FEASIBILITY REPORT ON THE AGRICULTURAL DEVELOPMENT PROJECTS IN IMO AND BENDEL STATES

FEASIBILITY REPORT

THE AGRICULTURAL DEVELOPMENT PROJECTS IN IMO AND BENDEL STATES

MAIN REPORT

JUNE 1977

FEDERAL REPUBLIC OF NIGERIA

FEDERAL DEPARTMENT OF AGRICULTURE

FEASIBILITY REPORT ON THE AGRICULTURAL DEVELOPMENT PROJECTS IN IMO AND BENDEL STATES

MAIN REPORT

JUNE 1977

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

The Japan International Cooperation Agency has performed the feasibility study on the agricultural development projects in Nigeria for a period of seven months since November, 1976 as technical co-operation to the Federal Republic of Nigeria.

During this period, the survey team consisting of nine experts, headed by Mr. Tetsuo Yaguchi of Nippon Koei Co., Ltd., carried out field survey and subsequent study in Japan.

Hereby presented is the final feasibility report on the projects in Imo and Bendel States, which has been prepared on the basis of the results of the survey and study carried out by the team.

I firmly believe that this report is worthwhile contribution to the social and economic development in Nigeria as well as promotion of friendship between the Federal Republic of Nigeria and Japan.

Finally, I take this opportunity to express my heartfelt gratitude to the Federal Development of Agriculture and other authorities concerned for their kind cooperation and assistance extended to the team, without which the survey work could not be completed so successfully.

June, 1977

Shinsaku Hogen
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

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

June, 1977

Dear Sir,

We have the pleasure of submitting herewith the feasibility report on the Agricultural Development Projects in Imo and Bendel States in Nigeria in compliance with the agreement between the Government of Japan and the Federal Government of Nigeria.

The purpose of the projects is to improve the present subsistence level of agriculture in the region through the introduction of irrigated rice production and to contribute to the national food production program.

To attain the purpose, the survey team conducted the field investigation and preliminary studies from November, 1976 to February, 1977. The results of the field survey were summarized into the Interim Report and submitted to the Government of Nigeria at the end of February 1977.

After coming back to Japan, the team made additional studies and analyses. All the results of the field investigation and study at home were compiled into the Draft Feasibility Report on the Agricultural Development Projects in Imo and Bendel States, which was submitted to the Government of Nigeria in May 1977. With regard to the draft report, discussion meetings were held in Lagos, Owerri and Benin City from May 29 to June 6, 1977 with the officials of the Federal Department of Agriculture, Imo State and Bendel State. They approved the proposed development plan and both the officials concerned and the farmers to be benefited are eager for the realization of the project under the technical guidance and assistance of Japan.

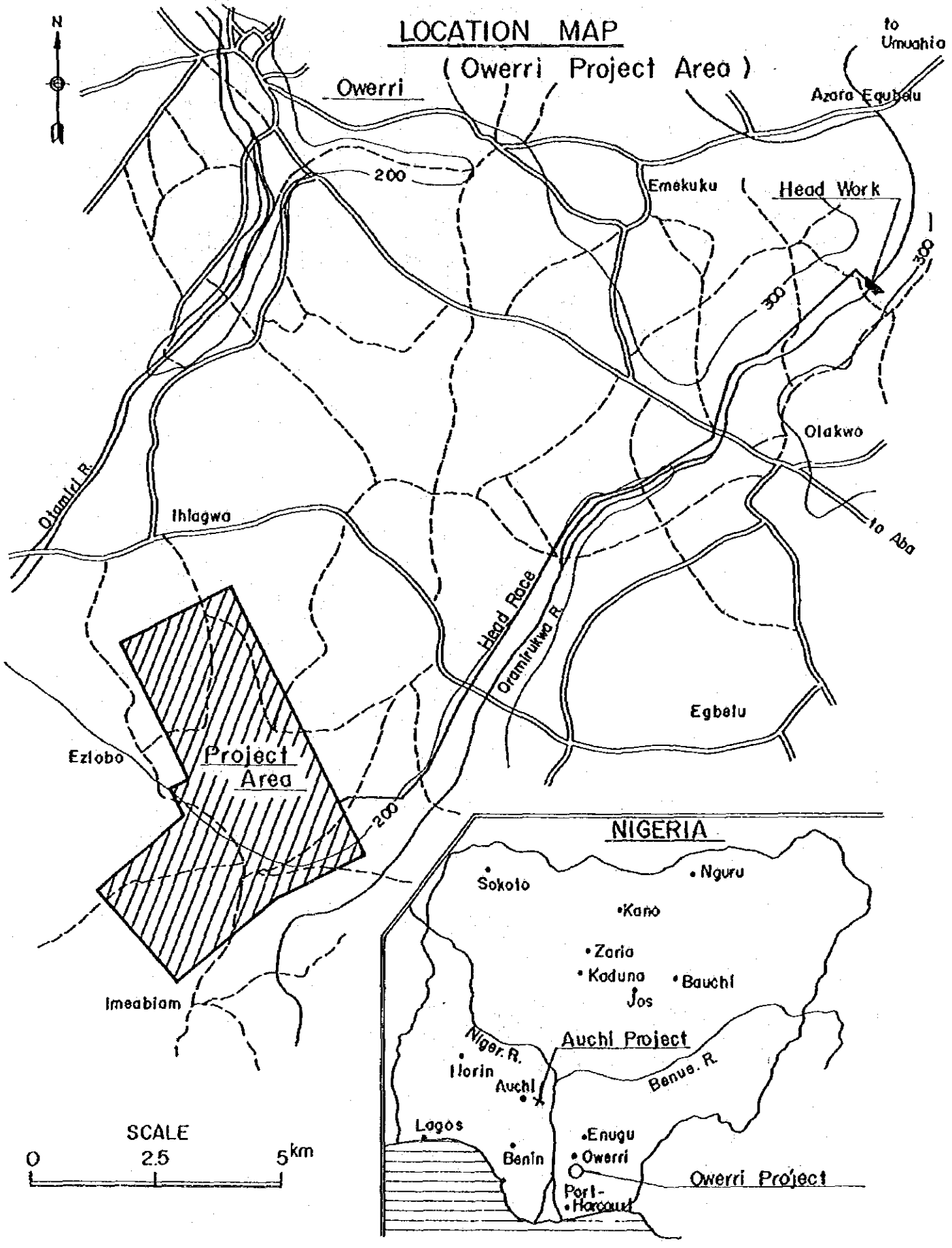
It is our sincere hope that the project be proceeded to the next stage of the detailed design for the early realization of the project in line with the recommendations presented in this report.

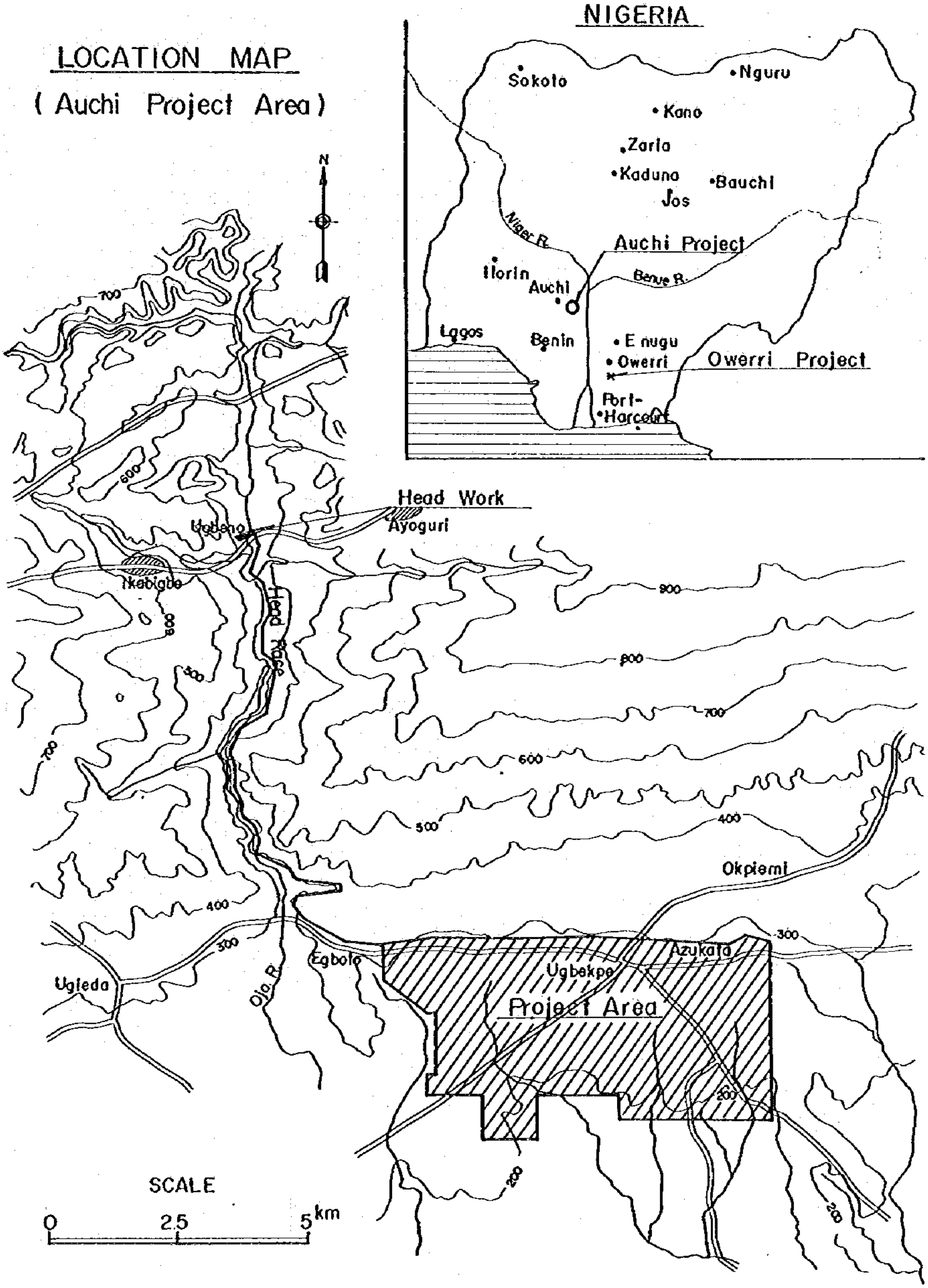
In submitting this report, we wish to express our sincere appreciation and gratitude to the personnel of your Agency, the Japanese Embassy in Nigeria, and the authorities concerned of the Federal Government of Nigeria, Imo State and Bendel State for the courtesies and cooperation afforded us during our field survey and home office work.

Very truly yours,

T. Yaguchi

Tetsuo Yaguchi
Leader for Feasibility Study Team on
Agricultural Development Projects
in Nigeria


LOCATION MAP
(Owerri Project Area)
N
Owerri
to Umuahia
Azara Egubelu
200
Emekuku
Head Work
300
300
Olakwo
Otamiri R.
Ihlagwa
to Aba
Head Race
Oramiriukwa R.
Egbelu
Ezlobo
Project Area
200
Imeabiam
NIGERIA
Sokoto
Nguru
Kano
Zaria
Kaduna
Bauchi
Jos
Auchi Project
Niger R.
Ilorin
Auchi
Benue R.
Lagos
Benin
Enugu
Owerri
Owerri Project
Port-Harcourt
SCALE
0
2.5
5km


LOCATION MAP
(Auchi Project Area)
NIGERIA
Sokoto
Nguru
Kano
Zaria
Kaduna
Bauchi
Jos
Niger R.
Auchi Project
Benue R.
Ilorin
Auchi
Lagos
Benin
Enugu
Owerri
Owerri Project
Port-Harcourt
N
700
600
Head Work
Ayoguri
Ugbeno
Ikabigbo
Head Race
900
800
700
600
500
400
500
400
300
Okpiemi
Azukala
Ugbekpe
Project Area
Egbolo
Ugieda
Oja R.
200
SCALE
0
2.5
5 km

S U M M A R Y

General Background

1. The Federal Military Government of Nigeria has requested the Government of Japan to provide technical assistance for the agricultural development. The Government of Japan entrusted the work to Japan International Cooperation Agency (JICA) and the feasibility study team was despatched to Nigeria by JICA from November 1976 to February 1977. This report is prepared on the basis of the findings in the field survey and results of the studies in Japan.

2. With an area of about 930,000 km^2, the Federal Republic of Nigeria maintains a population of about 75 million. Gross Domestic Product (GDP) of the country was about ₦16,000 million in 1975 with the annual growth rate of about 7%. The estimated per capita GDP is about ₦200.

3. Agriculture sector is still the most important sector in the national economy producing about one quarter of the GDP and providing an employment opportunity for about 70% of the labor force of the country. However, agriculture in Nigeria is kept at subsistence level featured by its low productivity and domestic market orientedness. Most of the agricultural products are consumed entirely in the country and the agricultural products shares only 5% of the total exports. Rice is planted on about 270 thousand ha or about 10% of the farmland in the country with total production of 500,000 tons per annum. The production is not enough to meet increasing demand, and about 6,000 tons of rice is imported annually.

4. Under such circumstances, the Government of Nigeria has a strong intention to increase production of rice in the Accelerated Food Production Program and plans to launch at least one rice production project in each State along the Lower Niger. In line with this national policy, Imo and Bendel States have been taken up as the most suitable areas for rice development and the area in the vicinity of Owerri in Imo State and the area in the neighbourhood of Auchi in Bendel State have been selected as the proposed project sites. These two projects are expected to function as the pioneers for future extension of similar projects to other regions.

The Owerri Project

5. The project area is located in the vicinity of Owerri City, the capital of Imo State, in the downstream basin of the Oramirukwa river. The area consists of 2,600 ha of flat land which is now used for shifting cultivation. Population in the area is about 6,400 with an population density of 250 per km^2, and about 90% of the inhabitants are engaged in agriculture.

6. Agriculture in the area is featured by traditional method based on mixed cropping of cassava, yam, maize and cocoyam under the shifting cultivation system. Rice cultivation is not practiced. The agricultural production is mainly for self consumption and the farm economy is on the subsistence level. The gross farm income of a typical farmer, cultivating 1.0 ha of farmland, is only about N880 per annum.

7. The project aims to reclaim 2,100 ha of paddy field on which complete double cropping of rice will be enabled. Intensive irrigation farming is to be introduced together with proper application of improved seeds, fertilizer and agro-chemicals. Besides, mechanized farming is proposed in order to modernize the farming practices and to cope with the shortage of manpower.

8. The Owerri Project has dual purposes, namely, to establish a rice estate as an enterprise (estate farm scheme) and also, to convert the primitive subsistance agriculture of the inhabitants into modern irrigated rice culture to enhance their living conditions (small holders' scheme). The paddy field of 1,015 ha will be allocated to the estate farm and 1,085 ha to the small holders' scheme in due consideration of the population in the area, present land tenure and optimum scale of the commercial operation. For the early materialization of the project, a pilot scheme is to be introduced in the estate farm on a land of 50 ha to execute training of the irrigated farming for the project staffs, farmers and extension workers together with research and seed multiplication.

9. Through the introduction of the intensive irrigated farming, yields of paddy are expected to increase to 5.0 t/ha in the small holder area and 4.5 t/ha in the estate farm. The productivity will increase linearly and attain the target yield in the 5th year on the estate farm and 7th year on the small holder area. Total annual production of rice will attain 14,000 tons at the full development stage in 1988.

10. For sustaining the proposed agricultural development, the following project works are needed: (i) construction of an intake weir on the Oramirukwa river, (ii) construction of irrigation and drainage canals throughout the area, (iii) establishment of an adequate farm road system, (iv) land reclamation and paddy field construction of 2,100 ha, and (v) installation of processing, storage, and office facilities for operation. (The principal features of these works are summarized in the attachment to this SUMMARY.)

11. The intake weir will be of concrete gravity type of 5.5 m high and 45 m long, and located on the Oramirukua river about 16 km upstream of the project area. From the weir, 3.0 m^3/sec of the irrigation water at maximum will be conveyed and distributed to each plot of paddy field through the canal system consisting of main, secondary, tertiary, and supply canals. All the canals are of earth type. In order to ensure optimum water management, discharge measuring and control devices will be equipped at the major diversion points.

12. The proposed drainage system will consist of collector and field drains. The excess water in every plot of paddy field is proposed to be drained within 36 hours or one and a half days to enable the efficient operation of farming machinery as well as to keep the field in optimum condition for crop growth.

13. The proposed road system will consist of main farm road of 7 m wide and branch farm road of 5 m wide. Main road will be laid along the main and secondary canals and serve as the main artery in the area, while the branch road will run along the tertiary and supply canals mainly for farming purposes. With this road system, the project area is to be covered by a grid of 225 m x 500 m.

14. The size of one plot of the paddy field is proposed to be 0.4 ha or 40 m x 100 m in consideration of efficiency of water management, workability of agricultural machinery, size of land holding by farmers, etc. The terminal irrigation unit to be commanded by one supply canal will consist of 12 plots of paddy field.

15. The processing and storage facilities needed for the project will consist of equipments for drying, parboiling, milling, storage, power supplying,and buildings for accommodating them. The milling equipment will comprise 3 sets of mills having a capacity of 1.5 t/hr, each. The facilities related to the project office will comprise office, garage, and training center, housings for staff, warehouses, workshops, etc.

16. To launch the project successfully, a project executing organization (tentatively called Owerri Project Office) will be established, which will be in charge of all the construction works of the project and operation of the estate farm. The project office will also provide the extension services and machinery services to the small holder area. In the small holder area, Agricultural Cooperatives will be established for introducing the mechanized irrigation farming smoothly and to attain the expected increase in rice production most efficiently.

17. Construction period of the project will span 63 months from October 1977 to the end of December 1982 comprising the mapping and detail design period of 9 months and the actual construction period of 54 months or four and a half years. Among the project works, the intake structures and major canals are scheduled to be constructed by April 1980. Partial operation of the project will, therefore, be possible after that time on. Yearly operation schedule of the project will be 400 ha in 1980, 950 ha in 1981, 1,820 ha in 1982, and full 2,100 ha in and after 1983. The pilot scheme of 50 ha will be started initially in 1980.

18. In view of unavailability of competent contractors for this kind of works in Nigeria, the construction works are proposed to be executed on the Force Account basis of the proposed project executing organization under technical guidance of experienced foreign experts.

19. The project costs or financial costs of the project is estimated at ₦22.64 million in total comprising foreign currency portion of ₦11.05 million equivalent and local currency portion of ₦11.59 million. The annual operation and maintenance cost of the project is estimated at ₦497 thousands at the full operation stage of the project. (Breakdown of the costs is given in the attachment to this SUMMARY.)

20. Estimated annual economic benefit of the project is ₦2.927 million at the full development stage. The benefit will increase linearly after the completion of the irrigation facilities and attain the target in 1988. Economic internal rate of return of the project is estimated at 12.0% which indicates that the project is economically feasible.

21. With the completion of the project, the gross income of the typical farmer will increase to about ₦3,740 from the present level of about ₦880. Although the farming cost and living expenses will increase corresponding to increase in farm inputs and improvement of the living standard, annual net reserve will become about ₦1,660. The increased revenue shows that the farmers will get substantial benefit from the project and have sufficient capacity to pay for charges to be imposed on the irrigation water and machinery services.

22. On the condition that selling price of rice is ₦560/t and the charges for the irrigation water and machinery services are ₦210/ha, the expected annual project revenue for the estate farm will be about ₦8.1 million. After deducting the production cost, the net profit will be ₦2.71 million at the full development stage which is equivalent to 11.9% of the investment costs and the financial rate of return for the estate farm is estimated at 10.2%.

The Auchi Project

23. The project area is located about 20 km east from Auchi Town and about 70 km north-east from Benin City, the capital of Bendel State. The area comprises about 2,850 ha of land which is also under the shifting cultivation. The area is sparsely populated compared with the Owerri Project area. The population is about 2,000 with a population density of 70 per km^2. Agriculture is the mainstay of the economy in the region and absorbs most of the working population in the area.

24. Traditional agricultural production is conducted in the project area under the shifting cultivation of such crops as cassava, yam, rice and maize. Rice is planted widely in the scattered plots in the rainy season, but the productivity is low with only 1.2 t/ha. The farm economy is based on the root and cereal crops supplemented by income from tree crops. It is still at the subsistence level and a typical farmer cultivating 1.5 ha of farmland gains the gross farm income of only about ₦1,120 per annum.

25. The project intends to reclaim about 2,100 ha of paddy field and to introduce irrigated paddy throughout the field. Double-cropping of paddy is envisaged, however, the cultivation area in the dry season will decrease to 600 ha due to the limited available water. The proposed cropping intensity will be about 130%. Intensive irrigation farming will be introduced including application of improved seeds, fertilizer and agro-chemicals. Besides, farming will be mechanized in order to ensure the efficient operation and management and to reduce the peak labor requirement.

26. The Auchi Project will also include an estate farm and small holder area. Since the number of farm families is comparatively small, 1,800 ha of the paddy field will be allocated to the estate farm and 300 ha to small holders. The estate farm will include a pilot scheme area of 50 ha to train project staffs, farmers and extension workers and to execute agronomic research and seed multiplication.

27. The target yield of paddy is 5.0 t/ha in the small holder area and 4.5 t/ha in the estate farm. The productivity will increase linearly and attain the target yield in the 5th year for the estate farm and 7th year for the small holder area. Total annual production of rice will be 8,700 tons at the full development stage in 1989.

28. The works required for the Auchi Project will consist of: (i) construction of an intake weir on the Ojo river, tributary of the Lower Orle river, (ii) establishment of irrigation and drainage canal systems, (iii) establishment of an adequate farm road system, (iv) land reclamation and paddy field construction of 2,100 ha, and (v) installation and building works of processing, storage, and office facilities to be needed in operation. (The features of the works are summarized in the attachment to this SUMMARY.)

29. As the water source for the project, the Ojo river has been selected where a simple run-of-river type weir is proposed to be constructed. The weir will be of concrete gravity type and have a height of 5.5 m and a width of 45 m. The maximum intake water quantity is 1.5 m^3/sec which is conducted to the irrigation area by a head race of about 12 km. Irrigation water is to be supplied to each plot of the paddy field through the proposed canal system consisting of main, secondary, tertiary and supply canals. In order to realize systematic and consistent water management

throughout the area, provision of an adequate discharge measuring and control devices is proposed. In addition, due to the rather steep topography, a number of drops will have to be constructed.

30. The proposed drainage system will consist of two types of canals such as collector and field drains. The excess water on the paddy field will be drained smoothly by these canals within, at least, 36 hours or in one and a half days in order to keep the field in optimum condition for crop growth and also for efficient operation of farm machinery.

31. In the midst of the area there runs a provincial road in a west-east direction. This road is expected to be functioned as the artery of the area. For the farming purpose, however, establishment of an adequate farm road system is needed additionally. The road system will consist of main farm road of 7 m wide and branch farm road of 5 m wide. It will cover the area by a grid of 225 m x 500 m.

32. A plot of paddy field in the Auchi area will have a size of 30 m x 100 m. It is smaller than the plot in Owerri due to the rather steep topography. 16 plots of paddy fields will constitute the terminal irrigation unit to be commanded by one supply canal.

33. The processing and storage facilities for the project will comprise equipments for drying, parboiling, milling, and storage as well as the power supplying equipment and buildings to accommodate these equipments. The milling equipment will consist of 3 sets of mills each of which has a capacity of 1.0 t/hr. Included in the facilities related to the project office are project office, garage and training center, housings for staff, warehouses and workshops.

34. A project executing organization (called Auchi Project Office) will be established in the project area for the implementation of the project. The project office will be responsible for all the construction works and operation of the estate farm. In the small holder area, Agricultural Cooperatives will be established for introducing the mechanized irrigation farming smoothly and to attain the high yield of rice efficiently. The extension services of the rice cultivation and machinery services will be provided through the Agricultural Cooperatives from the estate farm.

35. Construction period for the project will be 63 months starting in October 1977 and terminating at the end of December 1982. The initial 9 months are for preparation of topographic maps and detail design of the project facilities, and the remaining 54 months or four and a half years are for the actual construction works. It is scheduled that the key structures such as the intake weir, head race, main canals, and a part of secondary canals be constructed by June 1979. After that time on, partial operation of the project will become possible. The operation will progress in the order of 350 ha in 1979, 660 ha in 1980, 1,230 ha in 1981, 1,780 ha in 1982, and full 2,100 ha in and after 1983.

36. Construction of the project will be executed on the Force Account basis of the proposed project executing organization due to difficulty in recruiting competent contractors for this kind of works. To help execution of the works, technical guidance and assistance of well-experienced foreign experts will be necessary.

37. Total project cost or financial cost of the project will amount to N22.92 million consisting of foreign currency portion of N10.57 million equivalent and local currency portion of N12.35 million. The annual operation and maintenance cost will be N465 thousands at the full development stage of the project. (Breakdown of the costs is given in the attachment to this SUMMARY.)

38. Annual irrigation benefit to be derived from the implementation of the project is N1.925 million at the full development stage. The benefit will increase lincarly after the completion of the construction works and attain the target in 1989. Based on the benefit and estimated economic construction cost of the project, the economic internal rate of return of the project is estimated 7.1%, which indicates that the project possesses relatively low economic viability.

39. Farm budget analysis shows that the typical farmer in the area will gain the gross income of N3,166 per year. Annual net reserve will be N1,150 after deducting farming expenses and living expenses from the gross income. Compared with the present condition, the increase of revenue is considerable indicating that the farmers in the area will have enough incentives to be involved in the project and have sufficient capacity to pay for charges on the irrigation water and machinery services.

40. The expected annual project revenue of the estate farm is estimated at about N4.9 million on the condition that selling price of rice is N560/t and the charges for irrigation water and machinery services are N270/ha. After deducting the production cost, the net profit of the estate farm is estimated at N2.15 million per annum, corresponding to 9.4% of the investment costs. The financial rate of return for the estate farm is estimated at 7.8%.

Conclusions and Recommendations

41. The Owerri Project in Imo State and the Auchi Project in Bendel State are expected not only to contribute to the national rice production policy but to improve the present subsistence level of agriculture drastically thereby enhancing the living conditions of the inhabitants. In addition, the projects will play a role of pioneer in the field of the intensive irrigated farming of rice culture in Nigeria.

42. The Owerri Project is technically sound and economically feasible. The project is also acceptable from the financial view point. It is, therefore, recommended that steps are

taken soonest possible for the early implementation of the project by the Federal Government of Nigeria and Local Government of Imo State.

43. The Auchi Project is also technically sound and seems feasible economically taking into account the socio-economic impacts and indirect benefits to be generated by the project.

Features of Major Project Works

Major Project Works	Unit	Owerri Project Quantity	Auchi Project Quantity
1. Civil Works			
Headworks			
Concrete weir, length	m	42	45
-"- , height	"	5.5	5.5
-"- , volume	m^3	3,500	1,500
Embankment	"	32,000	270
Max. intake discharge	m^3/sec	3.0	1.5
Irrigation canals			
Head race	km	16.4	11.7
Main canal	"	-	7.0
Secondary canal	"	11.4	18.6
Tertiary canal	"	50.6	46.1
Supply canal	"	219	219
Drainage canals			
Collector drain	km	26	31.8
Field drain	"	110	105.0
Farm road			
Main farm road	km	20	23.4
Branch farm road	"	150	155
Paddy field construction	ha	2,100	2,100
2. Processing and Storage Facilities			
Rice mill buildings	m^2	6,000	5,300
Rice mill (1.5 t/hr for Owerri and 1.0 t/hr for Auchi, each 200 KVA)	Nos.	3	3
3. Office and Related Facilities			
Project office, garage and training center	m^2	2,525	2,525
Housings for staff	m^2	1,600	1,600
Warehouse, generator house and workshop	m^2	2,550	2,550
Motor pool	m^2	2,400	2,400

Project Cost for Owerri Project

(Unit: ₦1,000)

Item	Foreign Currency	Local Currency	Total
1. Civil works	5,680	6,970	12,650
2. Processing, storage, and office facilities	2,980	3,240	6,220
3. Initial farm investment	2,390	1,380	3,770
Total	11,050 (US$17,540,000)	11,590	22,640 (US$35,940,000)

Project Cost for Auchi Project

(Unit: ₦1,000)

Item	Foreign Currency	Local Currency	Total
1. Civil works	6,110	8,050	14,160
2. Processing, storage, and office facilities	2,580	2,910	5,490
3. Initial farm investment	1,880	1,390	3,270
Total	10,570 (US$16,780,000)	12,350	22,920 (US$36,380,000)

C O N T E N T S

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ABBREVIATION

km	Kilometer	m	meter
cm	centimeter	mm	millimeter
t	ton	kg	kilogramme
g	gramme	km^2	square kilometer
m^2	square meter	ha	hectare
m^3	cubic meter	kl	kiloliter
ℓ	liter	m^3/sec	cubic meter per second
ℓ/sec	liter per second	ℓ/sec/ha	liter per second per hectare
t/ha	ton per hectare	ℓ/ha	liter per hectare
kg/ha	kilogramme per hectare	hr(s)	hour(s)
t/hr	ton per hour	mm/day	millimeter per day
^oC	degree centigrade	%	percent
El	Elevation above mean sea level	lb	pound
PS	Horse power	ft.	foot
L.S.	Lump Sum	No(s)	number(s)
US$	U.S. dollar	Fig.	Figure
₦	Naira	IRR	Internal Rate of Return

O&M	Operation and Maintenance
GDP	Gross Domestic Product
GNP	Gross National Product
L.G.A	Local Government Area
FDA	Federal Department of Agriculture
MANR	Ministry of Agriculture and Natural Resources
ADC	Agricultural Development Corporation
NAB	Nigerian Agricultural Bank

ABBREVIATION

km	Kilometer	m	meter
cm	centimeter	mm	millimeter
t	ton	kg	kilogramme
g	gramme	km^2	square kilometer
m^2	square meter	ha	hectare
m^3	cubic meter	kl	kiloliter
ℓ	liter	m^3/sec	cubic meter per second
ℓ/sec	liter per second	ℓ/sec/ha	liter per second per hectare
t/ha	ton per hectare	ℓ/ha	liter per hectare
kg/ha	kilogramme per hectare	hr(s)	hour(s)
t/hr	ton per hour	mm/day	millimeter per day
^oC	degree centigrade	%	percent
El	Elevation above mean sea level	lb	pound
PS	Horse power	ft.	foot
L.S.	Lump Sum	No(s)	number(s)
US$	U.S. dollar	Fig.	Figure
N	Naira	IRR	Internal Rate of Return

O&M	Operation and Maintenance
GDP	Gross Domestic Product
GNP	Gross National Product
L.G.A	Local Government Area
FDA	Federal Department of Agriculture
MANR	Ministry of Agriculture and Natural Resources
ADC	Agricultural Development Corporation
NAB	Nigerian Agricultural Bank

1. INTRODUCTION

1. INTRODUCTION

1.1 Historical Background

The Federal Government of Nigeria intends to increase food crops production through the Accelerated Food Production Program along the Third National Development Plan (1975-1980) and requested the technical cooperation and assistance of the Government of Japan. In response, the Government of Japan agreed to provide the technical assistance and despatched the first mission to Nigeria in May 1976 for the purpose to verify the concrete contents for the cooperation and to select appropriate sites for rice production.

The mission visited six states along the lower Niger river and made recommendations that the Oramirukwa river basin in Imo State and the Orle-Edion river basin in Bendel State be taken up for the rice development project areas.

The recommendation was accepted by the Government of Nigeria and the present mission was despatched to Nigeria in November 1976 by Japan International Cooperation Agency (JICA) to execute the feasibility study for the recommended rice production projects.

1.2 Objectives and Scope of Work

The objectives of the study are to formulate the rice development projects in the Oramirukwa river basin in Imo State and the Orle-Edion river basin in Bendel State by conducting field survey and to analyze the project feasibility from technical, economical and financial view points.

The scope of work is divided into two stages, namely, field work in Nigeria and home work in Japan. The field work was conducted for selection and delineation of the project areas by collecting and review of relevant data and information and by execution of field surveys. The home work is carried out for the following studies and analyses:

(1) To determine definite layout of the projects;

(2) To formulate rice-oriented agricultural development plans;

(3) To prepare basic designs of the projects;

(4) To prepare an implementation schedule of the projects;

(5) To estimate the costs and benefits of the projects; and

(6) To make economic and financial evaluations.

The results of the study are compiled into the present Feasibility Report on the Agricultural Development Projects in Imo and Bendal States, consisting of the following volumes.

- Main Report
- Study Report
- Appendix

1.3 Acknowledgements

Grateful recognition is made for the cooperation and assistance during the field investigation, the collection of information and data and the execution of the surveys provided to the survey team by officials of the Federal Government of Nigeria and the Local Governments of Imo and Bendel States, other governmental authorities concerned, private organizations and individuals. Thanks are due to all of them.

2. BACKGROUND

2. BACKGROUND

2.1 National Economy

With an area of about 930,000 km^2, the Federal Republic of Nigeria maintains a population of about 75 million. Gross Domestic Product (GDP) of the country attained about ₦16,000 million in 1975 and its net annual growth rate was about 7% during the past five years. Per capita GDP was around ₦200 which indicates the country remains low among developing countries. Agriculture sector is still the most important sector in the national economy producing about one quarter of the GDP and providing an employment opportunity for some 70% of the labor force although oil sector is a dominant sector in terms of contribution to GDP and exports.

In 1975, total exports amounted to ₦4,900 million out of which petroleum represented about 90%. Main agricultural exports are cocoa, palm kernel, rubber and groundnuts and all the agricultural products were estimated to contribute by about 5%. Total imports attained ₦3,700 million and the balance of trade amounted to ₦1,200 million in 1975.

2.2 Regional Economy

Imo State was newly established from the former East Central State in February 1976. The state, bounded by Bendel, Rivers, Anambra and Cross River States, is one of the most densely populated area with a population of about 5.1 million on an area of 12,700 km^2. The population density is estimated at around 400 per km^2 in 1976. Although the Imo State is one of the principal oil-producing areas of the country maintaining some industrial establishments,agriculture is the most important sector in the economy, which provides employment for more than 70% of the labor force and about 90% of the rural employment. The agricultural production is characterized by its low productivity as well as subsistence level. Most of the land are devoted to food crops production and yam, cassava, cocoyam, maize and rice are the main products in the state. Population pressure in the state affects the agricultural production considerably by shortening fallow period and decreasing fertility of the land.

Bendel State, former Mid-Western State, is located mainly in the rain forest region bounded by Ondo, Kwara, Benue, Anambra, Imo and Rivers States. Total population is about 3.2 million with an area of 38,000 km^2 and the population density is around 80 per km^2 . As in the case of Imo State, agriculture is the mainstay of the state economy and its importance is reflected in the proportion of the population engaged in farming (more than 60%) and its contribution to GDP (about two thirds of GDP). Major food crops cultivated in the state are yam,

cassava, maize and rice. Tree crops such as rubber, oil palm and cocoa are also important in the state; the state is the second largest producer of palm oil and produces about 85% of the nation's rubber.

2.3 Agricultural Sector

2.3.1 Agriculture in General

As mentioned above, agriculture including livestock, forestry and fishery is the most important sector in the country. Production of a wide variety of crops and animal products is one of the predominant characteristic of the agriculture in the country. Agricultural activity is highly specialized by region from North to south because of the different climatic and other environmental conditions. As well as its low productivity domestic market orientedness is a distinctive character of the agriculture. Over 90% of the agricultural products are entirely consumed in the country, while only some portions of tree crops such as cocoa, palm kernel, palm oil and rubber are exported.

During the past five years from 1970 to 1975, production increase in the agricultural sector was not satisfactory. The annual growth rate was only 1.3% which is far below the increase rate of population and contrasts with the economic growth rate of 7.0% in the country. Production of food crops has not kept pace with the population growth during the period, which is reflected in the continued increase in food prices as well as rising in food imports. The import of food increased to about N300 million in 1975 from an average of about N50 million per year in early 1960's.

Agriculture both in Imo and Bendel States is also characterized by traditional farming, which is represented by shifting cultivation and mixed cropping using a few simple hand tools. The yields of major food crops remain low because of an insufficient use of improved seeds and agro-chemicals.

2.3.2 Rice Production

Rice is planted on about 270,000 ha or about 10% of the farmland in Nigeria. The production is estimated at about 500,000 tons in 1974/1975. Most of the rice is cultivated in the alluvial plains in the Niger and the Benue river basins. Yields are low, in general, of less than 2 t/ha on an average due to low yield potential of the local varieties, limited chemical application and poor water control together with the traditional cultural practices. All the products are consumed domestically. In addition, about 6,000 tons of rice is imported annually for meeting the domestic demand.

In Imo State, rice is planted on the inland and rainfed swamps in the Imo river and Cross river basins. In the area, rice development projects are now under implementation sponsored by IBRD and ADC. Most of the rice produced in the state is swamp rice and its productivity is generally low. Total production was estimated at about 130,000 tons/1 in 1974/1975.

In Bendel State, rice is cultivated mainly in the flood plain of the Niger river. The cultivation area was about 24,000 ha and rice production was around 34,000 tons in 1974/1975. In addition to the rice cultivation made by small farmers in the flood plain or the upland, mechanized rice production is now being implemented by the estate farms such as the Warrake Farm, Tiffany Farm, Agbede Farm and Alegbette Farm under the responsibility of the Bendel Food Production Board of Bendel State.

/1 Includes the products both in Imo State and Anambra State.

3. THE OWERRI PROJECT

3. THE OWERRI PROJECT

3.1 The Project Area

3.1.1 Location and Topography

The Owerri Project area is located in the south-western corner of Imo State about 10 km south of Owerri, where the capital of the state is situated.

The area consists of about 2,600 ha of land extending south-west between the Oramirukwa and the Otamiri rivers. To the north of the area there runs the Federal highway A-6 linking Owerri to Aba and, further, to Port-Harcourt with distances of about 40 km and 60 km respectively. The southern boundary of the area extends close to the border between Imo and Rivers States. Administratively, the area belongs to the Owerri District of the Owerri Local Government Area.

The area is gently undulating sloping downwards from north-east to south-west with an average gradient of 1:500. The ground surface elevation is about EL 64 m in the north and about EL 52 m in the south. There is no significant gully or depression within the area. Topographically, the area is provided with favourable conditions for irrigation and drainage.

3.1.2 Meteorology and Hydrology

1) Meteorology

Tropical climate prevails in the area, which is governed by two seasonal winds i.e., moist south-west wind from the sea and dry north-east Trade and "Hamattan" winds. A year can be divided into the wet season and the dry season.

The wet season lasts approximately seven months from April to October and the dry season, five months from November to March. Usually there is a short lull of the rainfall in August. According to the meteorological observation at Owerri, the annual rainfall averages at about 2,420 mm of which 88% is concentrated in the wet season. Number of the rainy days reaches to about 140 days per year. The design drought rainfall, which is used as the basis of the present irrigation planning, is estimated at 2,100 mm per annum with an occurrence probability of 20% or once in five years.

The monthly mean temperature is about 26°C throughout the year without noticeable variation. The monthly mean sunshin hours range from 2.5 hours per day in the midst of the wet season to about 6 hours per day in the dry season. The relative humidity is quite high averaged at about 80%. No evaporation data is available at Owerri. From the data at Umudike, about 35 km east of Owerri, the evaporation is estimated at 3-4 mm per day in the dry season and 2-3 mm per day in the wet season.

The climatic data concerning the project area are summarized in Table 1.

2) Hydrology

The Oramirukwa river is proposed as the source of irrigation water for the project. As shown in Fig. 1, it is originated in the plateau around Okwele (about EL 120 m), flows to southward across the Owerri-Umuahia and Owerri-Aba highways and pours into the Otamiri river which is one of the tributaries of the Imo river. The length of the river is about 40 km with the catchment area of 630 km^2 around the project area. The longitudinal slope of the river is about 1:1,000 on an average.

The water level gauging has been carried out at the above-mentioned crossing point with the Owerri-Umuahia highway since 1973 by the Agricultural Engineering Division of MANR, Imo State. From the result, the discharge of the river is estimated. The monthly mean discharge increases from April, reaches to the maximum of 11.8 m^3/sec in October and declines abruptly in November. The monthly mean discharge reaches to the minimum of 3.4 m^3/sec in March. Using the relation between these estimated discharges and the rainfall during the same period, the available discharge for the project is estimated under the 20% drought condition as shown in Table 2.

Although there still remain much to be clarified due to the scarcity of data, the water from the river seems to be enough for irrigation purpose of the project. With regard to the peak flood discharge, no data is available except information from nearby inhabitants. Therefore, references have been made to other rivers having the same flow characteristics. A rough estimate of the probable peak flood shows that the peak flood is 115 m^3/sec, 150 m^3/sec and 160 m^3/sec with the respective occurrence probability of 20%, 2%, and 1%.

3.1.3 Soil and Land Capability

The soils in the project area consist of weathering materials of Coastal Plains Sand. They are classified into Latosols of Oxisol Orthox according to 7th Approximation of U.S.D.A. and divided further into Loamy Soil Type and Sandy Loam Type. The former type of soils, extending over an area of 1,500 ha, have sandy loam to loamy texture in the surface and loamy texture in the sub-surface, whereas the latter type of soils occupies an area of 1,100 ha, which are featured by sandy loam texture throughout the solum.

With regard to chemical and physical properties, soils in the area have PH values ranging between 4.1 and 5.0 for H_2O and between 3.5 and 3.9 for N-KCL solution. The cation exchange capacity is very low ranging from 7.8 to 19.0 milli-equivalent per 100 grams of soil. The base saturation degree shows less than 10%, and the humus content of the surface soil is about 2% which decreases in

proportion to depth. Although the soils in the area seem to have relatively high permeability, they are considered to be suitable for the paddy field.

In due consideration of the properties of the soils and the topography, all of the land of the project area is classified into very suitable or suitable land for irrigation paddy cultivation.

3.1.4 Agricultural Setting

1) Population and land tenure system

Total population in the Owerri Project area including 6 villages located in the project area or adjacent to the project area is estimated at about 6,400 with the population density of 250 per km^2. Agriculture is the most important sector of the local economy and about 90% of the working population is now engaged in agricultural production.

The lands in the project area are held mainly by the community and kindred, while the lands owned by private farmers are quite limited. Average farm size is about 1.0 ha and the average family size is 6-7 persons in which about 3 workers are included. Their cultivated lands are generally fragmented and different plots are widely scattered.

2) Land use

Present land use in the Owerri Project area is estimated on the basis of the available aerophotos supplemented by checking field survey. The results are presented in Fig. 2.

Out of the total project area of 2,600 ha, 56% is allocated for scrub and grassland, 28% for cultivated land, 15% for light forest and the remaining 1% for non-agricultural land such as villages and roads. Main crops planted in the cultivated area are cassava, yam, maize and cocoyam which are supplemented by vegetables such as melon and beans. Rice is not cultivated in the project area.

3) Cropping calendar and farming practices

Major food crops in the project area are planted, in general, from early March to May in parallel with start of the wet season, and harvested during the dry season. The cropping calendar is, therefore, completely dependent on the rainfall condition. Typical cropping calendar for the major food crops in the project area is estimated on the basis of the collected data and field survey, which is presented in Fig. 3.

Shifting cultivation is the prevailing practice of the agricultural production with the fallow period of 3 to 4 years. The cultivation is made by traditional method using mainly man-power supplemented by a few agricultural tools such as cutlass and hoe. Fertilizer and agro-chemicals are not generally applied.

Mixed cropping is the most predominant cultivation system in the project area with root crops such as yam, cassava and cocoyam being grown on raised mounds and other crops, mainly maize, planted on the side of or between the mounds.

4) Farm crop production and farm economy

The estimated yields for the major crops are 7.5 t/ha for cassava, 7.0 t/ha for yam, 0.6 t/ha for maize and 3.1 t/ha for cocoyam. The yields are generally low due to the mixed culture and lack of fertilizer and plant protection. Total products are 5,400 tons of cassava, 1,680 tons of yam, 192 tons of maize and 220 tons of cocoyam.

Livestock breeding is not popular in the project area. But a few number of small stocks such as fowls, goats and pigs are kept by most farmers mainly for their consumption.

Farm economy in the project area is, in general, based on the root crops and cereal crops supplemented by tree crops. Farmers get their incomes mainly from selling the surplus crops and income from non-farm activity is negligible.

For typical farmers holding about 1.0 ha of the cultivated land, gross annual farm income/1 is around N883, annual farming expenses are N88 and annual living expenses are N781. Net reserves or the difference of the gross income and the gross outgo including farming expenses and living expenses are estimated at only N14 per year.

The net reserves are negligibly small indicating that the farm economy in the project area is on the subsistence level.

5) Marketing and institutions

Marketable surplus of the food crops is brought to the local market by farmers themselves and traded there through middlemen. Most of the food crops are traded in the form of raw materials except rice which is sold both as paddy and rice. Major export crops such as palm oil, cocoa and coffee are purchased mainly by the Marketing Board which is responsible for collecting these crops through the Licensed Buying Agents at the fixed price.

With respect to processing and storage facilities, they are barely sufficient even for the present low production level in the project area. There are a few number of cassava grating machines but no rice mill. Most of the agricultural products are stored in and around farmer's house and there is no special storage facilities. Under these situations, improvement of the processing and storage facilities is required for raising farm income by selling the products on favourable conditions.

/1 Total products multiplied by the farm gate price plus income from tree crops.

MANR of Imo State is responsible for agricultural extension service and research. The extension services are being provided through the divisional agricultural officer of MANR. There are about 13 extension workers in the Owerri Local Government Area, in which one to two extension workers are now engaged in the Owerri Project area. However, the extension services have not been satisfactory due to the shortage of the staffs and finance.

There are various agricultural credit schemes introduced through MANR in collaboration with the Ministry of Trade, Industry and Cooperatives and NAB in Imo State. But most of them have not been operated successfully partly due to poor management and partly due to insufficient financial resources. Facing this problem, Imo State is now launching on a new agricultural credit scheme called "Supervised Agricultural Credit Loans" providing credit with technical supervision for individual and cooperative farmers.

Agricultural cooperative activity has been promoted by the Ministry of Trade, Industry and Cooperatives as well as MANR. However participation of the farmers into Farmers Multipurpose Cooperative Societies is quite limited and only less than 5% of the farmers are involved.

3.2 The Project

3.2.1 Basic Concept

The Owerri Project aims to increase food crop production through the construction of the estate farm and to raise farm economy in the region through the development and extension of the rice cultivation to the small holder area.

For attaining these objectives, irrigated rice development plan is formulated on about 2,100 ha of the land. Rice is selected as the most suitable crop from the viewpoints of economical water use, profitability, and marketing. Mechanized farming is proposed for the operation of the project from the stage of land preparation to harvest. The farm mechanization intends to promote the efficient operation of the estate farm and to reduce the peak labor requirement on farm.

Out of the total irrigable area of 2,100 ha, 1,015 ha will be allocated to the estate farm and the remaining 1,085 ha to the small holder area. The allocation is made taking into account the economic scale of the estate farm, number of farm families, present land tenure, farm economy and labor requirement for the irrigated rice cultivation.

Project works to be required for materializing the development will include the construction of intake weir on the Oramirukwa river, the construction of irrigation canals, drainage canals and the related structures, farm road construction and paddy field construction. Installation of rice mill and storage facilities also constitutes an integral part of the project works.

For implementing the project, Owerri Project Office will be established in the estate farm, which will be responsible for the construction of the project works and operation of the estate farm. In the small holder area, Agricultural Cooperatives will be established organizing all the farmers to be involved for introducing the mechanized irrigation farming smoothly and realizing the expected increase in rice production efficiently.

Upon completion of these project works, land use will be changed completely and 2,100 ha of the land will be turned into irrigated land on which complete double cropping of rice will be introduced. Through the introduction of the irrigation farming together with the application of improved seeds, fertilizer and agro-chemicals, the productivity of rice will attain 5.0 t/ha of paddy in the small holder area and 4.5 t/ha of paddy in the estate farm at the full development stage of the project. Total annual production of rice will be about 14,000 tons or 20,000 tons of paddy.

3.2.2 Agricultural Development Plan

1) Proposed land use

Upon completion of the project works including paddy field construction and irrigation facilities, land use of the project area is expected to change considerably. Most of the scrub and grass land and the light forest will be reclaimed. About 81% of the total project area or 2,100 ha will become the irrigated land, while 370 ha will be allocated to the irrigation facilities and farm roads.

Irrigated paddy production will be introduced for all the irrigable area. Traditional crops such as yam, cassava, cocoyam and maize which are to be excluded from the irrigated area will be planted around the village and in the area outside the project area for home consumption.

2) Proposed cropping pattern

Rice is selected as a main crop for the irrigated farming. The selection is made in view of the profitability of rice, marketability and the farmers' incentive for rice production. For determining the proposed cropping pattern, climatic and soil conditions particularly in the wet season are carefully considered from the viewpoint of introducing mechanized farming.

The proposed cropping pattern is complete double crops of paddy intercropped with green manure as illustrated in Fig. 4. Wet season paddy will be planted from June - September and harvested from October - January. Dry season paddy will start one month after the harvest of the wet season paddy. Green manure will be planted after the harvest of the dry season paddy for improving organic contents of soils and maintaining the expected high yield. Through the introduction of the complete double cropping of paddy, cropping intensity of the Owerri Project will reach 200%.

3) Proposed farming practices and operation

Since the project area is relatively densely populated area and includes farm lands of the small farmers, the Owerri Project will include the development of the estate farm and the small holder. In due consideration of the economic size of the estate farm, optimum farm size per one farm family and available manpower for farming, 1,015 ha is allocated to the estate farm and the remaining 1,085 ha is allocated to the small holder with a rate of about 1.2 ha per each family.

Merchanized farming is proposed principally both for the estate farm and the small holder area. However, the mechanization for the small holder will be limited to partial operations such as land preparation and harvesting to rice milling to utilize the available manpower of each farmer, while complete mechanization will be practiced in the estate farm. The proposed farming practices both for the estate farm and small holder area are explained below.

Estate farm

For seeding method, direct seeding will be basically applied for the estate farm to reduce the labor requirement. However, transplanting will be partially practiced in the pilot scheme area for training farmers.

Land preparation will be made by using machinery. Paddy field will be plowed and harrowed after cutting weeds and burning. After puddling work, the seeds will be planted by using broad caster in shallow depth with the seed rate of 100 kg/ha. The seeds will be sterilized by agro-chemicals prior to the seeding.

Fertilizer application and plant protection are essential farming practices for attaining the anticipated high yield. Design volume of the fertilizer and agro-chemicals is estimated on the basis of the experience of the similar project in Anambra State and in Japan. Application of the fertilizer and agro-chemicals will be conducted basically by using machinery. The compound fertilizers will be applied as the basic fertilizer at the puddling time, while the urea will be applied at three different growth stages of rice, namely, about three weeks after seeding, at panicle formation stage and at heading stage. Agro-chemicals to be applied are herbicide, insecticide and fungicide. Weeding will be done three times by using herbicide such as Saturn and Stam. Insecticide will be applied mainly against stem-borer and leaf-hopper. Fungicide will be used for protecting plant from diseases at the panicle formation stage.

Irrigation water control is another important farming practice to ascertain the expected high yield. The irrigation water control will be carried out by the staff in the estate farm corresponding to the growing stage of the rice.

Harvesting will be conducted by using self-propelled type combine. The harvested paddy will be transported to rice mill for the processing.

Small holder area

Operation of the farm in the small holder area will be partially mechanized being supplemented by manpower of the farm families. Machinery services for land preparation, agro-chemicals spray and harvesting to rice milling will be provided by the estate farm, the cost of which will be paid by farmers.

Before starting the land preparation of the main paddy field, nursery bed will be prepared. The area for the nursery bed will be 400 m^2 per ha or 1/25 of the main field. The nursery period will be about 20 days. The seed rate is designed to be 35 kg/ha. Land preparation including weed cutting, burning, plowing and harrowing will be carried out by machinery in the same way as applied in the estate farm. Farmers in the small holder area will be involved in this work as assistant laborers.

Transplanting will be carried out by manpower. Labor requirement for the transplanting is estimated at 50 mandays/ha. Seedling will be transplanted to the main paddy field in shallow depth.

Application of fertilizer and agro-chemicals in the small holder area will be almost the same as that in the estate farm both in terms of volume and application timing. However, most of the application work will be carried out by manpower except the application of the insecticide and fungicide, which will be conducted by using machinery of the estate farm.

Irrigation water control for the whole project is to be made principally by the estate farm. But, the water control under the tertiary canals for the small holder area will be conducted by farmers themselves. Method of the water control on farm to be applied in the small holder area is almost the same as that of the estate farm.

Harvesting of the paddy will be made by the estate owned combine. Farmers in the small holder area will be engaged in the harvesting work as assistant laborers. The harvested paddy will be transported to the estate farm and milled there. All the paddy to be produced will be purchased by the estate farm except farmers' consumption.

4) Farm inputs and farm machineries

Farm inputs

Selection of the varieties of paddy has been made in view of resistance to lodging, growth period, yield and disease tolerance on the basis of the experimental results conducted by IITA and Uzo Uwani Pioneer Project, Anambra State. The selected varieties are TOS 103 and BG90-2 which are proved to have favorable features for introducing mechanized farming. These varieties will be tested in the pilot scheme area together with the other promising varieties.

As explained in the preceding section, considerable amount of farm inputs such as fertilizer and agro-chemicals will be required for sustaining the expected high yield of paddy. The design volumes of the fertilizer and agro-chemicals per ha are 200 kg of the compound fertilizer, 129 kg of the urea 30 % or 70 kg of the herbicide, 3 % of the insecticide and 30 kg of the fungicide both for the estate farm and small holder area. Annual farm labor requirement for the operation of the estate farm is about 59,200 mandays, while 252 mandays are required per one farmer holding 1.2 ha in the small holder area.

Farm machineries

Selection of the type of machinery and the estimate of the required number are made in due consideration of the climatic and soil conditions of the project area. The proposed type of the machineries is shown in Table 3, together with the required numbers. A workshop will be constructed for the efficient operation and maintenance of the project, which is to be equipped with necessary equipment and tools.

5) Rice mill and storage facilities

For processing, keeping the products in good quality and marketing them on favorable conditions, rice mill and storage facilities will be installed for the project. The proposed number of the rice mill is 3 with the capacity of 1.5 t/hr each, assuming that workable days of the rice mill are 300 days per year and the operation hour is 16 hours per day. Milling efficiency will be raised to 70% from the present 50 - 60% at the local mill.

The storage facilities to be installed will be the one with the capacity of about 7,000 tons of rice, which will be enough to accommodate the products during one crop season. Detailed features of the rice mill and the storage facilities are presented in Table 4.

6) Anticipated crop yield

Upon completion of the project works, productivity of rice is expected to increase considerably through the introduction of irrigated farming using improved seed, fertilizer and agro-chemicals. The anticipated yield is estimated at 4.5 t/ha of paddy for the estate farm (direct sowing) and 5.0 t/ha of paddy for the small holder area (transplanting) at the full development stage. The estimate has been made on the basis of the experimental data of the similar projects in Anambra State and IITA. It is assumed that the yield under direct sowing method will be about 10% less than that under transplanting method from the experience in Japan and the experimental data in Anambra State.

The yield of rice will increase gradually corresponding to the increase in land productivity and will attain the anticipated yield in the 5th year for the estate farm and 7th year for the small holder area after completion of the irrigation facilities. It is expected to take longer time for attaining the target yield in the small holder area as the farmers in the area are not accustomed to irrigated farming and have to accumulate their experience and knowledge of irrigated rice cultivation.

Anticipated total production of rice is estimated at about 14,000 tons (20,000 tons of paddy) at the full development stage in 1988.

7) Pilot scheme

Since the Owerri Project is a pioneer project for irrigated farming in the region and farmers in the project area are not accustomed to irrigation, establishment of the pilot scheme is indispensable for successful operation of the project. Particularly, as the project allocates large portion to the small holder area, the farmers are required to be trained intensively in the pilot scheme for the development.

The primary objectives of the pilot scheme are a) training and demonstration of mechanized irrigation farming to project staffs, extension workers and key farmers to be involved in the small holder area, b) agronomic research on rice cultivation, and c) seed multiplication.

The proposed site for the pilot scheme will be in the north-east corner of the project area. The size of the pilot scheme will be about 50 ha which will consist of 2 ha of the agricultural research field, 20 ha of the seed multiplication field and 28 ha of the training field.

3.2.3 Project Works

1) General

For materializing the agricultural development mentioned in the preceding section, the following project works are needed: i) construction of irrigation facilities including an intake weir on the Oramirukwa river; ii) construction of drainage facilities; iii) establishment of farm road system; iv) land reclamation and construction of 2,100 ha of paddy field; and v) installation of processing and storage facilities including construction of the related facilities to the proposed project office. The principal features of these works are summarized in Table 5.

2) Irrigation facilities

Irrigation system

The irrigation system will consist of the simple run-of-river type intake weir, a head race, main and secondary canals, tertiary and supply canals. With this canal system completed, systematic irrigation water control will be established within the area consistently from the intake to each of the terminal irrigation units.

Diversion water requirement

The diversion water requirement for the irrigation, which is used as the basis for determining the capacities of these irrigation facilities, is estimated as summarized in Table 6. /1 The estimated diversion water requirement is 3.0 m^3/sec or 1.43 l/sec/ha on the monthly mean basis.

Intake weir

The proposed weir is to be constructed on the Oramirukwa river about 4 km upstream from the bridge of the Owerri-Aba highway in due consideration of the ground surface elevation of the proposed irrigation area and the required effective head. At the site, width of the river is about 20 m with the flood plain extending about 180 m. The river bed is constituted of the top soil and the underlying alluvial layer.

/1 Refer to Chapter 6.2 of the Study Report.

The top soil consists of grey organic soft mud with a depth of about 1.5 m, while the underlying alluvial deposits are composed of grey sandy loam and sand. The bearing strength of these deposits will be enough for supporting the embankment of a few meters high.

In due consideration of the geological condition of the river bed, the floating type concrete gravity weir is proposed to be constructed. The crest elevation will be El. 67.5 m, and the weir will be 5.5 m high and 45 m long. In the right end of the weir, a scouring sluice with 1 set of gate, 1.5 m wide and 2.2 m high, will be equipped Embankment will be needed for both sides of the weir. The right side embankment consists of low dike of 250 m long and 3 m high at maximum and the left side embankment with a length of 207 m and a height of 6 m at maximum. The intake structures will be constructed on the right bank equipped with 2 sets of sluices, each of 2.0 m wide and 1.5 m high.

Irrigation canals and related structures

The head race will be constructed for conveying irrigation water from the intake structures to the project area where the irrigation water is delivered to the tertiary canals through main or secondary canals. The tertiary canals will be diverted from the secondary canals with an interval of about 500 m and will supply water to the irrigation unit of 30-80 ha. Distribution of water within the unit will be made by the supply canals to be branched off from the tertiary canals with an interval of 225 m. (General layout of the canals is shown in Dwg. No.01)

All the canals will be of trapezoidal earth type with dimensions ranging from 2.50 m to 0.30 m of the bottom width and from 2.0 m to 0.6 m of the height. The hydraulic gradient varies from 1/6,000 on the head race to about 1/2,000 on the tertiary canals.

Since the canals are to run across the rivers, streams, and roads, many related structures such as flumes, culverts, and cross drains will be needed. In addition to these structures, turnouts, checks and spillway structures will also be needed to distribute water or to secure the rational water management. Required number of these structures is 208 culverts, 153 cross drains, 432 turnouts and 3 spillways.

3) Drainage facilities

The proposed drainage system will consist of collector and field drains. The drained water from every plot of paddy field will be discharged into field drains and, further, into the collector drains.

The drainage requirement is designed in such a manner that excess water on the paddy field will be drained out within 36 hours. The excess water will come out by the maximum daily rainfall of 100 mm, which will occur once in five years. All the drainage canals have trapezoidal section with a side slope of 1 : 1.5.

4) Road

The proposed road system consists of two types of roads, i.e., main road and branch road. Main road will run along the main and the secondary irrigation canals and serve as the main artery in the area and transportation between villages. While, the branch road will be laid along the tertiary and supply irrigation canals and used mainly for farming purposes. The project area will be covered by the proposed road net work with an average grid of 225 m x 500 m.

The main road will have an effective width of 7 m with laterite pavement of 30 cm thick. The effective width of the branch road is 5 m with laterite pavement of 20 cm thick. Total width will be 10 m for the main road and 7 m for the branch road.

5) Paddy field

A typical layout of paddy field proposed for the project is presented in Fig. 5.

The terminal irrigation unit will be commanded by one supply canal and will consist of 12 plots of paddy field. The land surface of the project area is rather flat with an average slope of 1 : 500 and hence, size of the plot is decided mainly from the viewpoints of water management and the size of land holding by farmers. Proposed size of one plot is 40 m x 100 m.

6) Processing, storage and office facilities

As explained in the preceding section, the rice mill and the storage facilities will be constructed, which will consist of: 3-receiving equipment (3.5 t/hr); 3-drying equipment (10 t/hr); 3-parboiling equipment (1 t/hr); 3-milling equipment (1.5 t/hr); 5-storage equipment (1,000 t bin); 3-power supplying equipment (200 KVA);and buildings to accommodate them.

The facilities related to the project office comprise project office, garage and training center, housings for staff, warehouses, workshop, motor pools, etc. Total floor area will amount to about 9,100 m^2. These facilities, together with the processing and storage facilities, will be constructed in the vicinity of the proposed pilot scheme area.

3.2.4 Project Organization

1) General

For the early realization of the project, most appropriate organization shall be established from the stage of financial arrangement for necessary coordination between various governmental organizations, to the stage of the project construction and its operation. Referring to the similar projects in Nigeria and experience in Japan, an efficient organization is proposed in this section.

The proposed organization will consist of three components, namely, a Project Coordination Committee, Owerri Project Office and Agricultural Cooperatives. The Project Coordination Committee will be initially established for executing necessary arrangement including the financial arrangement. A project executing organization, the Owerri Project Office, will be installed through the arrangement of the Project Coordination Committee, which will be responsible for the project construction and its operation and maintenance. In the small holder area, the Agricultural Co-operatives is proposed to be established for introducing the irrigated farming most efficiently. For coordinating the activity between the project executing organization and the Agricultural Cooperatives, a Farm Operation Committee will be established. (Overall project implementation organization is illustrated in Fig. 6.)

2) Project Coordination Committee

The Project Coordination Committee will be organized prior to establishment of any project executing organizations. The Committee will be responsible for establishing the overall policies, implementation planning, financial arrangement and coordination between various governmental organizations. The Project Coordination Committee will also be in charge of supervisory services and guidance to the project executing organization for the operation of the project.

3) Owerri Project Office

For the execution of the project, a project executing organization will be established in the project area under the guidance and arrangement of the Project Coordination Committee. The executing organization, tentatively called Owerri Project Office, will be responsible for implementation of the project construction and its operation and maintenance.

The function of the Project Office is to cover all the construction of the project works and the operation of the estate farm. The Project Office will also be in charge of distributing agricultural inputs and providing machinery services and extension services to the small holder area. As farmers in the Owerri Project area have no experience in rice cultivation and the extension services in the State are still insufficient to handle the large scheme, the extension services are, in particular, the important function of the Project Office.

For executing these functions, the Owerri Project Office, headed by Project Manager, will have six departments such as Engineering, Production, Extension Services, Farm Machinery, Processing and Marketing and Administrative.

Required number of staffs is estimated us presented in Study Report. Since there exists an acute shortage of experienced personnel in the country, some specialist staffs will have to be recruited from abroad for the successful operation of the project.

4) Agricultural Cooperatives

The Agricultural Cooperatives will be established organizing all the farmers to be involved in the small holder area. The establishment of the farmers' cooperative organization aims to introduce mechanized irrigation farming smoothly into the small holder area and to attain the expected increase in rice production most efficiently.

The Agricultural Cooperatives will be organized principally on the basis of the irrigation system in due consideration of the village size. In the Owerri Project area, about 19 Farmers Cooperative Units will be established, each of which consist of 40 - 60 farmers. The Farmers Cooperative Units will be integrated into two Branch Agricultural Cooperatives which will be further integrated into one Federal Agricultural Cooperative.

The function of the Agricultural Cooperatives will include various services related to the irrigated farming such as irrigation water control, distribution of farm inputs and promotion of joint cultivation. For maintaining good coordination and cooperation between the Project Office and the Agricultural Cooperatives, a Farm Operation Committee will be established.

3.3 Implementation Schedule and Construction Plan

3.3.1 Implementation Schedule

The implementation schedule of the project is bar-charted in Fig. 7. It is prepared based upon the following conditions:

(1) Mapping works of the project areas will be started in October 1977 upon arrival of the dry season and be finished in three months;

(2) Detailed design works of the project will be started following the completion of mapping works and be finished in six months;

(3) In parallel with the detailed designs, procurement of construction machinery and equipment will be started partially;

(4) Upon completion of the detailed designs, construction of the project works will be started and be completed in four and a half years;

(5) Except for minor on-farm structures, all the construction works will be executed by using construction machinery and equipment; and

(6) Workable days for the construction are 210 days per year.

Commencement of construction of the project works will be in July 1978 and completion of the whole construction works will be at the end of December 1982. However, since the intake structures and head race will have been constructed and commissioned by May 1980, partial operation will become possible after that time on. According to the proposed reclamation schedule and cropping pattern, initial operation will be made on about 400 ha including 50 ha of the pilot scheme in 1980. The area under operation will be 950 ha in 1981, 1,820 ha in 1982 and 2,100 ha in 1983.

3.3.2 Construction Plan

In view of unavailability of competent contractors for this kind of construction works, it is proposed that the project works be constructed on the force account basis of the Government or the project executing organization to be established. As the mechanized construction of paddy field is still unfamiliar to Nigeria, technical guidance by well-experienced foreign experts will be necessary.

Major construction works consist of headworks for intake of irrigation water, irrigation and drainage canals, farm roads,

and paddy field of 2,100 ha. The works involve substantial amounts of earth-moving works in rather short construction period. It is, therefore, proposed that construction machinery and equipment be used extensively. For each of the major works, the construction plan is explained as follows.

1) Headworks for water intake

The main works comprise the constructions of a concrete fixed weir with the downstream apron, sand scouring sluice, intake structures, and right and left banks' embankments. The construction will be done in two dry seasons from September 1978 to the end of March 1980.

The construction works will be carried out in two steps in accordance with the diversion procedure of the river water. In the first dry season in 1978/79, the diversion canal and coffer dams will be constructed. After the diversion of the river water, the weir and related structures such as the apron, sand scouring sluice, and intake structures will be constructed. In the second dry season in 1979/80, the river water is diverted again by the conduits through the weir, and the embankment works will be executed. The embankment volume is estimated at about 32,000 m^3, of which materials will be available from the hill on the left bank.

2) Irrigation canals

The irrigation canals consist of a head race of about 16 km, secondary canals of about 11 km, tertiary canals of about 51 km and supply canals of 219 km. In order to expedite the commencement of the project operation, major canals such as the head race and the secondary canals are scheduled to be completed in about twenty months from August 1978 to April 1980. Construction of the tertiary and supply canals will be made in four years from the beginning of 1979 to the end of 1982 keeping pace with the development schedule of the paddy field.

Mechanized construction method will be applied to the head race, secondary canals and a part of the tertiary canals, while most of the tertiary canals and supply canals are to be excavated by manpower.

3) Drainage canals

The drainage canals consist of collector drains of 26 km and field drains of 110 km. Since the collector drains are to be laid in lowland and natural depressions, the excavation works will only be possible in the dry season. It is scheduled that these drains be constructed in four dry seasons from 1979 to 1982 using construction machinery. The field drains are minor ditches and the construction will be continued even in the rainy season mainly by manpower. It will span four years from the beginning of 1979 to the end of 1982 keeping pace with the construction schedule of the paddy field.

4) Farm roads

Two types of farm roads are proposed i.e., the main farm road of 20 km and the branch farm road of 150 km. In order to facilitate easy access to the construction sites, these roads are scheduled to be constructed in the early stage of construction by the end of 1980.

All the roads are to run along the canals so that the excavated soils of canals will be used as the road bed. The laterite, which will be used for surfacing materials, will be available from nearby hills.

5) Paddy field

Paddy field construction needs a considerable amount of elaborate earth-moving works and will be vital to the successful implementation of the project. By using construction machinery at the maximum extent, 2,100 ha of total paddy field will be reclaimed in four years from the beginning of 1979 to the end of 1982. The yearly schedule of the reclamation will be 600 ha in 1980, 700 ha in 1981, and 800 ha in 1982.

The paddy field construction works consist broadly of tree felling and removal of roots, terracing, minute levelling and plot border construction. All these works will be executed by using mainly bulldosers of 21 - 15 ton class.

3.4 Cost Estimate

3.4.1 General

The cost for the implementation of the Owerri Project is estimated on the basis of the preliminary design of the project works taking into account the construction method to be applied, productivity of labor and machineries with the following assumptions:

a) Major construction and farm machineries and materials such as steel, fertilizer and agro-chemicals are to be procured by international competition bidding;

b) Cost for the construction machinery is valued by the procurement cost;

c) Construction of the project works will be made by Force Account of the Government or project executing organization;

d) Compensation cost for the crops which are planted on the proposed head race area will be paid to farmers;

e) Physical contingency of the cost estimate is about 15% for the direct construction cost and 5% for the procurement cost of the machineries and equipment;

f) Price contingency applied in the estimate is: 7.5% in 1978; 7.5% in 1979; 7.0% from 1980 onwards for foreign currency portion and 15% in 1978; 15% in 1979; 10% from 1980 onwards for local currency portion;

g) Price level for the cost estimate is principally mid-1977; and

h) All the conversion rate from US$ to ₦ is ₦1.0 = US$1.58.

3.4.2 Project Cost

Total project cost for the Owerri Project is estimated at ₦22.64 million comprising the foreign currency portion of ₦11.05 million equivalent and the local currency portion of ₦11.59 million. A summary of the total project cost is given in Table 7 and its annual disbursement schedule is presented in Table 8.

The project cost consists of (1) cost for the civil works including land reclamation, (2) cost for the processing and storage facilities including project office and its related facilities, and (3) initial farm investment including procurement cost of agricultural machinery. Each of the cost components is briefly shown as follows.

1) Construction cost of civil works

Based upon the assumptions and conditions mentioned above,

construction cost of the civil works is estimated as shown in Table 9. The estimated cost for the civil works is ₦12.65 million consisting of foreign currency of ₦5.68 million equivalent and local currency of ₦6.97 million.

The cost for the engineering services includes the cost required for the detailed design and technical supervision during construction by foreign experts. Contingencies consist of physical contingency and provisions for price escalation, which are estimated on the assumed conditions.

2) Construction cost of processing, storage, office facilities

Cost required for construction of these facilities is estimated at ₦6.22 million including the procurement and installation cost of rice mills. Detailed breakdown is given in Table 10.

In the cost for the office and related facilities, the cost necessary for the related facilities of the pilot scheme is included.

3) Initial farm investment

The initial farm investment comprises the procurement cost of agricultural machinery and farming expenses required for the initial operation of the project. The estimated cost for the initial farm investment is ₦3.77 million. Breakdown of the cost is given in Table 11.

3.4.3 Operation and Maintenance Cost

The operation and maintenance cost (OM cost) is needed annually after the commencement of the project operation. It comprises the costs for: (1) operation and maintenance of the irrigation and drainage facilities, and roads; (2) maintenance of the project office and its related facilities; and (3) overhead and personnel expenses.

At the full operation stage of the project, annual OM cost is estimated at ₦497 thousands as shown in Table12.

3.5 Price Prospects and Benefit Estimate

3.5.1 Marketing and Price Prospects

1) Marketing prospects

In 1974, about 500,000 tons of rice including 6,000 tons of the imports was consumed in whole Nigeria which means that per-capita consumption of rice is equivalent to about 7.0kg. In view of the current shifting of dietary preference from root crops to rice, potential demand for rice would be considerably higher than the present consumption.

Under this situation, the anticipated demand for rice is forecasted on the basis of the present consumption assuming that the consumption of rice will increase corresponding to per-capita income increase and anticipated population growth with the following conditions:

a) Population in the country was 75 million in 1976 and will increase by 2.5% per annum;

b) Present per-capita consumption of rice is 7.0 kg and will increase by the rate of (income elasticity of demand) x (growth rate of per-capita income);

c) Income elasticity for rice is 0.6; and

d) Growth rate of per-capita income is 4.0%.

Results of the estimate are presented in Table 13. In the estimate, total demand for rice is expected to attain 815,200 tons in 1985 and 1,320,000 tons in 1995. The estimated figures are slightly lower than the figures estimated by Federal Ministry of Agriculture and Natural Resources[1], which indicates that the estimate is within a reasonable range.

In order to meet the estimated demand, rice production should increase by around 5% per annum. In the Third National Development Plan, domestic production of rice is expected to grow at an annual rate of 14%. However, the expected growth rate seems to be too much ambitious in due consideration of the past trend and even 5% of the increase per annum could not be attainable without intensive support of the Government for the implementation of rice development projects.

Incremental rice production generated by the Owerri Project is about 14,000 tons in 1988. Taking into consideration the existing potential demand for rice and its future increase, the increased amount will be readily absorbed into the economy with no significant impact on domestic price.

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[1] "Agricultural Development in Nigeria 1973-1985" Federal Ministry of Agriculture and Natural Resources, Joint Planning Committee, Lagos 1974.

2) Price prospects

Farm gate prices of the food crops are estimated both for economic analysis and financial analysis. Economic farm gate prices are estimated basically on the basis of the international market price. The prices of the tradable goods such as rice and maize are evaluated by using the border price/1 taking into account the transportation cost and marketing costs. The economic prices for non-tradable goods such as yam, cassava and cocoyam are estimated based on the production cost plus assumed mark up rate.

Financial farm gate prices are estimated on the basis of the current local market prices by deducting market overhead cost and transportation cost. With respect to the price of rice, the domestic price has increased considerably since 1973. According to the collected information, present local market price of milled rice is around N700-1,000/t, which is considerably high compared with the current international market price of N170-220/t /2. However, in due consideration of the existing strong demand and expected future demand, the present market condition will not change substantially and the relatively high price will continue in the future. Domestic inflationary trend will also sustain the current high price.

Under these assumptions, mill gate price of rice is estimated conservatively at N560/t and N394/t in terms of the financial and economic prices, respectively. Farm gate price of paddy is also estimated at N308/t as the financial price and N251/t as the economic price.

The estimated financial and economic prices of the food crops are presented in Table 14.

The prices of the farm inputs are also estimated both economically and financially applying the same method used in the estimate of the food crops price. Results of the estimate are shown in Table 15.

3.5.2 Estimate of Irrigation Benefit

Project benefit consists of direct benefit and indirect benefit. Direct benefit is the expected net incremental value of the agricultural products through the implementation of the irrigation project, while indirect benefit includes the employment opportunity to be increased, transfer of knowledge and contribution to even income distribution and regional economy as a whole. For the economic evaluation of the project, only the direct benefit is incorporated for the conservativeness of the analysis.

The irrigation benefit is estimated by calculating the net incremental value, which is the difference of the total returns to be produced in the project area between under future without-project condition and future with-project condition.

/1 IBRD forecast price around 1985.
/2 Price of rice FOB Bangkok around 1976.

For the estimate of the irrigation benefit, net income of each crop per ha is firstly calculated on the basis of the estimated economic price and volume for inputs and outputs both on future without-project condition and future with-project condition. It is assumed that present agricultural condition will not change considerably and remain at the present level without introducing substantial investment in the agricultural infrastructure and/or institutions. Results of the calculation are presented in Table 16.

Total returns of agricultural production are calculated by applying the net income per crop per ha estimated above to the cultivated area in the project area. The irrigation benefit for the Owerri Project is thus estimated at ₦2.927 million as the difference of the two total returns which is shown in Table 17.

Build-up period of the irrigation project is assumed at 5 years for the estate farm and 7 years for the small holder area after completion of the irrigation facilities during which the benefit will increase linearly.

3.6 Project Evaluation

3.6.1 General

Project evaluation is made to ascertain the feasibility of the project in view of economic, financial and socio-economic aspects.

The economic feasibility of the Owerri Project is evaluated by calculating the internal rate of return on the basis of the economic construction cost and benefit. Sensitivity analysis is also made with respect to change in the project costs, productivity of rice and price of rice.

Financial evaluation is conducted both from the viewpoints of farmers to be involved in the project and the estate farm. Typical farm budget is analyzed to assess whether the project will have sufficient incentive to the farmers with enough income increase and to assess the capacity to pay. For ascertaining the financial soundness of the project for the project executing organization, profitability of the estate farm is assessed on the basis of the estimated project revenues and the operation cost together with the assessment of financial rate of return.

Socio-economic impacts of the project are briefly assessed in due consideration of the effect of the project on the regional economy.

3.6.2 Economic Evaluation

1) Economic project costs and benefits

Economic project costs

For the economic evaluation, economic construction costs are estimated by applying the following adjustments to the project costs (or financial costs) estimated in the preceding section:

a) Cost for the construction machineries is valued by their depreciation cost instead of the procurement cost;

b) Compensation costs for land acquisition are excluded;

c) Price contingency for the construction cost is excluded;

d) Shadow exchange rate of ₦1 = US$1.27 is applied instead of the official rate for conversions from US$ to ₦;

e) Wage of the unskilled labor is shadowed at 60% of the current wage rate; and

f) Import taxes on the construction machineries are excluded.

Through these adjustments, the economic construction costs of the Owerri Project are estimated at ₦14.37 million consisting of ₦8.556 million of foreign currency portion and ₦5.814 million of local currency portion.

The estimated costs are summarized into Table 18 and its annual disbursement schedule is shown in Table 19.

Annual operation, maintenance and replacement costs are estimated at ₦497,000 at its full development stage.

Economic benefit

As explained in the preceding section, only the irrigation benefit is incorporated in the calculation of economic internal rate of return. The estimated benefit is ₦2.927 million at the full development stage of the project. The benefit will increase linearly after completion of the irrigation facilities and will attain the target amount in 1988.

2) IRR of the project

On the basis of the economic construction costs and benefit, economic internal rate of return (IRR) of the project is calculated for the project life of 30 years after completion of the project construction works. The estimated IRR is 12.0% which indicates the project is economically feasible.

Sensitivity analysis is made with respect to the increase in the project cost and reduction of the productivity of rice and its price. The results are presented in Table 20, which show that the economy of the project is quite sensitive to the change in the productivity of rice and the price but not so sensitive to increase in the project costs.

3.6.3 Financial Analysis

Farm budget analysis

At present, typical farmer in the project area holding 1.0 ha gains ₦883 annually as the gross farm incomes and the net income is only ₦14.

Upon completion of the irrigation project, 1.2 ha of the irrigated land will be allocated to each farm family. The gross income is expected to increase considerably up to ₦3,742 at the full development stage through the introduction of the intensive irrigation farming. Farming expenses will increase in proportion to the increase in farm inputs dosage. Living expenses will also increase for the improvement of their living standard. Total expenses will amount to ₦2,085 for the typical farmer.

Annual net reserve or capacity to pay which is defined as the difference between the gross income and the total expenses will

increase to N1,657 in the project area. The increased net reserve indicates that the typical farmers will have sufficient capacity. to pay for charges on the irrigation water and machinery services.

Profitability of the estate farm

Profitability of the estate farm is assessed on the basis of the estimated revenue and the operation cost including the depreciation cost of the investment cost.

The revenue for the estate farm consists of income from selling rice including not only the products in the estate farm but also the products in the small holder area and charges on the irrigation water and machinery services to be collected from farmers. Assuming that selling price of milled rice is N560/t and the charges to be imposed on the farmers shall cover the operation and maintenance cost for the irrigation facilities, farm machineries and rice mills, the expected annual revenues of the estate farm are estimated at N8.11 million at the full development stage.

The operation cost for the estate farm includes the production cost of rice, depreciation cost for the equipment and building facilities and operation and maintenance cost for the irrigation facilities and the project office. Purchasing cost of paddy from farmers is also included in the operation cost, which is valued at N308/t. The estimated annual operation cost of the estate farm is N5.40 million at the full development stage of the project.

Net profit of the estate farm is, thus, calculated at N2.71 million per year. The profit ratio to the project costs or total investment cost is 11.9% at the full development stage. The financial rate of return for the estate farm is estimated at 10.2%.

3.6.4 Socio-Economic Impacts

Besides the irrigation benefit, indirect benefits such as creation of employment opportunity, transfer of knowledge and experience, and contribution to regional economy are expected to be derived from the implementation of the project.

Creation of employment opportunity will be one of the valuable indirect benefits of the project implementation from the stage of the construction to the operation. About 321 permanent staffs and laborers will be employed in the Owerri Project Office together with 24,600 mandays of seasonal laborers per year. Increase in employment opportunity is expected on farm by introducing the intensive farming, which will provide the benefit for solving the unemployment problem in the region.

Transfer of knowledge and demonstration effect are another impacts on the economy. During the construction stage, local staffs will gain the experience in various work fields, while the project staffs, extension workers and farmers in the project area

will be trained intensively for acquiring the technics of the irrigation farming together with operation and maintenance of the farm machineries and equipment. Since the project is the first intensive irrigated paddy cultivation project with mechanized farming in the state, considerable demonstration effects will be extended to the region.

Increased agricultural production will contribute to solve the food crops shortage in the country and also contribute to increase in farm income. As the farm income is relatively lower than that in urban area, the increased farm income will contribute not only to enhance the regional income but also to even income distribution in the country.

All these effects mentioned above will contribute to promote the national policy described in the third development plan which includes even distribution of income, reduction of unemployment and increase in the food supply. Socio-economic stability is also expected to be facilitated in the region through the effects.

4. THE AUCHI PROJECT

4. THE AUCHI PROJECT

4.1 The Project Area

4.1.1 Location and Topography

The Auchi Project area lies in the northern part of Bendel State about 20 km east of Auchi, which is the administrative center of the Etsako Local Government Area of the state. Benin City, capital of the state is located about 70 km south-west of Auchi.

The area covers about 2,850 ha of land situated in the east bank of the Ojo river which is one of the tributaries of the Orle river. The area extends to the east-west direction with an approximate length of 10 km and a width of 5 km. The northern boundary of the area is hilly plateau, while the southern boundary is annually inundated lowland by the Orle river. In the northern part of the area there runs a provincial road from west to east connecting Auchi to Agnebode town on the verge of the Niger river with an approximate distance of 45 km.

The topography of the area is almost flat declining gently from north to south with an average slope of 1 : 100. The ground surface elevation is about EL 100 m in the north and EL 60 m in the south. The slope of the land surface is rather steep from the viewpoint of canal construction. Several streams run in the area, generally, to south providing the area with favourable drainage condition.

4.1.2 Meteorology and Hydrology

1) Meteorology

The climate of the Bendel State around Auchi has the transitional nature between the coastal climate and the inland climate. The area has less rainfall and relatively lower temperature in comparison with the climate of Imo State. A year is divided into the wet season of seven months from April to October and the dry season of five months from November to March. The average annual rainfall at Auchi is about 1,240 mm of which about 90% is precipitated in the wet season. Number of rainy days is about 90 days in a year. Rainfall record is available at Auchi for about 15 years. Based upon this record, the probable rainfall is estimated at 1,050 mm per annum under the 20% drought condition, which is taken as the basis of the present irrigation planning.

Mean monthly temperature is about 25°C throughout the year with little variation. Relative humidity ranges from about 80% in the midst of the wet season to 55% in the driest month. In coincidence with the seasonal distribution pattern of rainfall, mean monthly sunshine hours fluctuate from about 8 hours per day in the dry season to about 5 hours per day in the wet season. As regards evaporation, no long term data is available. The climatic data concerning the Auchi Project area are summarized in Table 23.

2) Hydrology

The Orle and Edion rivers originate in the Basement Complex highlands (about EL 600 m) in the vicinity of Igarra, and flow first in a southerly direction for about 55 km and 40 km respectively. The two rivers join into the Orle river near the Auchi-Irrua highway and run to an easterly direction for about 50 km to its confluence with the Niger river near Alegbette. In the downstream reach, the Ojo river which is the proposed water south for the Auchi Project joins the Orle river. The location map of the basin is shown in Fig. 8.

Total catchment of the Orle-Edion basin is about 2,200 km^2 consisting of Upper Orle basin of 620 km^2, Edion basin of 700 km^2, and Lower Orle basin of 800 km^2.

The catchment area of the Ojo river is about 240 km^2 or 27% of that of the Lower Orle. The length of the river from its origin to the proposed intake site is about 25 km and the longitudinal gradient is about 1 : 100. The catchment area is covered almost by dense forests.

There exists no previous river gauging in the Orle-Edion basin except rough flow measurements carried out in the dry season in 1975 by the British Mission./1 According to the estimate, the minimum flow in the driest month of March is 0.6 m^3/sec in the Upper Orle, 0.7 m^3/sec in the Edion, 2.3 m^3/sec in the Lower Orle, and 0.3 m^3/sec in the Obe river, which has a catchment area of 240 km^2 in the Lower Orle basin.

During the present field survey, the discharge of the Ojo river has been measured continuously and the discharge is estimated at about 0.6 m^3/sec at the beginning of January, about 0.4 m^3/sec in mid-January and about 0.3 m^3/sec in the early February. These figures coincide fairly with the above estimate.

Since no other data is available at present, the river discharge for the purpose of the present planning is estimated by multiplying the probable rainfall by the run-off coefficient, which is obtained from the other rivers in Nigeria. Using 20% drought discharge as the basis for the irrigation planning, discharges of the Ojo river are estimated as shown in Table 24.

/1 Refer to "Report of the Orle Basin Appraisal Mission" by the Ministry of Overseas Department, England in 1976.

With regard to peak flood discharge of the river, there is no data available. From the trace on the river bank, the flood ever happened is estimated to be about 70 m^3/sec. Taking this value into consideration and making references to the data from other rivers, the probable peak flood of the river is estimated at 65 m^3 with 20 % probability, 80 m^3/sec with 2 % probability and 90 m^3/sec with 1 % probability.

4.1.3 Soil and Land Capability

From the morphological characteristics and the results of the laboratory test, the soils in the Auchi Project area are classified into two Great Soil Groups, namely, Latosols and Lateritic Soils with Plinthite. Latosols are divided further into two Soil Types, Loamy Soil Type and Clay Loam Soil Type, depending on the soil texture.

Most of the soils in the project area are classified into Latosols. About 2,800 ha or 98 % of the soils in the area belong to Latosols in which 1,820 ha of the area belongs to Loamy Soil Type and 980 ha to Clay Loam Soil Type. Lateric Soils dominates only 50 ha or 2 % of the total area.

With regard to the chemical and physical properties of the Latosols, PH values range between 5.5 and 6.7 for H_2O and between 4.2 and 6.7 for N-KCL solution. Cation exchange capacity shows about 12 milligrams equivalent per 100 grams of soils throughout the profile. The exchangeable base content is in low degree and its value decreases corresponding to the depth. The humus content is relatively low ranging from 0.6% to 1.3% of the surface soil. The specific gravity shows 2.3 to 2.6 throughout the profile. From these figures, Latosols in the area are deemed to be suitable to the irrigated paddy cultivation.

Lateritic Soil with Plinthite is formed in the lowland along small streams which have high groundwater table in wet season. Due to the seasonal saturation with water, Plinthite horizon has developed in the subsoil caused by many iron and manganese concretions. The soils of this group have low agricultural potentiality.

In due consideration of the properties of the soils, about 2,640 ha or 93 % of the project area is classified into very suitable land for irrigated paddy cultivation and only 210 ha or 7 %, into unsuitable land in terms of land capability.

4.1.4 Agriculture Setting

1) Population and land tenure system

Total population of the Auchi Project area is about 2,000 with relatively sparse population density of 70 per km^2 compared with that of the Owerri Project area. Most of the working population

are engaged in agricultural activity. All the lands in the project area are held by the community excepting the limited area for farmers' quarters. The cultivated lands are allocated to the member farmers by the community in each crop season.

Average farm size is relatively large and about 1.5 ha of the land is now under cultivation by one farm family. Average family size in the project area is estimated at 6-7 persons in which about 3 adult workers are included. Land fragmentation is characteristic of the land tenure system in the project area.

2) Land use

As presented in Fig. 9, the Auchi Project area is less developed area in terms of the land use. Out of the total project area of 2,850 ha, about 68% is used for light forest, 21% for scrub and grassland, only 10% for cultivated land and 1% for non-agricultural land such as villages and roads. The forest land is large in the project area with relatively high density.

Major food crops produced in the cultifated land are rice, cassava, yam and maize supplemented by beans, potatoes and vegetables.

3) Cropping calendar and farming practices

As in the case of the Owerri Project area, the cultivation of the major food crops starts from the beginning of the wet season and major food crops are harvested mainly during the dry season. Typical cropping calendar for the major crops is estimated for the project area and illustrated in Fig. 10.

Shifting cultivation and mixed cropping are the prevailing practices in the Auchi Project area. The fallow period of the shifting cultivation is relatively long of 4 to 5 years. The cultivation is completely traditional conducted by mainly manpower without application of fertilizer and agro-chemicals. Yam, cassava and maize are cultivated as mixed crops while rice is generally planted as a sole crop.

4) Farm crop production and farm economy

The estimated yields for the major crops are 7.5 t/ha for cassava, 7.3 t/ha for yam, 1.2 t/ha for rice and 1.1 t/ha for maize in the project area. Total products are 900 tons of cassava, 292 tons of yam, 120 tons of rice and 77 tons of maize. Agricultural products are considerably small compared with that of the Owerri Project area due to the less intensive land use.

Livestock breeding is not a main line of the agricultural activity in the project area. But, farmers hold a few small stocks mainly for their consumption.

The farm economy in the project area is based mainly on food crop production supplemented by tree crops. Farmers get their

incomes mainly from selling the food crops and income from non-farm activity is negligible.

For typical farmers in the Auchi Project area, holding about 1.5 ha of the cultivated land, gross annual farm income[1] is about N1,116, annual farming expenses are N183 and annual living expenses are N841. Net reserves or the difference of the gross income and the gross outgo including farming expenses and living expenses are estimated at N92 per year. The net reserves are considerably small indicating that farm economy in the project area is on the subsistence level.

5) Marketing and institutions

Marketable surplus of the food crops is brought to the local market by farmers and traded through middleman. Most of the crops are traded in the form of raw materials except rice which is sold both as paddy and rice. Major export crops such as palm oil, cocoa and coffee are purchased mainly by the Marketing Board which is responsible for collecting these crops through the Licensed Buying Agents at the fixed price.

There are a few grating machines for cassava and two rice mills in the project area. These machineries, however, are not well maintained and are frequently under trouble. Most of food crops produced are stored in and around farmers' houses. Existing processing and storage facilities are barely sufficient even for the present production level but their improvement is required for raising farm income by selling the products on favourable conditions.

Agricultural extension service and research work are undertaken by MANR of Bendel State through the divisional agricultural officer and research stations. About 26 extension workers are now in charge of the Etsako Division, Bendel State, of which two are involved in the Auchi Project area. But, the area covered by one extension worker is large and the extension services are not sufficient.

There are various agricultural credit schemes introduced through MANR in collaboration with the Ministry of Trade, Industry and Cooperatives and NAB in Bendel State. But most of them have not been operated successfully and utilization of the credit is quite limited mainly for tree crop producing farmers and cooperative farmers. Agricultural cooperative activity has been promoted by the Ministry of Trade, Industry and Cooperatives as well as MANR. Participation of the farmers into Farmers Multipurpose Cooperative Societies is quite few in the project area; less than 5% of the farmers are involved. This is caused by the present land tenure system and shortage of manpower and finance.

/1 Total products multiplied by the farm gate price plus income from tree crops

4.2 The Project

4.2.1 Basic Concept

The objectives of the Auchi Project are improvement of the present agricultural situation, increasing food crops production and raising farm economy in the region.

After studying the present condition of the agriculture, available water resources from the Ojo river, lands and manpower in the region, irrigation development plan is formulated for the area of 2,100 ha. In the plan, rice is selected as the proposed crop in due consideration of the economical water use, the profitability of the production and its marketability. Mechanized farming is proposed for the operation of the project. The mechanization will be particularly required for the development because of the low population density of the area and considerable labor requirement for the project operation under manpower intensive method.

As in the case of the Owerri Project, the Auchi Project includes the estate farm and small holder area. However, the area for small holder is quite limited due to the sparse population of farmers in the region. Out of the total irrigable area of 2,100 ha, 1,800 ha will be allocated to the estate farm and the remaining 300 ha will be allocated to the small holder area.

In order to realize the objectives, an intake weir will be constructed on the Ojo river together with the construction of irrigation canals, drainage canals, the related structures, farm roads and paddy field. Rice mill and storage facilities will also be installed in the estate farm.

For the implementation of the project, Auchi Project Office will be established in the estate farm. The Project Office will be responsible for all the construction of the project works and operation and management of the estate farm. In the small holder area, Agricultural Cooperatives will be established to introduce the mechanized irrigation farming smoothly and to attain the expected increase in rice production most efficiently.

Upon completion of these project works, land use will be changed completely and 2,100 ha of the land will be changed into irrigated land. However, the cropping intensity in the project area will be about 130% and the cultivating area of dry season paddy will be only 600 ha due to the scarcity of the available water in the dry season. Through the introduction of the irrigation farming together with the application of improved seeds, fertilizer and agro-chemicals, the productivity of rice is anticipated to increase to 4.5 t/ha of paddy in the estate farm and 5.0 t/ha of paddy in the small holder area at the full development stage of the project. Total annual production of rice will be about 8,700 tons or 12,400 tons of paddy.

4.2.2 Agricultural Development Plan

1) Proposed land use

The land use of the project area will be changed considerably after completion of the project works including paddy field preparation and irrigation facilities. Most of the light forest and all the scrub and grass land will be reclaimed. About 74% of the total project area or 2,100 ha will become the irrigated land, while 370 ha will be allocated to the irrigation facilities and farm roads.

Irrigated paddy production will be introduced for all the irrigable area. Traditional crops such as yam, cassava and maize will be planted around the village and the area outside the project area for home consumption.

2) Proposed cropping pattern

Rice is chosen as the proposed crop for the irrigated farming in view of the profitability of rice, marketability and the farmers' incentive for rice production.

For determining the cropping pattern of the Auchi Project, climatic and soil conditions are carefully considered in such manners that the cultivating area in the dry season will be maximised within the constraint of the limited available water from the Ojo river.

The proposed cropping pattern consists of 2,100 ha of wet season paddy and 600 ha of dry season paddy intercropped with green manure as illustrated in Fig. 11. Wet season paddy will be planted from April to June and harvested in August to October. Dry season paddy will be planted in September and December and harvested in January and April. Green manure will be planted widely both after wet season paddy and dry season paddy for improving organic contents of the soil. Cropping intensity of the Auchi Project will be about 130%.

3) Proposed farming practices and operation

The Auchi Project is proposed to be operated mainly by the estate farm since the project area is sparsely populated and the present cultivated area is small with relatively small numbers of farmers. In due consideration of the optimum farm size together with the available manpower on farm, 1,800 ha is allocated to the estate farm and the remaining 300 ha is allocated to the small holder in which about 1.2 ha will be distributed to each farm family to be involved in the project area.

Mechanized farming is proposed principally both for the estate farm and the small holder area. However, in the small holder area, the mechanization will be limited to partial operation, mainly for land preparation and harvesting to rice milling for utilizing available manpower at the maximum extent, while complete mechanization will be introduced in the estate farm. The proposed farming practices both for the estate farm and the small holder area are explained below.

Estate farm

For the seeding method, direct seeding will be basically applied for the estate farm to reduce the labor requirement. However, transplanting will also be practiced in the pilot scheme area for training farmers.

Land preparation will be made by using machinery. Paddy field will be plowed and harrowed after cutting weed and their burning. After puddling work, the seeds will be planted by using broad caster in shallow depth with the seed rate of 100 kg/ha. The seeds will be sterilized by agro-chemicals prior to the seeding.

Fertilizer application and plant protection are the most important farming practices for attaining the anticipated high yield of rice. The application will be conducted basically by using machinery. Compound fertilizer will be applied as the basic fertilizer at the puddling time. Urea will be applied at three different growth stages of rice, namely, about three weeks after seeding, at panicle formation stage and at heading stage. Agro-chemicals to be applied are herbicide, insecticide and fungicide. Weeding will be done three times by using herbicide. Insecticide will be applied three times mainly against stem-borer and leaf-hopper. Fungicide will also be used for protecting the plant from diseases at the pancile fromation stage.

Irrigation water control is another important farming practice for ascertaining the expected high yield. The water control will be carried out by the staff of the estate farm. The water control will correspond to the growing stage of rice.

Harvesting will be made by using self-propelled type combine. The harvested paddy will be transported to rice mill to be installed in the estate farm.

Small holder area

Operation of the farm in the small holder area will be partially mechanized being supplemented by manpower of the farm families. Machinery services for land preparation, agro-chemicals spray and harvesting to rice milling will be provided by the estate farm, the cost of which will be paid by farmers. In the small holder area, transplanting method will be applied for utilizing the available manpower of farm family most efficiently.

Before starting the land preparation of the main paddy field, nursery bed will be prepared. The area for the nursery bed will be 400 m^2 per ha or 1/25 of the main paddy field and the nursery period will be about 20 days. The seed rate is designed to be 35 kg/ha. Land preparation including weed cutting, burning, plowing to harrowing will be carried out by machinery in the same way as applied in the estate farm. Farmers in the small holder area will be involved in this work as assistant laborers.

Transplanting will be carried out by manpower. Labor requirement for the transplanting is estimated at 50 man days/ha. Seedling will be transplanted to the main paddy field in shallow depth.

Application of fertilizer and agro-chemicals in the small holder area will be almost same as that in the estate farm both in terms of volume and application timing. However, most of the application work will be carried out by manpower except the application of the insecticide and fungicide, which will be conducted by using machinery of the estate farm.

Irrigation water control for the whole project area is to be made principally by the estate farm, but the water control under the tertiary canals for the small holder area will be conducted by farmers themselves.

Harvesting of the paddy will be conducted by the estate owned combine. Farmers in the small holder area will be engaged in the harvesting work as assistant laborers. The harvested paddy will be transported to the estate farm and milled there. All the paddy will be purchased by the estate farm except the farmers' consumption.

4) Farm inputs and farm machineries

Farm inputs

TOS 103 and BG90-2 are chosen as the proposed varieties on the basis of the experimental results conducted by IITA and Uzo Uwani Pioneer Project, Anambra State. The selected varieties possess favorable features such as high yielding, resistance to lodging, relatively short growing period and disease tolerance. In the pilot scheme, these varieties will be tested together with other promising varieties.

As explained in the preceding section, considerable amount of farm inputs such as fertilizer and agro-chemicals will be applied for sustaining the expected high yield. The design volumes of the fertilizer and agro-chemicals per ha are 200 kg of the compound fertilizer, 129 kg of the urea, 30 ℓ or 70 kg of the herbicide, 30 ℓ of the insecticide and 30 kg of the fungicide both for the estate farm and the small holder area. Annual farm labor requirement for the operation of the estate farm is about 64,300 man days, while 252 man days are required per one farmer holding 1.2 ha in the small holder area.

Farm machineries

Selection of the type of machinery and the estimate of the required number are made taking into account the climatic and soil condition of the project area. For the estimate of the number of

machineries, workable days in the wet season in the Auchi Project area are assumed to be longer than that in the Owerri Project area due to the limited rainfall. The proposed type of the machineries is presented in Table 25 together with the estimated numbers. A workshop will be constructed for the efficient operation and maintenance of the project,

5) Rice mill and storage facilities

For processing, keeping the products in good quality and marketing them on favorable conditions, rice mill and storage facilities will be installed for the project. The proposed number of the rice mill is 3 with the capacity of 1.0 t/hr each, assuming that workable days of the rice mill are 300 days per year and the operation hour is 16 hours per day. Milling efficiency will be increased to 70% from the present level of 50-60%.

The storage facilities to be installed will be one with the capacity of about 6,700 tons of rice, which will be enough to accomodate the products through a year. Detailed features of the rice mill and storage facilities are presented in Table 26.

6) Anticipated crop yield

Upon completion of the project works, productivity of rice is expected to increase considerably through the introduction of irrigated farming using improved seed, fertilizer and agro-chemicals. The anticipated yield is estimated at 4.5 t/ha of paddy for the estate farm (direct sowing) and 5.0 t/ha of paddy for the small holder area (transplanting) at the full development stage. It is assumed that the yield of direct yield under direct sowing method will be about 10% less than that under transplanting method from the experience in Japan and the experimental data in Anambra State.

The yield of rice will increase gradually corresponding to the increase in land productivity and will attain the anticipated yield in the 5th year for the estate farm and 7th year for the small holder area after completion of the irrigation facilities.

The anticipated production of rice will be about 8,700 tons (or 12,400 tons of paddy) at the full development stage in 1989.

7) Pilot scheme

The proposed project is a pioneer project for irrigation farming in the region and farmers are not accustomed to irrigation. It is, therefore, considered that establishment of the pilot scheme is indispensable for successful operation of the project. Although the allocated area for small holder area is relatively small in the Auchi Project area, training of farmers will be required for the development of the whole project.

The primary objectives of the pilot scheme are a) training and demonstration of mechanized irrigation farming to project staffs,

extension workers and key farmers, b) agronomic research on rice cultivation, and c) seed multiplication.

The proposed site for the pilot scheme will be in the north-west part of the project area, where irrigation water will be available from 1979 in the early stage of the project construction. The size of the pilot scheme will be about 50 ha, which will consist of 2 ha of the agricultural research field, 18 ha of the seed multiplication and 30 ha of the training field.

4.2.3 Project Works

1) General

To realize the agricultural development proposed in the preceding sections, the following project works are required: (i) construction of irrigation facilities; (ii) construction of drainage facilities; (iii) establishment of farm road system; (iv) reclamation and paddy field construction of 2,100 ha; and (v) installation of processing and storage facilities including construction of the related facilities to the proposed project office. Principal features of these works are shown in Table 27.

2) Irrigation facilities

Irrigation system

The irrigation system will consist of the simple run-of-river type intake weir, a head race, main and secondary canals, tertiary and supply canals. General layout of these canals system is shown in DWG. No. 02.

Diversion water requirement

The diversion water requirement for the project, which is used as the basis for determining the capacities of these irrigation facilities, is estimated as shown in Table 28 /1.

The diversion water requirement is estimated at 1.5 m^3/sec or 0.71 l/sec/ha on the monthly mean basis.

Intake weir

The weir site is selected on the Ojo river just upstream of the bridge on the road running through Ikabigbo and Ayoguri to take water within the shortest distance from the project area. At the site, the river is about 35 m wide and 2.5 m deep. Geological condition of the site is favorable for the weir construction. The depth to foundation rock is approximately 1 m in the river course and within 4 m in both banks of the river. The surface

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/1 Refer to Chapter 6.2 of the Study Report.

soil of the left bank consists of sandy loam, which is deemed to be suitable as embankment materials. The surface soil of the right bank includes stiff clay, which will be used as the foundation of low embankment if properly stripped.

A fixed type concrete gravity weir, 21 m long and 5.5 m high, will be constructed across the river on the solid foundation rock. In the left end of the weir, one set of sand scouring sluice, 1.5 m wide and 3.2 m high, will be installed. An apron will be constructed in the downstream of the weir with a length of 16 m. The intake structures will be constructed on the left bank, just upstream of the weir. The maximum intake discharge is 1.5 m^3/sec and the proposed intake water level is EL. 99.85 m. The intake gate will consist of 1 set of sluice gate, 2 m wide and 1.5 m high.

Irrigation canals and related structures

The head race will be constructed for conveying irrigation water from the intake structures to the project area. After that, irrigation water is delivered to the tertiary canals through main and secondary canals. The tertiary canals are diverted from the secondary canals with an interval of about 500 m and will supply water to the irrigation unit of 30-80 ha. Distribution of water within the unit will be made by the supply canals to be branched off from the tertiary canals with an interval of 225 m.

The canals will have a trapezoidal shape with dimensions ranging from 1.8 m to 0.30 m of the bottom width and from 2.0 m to 0.6 m of the canal height. The hydraulic gradient varies from 1/4,000 around the head race to about 1/2,000 on the tertiary canals.

As the canals are to run across the rivers, streams, and roads, many related structures such as flumes, culverts, and cross drains will be needed. In addition to these structures, turnouts, checks and spillway structures will also be needed to distribute water or secure the rational water management. The slope of the ground surface is rather steep so that a number of drops will be necessary. Required number of these structures is: 2 flumes; 198 culverts; 105 cross drains; 483 turnouts; 8 spillways and 50 drops.

3) Drainage facilities

The proposed drainage system will consist of collector and field drains. The drained water from every plot of paddy field will be discharged into field drains and, further, into the collector drains. The layout of the drainage system is shown in DWG. No. 02.

The design drainage requirement is decided so as to drain the excess water on paddy fields within 36 hours. The excess water will come out by the maximum daily rainfall of 122 mm which occurs with the probability of once in five years. All the drainage canals have trapezoidal section with a side slope of 1 : 1.5.

4) Road

The proposed road system consists of main road and branch road.

Main road will run along the main and the secondary irrigation canals and serve as the main artery in the area and transportation between villages. While, the branch road will be laid along the tertiary and supply irrigation canals mainly for farming purposes. The project areas will be covered by the proposed road net work with an average grid of 225 m x 500 m.

The main road will have an effective width of 7 m with laterite pavement of 30 cm thick. The effective width of the branch road is 5 m with laterite pavement of 20 cm thick. Total width will be 10 m for the main road and 7 m for the branch road.

5) Paddy field

A typical layout of paddy field proposed for the project is presented in Fig. 5.

The terminal irrigation unit will be commanded by one supply canal and consist of 16 plots of paddy field. Size of the plot is decided at 30 m x 100 m taking into consideration the slope of the ground surface, water management, workability of agricultural machinery, size of land holding per farmer, etc., among which the slope of the ground surface is most important factor.

6) Processing, storage and office facilities

The processing and storage facilities for the Auchi Project consist of: 3-receiving equipment (3.0 t/hr), 3-drying equipment (10 t/hr), 3-parboiling equipment (0.6 t/hr), 3-milling equipment (1.0 t/hr), 5-storage equipment (1,000 t bin), 3-power supplying equipment (200 KVA) and buildings to accomodate them.

The facilities related to the project office comprise project office, garage and training center, housings for staff, warehouses, workshops, motor pools, etc. Total floor area will amount to about 8,900 m^2. These facilities, together with the processing and storage facilities, will be located in the vicinity of the proposed pilot scheme area.

4.2.4 Project Organization

1) General

In order to materialize the project, most appropriate organization shall be established from the stage of financial arrangement for necessary coordination between various governmental organizations to the stage of project construction and its operation. An efficient organization is proposed in this section in due consideration of the similar projects in Nigeria and experience in Japan.

The proposed organization will consist of three components, namely, a Project Coordination Committee, Owerri Project Office and Agricultural Cooperatives. The Project Coordination Committee will be initially established for executing necessary arrangement including the financial arrangement. A project executing organization

will be established through the arrangement of the Project Coordination Committee. The Project Office will be responsible for the project construction and its operation and maintenance. The Agricultural Cooperatives is to be established for introducing the irrigated farming smoothly in the small holder area. For coordinating the activity between the project executing organization and the Agricultural Cooperatives, a Farm Operation Committee will be established. (Overall project implementation organization is illustrated in Fig. 12.)

2) Project Coordination Committee

The Project Coordination Committee will be organized prior to establish any project executing organizations. The Committee will be responsible for establishing the overall policies, implementation planning, financial arrangement and coordination between various governmental organizations. The Project Coordination Committee will also be in charge of supervisory services and guidance to the project executing organization for the operation of the project.

3) Auchi Project Office

For the execution of the project, a project executing organization will be established in the project area under the guidance and arrangement of the Project Coordination Committee. The executing organization, tentatively called Auchi Project Office, will be responsible for implementation of the project construction and its operation and maintenance.

The function of the Project Office is to cover all hte construction of the project works and the operation of the estate farm. The Project Office will also be in charge of distributing agricultural inputs and providing machinery services and extension services to the small holder area.

For executing these functions, the Auchi Project Office, headed by Project Manager, will have five departments such as Engineering, Production, Farm Machinery, Processing and Marketing and Administrative.

Required number of staffs is estimated, details of which are explained in Study Report. Since there exists an acute shortage of experienced personnel in the country, some specialist staffs will have to be recruited from abroad for the successful operation of the project.

4) Agricultural Cooperatives

The Agricultural Cooperatives will be established organizing all the farmers to be involved in the small holder area for the Auchi Project. The establishment of the farmers' cooperative organization aims to introduce mechanized irrigation farming smoothly into small holder area and to attain the expected increase in rice production most efficiently.

The Agricultural Cooperative will be organized principally on the basis of the irrigation system in due consideration of the village size. In the Auchi Project area, about 5 Farmers Cooperative Units will be established, each of which consists of 40-80 farmers. The farmers Cooperative Units will be integrated into one Federated Agricultural Cooperative.

The function of the Agricultural Cooperatives will include various services related to the irrigated farming such as irrigation water control, distribution of farm inputs and promotion of joint cultivation. For maintaining good coordination and cooperation between the Project Office and the Agricultural Cooperatives, a Farm Operation Committee will be installed.

4.3 Implementation Schedule and Construction Plan

4.3.1 Implementation Schedule

The implementation schedule of the project is bar-charted in Fig. 13. It is prepared based upon the following conditions:

(1) Mapping works of the project areas will be started in October 1977 upon arrival of the dry season and be finished in three months;

(2) Detaled design works of the project works will be started following the completion of mapping works and be finished in six months;

(3) In parallel with the detailed design, procurement of construction machinery and equipment will be started partially;

(4) Upon completion of the detailed design, construction of the project works will be started and be completed in four and a half years; .

(5) Except for minor on-farm structures, all the construction works will be executed by using construction machinery and equipment; and

(6) Workable days for the construction are 275 days per year.

Commencement of construction of the project works will be in July 1978 and completion of the whole construction works will be at the end of December 1982. However, since the intake structures and head race will have been constructed and commissioned by July 1979, partial operation will become possible after that time on. According to the proposed reclamation schedule and cropping pattern, initial operation will be made on about 350 ha including 50 ha of the pilot scheme in 1979. The area under operation will be 660 ha in 1980, 1,230 ha in 1981, 1,780 ha in 1982 and 2,100 ha in 1983.

4.3.2 Construction Plan

Since competent contractors are not available in Nigeria for this kind of construction works, it is proposed that the project works be constructed on the force account basis of the Government or the project executing organization to be established. In addition, to help Nigerian staff in executing the construction, technical guidance by well-experienced foreign experts will be necessary.

Major construction works consist of headworks for intake of irrigation water, irrigation and drainage canals, farm roads, and paddy field of 2,100 ha. The works involve substantial amounts of earth-moving works in rather short construction period. It is, therefore, proposed that construction machinery and equipment be used extensively. For the major works, the construction plan is explained as follows.

1) Headworks for water intake

Since the scale of the works is smaller than that for the Owerri Project, the construction will be executed only in about one year mainly during the dry season of 1978/79.

The construction will start in August 1978 together with the construction of the intake structures on the left bank of the river. After that, the diversion canal will be excavated on the right bank of the river and with construction of coffer dams across the river, the river course will be diverted. Foundation excavation and concrete placing works for the weir and related structures will follow in succession, and upon the completion of these works, backfilling works of the diversion canal will be executed.

It is scheduled that all the works will be completed by the end of the dry season of 1978/79.

2) Irrigation canals

The irrigation canals comprise a head race of about 12 km, main canal of 7 km, secondary canals of about 19 km, tertiary canals of about 46 km, and supply canals of 219 km.

In order to realize the early implementation of the project, construction of the head race will be carried out almost in parallel with the headworks construction. Construction of main and secondary canals will also be finished by the end of 1979. Construction of minor irrigation canals such as tertiary and supply canals will be made in four years from 1979 to 1982. Construction of major canals such as the head race, main and secondary canals, and a part of the tertiary canals will be made by using construction machinery, while most of the tertiary canals and the supply canals will be constructed by manpower.

3) Drainage canals

Total length of the drainage canals is about 137 km comprising collector drains of about 32 km and field drains of 105 km. Similar to the drainage construction for the Owerri Project, the collector drains will be constructed in four dry seasons from 1979 to 1982, whereas construction of the field drains will be executed throughout the year for four years in parallel with the paddy field construction.

4) Farm roads

The roads are classified into the main farm road of about 23 km and the branch farm road of 155 km. They will be completed by the end of 1979 and 1980, respectively. Surfacing materials such as gravels and laterites are easily available from the Ojo river and the hills around Auchi.

5) Paddy field

Total paddy field to be reclaimed is 2,100 ha which will be developed in four years from 1979 to 1982 with a rate of 525 ha per year making full use of construction machinery and equipment.

4.4 Cost Estimate

4.4.1 General

The cost required for the implementation of the Auchi Project is estimated on the basis of the preliminary design of the project works taking into account the construction method to be applied, productivity of labor and machineries with the following assumptions:

a) Major construction and farm machineries and materials such as steel, fertilizer and agro-chemicals are to be procured by international competition bidding;

b) Cost for the construction machinery is valued by the procurement cost;

c) Construction of the project works will be made by Force Account of the Government or project executing organization;

d) Compensation cost for the crops which are planted on the proposed head race area will be paid to farmers;

e) Physical contingency of the cost estimate is about 15% for the direct construction cost and 5% for the procurement cost of the machineries and equipment;

f) Price contingency applied in the estimate is: 7.5% in 1978; 7.5% in 1979; 7.0% from 1980 onwards for foreign currency portion and 15% in 1978; 15% in 1979; 10% from 1980 onwards for local currency portion;

g) Price level for the cost estimate is principally mid-1977; and

h) All the conversion rate from US$ to ₦ is ₦1.0 = US$1.58.

4.4.2 Project Cost

The project cost for the Auchi Project is estimated at ₦22.92 million comprising the foreign currency portion of ₦10.57 million and the local currency portion of ₦12.35 million. A summary of the total project cost is presented in Table 29 and its annual disbursement schedule is shown in Table 30.

The project cost consists of (1) cost for the civil works including land reclamation, (2) cost for the processing and storage facilities including project office and its related facilities, and (3) initial farm investment including procurement cost of agricultural machinery. Each of the cost components is briefly explained as follows.

1) Construction cost of civil works

Based upon the assumptions and conditions mentioned about, construction cost of the civil works is estimated as shown in Table 31. The estimated cost for the civil works is 14.16 million comprising foreign currency portion of 6.11 million equivalent and local currency portion of N8.05 million. The cost for the engineering services includes the cost required for the detailed design and technical supervision during construction by foreign experts. Contingencies consist of physical contingency and provisions for price escalation which are estimated on the assumed conditions.

2) Construction cost of processing, storage, office facilities

Cost required for construction of these facilities is estimated at N5.49 million including procurement and installation cost of rice mill. The breakdown is given in Table 32.

In the cost for the office and related facilities, the cost necessary for the related facilities of the pilot scheme is included.

3) Initial farm investment

The initial farm investment comprises the procurement cost of agricultural machinery and farming expenses required for the initial operation of the project. The estimated cost for the initial farm investment is N3.27 million. Breakdown of the cost is given in Table 33.

4.4.3 Operation and Maintenance Cost

The operation and maintenance cost (OM cost) is needed annually after the commencement of the project operation. It comprises the costs for: (1) operation and maintenance of the irrigation and drainage facilities, and roads; (2) maintenance of the project office and its related facilities; and (3) overhead and personnel expenses.

At the full operation stage of the project, annual OM cost is estimated at N465 thousands as shown in Table 34.