water from the Lota river and drains to the Aklamadow lagoon through a small channel which passes between the pilot farm and the proposed sugar factory site.

It is planned to utilize the Bla lagoon as a suction pond of No.2 and No.4 pumping stations and No.9 pumping station which is for the sugar factory use. For this purpose, it is necessary to fix the minimum operation level of the Bla lagoon at El.3.5 m. The maximum operation level is determined at El.4 m. Consequently, an active storage capacity of about 200,000 m^3 corresponding to 8.5-hour operation of No.1 pumping station is provided for the adjustment of pumped discharge.

No.1 gate will be installed across the channel between the Bla and Aklamadow lagoons to maintain the above-mentioned operation levels. It will have four electric-driven steel gates with a height of 2 m and a width of 5 m, which are capable of 72 m^3/sec, a peak discharge estimated to occur in the Lota river at a recurrence interval of 10 years.

Drawing No.500-01 shows the design of the No.1 gate.

(6) Irrigation canals

In principle the main canal conveies water which is delivered by pump through the highest ground in an irrigation block. It normally passes on a ridge of traverses on a slope. Where the relief in the block is required, a secondary canal branches off from the main canal. The gradient of these canals is designed to be 1/3,000 - 1/4,000. Cross regulators are installed in the main and secondary canals to maintain the water surface in these canals high enough to divert water to the distribution canals for varied

discharge conditions. The distribution canal is constructed with a slope of 1/500 - 1/1,000 to distribute water from the main or secondary canal to the field ditches through turnouts.

The canals in the lowland area are designed as earth canal, because of low permeability of soils. B5, B6 and B7 main canals and their related secondary canals are, on the other hand, proposed to be concrete-block-lined, in view of pervious soils and length of canals. The length, commanding area and design discharge of each canal are summarized in Table 4-8. The design of canals and their related structures is shown in Drawing Nos. 100-01 - 100-11 and 400-01 - 400-08.

(7) Farm pond

The watering on the field is carried out in 18 hours a day, while the capacity of pumping station is determined assuming a 24-hour operation for the peak irrigation requirement for economy. A farm pond is provided at the delivery end of every pumping station with a capacity of 6-hour full operation, except No. 2 pumping station. This farm pond can simplify the water management and it minimizes the electricity consumption.

No. 2 pumping station is connected with a large canal system involving B5, B6 and B7 main canals. The distance between the delivery end of the pumping station and the furthest end of B7 canal is 30 km. This means a time lag of about 13 hours that unables 18-hour watering. By this reason, a regulating pond just enough for the pump operation is constructed at the delivery end of No. 2 pumping station and a farm pond for the 6-hour storage is provided at the head of every distribution canal.

4.3.3 Drainage facilities

(1) Provision against the Volta flood

Agencies investigated the lower Volta floodplain have recommended a design flood of 200,000 cusecs (5,660 m^3/sec) in the Volta river, expecting the flood control effect of the Akosombo dam. The previous design of the project was made based on these recommendations. This design flood is taken up also in the present design.

According to the "Ghana Power Study" by Kaiser Engineers International Inc. in 1971, the regulated discharge of 5,660 m^3/sec would have a return

period of 30 years. It is presumed that this return period can be elongated if a flood forecasting system would be introduced. Anyhow the return period of 30 years is long enough for the design of an agricultural project.

It is estimated that the discharge of 5,660 m^3/sec corresponds to a water surface El. 3.5 m at the shore of the project area. The irrigable area is, as a rule, located above this level and the pumping stations proposed on the Volta are designed to be safe against this flood.

(2) No. 2 gate

The Ke and Keli lagoons are located in a depression at the center of the project area. This depression connects with the Volta river through a narrow channel passing between the proposed No. 2 and 3 blocks. To use the land as much as possible in this depression, a gate is proposed on the above-mentioned channel. It is herein named No. 2 gate and is installed with two numbers of slide gate with a height of 2.5 m and the width of 3 m as shown in Drawing No. 500-02. This gate will normally drain the depression and it will be closed when a large flood would occur in the Volta river. During the closure of the gate, the depression will be drained to the Angaw creek.

(3) Safety against tributary flood

The Ayisa, Taliba, Wuonyi and other rivers flow into the depression of the Ke and Keli lagoons. This depression is drained to the Volta river through a narrow channel on which No. 2 gate is proposed and the Angaw creek. The discharge capacity of these two channels is too small compared with the watershed area of 144 km^2.

It would be a primary importance to develop the depression, if rice cultivation would be involved. In the previous report, the construction of retention dams on the Ayisa, Taliba and Wuonyi river was proposed. For the sugar cane growing as presently proposed, it is more necessary to protect the land from flooding than in the case of rice cultivation. The cheapest compromise would be utilization of land above the water surface which is expected in case of a heavy rainfall, while saving the costly dam construction.

The catchment area of the Volta river is about 400,000 km^2 and the Volta lake surface is very large. It is not expected that a 30-year storm rain would occur in the project area concurrently with a 30-year flood in the Volta river. A study was made assuming a 10-year probable 24-hour rainfall in the project area with No. 2 gate closed due to 30-year flood in the Volta river as described in Annex IV. The volume of flood coming into the depression is estimated to be 14 million m^3, which can be stored in the depression below El. 3m. Therefore, the boundary of irrigable area in the depression is determined at El. 3m. This water will be drained at a low rate through the Angaw creek. If this rate is assumed to be 5 m^3/sec, the entire water will be drained in a month. The above assumed case will be very rare. It would be more frequent that the Volta water level would be low and depression would be drained more rapidly by opening No. 2 gate. The discharge capacity of the gate is so designed that 14 million m^3 of water can be drained within one week.

No. 1 gate will be opened, if flood in the Volta river penetrates the Aklamadow lagoon. A calculation shows that the structures of No. 1 gate and No. 2 pumping station will be safe even a 10-year probable flood would occur in the Lota river concurrently with the water surface of the Aklamadow lagoon at El. 3.5 m.

(4) Drainage canals

The drainage on the field is collected by collector drains which are earth channels lying in the intervals of 400 - 800 m. The collector drain runs approximately in the direction of land gradient and it joins with a main drain. The main drain is either man-made earth canal or natural stream, which is improved for increased discharge if necessary.

The drainage requirement is estimated to be 13 l/sec/ha, assuming that a 24-hour rainfall of 160 mm occuring once in 10 years is drained within 24 hours.

The length and design capacity of drains are tabulated below:

	Total Length (km)	Capacity (m^3/sec)
Main drain	69.1	0.112 - 52.0
Collector drain	143.3	0.089 - 1.281

4.3.4 Road system

(1) General

It is clear that the road network has a vital importance to the mechanized irrigation farming. Particularity in the sugar cane production project, a high-speed transportation of cane from the farm to the factory is essential to avoid sucrose deterioration in the harvested cane.

(2) Existing road

The existing Sege-Mepe road is available for the project-to-market transportation. This laterite-paved road is being improved by Department of Social Welfare and Community Development. Asphalt pavement has been provided for about 6 km on Sege side and it is expected this work will be completed up to the project boundary before the construction of the project will start. It is, therefore, assumed that the construction of the project includes the rehabilitation of the existing road for 10 km between B5-1 main canal crossing and No. 3 pumping station involving the construction of a bypass beside Aveyime. This road will be rehabilitated in the early stage of construction and later on it will constitute a part of the main road network.

(3) Main road

The main road network is planned in consideration of the convenient access from every farm to the factory, market and other farms. Every farm is accessible to a main road within 2 km of travel on minor-grade road. The distance from a farm to the factory is 13 km on an average and it is 25 km at the maximum.

The main roads to be newly constructed are about 60 km in total length. The main road for Block 1 is located along B1 main canal and connects with the existing road at No. 3 pumping station. The main road branching off from the existing road near the sugar factory runs through Blocks 2, 3 and 4 and connects with Accra-Tefle road at the eastern end. The main road traversing Blocks 5, 6 and 7 crosses the existing road at about 1 km to the south of Aveyime and connects with Accra-Tefle road in the east. The north-south-running main road provides a short cut between Blocks 2 and 6.

The main roads will be metalled to an effective width of 8 m. Asphalt pavement may be introduced in the future but an initial cost consideration has resulted a proposal of gravel metalling. According to the data collected from Department of Social Welfare and Community Development the asphalt pavement costs 3 times the gravel metalling.

(5) Secondary and tertiary roads

The secondary and tertiary roads network is proposed to form meshes of approximately 800 m square which surrounds 16 unit farms. The secondary roads of 6 m width being laterite paved are located in the routes which are more important compared with the 4 m width tertiary road also being laterite paved.

4.3.5 On-farm development

A typical layout of on-farm facilities is shown in Drawing No. 400-08. Each unit farm is a rectangular plot of 400 m x 100 m as a standard. The field ditch supplies water to the field branching off from the distribution canal. The field drain joins with the collector drain. Both the field ditch and field drain are unlined trapezoidal channels. The field road is a 4-m-wide unpaved road encircling each unit farm. The total length of these facilities are estimated as follows:

Field ditch	:	750 km
Field drain	:	750 km
Field road	:	800 km

4.3.6 Settlement compound

As stated in Chapter VI, 800 families of settlers will be transmigrated to Block-6 and Block-7. The location of the settlement compound is shown in Drawing No. 000-01.

For the establishment of the settlement compound, the following works will be provided under the project and all the costs for these works are included in the project cost.

(a) Land clearing and grading for the settlement compounds; 30 ha

(b) Roads in the settlement compounds; 25 km

(c) Outdoor drainage and sewerage works; 12 km

Although total domestic-use water of 0.028 m^3/sec was included in the design of irrigation system, the costs for water treatment facilities and distribution pipes are not included in the project cost.

The houses for settlers are assumed to be constructed by settlers themselves and their cost is not taken as the project cost.

4.3.7 Electric power supply system

As stated in the paragraph 4.3.2-(3), all the pumps in the project area use electricity supply. The sugar factory has its own power generators, but it will require 2,000 kW from outside in case of one unit breakdown. In addition, the supply of electricity is necessary to operate and maintain the project and for the rural electrification in the area. The electric power required in the project area is summarized below:

Facilities	Power requirement (kW)
Pumping stations	2,800
Sugar factory	2,000
Others	900
Total	5,700

In the discussion with the Director of Ghana Electricity Corporation (G.E.C.), it was understood that G.E.C. would seriously consider the construction of transmission and distribution lines supplying from the Akuse substation to the project, if the project would be implemented. In this report, these power supply system is not regarded as the project facilities but a recommended alignment is shown in Drawing No. 000-12. The construction cost of proposed system will be approximately US$2,400,000.

4.3.8 Rehabilitation of Aveyime pilot farm

The Aveyime pilot farm has a total area of 80 ha of which 75 ha has irrigation facilities including two pumping system with a capacity of 0.163 m^3/sec, 4.2-km long irrigation canals and 1.0-km long drainage canals. However, these facilities are inactive due to poor maintenance, and only 30 ha of the farmlands are used for paddy cultivation at present. Before utilization of this farm as the pilot farm for the project, the following rehabilitation works are required. All the costs for the rehabilitation are included in the project cost.

(a) Replacement of diesel engines for two existing pumps,

(b) rehabilitation of irrigation canals and drainage canals, and

(c) widening of farm roads and gravel metalling.

4.3.9 Office and quarters

Office and quarters for the operation and maintenance of the project facilities will be provided in the vicinity of Aveyime. These will be also used by the supervising personnel during the construction period. The numbers of these facilities are shown in the following table.

Project office, 800 m^2	1 no.
Co-operative office, 200 m^2	3 nos.
Rest house, 300 m^2	4 nos.
Guest house, 150 m^2	5 nos.
Clinic, 200 m^2	1 no.
Residences	
- for superintendent, 150 m^2 (for 1 family)	7 nos.
- for senior officer, 100 m^2 (for 1 family)	36 nos.
- for junior officer, 100 m^2 (for 2 families)	34 nos.
- for assistant officer, 100 m^2 (for 10 persons)	67 nos.

4.4 Sugar Plant

4.4.1 General

As stated in chapter 4.3.5, the cane field of 7,500 ha will ultimately be capable of supplying about 450,000 tons of cane annually to a sugar factory.

Since a sugar factory with a daily crushing capacity of 2,000 tons of cane is in operation at Asutsuare located at about 32 km northwest of the project area, a study has been made on the possibility of transporting cane produced in the project area to the factory at Asutsuare. As this would require the construction of a new road, it has been concluded that the establishment of a new sugar factory in the project area is more advantageous in view of the following reasons: (1) high transportation charge of cane due to the long hauling distance, and (2) impossibility to extend the grinding period of the Asutsuare factory to more than 170 days for milling 340,000 tons of cane from the climatic conditions of this area.

4.4.2 Location of sugar plant

The proposed site of the sugar plant is located at about 1.5 km east of Aveyime (Refer to Drawing No. 000-01). The location assures advantages in the facts that it falls on the center of the proposed cane fields, the required water for the plant operation is easily obtained from Bla lagoon through No. 9 pumping station, the foundation of the site has sufficient bearing capacity to support the plant and its related complex, and it is free from the flood damages. In addition, the site has also merits in easy access by means of the laterite paved road, which connects to the Accra-Tefle asphalt paved highway at a point of about 18 km south from Aveyime. Moreover, sufficient manpower potential is available for running the proposed sugar plant.

4.4.3 Capacity of sugar plant

The proposed cane farm will produce 450,000 tons annually when it comes to the full operation. The harvesting or milling period will be the major dry season from early November to mid-April; 165 days.

Deducting estimated stoppage of 15 days due to checking and cleaning of machinery and equipment, the annual average net working days of the factory will be 150 days. The proposed plant is therefore determined to have 3,000 tons of processing sugar cane per day; 450,000 tons/150 days.

4.4.4 Products of sugar plant

The prospective product of the sugar plant is the granulated refined sugar. The quality standard of the product sugar will be:

Polarization	99.90%
Invert sugar	0.02%
Moisture	0.02%
Ash	0.02%
Colour value	0.1° Stammer

The output will vary with the production programme of sugar cane. It is expected that the full operation of the plant will be attained in the 12th year from the commencement of the project construction. The annual outputs during the build-up period are estimated as shown in the following table, together with the amount of molasses as a by-product. In this table, the rendment/1 assumed is based on the figures shown in Table 4-5.

Year	Cane production (tons)	Sugar yield (%)	Sugar production (tons)	Molasses production (tons)
1980/81	104,400	7	7,300	6,300
1981/82	211,600	8	16,900	11,600
1982/83	338,000	9	30,400	16,900
1983/84	346,500	10	34,700	15,600
1984/85	382,400	10	38,200	17,200
1985/86	411,600	10	41,200	18,500
1986/87	450,000	10	45,000	20,300

/1 Rendment: Recoverable sugar in cane, expressed as a percentage of weight of cane

4.4.5 Outline of process

The proposed sugar plant will produce the plantation refined sugar by applying a defecation process in the raw sugar production and processes of remelting, carbonation, decolourization by active carbon and ion exchange resin for the refining.

General outline of the equipment and manufacturing method is referred to Fig. 4-2 and in more detail Drawing No. 700-04 (OUTLINE OF PROCESS) in the separate volume. General discription regarding the manufacturing process is as follows:

- Cane receiving: Sugar cane will be transported to the cane yard by trailers and weighed by means of truck scales. The cane will be unloaded onto the yard by trailer tipping table and stockpiled for a while. Cane will be then conveyed to the cane feeding table by the cane stackers.

- Cane milling: The cane unloaded onto the cane feeding table, will be fed to the cane carrier and cut into small pieces by two sets of cane cutter installed on the cane carrier and further shredded by cane shredder. The juice in cane will be extracted by the milling machine. The mixed juice thus obtained will be conveyed to the clarifying station through the strainer. The bagasse will be supplied to the boilers.

- Juice clarifying: The mixed juice will be weighed by a juice weighing scale and, after being heated by juice heater, it will be limed and heated again up to 105°C, and conveyed to a clarifier. The limed juice will be separated into the clarified juice and muds in the clarifier. The clarified juice will be fed to the first vessel of an evaporator. The sedimented muds will be filtered by a rotary vacuum filter. The filtrate will be fed back to the mixed juice receiver. The filter cake which is obtained as a by-product will be used as the fertilizer on the cane field.

- Syrup thickening: The clarified juice will be concentrated into syrup of Brix 60 at the quadruple effect evaporator. The syrup will be led to the vacuum pan station.

- Pan boiling and curing: The syrup will be boiled up to massecuite by three-stage boiling with triple seed system. In this boiling system, C sugar will be used as the seed for B massecuite boiling and B sugar as the seed for A massecuite boiling, and only A sugar will be regarded as a raw sugar product. A sugar will be directly washed in A centrifugals up to purity of 99% and it will then be sent to a refinery house.

- Remelting: The washed raw sugar will be remelted with hot water in the continuous melter and changed into raw liquor of Brix 60 in the regulating tank. The raw liquor will be pumped up to the carbonation towers.

- Carbonation and filtration: The raw liquor will be continuously carbonated in the carbonation towers for coagulating various impurities contained in the liquor. Carbon dioxide (CO_2) from boiler flue gas will be used for this carbonation process. The flue gas will be cleaned by the dust collector and scrubbers before being delivered to the carbonation towers by the CO_2 gas compressor. The carbonated raw liquor will be filtered for removing out the coagulated impurities from the liquor. Thus brown liquor is obtained and it will be pumped up to the decolourization station.

- Decolourization: The decolourization of brown liquor will be performed by mixing with an adequate quantity of active carbon for an hour in the decolourization tank. After being delivered from the tank, the liquor will be filtered twice. The filtrate, called clear liquor, will be sent to the ion exchange tower in which the final step of decolourization process of the liquor will be performed. After the treatment in the tower, fine liquor will be obtained, and it will be pumped up to the vacuum pan station for refined sugar boiling.

- Refined sugar boiling: The fine liquor will be boiled in the vacuum pan by 4-stage straight boiling system to be massecuite. The massecuite will be divided into molasses and refined sugar crystals in the centrifugal machine. The molasses exhausted from the 4th centrifugal will be fed back to the raw sugar boiling station.

- Drying and cooling: The refined sugar thus obtained will be held in the sugar bins after being dried by a sugar drier and cooler and sieved by a sugar screen.

- Packing and storage: The refined sugar will be packed with polyethylene laminated paper bag (30 or 50 kg). The packed sugar will be stored in the warehouse. The prospective storage capacity will be equivalent to the one-month production.

4.4.6 Proposed layout

The size of the plant site will be about 10 ha as referred to GENERAL PLAN OF SUGAR PLANT in Drawing No. 700-01. The main factory building will be of three-storied structure with a total floor area of about 8,800 m^2. The proposed plant will include the following compound.

Buildings	Floor area (m^2)
(1) Main factory building	
- Cane carrier	300
- Mills	930
- Processing room	5,190
- Boiler	1,220
- Power room	430
- Repair shop	430
- Others	320
Sub-total	8,820
(2) Chemical store	150
(3) Sugar warehouse	2,520
(4) Factory office and laboratory	200
(5) Garage	90
(6) Weighing houses	20
Total	11,800 m^2

4.4.7 Water and power supplies

The sugar plant will require about 45,000 - 60,000 m^3 of water per day. It will be supplied by the small pumping station with a peak capacity of 0.694 m^3/sec to be constructed on the eastern side of the Bla lagoon to which water will be always fed from the No. 1 pumping station.

The electric power necessary for factory process, for lighting and other purposes will normally be supplied by two sets of 1,600 kW steam turbine generator. When one set of steam turbine generator being out of service or during the off-season, the deficient portion of the electric power will be supplied from the existing Akuse sub-station, from which the transmission and distribution line will be extended by the Electricity Corporation of Ghana.

4.5 Construction Plan

4.5.1 Construction programme

The time required for the construction of this project is estimated to be 77 months including the time necessary for the detailed survey and design, tender calling and contract award, preparatory works, main construction work and trial running of the facilities. A proposed construction time schedule of the project is illustrated in Fig. 4-3. Assuming that the survey and design works will start from August 1976, the construction of the project works could be completed by the end of June 1982. As difficulties would be encountered by the construction works in the wet season from March to June and from September to November, the construction works are proposed to be concentrated in the dry season. Most of the works except for the concrete work for the related structures of irrigation canal and building work will be interrupted in June because of extremely heavy rainfall in this month.

It is assumed that all the construction works will be undertaken by the contractors selected through international competitive bidding.

Because of the time requirement, some construction works in the initial stage of construction have to depend on the construction machinery locally available, without waiting for the arrival of those to be brought from abroad by the contractor.

It is assumed that the transmission and distribution lines will be constructed by Ghana Electricity Corporation before electricity is needed for the test run and operation of permanent facilities.

The time schedule of each construction work is briefly explained as follows.

(1) Preparatory works

Prior to starting the main construction works, the following preparatory works are carried out and they are completed after 6 months from the commencement.

a) Unloading facilities and stock yards;

b) Electric power supply system;

c) Water supply facilities; and

d) Access roads

The office and quarters for the permanent use are compatibly utilized for lodging the supervising personnel during the construction. The construction of them is, therefore, started in parallel with the preparatory works.

(2) Infrastructures

The principal works involved in the construction of infrastructures are pumping stations, irrigation facilities, drainage facilities, farm roads, land reclamation, preparation of residential areas for the settlement farmers, rehabilitation of the Aveyime pilot farm, office and quarters.

In preparing the construction time schedule for the above works, following planting schedule of sugar cane mentioned in Chapter 4.2.5 is taken into account.

1979	1980	1981	1982
1,650 ha	1,650 ha	2,100 ha	2,100 ha

In the proposed design, blocks 1-4 have independent irrigation systems and their areas range between 400 and 650 ha, while blocks 5-7 are supplied by a single irrigation system of two large pumping stations

and their areas are as large as 1,700-2,000 ha. To meet the requirement of planting schedule, the construction will start with small blocks of small irrigation systems from the beginning of August, 1977.

As for No.1 and No.2 pumping stations, the civil works will first be completed during the period from July 1978 to May 1979 for the No.1 pumping station and from July 1979 to April 1980 for the No.2 pumping station respectively. The number of pump units to be installed in these pumping stations will be increased according to the plantation schedule as follows:

	Number of pump units	
	No.1 pumping station	No.2 pumping station
by the end of July 1979	2	-
" 1980	3	2
" 1981	5	4
" 1982	7	6

The construction of irrigation canals will be carried out during the period from the beginning of July 1978 to the end of November 1982 keeping pace with the planting schedule. The construction work will be proceeded from upper parts of the canal downwards and from larger canals to smaller canals. The excavated soil will be utilized as much as possible for the canal and road embankment if the soil mechanical tests show to be good for the embankment.

The construction of drainage facilities will be undertaken in the same manner and during the same period as those of the irrigation canals.

Since the farm roads can be used for the access in the construction period, their construction will be started as early as possible. The construction work will be started from the beginning of November 1977 and completed by the end of May 1982.

The major works for the land reclamation are land clearing and grading. These works will be started from the beginning of July 1978 and completed by the end of November 1982 in keeping with the plantation schedule.

The preparation work of the residential area for the settlement farmer should be completed by the end of July 1980 when the settlement programme starts.

As mentioned in chapter 4.2.6, the Aveyime pilot farm will be used as the pure-line reserve farm of sugar cane for this project, but most of the irrigation and drainage facilities are inactive due to poor maintenance. Accordingly, this farm requires rehabilitation before use. Considering that 16 months of nursery periods; 8 months in the pure-line reserve farm and 8 months in ordinary nursery farm, are required before planting in the main fields, the rehabilitation works should be completed by the end of March 1978.

The office and quarters will be constructed in accordance with the increase of the personnels required for the operation and maintenance, but, for the use by the supervisory personnels, the following buildings will be constructed by the end of June, 1978:

Project office	1
Guest houses	5
Clinic	1
Residential houses	20

(3) Sugar factory

The construction of sugar factory will include the following major steps:

a) Contract for the procurement of factory plant including factory buildings,

b) Manufacturing of the factory plant,

c) Preparatory works,

d) Civil works,

e) Transportation of the equipment and materials to the job site,

f) Construction of the factory building,

g) Erection and installation of the plant, and

h) trial running.

According to the development programme of the sugar production, it is proposed that the initial operation of the factory be commenced from the beginning of November 1980 when the first sugar cane is harvested. Since it will at least take about two years to complete the construction of factory plant from the issue of the Letter of Credit, the issue of this letter is required to be dated back to March or April 1978.

Soon after the issue of Letter of Credit, the manufacturing of the plant will be started and completed by the end of October 1979. Following the preparatory works which will take two months from the beginning of November to December 1978, the civil works including the foundation of plant and the intake facilities for service water will be done in parallel with the manufacturing of the plant.

Upon completion of the foundation structure, the construction of factory building will be carried out during the period from the beginning of July to the end of February 1980. This work will be followed by the erection and installation works of the plant equipment. It is assumed that the wiring work of power transmission lines will be completed by Ghana Electricity Corporation by the end of February 1980.

The trial running of the factory will be done for two months from the beginning of September to the end of October 1980. Then, the actual operation of the factory will be started from the beginning of November 1980.

4.5.2 Construction quantities, materials and machinery

The main construction quantities and materials required for the construction works are summarized in Table 4-9. The numbers of the major construction machinery to be needed by the contractor are estimated and shown in Table 4-10.

CHAPTER V COST ESTIMATE

5.1 Capital Cost

5.1.1 General

The cost estimate is made for the local and foreign currency portion, respectively. All the construction costs are estimated on the unit price basis. The unit prices used in the estimates are calculated on the basis of the current prices in Ghana for the local currency portion and on the world-wide prices for the foreign currency portion in July 1975. All the costs are converted into U.S. dollars by using the current exchange rate of ₵1.15 = US$1.0 = ¥300. Price escalation factor is disregarded in the estimates. Physical contingencies are assumed to be 15 % of the direct costs in view of the preliminary nature of the estimates. All the estimates are exclusive of import duties or taxes on machinery, equipment, materials, etc.

The cost estimate consists broadly of the following three portions: (1) construction cost of infrastructural facilities, (2) construction cost of sugar plant and (3) initial farm investment including costs for farm buildings, farm machinery, pilot farm facilities, expatriate assistance, initial farm operation and O & M equipment. The detailed cost estimates are given in Annex VII. They are summarized hereunder.

5.1.2 Construction cost of infrastructural facilities

The construction cost of infrastructural facilities is estimated on the assumption that all the works are carried out by the contractors selected through the international competitive bidding and construction machinery required for the civil works are brought in by the contractors.

The estimated construction cost consists of the cost of preparatory works, direct construction cost, engineering and administration expenses and physical contingency. It is estimated at US$37,120,000 equivalent in total which corresponds to US$4,950 per ha on an average, as shown below:

Description	Foregin currency (US$1,000)	Local currency (US$1,000)	Total (US$1,000)
(1) Preparatory works	210	480	690
(2) Pumping stations	2,750	2,310	5,060
(3) Irrigation canals	2,440	6,120	8,560
(4) Drainage canals	990	1,510	2,500
(5) Gate structures	380	540	920
(6) Roads	1,810	4,320	6,130
(7) On-farm development	1,020	920	1,940
(8) Settlement compound	80	100	180
(9) Offices and quarters	-	4,200	4,200
Sub-total	9,680	20,500	30,180
(9) Engineering and administration	1,800	330	2,130
(10) Contingency	1,680	3,130	4,810
Total	13,160	23,960	37,120

More detailed estimate of construction cost of infrastructural facilities is shown in Table 5-1.

5.1.3 Construction cost of sugar plant

The construction cost of sugar plant comprises the cost for: (1) procurement of the factory plant, (2) civil works such as piling and construction of the factory foundation, (3) construction of the factory buildings, (4) erection and installation of machinery and equipment, (5) construction of water supply system, (6) engineering and administration, and (7) physical contingency. The total construction cost of the sugar plant is estimated at US$27,490,000 equivalent as summarized below. More detailed estimate is shown in Table 5-2.

	Description	Foreign currency (US$1,000)	Local currency (US$1,000)	Total (US$1,000)
(1)	Procurement of sugar plant	17,200	-	17,200
(2)	Construction of foundation and factory buildings	61	1,549	1,610
(3)	Erection and installation	1,100	2,850	3,950
(4)	Construction of water supply system	131	129	260
	Sub-total	18,492	4,528	23,020
(5)	Engineering and administration	743	147	890
(6)	Contingency	2,875	705	3,580
	Total	22,110	5,380	27,490

5.1.4 Initial farm investment

The initial farm investment comprises the cost for: (1) farm buildings such as warehouses, garage and repair shop, (2) farm machinery for the cane field of 7,500 ha, (3) pilot farm facilities (refer to Annex III), (4) expatriate assistances required for the initial operation stage of the project (refer to chapter 6.4), (5) initial farm operation cost which will be needed for covering the farming costs invested before a first farm revenue is obtained, and (6) O & M equipment for infrastructural facilities. Such initial farm investment required for the commencement of sugar cane cultivation is estimated at US$10,170,000 as shown below:

	Description	Foreign currency (US$1,000)	Local currency (US$1,000)	Total (US$1,000)
(1)	Farm buildings	-	573	573
(2)	Farm machinery	4,620	-	4,620
(3)	Pilot farm facilities	144	71	215
(4)	Expatriate assistance	2,106	468	2,574
(5)	Initial farm operation	112	562	674
(6)	O & M equipment	200	-	200
	Sub-total	7,182	1,674	8,856
(7)	Contingency	1,068	246	1,314
	Total	8,250	1,920	10,170

More detailed estimate of initial farm investment is shown in Table 5-3. The detailed cost estimates of farm machinery and O & M equipment are given in Table 5-4 and 5-5, respectively.

5.2 Annual Fund Requirement

The total capital cost of the project is US$74.78 million equivalent comprising US$37.12 million equivalent for infrastructural facilities, US$27.49 million equivalent for sugar plant and US$10.17 million for initial farm investment. These costs are broken down into annual fund requirement in accordance with the proposed construction schedule as summarized below. More detailed estimates are given in Annex VII.

(US$1,000)

Year	Infrastructure	Sugar plant	Initial farm investment	Total
1976/77	640			640
1977/78	3,020		404	3,424
1978/79	10,960	11,050	1,141	23,151
1979/80	11,114	15,538	1,717	28,369
1980/81	6,036	902	2,019	8,957
1981/82	4,750		2,142	6,892
1982/83	600		2,253	2,853
1983/84			266	266
1984/85			76	76
1985/86			76	76
1986/87			76	76
Total	37,120	27,490	10,170	74,780

5.3 Production Costs

The production costs consist of: (1) production cost of sugar cane and fallow crop, (2) manufacturing cost of sugar, and (3) general expenses for the operation of the project. They are estimated and summarized as shown below:

Year	Cane to be processed (tons)	Crop production cost (US$1,000)	Sugar manufacturing cost (US$1,000)	General expenses (US$1,000)	Total cost (US$1,000)
1977/78	-	4	-	-	4
1978/79	-	121	-	83	204
1979/80	-	345	-	121	466
1980/81	104,400	1,395	1,177	167	2,739
1981/82	211,600	2,424	1,365	287	4,076
1982/83	338,000	4,597	1,593	349	6,539
1983/84	346,500	5,048	1,618	390	7,056
1984/85	382,400	5,073	1,682	390	7,145
1985/86	411,600	5,045	1,734	390	7,169
1986/87 and after	450,000	5,080	1,800	390	7,270

Total production cost at the stage of full operation of the project is about US$7.27 million per annum for the sugar production of 45,000 tons. The unit production cost per ton of sugar is then estimated at US$162.

5.3.1 Production cost of crops

Production cost of sugar cane and fallow crops includes all the farming expenses required for the field of 7,500 ha. It consists mainly of: (1) operation cost of farm machinery and equipment, (2) personnel cost, (3) procurement cost of farm inputs such as fertilizer, agro-chemicals, etc., (4) repair and maintenance cost of farm buildings such as warehouse, workshops, garages, etc., and (5) operation and maintenance cost of the irrigation, drainage and road facilities.

The production cost of crops at the full operation stage of the project is summarized as follows:

Item		Estate farm (US$1,000)	Settlement farm (US$1,000)	Total (US$1,000)
(1)	Farm input cost	365	323	688
(2)	Personnel cost	961	787	1,748
(3)	Machinery cost	983	743	1,726
(4)	Repair and maintenance cost of buildings	3	3	6
(5)	O & M cost of irrigation, drainage and road facilities	314	234	548
(6)	O & M cost of pilot farm	100	-	100
(7)	Land rent	11	8	19
(8)	Miscellaneous	143	102	245
	Total cost	2,880	2,200	5,080

The production cost of crops is estimated in detail in Table 5-6, and more detailed estimates of farm input cost, personnel cost and O & M cost of infrastructural facilities are given in Tables 5-7, 5-8 and 5-9.

The production cost of crops during the build-up period of the project is estimated in Table 5-10.

5.3.2 Manufacturing cost of sugar

The manufacturing cost of sugar mainly consists of: (1) procurement cost of sub-materials needed for sugar manufacturing such as quick lime, active carbon, etc., (2) personnel cost, and (3) repair and maintenance cost of the factory plant including the buildings. The manufacturing cost of sugar at the full stage of the factory operation is estimated as summarized below:

Item		Cost (US$1,000)
(1)	Sub-material cost	515
(2)	Personnel cost	686
(3)	Repair and maintenance cost	378
(4)	Polyethylene laminated bags	135
(5)	Miscellaneous	86
	Total	1,800

The detailed estimate of the manufacturing cost is given in Table 5-11. The details of the sub-material cost and personnel cost are shown in Tables 5-12 and 5-13. The manufacturing costs during the build-up period are estimated in Table 5-14.

5.3.3 General administration cost

The general administration cost is the expenses required for the project administration needed after implementation of the project. It consists of: (1) salary for administrative staff , (2) transportation and travelling expenses, (3) cost of office supplies, (4) repair and maintenance cost of the offices and quarters, and (5) welfare expenses including costs of medical treatment, social insurance, entertainment for workers, etc. The general administrative cost at the full operation stage is estimated as summarized below:

Item		Cost (US$1,000)
(1)	Personnel cost	143
(2)	Communication & travelling expenses	48
(3)	Office supplies	50
(4)	Repair & maintenance cost of offices and residences	50
(5)	Welfare expenses	79
(6)	Miscellaneous	20
	Total	390

The details are given in Table 5-15. The general administration cost during the build-up period is estimated in Table 5-16.

CHAPTER VI ORGANIZATION AND MANAGEMENT

6.1 Project Organization

6.1.1 General

Presently there is no other organization pertaining to sugar production than the Sugar Industry Board and GHASEL in Ghana as mentioned in Chapter 2.3.4

The Aveyime Sugar Production Project is a large scale sugar production pioneer project in the Accra plains. At the full stage this project will produce 45,000 tons of sugar that plays an important role in foreign currency saving. Besides this project contains the largest scale of land settlement programme for the purpose of raising and stabilizing local farmers standard of living by mechanized irrigation farming. Accordingly this project will bring about strong influence on the economy at national level as well as elevation of local farmer's living standard at regional level. It is therefore recommended that this project should not be operated by private joint stock system but a governmental agency.

The governmental agency should be responsible for the management of the settlement farm land at the initial stage of the settlement because of farmers' lacking in experience of sugar cane cultivation.

6.1.2 Aveyime Project Authority

The project would be administrated by an autonomous Project Authority which is outlined in the organizational chart in Fig. 6-1.

The Project Authority's operative functions will be shared by three Departments and an office. The three departments are the Administration Department, the Factory Department and the Sugar Cane Production Department. The office is the Construction Office.

The Board of Directors of the Project Authority will be made up four directors who would be nominated by the Government. This Board will set the project policy which needs the governmental approval. Annual budget

and audit of the Project Authority will also be approved by the Government. The chairman of the Board will be the president who will have the complete executive charge of all activities of the Project Authority.

The Administration Department will be responsible for the coordinations among the three departments and the office concerning personnel, archives, general affairs as well as clarification of financial and managerial status. Besides this department will carry out works concerning purchase of materials. This department is functionally subdivided into three sections.

The Sugar Cane Production Department will be responsible for smooth supply of sugar cane as the raw material to the factory. This department will carry out the operation and maintenance of irrigation and drainage facilities and all farm operation accruing from sugar cane production process for both the estate and settlement area. Furthermore this department plays an important role in good quality seed supply and the promotion of farmer's cooperative. This department is subdivided into three sections.

The Factory Department will be responsible for all the works accruing in the process of sugar manufacturing from sugar cane supplied by the Sugar Cane Production Department. Functionally this department is composed of two sections.

The Construction Office will be responsible for all construction works accruing in the process of sugar factory and infrastructual facilities in the sugar cane field. This department will have five sections. This department would be phased out after all the construction activities are completed.

The details of functions of these sections are explained in section 6.1.2 and 6.1.3, Annex VI.

The staff required for the Project Authority which operates its full functions are as shown in section 6.1.2, Annex VI.

6.1.3 Expatriate assistance

For the effective operation and management of a large intensive agricultural development project, experienced professional manpower will be required at all levels of the responsible organization as a whole.

Major works to be done by expatriate staff would be the detailed survey, detailed design including preparation of contract documents, advice and assistance to supervision of the project construction works by the Project Authority and technical & managerial assistance and guidance to operation and management of the project including pilot farm.

The expatriate staff required for above works are shown in section 6.1.4, Annex VI.

6.2 Settlement Programme

6.2.1 Settlement area

In selecting the settlement area, the following conditions are taken into consideration.

(1) It is desirable to locate the settlement area at one consolidated place rather than several scattered places for the convenience of community development and efficiency of farming and management of cooperatives.

(2) An irrigation block containing both estate and settlement farms would complicate the water management and farm operation .

(3) The envisaged settlers will need a preliminary training in a established estate farm.

In consideration of the above-mentioned conditions, Irrigation Blocks 6 and 7 of 3,200 ha which will be constructed last of all are the most suitable for the settlement area.

6.2.2 Farm size for the settlers and number of settlers

As mentioned in Chapter 4.2.3, mechanized operation services are given to the settlement farm by the Project Authority. The peak farm labour requirement

in the proposed settlement farm is estimated to be 0.5 person per ha, and the number of available family labour force for a standard farming family is estimated at 2.5 persons. Then the maximum land holding which is cultivated by the family labour force would be about 4 ha. The net farm income in the case of 4 ha of holding size is calculated to be US$4,530 equivalent.

Taking into consideration the situation mentioned above and other functions such as availabilities of manpower resources, nature of the project and the Government policy, etc., the average size of holding in the project area is proposed to be 4 ha for each settlement farm family. Accordingly total number of settlement families amounts to 800. (3,200 ha/ 4 ha).

6.2.3 Settlement schedule

The ultimate success of the project will depend largely on the ability of settlers. However, farmers in and around the project area would not have any experience of sugar cane growing. Training in the practical farm operation would be required. According to the construction time schedule and sugar cane cropping calendar, settlement would be carried out as follows.

i) Selection: The Project Authority would concentrate on the publicity and invitation for settlers from the beginning of the 4th year of construction and select settlers until the end of December in the 6th year.

ii) Training in the estate farm: The selected farmers should be engaged in the estate farm as hired labourers, at least for a year before farm operation in settlement area and get techniques of farm operation.

iii) Commencement of farm operation: The area of 4 ha will be allotted to the settlers who are authorized on farm operation and management by the Project Authority. The farm operation would be from July of 6th year. The settlement for 800 families would be finished by December of the 7th year.

The Construction Office and the Sugar Cane Production Department will be fully responsible for all works concerning settlement.

6.2.4 Community development

The settlers will newly establish four villages as shown in Drawing No. 000-01. Necessary public facilities such as meeting halls, schools, cooperative offices, religious buildings etc., would be built by the governmental subsidy in parallel with the project construction.

6.2.5 Farmers organization

It is proposed that four cooperatives will be established in the project area from the 5th to 6th year of construction.

The duty of the cooperatives will be to provide the necessary services related to the farming activities, such as supply of farm requisites, operation and maintenance of terminal irrigation facilities, collective farm operations, etc.

Each cooperatives will have four branches. During the initial stage of the settlement, all the activities of the cooperative should be carried out under the direction of the Aveyime Project Authority. The chief of cooperative branches will be initially appointed by the Authority. At the end of the initial stage the cooperative will establish its own executive body which will be composed of a chairman, a vice chairman and at least four executive directors.

CHAPTER VII MARKET AND PRICE PROSPECT

7.1 Present Sugar Price and Marketing in Ghana

In Ghana, marketing of sugar is controlled by the Logistic Committee. Sugar produced by the existing two factories is exclusively delivered to the committee at the fixed ex-factory price of ¢60.40/bag (US$1,050/ton). The committee has the custody of all the imported sugar as well. Sugar is allocated to a restricted number of wholesalers according to their past business results. The wholesale and retail prices of the granulated sugar are officially fixed at ¢66.165/bag (US$1,150/ton) and ¢71.12/bag (US$1,237/ton), respectively.

There is a clear evidence that the people prefer cube sugar to granulated sugar. The imported cube sugar is retailed at nearly double price of the granulated sugar being produced in the country, because of the Government policy of self-reliance.

The sugar price is determined by the Sugar Board, taking into account the international sugar prices, the sugar manufacturing costs at the existing factories and the prevailing prices of other commodities. The present ex-factory price of ¢60.4/bag was determined in February, 1975. This fixed price includes the excise tax of ¢0.25/bag and the government fund for sugar price stabilization of ¢15.15/bag. The net factory's revenue is therefore ¢45.0/bag (US$780/ton).

The price of sugar cane supplied by the farmers is also determined by the Sugar Board, in close consultation with the Ghana Sugar Cane Growers Association and the Agricultural Development Bank. The price of sugar cane was increased from ¢10 to ¢20 per ton in Dec., 1975 to encourage the domestic sugar production.

In spite of the Government's effort, sugar is scarcely seen on the market due to shortage of supply and higher price in the black market. A considerable amount of the marketed sugar is reportedly concealed and hoarded in anticipation of higher prices in the black market. Increased production of sugar in the future will require improvement in the sugar marketing process.

7.2 Prospective Sugar Market

Ghana is believed to consume about 90,000 tons[/1] of sugar annually at present, as compared with the total production by the existing sugar factories of about 11,000 tons in 1974. The domestic sugar production has never been able to meet the country's sugar demands. With the 5-year rehabilitation programme now under way, it is anticipated that the present production will be increased gradually up to 45,000 tons by the end of 1978. The installed capacity of the existing two factories will be then completely utilized. Even with this achievement, Ghana will have to import at least 80,000 tons of sugar in 1980 to meet the local consumption which by then will have increased to about 125,000 tons at the minimum. Under these conditions, self-sufficiency in sugar production in Ghana could not be attained easily within a short period. In the proposed plan, sugar production in the Aveyime project area will amount to 45,000 tons per annum at its full operation stage. Sugar thus produced will be entirely consumed within the country.

7.3 Price Setting for Project Evaluation

The economic viability of the project is assessed on the basis of the price forecast on the imported sugar in Ghana. The imported sugar prices in the past were more or less affected by the international market prices. The study is summarized as follows:

7.3.1 World supply and demand for sugar

The world sugar production in 1974 was about 80 million tons, raw sugar equivalent, including 32 million tons of beet sugar and 48 million tons of cane sugar. The production has increased at an annual rate of about 2 million tons as a general trend since 1945, but it largely fluctuates depending on the climate and stocks.

The sugar consumption nearly keeps up with the production. The world sugar consumption in 1974 is estimated to be 79 million tons, raw sugar equivalent. The annual consumption per capita ranges from 30 to 55 kg in the developed countries and sugar producing countries,

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/1 International Sugar Organization Yearbook, 1974

while it is between 1 and 20 kg in most of the developing countries. The annual sugar consumption per capita in the countries on the coast of the Gulf of Guinea is as shown in Table 7-1.

About 22 million tons of sugar are put into international market. Major exporting countries are Cuba, Brazil, Australia and the Philippines, while major importing countries are USA, USSR and Japan. Net international trade volume is about 19 million tons, as about 3 million tons of imported sugar is re-exported. There have been preferential markets handling about 9 million tons of raw sugar. Remarkable amount of sugar is traded at premium price under the US Sugar Act, Commonwhealth Sugar Agreement and Trade Agreement between the USSR and Cuba. Under the boom of sugar price in 1974, the US Sugar Act was abolished and the Commonwhealth Sugar Agreement was expired. Some countries are moving to new agreements.

7.3.2 World sugar price

The raw sugar traded in the free market is about 10 million tons. The price is determined at the sugar exchanges in London and New York. The monthly price range in terms of ISC Standard Price is shown in Fig. 7-1 for 1961 to date.

The free market price was maintained between US¢3.25 - 4.35/lb. until 1961, based on the 1953 and 1958 International Sugar Agreements.

Cuba, holding 39 % of the total world export, rejected the quotas laid down in the UN Sugar Congress in 1961 and switched its most export to USSR. Then a boom took place in 1962-64. The price reduced far below the production cost afterward in 1965-68. The 1968 International Sugar Agreement was initially effective for both importers and exporters, being in force between 1969 and 1973. The poor harvest in Cuba and USSR induced a new boom in 1972. The situation became worse due to poor harvest in Europe in 1973 and oil crisis. With the Agreement expired, the price continued to rise and it marked US¢63.76/lb. (ISC Standard Price) on November 20, 1974. Subsequent reaction showed a bottom price of US¢12.18/lb. in June 19 and 20, 1975.

The abatement of the exorbitant price rise was brought about by the consumer resistance and the consequent cessation of import. It has been much encouraged by the expectation of ample supply of beet sugar in 1976. There is a plain movement to an intenational agreement at present for the cooperation to keep the sugar price remunerative for both the exporting and importing countries. The recent international sugar prices seem to show that the drastic boom has ended and the price is going to be stabilized to a certain extent as shown below:

Year	Highest (US¢/lb)	Lowest (US¢/lb)	Average (US¢/lb)
1968	2.84	1.26	1.85
1969	3.78	2.17	3.20
1970	4.30	2.77	3.67
1971	7.10	3.82	4.50
1972	9.68	5.12	7.13
1973	14.03	8.38	9.48
1974	63.76	12.73	29.77
1975			
Jan.	45.55	34.30	38.33
Feb.	37.05	28.79	33.14
Mar.	29.05	24.05	26.50
Apr.	26.49	19.05	24.06
May	19.76	15.30	17.38
June	16.24	12.18	13.83
July	19.55	13.91	17.06
Aug.	20.95	16.90	18.73
Sept.	16.68	13.80	15.45
Oct.	14.80	13.65	14.09

The sugar price would not return to the level which was prevailing before 1972 under any circumstances because of stable growth of world sugar demand, and various difficulties to expand sugar production arising from the recent increases in the capital cost of new mills and associated crop development and direct sugar production cost. Quantitative forecast could not be applied for a long term sugar price, because many uncertainties are involved at present. The price will continue to fluctuate in the future. However, it could be estimated that the average sugar price will fall in a range between US¢10/lb and US¢20/lb (US$220-440/ton) based on the above-mentioned facts.

7.3.3 Imported sugar price in Ghana

Ghana has imported refined sugar from the free market. For estimating the future import price of refined sugar, the costs for the raw sugar refining and transporting to Ghana are added on top of the estimated raw sugar price. These costs are estimated to be US$180/ton as shown below:

Item	Amount (US$/ton of sugar)
- Sub material cost	21
- Personnel cost	27
- Depreciation of plant	6
- Maintenance cost of plant	12
- Sales expenses	22
- General administration cost	13
- Interest	23
- Sales of molasses	2
- Profit	8
- Freight, insurance and other expenses	50
Total	180

The import price of refined sugar corresponding to the international raw sugar price which is estimated in Chapter 7.3.2 is calculated as folows:

Lower Range; US$220/ton + US$180/ton = US$400/ton
Center Value; US$330/ton + US$180/ton = US$510/ton
Upper Range; US$440/ton + US$180/ton = US$620/ton

The actual import prices of refined sugar in the past are not always related with international market price of raw sugar. This is especially true when the market price largely fluctuates. The annual averages of the actual import prices of granulated refined sugar are calculated for the period of 1965 - 1973. The results are compared with the annual mean of ISC Standard Price in Table 7-2. The table indicates that the import price of refined sugar is 13-73 % higher than the ISC Standard Price, or on the average 47 % higher. These percentages do not much differ from the ratio of the estimated cost of refining and transportation to the raw sugar price.

7.3.4 Imported sugar price for project evaluation

The landing, storing and delivery costs are added on top of the import price. They are estimated to be 5-6 % of import price, being negligible if compared with the accuracy of estimated import price. The import duty and surcharge are, in principle, determined to adjust the difference in prices of imported goods and national products. These costs are not taken into account in evaluating the economic efficiency of the project. For the convenience of economic evaluation of the project, the sugar price is consequently assumed to be in the range of US$400-620/ton.

CHAPTER VIII BENEFIT AND ECONOMIC EVALUATION

8.1 General

Herein described benefits and costs are based on the prices in July 1975, with an exception for the sugar price. A single value can not be assigned to the sugar price at present as mentioned in Chapter VII. Therefore, the internal rate of return of the project is calculated for the whole possible range of imported refined sugar price between US$400/ton and US$620/ton.

The context of this chapter is arranged as follows: The benefit and the internal rate of return are explained assuming the sugar price of US$510/ton which is the center value of possible price range. Thereafter, the internal rate of return is shown for the sugar price ranging between US$400/ton and US$620/ton in the sensitivity analysis.

8.2 Benefits

Direct benefit or primary benefit of the project is defined as the difference between the net production value without the project and the net production value with the project. The net production value without the project is assumed to be represented by the value under the present condition because no significant change will occur in future so far as the present traditional farming is maintained.

The net production value without the project is estimated to be US$0.17 million equivalent in total as shown in Table 8-1. The net production value with the project is considered to be the net production value which is derived from gross value of sugar and fallow crops output less production cost. The net production value will be approximately US$16.46 million equivalent at the full production stage, as shown in Table 8-2. The value of molasses is not considered as a benefit, because of the uncertain market outlet.

The direct benefit of the project will be US$16.30 million equivalent, or US$2,173 equivalent per ha, as shown below:

	With project	Without project	Difference
(1) Gross production value	23,734	355	23,379
(2) Production cost	7,270	187	7,083
(3) Net production value	16,464	168	16,296

The increase of the total direct benefit during the build-up period is estimated in detail and shown in Table 8-3.

The increase of economic activities such as increased employment of labour and increase in marketing activities which will be accelerated by the increased farm income, etc. can be taken as indirect benefits. Intangible benefits such as social stability, improved welfare of community, improved diet and health, demonstrational effect of irrigation farming to the neighbouring potential areas, etc. will be surely resulted from the project implementation. For conservative estimate of the project, however, these indirect and intangible benefits are not taken into account.

8.3 Internal Rate of Return

For the economic evaluation of the project, the internal rate of return is calculated on the basis of the following assumptions:

(1) The economic life of the project is assumed to be 50 years after completion of the construction. The pumping facilities, sugar plant and buildings are assumed to be replaced at 20-, 25- and 30-year intervals, respectively. The machinery and equipment for operation and maintenance of the project are depreciated on the basis of actual working hours.

(2) The total economic cost of the project is US$74.78 million equivalent which consists of US$37.12 million for infrastructural facilities, US$27.49 million for sugar plant and US$10.17 million for initial farm investment.

(3) The costs are invested in accordance with the proposed implementation schedule.

(4) Full benefits will be attained through gradual increase during the build-up period of 8 years. Annual net benefits are US$16.30 million at the full development stage.

(5) Zero point is fixed at July, 1977, that is the proposed commencement time of project construction.

The cost and benefit streams of the project are prepared as shown in Table 8-4, based on the assumptions mentioned above. From the cost and benefit streams, internal rate of return (IRR) is calculated at 15 % as shown graphically in Fig. 8-1. This internal rate of return is

considered high enough to endorse the economic feasibility of the project.

Sensitivity tests are made changing the most sensitive parameters; the sugar price and the investment costs. The production decrease is not taken into consideration in the sensitivity tests because the estimate of production is conservative enough. The following table summarizes the assumptions and the impact on the internal rate of return for each case tested (refer to Fig. 8-1). Fig. 8-2 shows the results of sentitivity test in which sugar price takes values between US$400 and US$620.

Case	Description	IRR(%)
1.	Sugar price : US$400/ton Capital cost : no increase	11
2.	Sugar price : US$620/ton Capital cost : no increase	18
3.	Sugar price : US$400/ton Capital cost : 30% increase	9
4.	Sugar price : US$510/ton Capital cost : 30% increase	12
5.	Sugar price : US$620/ton Capital cost : 30% increase	15

The internal rate of return will be between 11 % and 18 % for the possible range of sugar price. If the capital cost would be higher by 30 % than the present estimate and the other conditions would remain unchanged, the internal rate of return will lower to a range of 9-15 %.

By the above-mentioned studies, it is concluded that the Aveyime Sugar Production Project is economically sound.

CHAPTER IX FINANCIAL JUSTIFICATION

9.1 General

The financial analysis is made from three different standpoints, i.e., Project Authority's income and expenditure, farmer's income and expenditure and saving in foreign exchange.

From the standpoint of Project Authority, the income accrues from sales of sugar and water charge collected from the settlement farmers, while the expenditure consists of the repayment of total capital, sugar production cost in the factory, sugar cane production cost in the estate farm, cost of sugar cane to be bought from the settlement farm and Authority's administration cost.

From the standpoint of a farmer in the settlement farm, the income arises from the sales of sugar cane to the Authority and sales of fallow crops to the market. On the other hand, the expenditure comprises the crop production cost less family labour cost, taxes, living expense and water charge to be paid to the Authority.

The saving in the foreign exchange is measured as a difference between the foreign currency to be spent on the import of sugar, unless the project would be implemented, and the total foreign component in the expenditure.

All the prices related to the project are fixed at the level in July, 1975.

9.2 Sugar Price

The net revenue of sugar factory is US$780/ton (¢45/ton) at present as mentioned in Chapter VII. This price is officially determined under the condition that the existing factories are ineffective. It is expected that this price would be lowered when the rehabilitation of existing factories would succeed. For a conservatism, the sugar price for the financial analysis is assumed to be US$510, which is about 65 % of the present price.

9.3 Sugar Cane Price

The price of sugar cane to be paid by the Authority to the settlement farmer is assumed to be the present official price of US$17.4/ton (¢20/ton).

9.4 Water Charge

There is no system of collecting water charge from the farmers in Ghana. It is recommended that the Project Authority establish a basic rule regarding the water charge in order to cover a part of the repayment of a loan and the operation and maintenance of the infrastructural facilities and farm machinery.

As for the settlement farm, the water charge is tentatively set at US$683 equivalent per ha at the full development stage. This will cover (1) operation and maintenance cost of infrastructural facilities (2) cost of machinery operation provided by the estate farm, (3) production cost of seed cane which will be produced on the estate farm, (4) land rent and (5) 30 % of the debt repayment of the loan for infrastructural facilities and initial farm investment, as shown in Table 9-1. It is recommended that portion of the debt repayment be decided on the basis of more detailed farm economic studies. It is assumed that, in this report, 70 % of the debt repayment will be subsidized by the Authority.

With this water charge introduced, above-mentioned cost items (1), (2), (3) and (4) for the settlement farm enters in the cost side of the Project Authority, and the crop production cost of a settlement farmer reduces to the cost of fertilizers and chemicals only.

9.5 Repayment Condition

The repayment condition assumed in the financial analysis is as follows:

Annual compound interest rate	: 8.5 %
Repayment period,	: 25 years including 7 years of grace of both the principal and interest

9.6 Financial Statement

The financial statement from the standpoint of the Project Authority is presented in Table 9-2 covering the whole repayment period. The surplus is expected from the 7th year of the project, and it increases to US$5,084,000 equivalent in the 12th year onward. A certain part of construction cost can be covered by the income and the net capital required is, accordingly, US$65,905,000 equivalent at the price level in July 1975. The above-mentioned surplus at the full production stage is 7.7 % of the capital or 20.2 % of the gross income.

9.7 Economy from the Farmer's Viewpoint

As estimated in Chapter 3.10, the net reserve of the farmer holding the typical farm size of 1.5 ha is currently US$320 equivalent, which may be insufficient to cover the necessary outgoes for investment to ensure enlarged reproductions.

With the implementation of the project, the net income will be increased with a leap to about US$4,530 equivalent per annum for the typical farmer holding 4.0 ha as the farm settler. Deducting the water charge and living expenses, the farmer will be able to reserve about US$980 equivalent per annum, as shown in Table 9-3. This amount corresponds to three times of the present net reserve or more.

9.8 Saving in Foreign Exchange

The prospective refined sugar production of 45,000 tons will be valued at US$22,950,000 of foreign currency, if wholly imported at the price of US$510/ton. This amount is regarded as the gross saving in foreign exchange due to the project.

The foreign component in the production cost is summed up, with reference to Tables 5-5 and 5-10, as follows:

Item	Cost (US$1,000)
Farm machinery replacement	649
Farm machinery spare parts	514
Fuel and Lubricant	563
Fertilizers	409
Chemicals	153
Factory spare parts	378
Factory sub-material	515
Polyethyelene laminated bags	135
Total	3,316

If the net required capital is wholly invested by a foreign loan, the annual debt repayment will be US$10,358,000 equivalent as seen in Table 9-2. The net saving in foreign exchange is calculated by deducting the above-mentioned foreign component of production cost and annual debt repayment from the gross saving. It is US$9,276,000 equivalent.

Another estimate is made of the case that only the foreign portion of required capital is invested by a foreign loan. The foreign component of the capital cost is calculated to be 58 % of total capital cost. Applying this percentage to the annual debt repayment of the former case, the approximate value of annual capital cost for this case is obtained to be US$6,008,000 equivalent. Accordingly, the net saving in foreign exchange is estimated to be US$13,626,000 equivalent.

In consequence, the project will contribute to save the foreign exchange in an annual amount between US$9 million and US$14 million equivalent.