

No. 02

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GHANA IRRIGATION DEVELOPMENT AUTHORITY
THE REPUBLIC OF GHANA

**THE STUDY
ON
THE REHABILITATION OF IRRIGATION PROJECTS
IN
THE REPUBLIC OF GHANA**

Volume I

MAIN REPORT

MAY 1997

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Preface

In response to the request from the Government of the Republic of Ghana, the Government of Japan decided to conduct the study on the Rehabilitation of Irrigation Projects in the Republic of Ghana and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Ghana a study team headed by Mr. Kunio Irie, Nippon Koei Co. Ltd., between September 1995 to March 1997.

The team held discussions with the officials concerned of the Government of Ghana, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

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

May, 1997



Kimio Fujita
President

Japan International Cooperation Agency



1139003 (6)

May 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

Letter of Transmittal

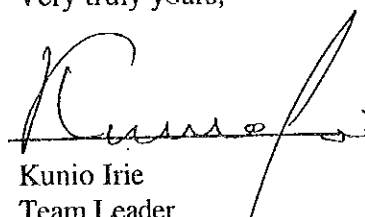
We are pleased to submit to you the report on the Study on the Rehabilitation of Irrigation Projects in the Republic of Ghana. This report presents the results of all works performed in both Ghana and Japan during a total period of 19 months from September 1995 to March 1997.

The Project includes 5 priority areas which were selected from 12 existing irrigation areas in Ghana, and covers a total development area of 473 ha. The development plan formulated for these five areas consists of rehabilitation and upgrading of existing irrigation facilities, strengthening of farmers' organisations aiming at operation and maintenance of the Project by the beneficiaries themselves, improvement of marketing and credits, training of the Government's front-line staffs and farmers, environmental conservation in and around the Project area, promotion of women's participation in the Project, and so on. All farmers in the areas have shown a positive attitude toward the Project implementation, and it may be said that such farmers' attitude will be instrumental in achieving sustainable operation and maintenance of the Project.

We believe that the Project implementation will help not only to improve farmers' living standards in the Project areas but also to develop rural socio-economy, and we would like therefore to recommend to implement the Project as early as possible.

We wish to express our deep appreciation and sincere gratitude to your Agency, the Ministry of Foreign Affairs, and the Ministry of Agriculture, Forestry and Fisheries. We also wish to express our deep gratitude to your Ghanaian Office, the Embassy of Japan, the Ghana Irrigation Development Authority and other authorities concerned of the Government of Ghana for the close cooperation and assistance extended to us during our field investigations and studies.

Very truly yours,

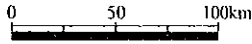


Kunio Irie
Team Leader
The Study Team of the Study
on the Rehabilitation of Irrigation
Projects in the Republic of Ghana



LOCATION MAP

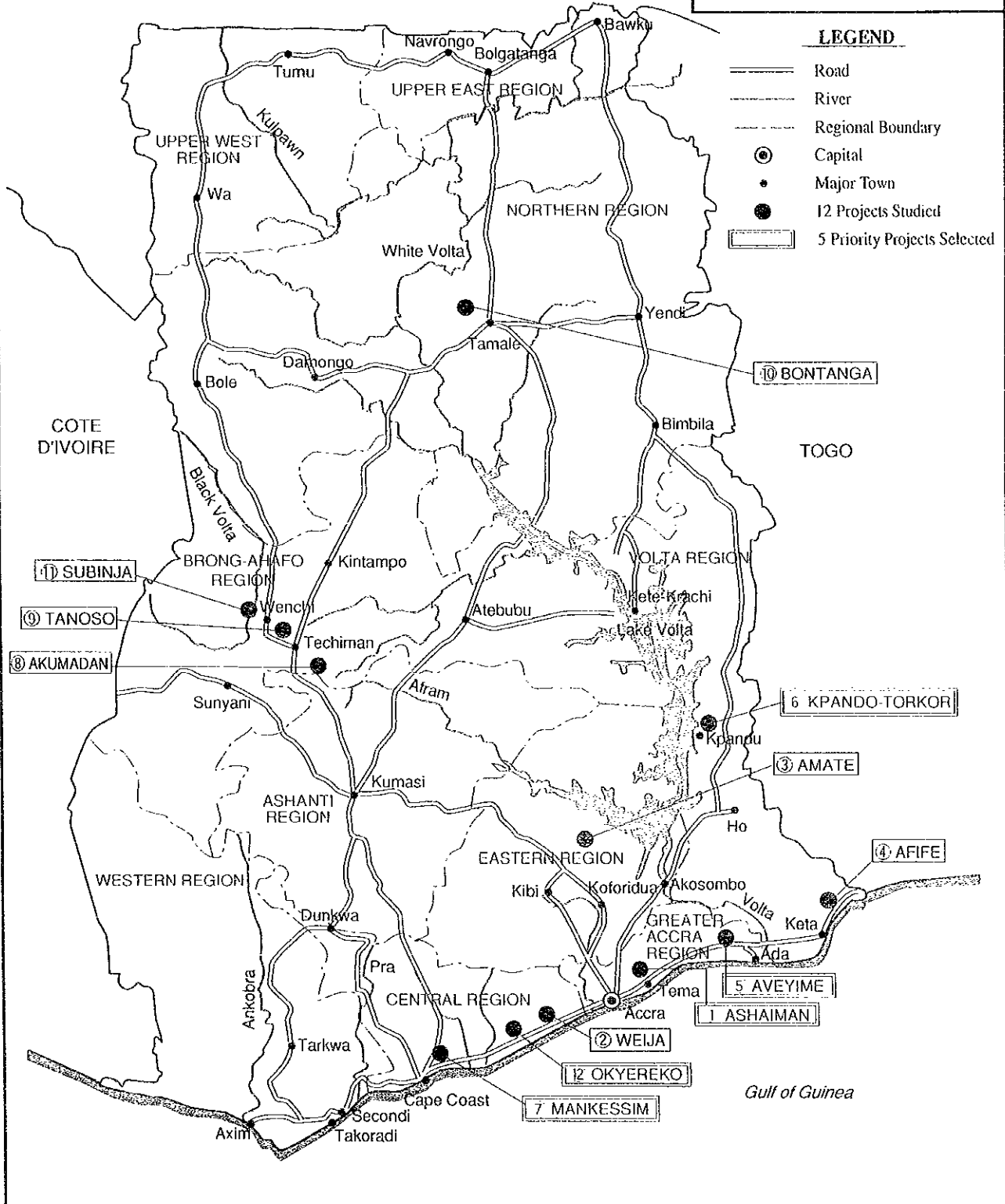
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BURKINA FASO

LEGEND

- Road
- River
- Regional Boundary
- Capital
- Major Town
- 12 Projects Studied
- 5 Priority Projects Selected





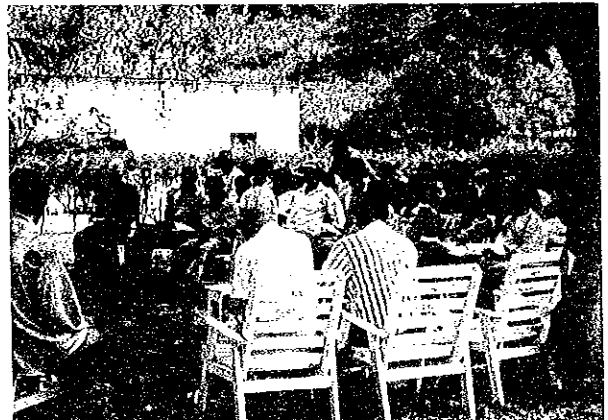
Left Bank Main Canal
(Ashaiman)



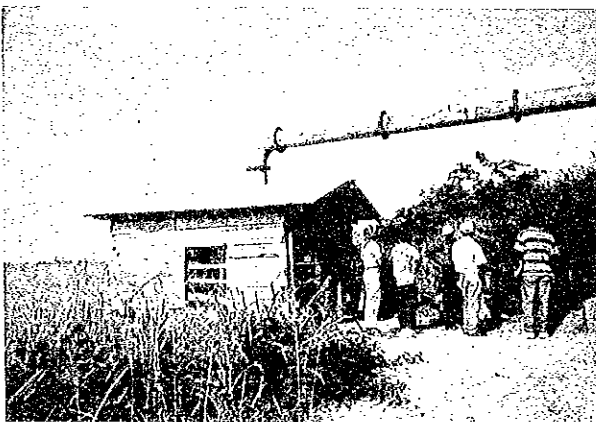
Experimental Farm - IDC
(Ashaiman)



Okra Cultivation (Irrigated)
(Ashaiman)



Public Meeting with Farmers
(Ashaiman)



Pump House
(Aveyime)



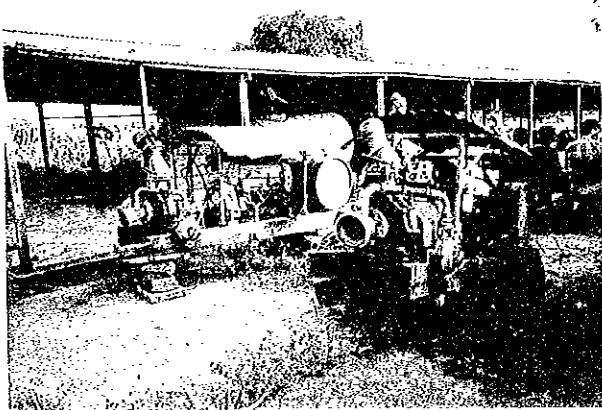
Damaged Pump
(Aveyime)



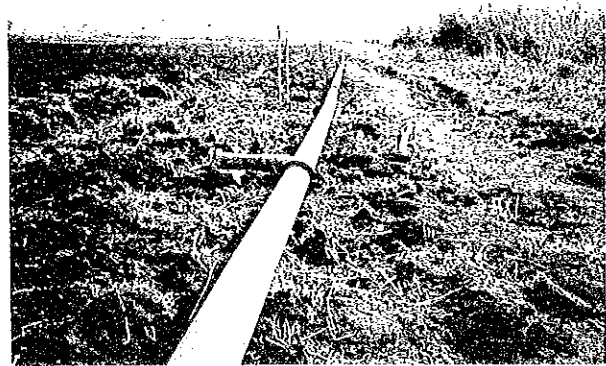
Main Canal
(Aveyime)



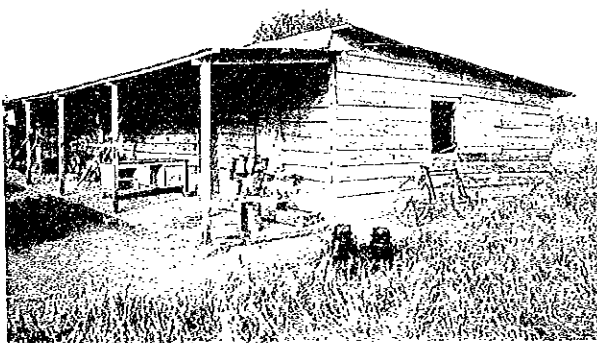
Maize and Cassava - Rainfed
(Aveyime)



Movable Pump with Diesel Engine
(Kpando-Torkor)



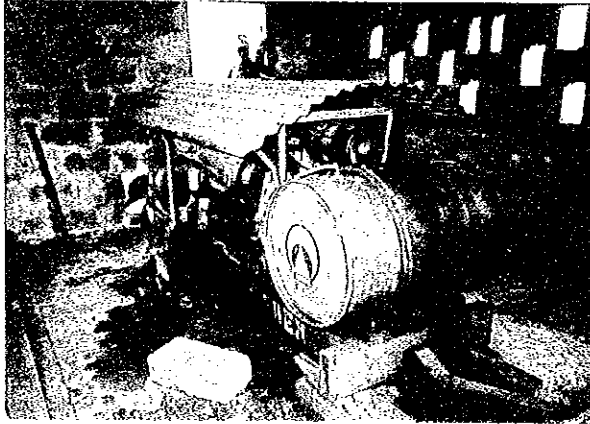
Pipe Line
(Kpando-Torkor)



Project Office
(Kpando-Torkor)



Okra Cultivation (Rainfed)
(Kpando-Torkor)



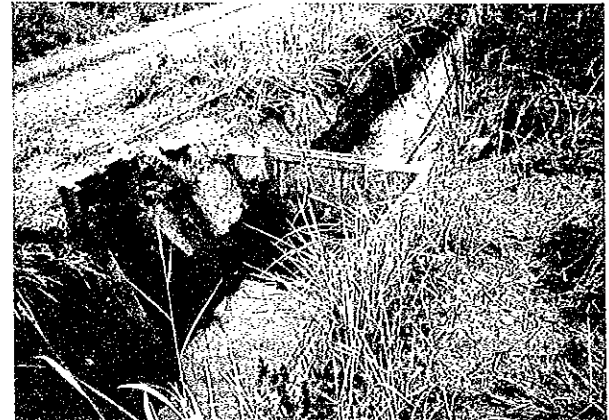
Pump and Pump House
(Mankessim)



Farm Road in the Project Area
(Mankessim)



Sweet Potatoes - Rainfed
(Mankessim)



Turn-out and Check Gate
(Okyereko)



Farmers' Society
(Okyereko)



Middlemen - Market Mummy
(Okyereko)

SUMMARY

1. Authority

This Final Report (the Report) on the Rehabilitation of Irrigation Projects (the Project) is prepared in accordance with the Scope of Work agreed upon between the Ghana Irrigation Development Authority (GIDA) and the Japan International Co-operation Agency (JICA) on 19 April 1995. The Report presents the results of all works performed in both Ghana and Japan during Phase-I and Phase-II Studies (the Study) covering the selection of and feasibility study on 5 priority projects to be implemented within the framework of the overall Project.

2. Priority Projects

The existing irrigation projects operated and managed by GIDA should play an important role in developing more profitable agriculture under the key policies set forth in the Medium-Term Agricultural Development Programme (MTADP) of the Government. Unfortunately, however, most of them are having low level performance due to a combination of various constraints. The prevailing constraints are represented by low productivity due to deterioration of irrigation facilities, shortage of irrigation water, soil problems, and weakness of support services from the related institutes. GIDA had already examined the existing projects and listed up 12 projects for early rehabilitation. During Phase-I Study, an overall rehabilitation plan for the 12 existing irrigation projects was prepared at master plan level mainly for the purpose of selecting the priority projects for feasibility study in Phase-II Study.

The above 12 projects were evaluated, using the data and information obtained through the field survey on the following 6 parameters: (i) deterioration and problems of present project facilities, (ii) water resources and effect on the downstream area, (iii) present participation in operation and maintenance (O&M) of projects, (iv) present activity and performance of farmer's organisations, (v) present farmers' economy, and (vi) environmental effects. In addition, the priority projects were on the basis of the economic evaluation in terms of Economic Internal Rate of Return (EIRR) and urgency of rehabilitation. The following is a summary of the evaluation results:

Parameter	Full Mark	Ashaiman	Weija	Amate	Aflife	Aveyime	K.-Torkor	Mankessim	Akumadan	Tanosu	Bontanga	Subinja	Okyereko
1. Facility													
- Dam & reservoir	5	1	1	(1)	1	(1)	(1)	2	(1)	(1)	2	(1)	3
- Pump	5	1	4	5	(1)	5	5	5	5	5	(1)	5	(1)
- Irrigation network	5	5	3	5	2	5	5	5	5	5	2	5	5
- Drainage network	5	5	3	1	3	2	1	3	1	1	3	1	3
- Road	5	4	2	4	3	4	4	4	3	4	3	4	4
- Buildings	5	3	3	4	2	4	5	4	5	5	2	5	4
Sub-total	30	19	16	20	12	21	21	23	20	21	13	21	20
2. Water	5	5	5	5	5	5	5	5	4	5	5	5	5
3. Participation	3	3	2	3	3	3	3	3	3	2	3	2	3
4. Activity	5	4	3	5	4	5	5	5	5	3	4	4	5
5. Farmers' economy	5	1	2	3	4	3	3	3	5	4	4	5	4
6. Environment	5	4	4	2	4	3	2	3	2	2	4	2	4
Total Point Given	53	36	32	38	32	40	39	42	39	37	33	39	41
EIRR (%)		4.2	6.9	16.9	16.3	13.6	20.2	16.0	0.4	-3.4	17.7	7.1	13.0

Note : Figures in brackets are the minimum points given to the corresponding project, in case of no corresponding facilities.

The first selection of priority projects proposed for finalisation through discussion with GIDA was made on the basis of the above table and taking into account the following characteristics of the projects:

As seen in the above table, the highest score (42 points) is given to the Mankessim project followed by the Okyercko project (41 points), and their EIRRs are 16.0 % and 13.0 %, respectively. The present cropped areas under irrigation are 26 ha in Mankessim and 22 ha in Okyereko, while their total potential irrigable areas are 176 ha and 111 ha respectively. Irrigation water is available for both projects but the Okyereko area should be supplied with additional water from the Ayensu river. According to the questionnaire survey results, gross farm income per family and the farmers' living standards in the project areas are still low compared with those in other areas. It is then proposed that these projects be selected for the feasibility study.

The Aveyime project is given the third highest score (40 points), and its EIRR is 13.6 %. At present, project functions are mostly interrupted because of serious deterioration of most of the project facilities. Consideration has to be given to this serious situation. Other physical negative factors are not found.

With regards to the Kpando-Torkor project, the actual cropped area under irrigation is only 13 ha at present because of serious deterioration of pumps and the sprinkler system, despite the fact that the project has 356 ha of irrigable land and ample water source for irrigation. EIRR of the Kpando-Torkor project is 20.2 %, which is acceptable for its selection as a priority project. In addition, after its rehabilitation this project could be used as a model for extension of improved irrigation farming with sprinkler system in gentle sloping areas.

Then, Aveyime and Kpando-Torkor projects are proposed for feasibility study.

A lower score (36 points) is given to the Ashaiman project, and its EIRR is also low, 4.2 %. Although the needs of rehabilitation are very high because of serious deterioration of the irrigation and drainage networks, the main problem of this project is serious water shortage. The water study shows that the area irrigable with 80% dependability would be 44 ha. However, consideration should be paid to the existence of the Irrigation Development Centre (IDC) in this area. The main activities of IDC are rice and horticulture experiments, soil research, and agro-environmental research. As mentioned in Annex 1 "Overall Study at Master Plan Level", various plans and programmes are proposed for institutional improvement of GIDA as well as the existing farmers' societies in connection with the projects rehabilitation. In this framework, the function of IDC will be very important for successful implementation of projects rehabilitation, transfer of O&M to the society as well as their follow-up works. It is therefore expected that IDC play a more important role in strengthening research activities for improving irrigation farming and training of extension officers and farmers as well in the reactivated projects. Then, this project is also proposed for feasibility study.

The selected priority projects are located in Ashaiman, Aveyime, Kpando-Torkor, Mankessim, and Okyereko. Potential and developed areas in each of the 5 priority projects under the present conditions were examined based on the available information obtained from GIDA and site inspection made by the Study Team. The results are as follows:

(Unit: ha)

Project	GIDA's Information		Examination Results		Lowland	Upland
	Potential Area	Developed Area	Potential Area	Developed Area		
Ashaiman	155	135	148	67*	67	-
Aveyime	280	60	112	64	64	-
Kpando-T.	400	40	461	40	-	40
Mankessim	320	20	96	17	-	17
Okyereko	100	40	95	40	40	-
Total	1,255	295	912	228	171	57

Note: The area shown in the above table is gross area.

* shows the land area located on the left bank of the project being irrigated at present.

Out of the five selected projects, 3 are served by dams and reservoirs, and the remaining 2 projects use pumps to tap irrigation water from the Volta river and the Volt lake. The existing dams and reservoirs are maintained in good condition and do not need rehabilitation. However, most of the projects served by pumps are not able to satisfy the required irrigation demand because of lack of proper maintenance and deterioration of pumps including their auxiliary equipment. In addition, irrigation canals including related structures in some projects and the equipment for sprinkler irrigation are also deteriorated because of long time use and the lack of maintenance works. The rehabilitation and upgrading of these project facilities are the basic requisite to recover their low productivity at present. Therefore, a high priority is given to the rehabilitation of these projects, as an important measure, to achieve the key policies set out in MTADP.

3. Basic Concept for Projects Rehabilitation

The overall development strategy for more profitable agricultural development in connection with the projects rehabilitation was studied to formulate the feasibility study on each of the priority projects, based on all the study results obtained from both field and home office works during Phase-I and Phase-II.

(1) Agricultural Development Strategy and Policy

The final target of the proposed agricultural development in the reactivated projects can only be achieved through comprehensive development of not only direct measures for increase in agricultural productivity of the projects but also other supporting measures such as strengthening and improvement of GIDA as well as the existing farmers' organisations, particularly in terms of efficient O&M of the projects and provision of sufficient support services to the farmers, and improvement of linkage with other government institutes concerned. This suggests that the Rehabilitation Plan for the priority projects be formulated in the form of "integrated and

balance agricultural development.” The essential policies to be taken for this purpose will be as follows:

- (a) Increase and stabilisation of agricultural productivity
- (b) Rehabilitation and improvement of agricultural production infrastructure
- (c) Institutional improvement and strengthening

The increase and stabilisation of agricultural productivity through elimination or alleviation of various constraints that currently exist in the project areas are considered to be the most important factors contributing to the achievement of the key policies in MTADP. The essential policies to achieve this purpose will be (i) intensification of farming and crop production, (ii) extension of improved farming, and (iii) crop diversification.

The rehabilitation and improvement of the existing agricultural production infrastructure should also have a high priority. The rehabilitation and upgrading of the existing project facilities, particularly irrigation and drainage systems, are the basic requisite for increase and stabilisation of crop production.

The objectives of the institutional improvement plan are to improve the institutes for successful and sustainable O&M of irrigation facilities by the farmers themselves and to increase farmers' crop production through the strengthening of agricultural support services. The major concepts to achieve these objectives are as follows:

- 1) Prior to the handing-over of O&M, GIDA should be strengthened as an O&M executing agency.
- 2) The managing system of O&M and its supporting system by GIDA should be simplified in order to make the related activities efficient and smooth.
- 3) A proper implementing period of handing-over should be set up under the Project, taking into account the actual situation of the societies' activities, farmers' ability and the experience of GIDA's front line staff.
- 4) Successful and sustainable O&M by the farmers needs a lot of support services from various agencies concerned. The institutional plan should therefore cover improvement and co-ordination of all the activities involved in O&M.
- 5) In order to ensure sustainable O&M by the farmers, farmers' participatory implementation should be adopted in the O&M handing-over plan, with the establishment of a monitoring system in the executing agency.
- 6) Strengthening of agricultural support services such as marketing and credits as well as the rehabilitation of irrigation facilities is also a prerequisite factor to achieve the final target of the Project.
- 7) O&M by the farmers should be realistic and possible from the financial viewpoint. With this in view, the O&M cost should be minimised.
- 8) In order to arouse the farmers' sense of belonging and responsibility for the O&M of facilities, all lands in the project areas should be allocated permanently to the

farmers, in accordance with L.I. 1350 of GIDA and traditional custom of land holding in the country.

(2) **Basic Concept for Rehabilitation of Project Facilities**

Most of the existing project facilities need rehabilitation including some improvement works, except for the dams and reservoirs. The facilities to be rehabilitated will be the irrigation and drainage systems, farm road network, and project buildings for both O&M works and farming. The rehabilitation plan and preliminary design of the facilities at feasibility study level should be prepared, taking into consideration the following:

- 1) Elimination or alleviation of constraints for smooth O&M of the existing system
- 2) Expansion of the project area in the light of the original plan, if any
- 3) Maximum use of the existing facilities for cost-saving
- 4) Easy operation and maintenance of the project facilities
- 5) Application of the design discharge estimated in a logical manner
- 6) Soil erosion control measures for steep topography areas in connection with the drainage system

4. Agricultural Development Plan

(1) **Proposed Crops and Cropping Patterns**

A variety of crops are already grown in the project areas, though continuous cultivation of one to two crops is seen in some areas. They are paddy rice, maize, cassava, groundnuts, cowpea, and vegetables. Maize, cassava, groundnuts and cowpea are food crops for the people, and vegetables are cultivated mostly for earning cash income. Basically, the crops to be proposed for the reactivated projects will therefore be selected from the present crop varieties. In order to increase farm income, appropriate combination of a variety of crops should be taken into consideration in preparing the proposed cropping patterns, particularly in lowlands of Ashaiman, Aveyime and Okyereko where the main crop is rice.

The main issues in preparation of the cropping patterns to be proposed for the reactivated projects will be (i) full and effective use of existing farmland particularly in the rainy season, (ii) elimination or alleviation of crop damage due to continuous cultivation, and (iii) appropriate combination of food and cash crops to expect higher returns which result in the increase in farm income.

The present cropping intensity is still low, ranging from 33% in Kpando-Torkor to 110% in Mankessim. The proposed cropping patterns should therefore be prepared so as to use fully the irrigable area in all of the five projects in both the wet and dry seasons. The area is to be delineated through water balance study. Consideration should also be paid to the elimination

or alleviation of crop damage due to continuous cultivation in order to ensure higher crop yields and quality products, especially for tomato, pepper, egg plant, and okra. It is recommended to cultivate these vegetables once in every 3 to 4 years.

(2) Post-harvest, Agro-processing, Storage and Marketing

In the project areas where upland crops are cultivated, no drying floors are available, and the farmers have to bring the products to their houses. It is therefore recommended that drying floors be constructed in the areas where vegetables, maize, cowpea, and groundnut are proposed as the main crops.

Since the existing threshers and millers in the rice growing projects are generally deteriorated, they should be replaced by new ones. Because there are no factories for processing of vegetables in and around the project areas, it is advisable to provide the floors with simple roofs for selecting marketable products of good quality, such as tomato, egg plant, onion, okra, etc.

Although some storage houses are available in most of the rice growing projects, no storage is provided in the areas where upland crops are grown mainly, and the farmers usually store the products in their houses. Storage houses are required for these projects.

Presently, most of farm products are sold at farm gate to middlemen, market mammy in most cases. The market prices of farm products vary with the seasons as well as the location of markets. Particularly, the prices of cash crops such as vegetables fluctuate with the demand-supply situation and provide the basis on which to decide the crops and varieties to be planted, cropping area, crop calendar, and rotation patterns. Therefore, market research is essential for marketing of farm products as well as farm inputs. Under the free market system, it is also essential to produce the products in good quality and appropriate quantity to meet the market requirements, and to ship constantly and/or timely every year according to the market situations. For these purposes, more active services by the existing farmers' societies will be required to control quality and quantity of products so that the farmers can negotiate with the middlemen on appropriate prices of products as well as of inputs through the societies.

5. Rehabilitation Plan of Project Facilities

(1) Delineation of the Project Area

Since topographic maps on a scale of 1 to 5,000 covering each of the priority projects were made available for further study of the project areas, additional field investigation was conducted in each project area. In parallel with such field investigation, public meetings with the project beneficiaries were held, and the project boundary was confirmed with the farmers concerned at each project site. As a result, alternative project areas to be rehabilitated were determined in order to prepare the optimum rehabilitation plan for each priority project from both

technical and economic points of view. Then, a comparative study of the alternative plans was performed for the Aveyime, Kpando-Torkor, Mankessim and Okyereko projects, based on the proposed crops, cropping patterns, irrigation plan, water balance study, project costs, and incremental project benefits of each of the projects. Based on the comparative study results, the optimum size of the area to be rehabilitated for each project, which is the basis for the feasibility study on the projects rehabilitation, was determined as summarised below:

Project	Optimum Rehabilitation Area
Ashaiman	56 ha
Aveyime	95 ha
Kpando-Torkor	155 ha
Mankessim	86 ha
Okyereko	81 ha

(2) Rehabilitation Plan of the Irrigation System

The proposed rehabilitation plan for each of the priority projects is as follows:

1) Ashaiman Project

This project is presently suffering from serious water shortage, and as a result only 56 ha of land on the left bank are being irrigated, despite the fact that 130 ha of land have already been developed on both the left and right banks. According to the water balance study, there would be no spilling water from the reservoir, when the land is cultivated with paddy rice. Even if the storage capacity of the reservoir is increased by heightening the crest elevation of the spillway or dam, the increased water amount would be consumed mostly by evaporation due to the increase in water surface area in the reservoir. For this reason, the heightening of the spillway or dam crest is not proposed. No other supplemental water sources could be found in and around the project area. Therefore, the project area to be rehabilitated will have to be restricted to the above 56 ha on the left bank. Since the existing dam, reservoir, and intake facilities are maintained in good condition, no rehabilitation works will be required. However, the existing irrigation facilities including canals and related structures are severely deteriorated, which accelerates the present water shortage because of much water leakage from the canals and structures. Therefore, the existing irrigation system will have to be rehabilitated totally. The main and lateral canals are proposed to be lined with concrete flume mainly for easy construction as well as O&M of the system after rehabilitation. All of the related structures such as turnout, check, drop, cross drain, culvert, etc. will also be replaced by new ones. The canal layout will follow the existing one without any modification so as to avoid additional land acquisition for canal construction.

2) Aveyime Project

Paddy rice had been cultivated in 63 ha of existing paddy field in both the wet and dry seasons, using irrigation water pumped from the Volta river. Unfortunately,

however, irrigation services have been interrupted since 1995, because all pumps were completely deteriorated. Even under these conditions, some farmers still continue paddy rice cultivation with irrigation water supplied from the adjacent streams by using their own small pumps. As already discussed in section 5 (1) of this Summary, the present irrigation area will be expanded to 95 ha net as the most optimum rehabilitation plan. The irrigation canal network including related structures is also deteriorated as seen in the Ashaiman area. Therefore, the pump stations as well as the canal network will have to be rehabilitated totally, and the existing canal network will be extended to irrigate additional 2 blocks by gravity. The remaining block will require a new sprinkler irrigation system considering the soil condition and elevation of the land. The proposed pump stations will be electrified for easy O&M as well as for lower O&M cost.

3) Kpando-Torkor Project

The potential area for irrigation development under this project is estimated at 415 ha net from the detailed topographic maps on a scale of 1 to 5,000. The area is topographically divided into 4 blocks: A, B, C, and D from downstream to upstream in sequence. In addition, each block is divided into 2 parts, highland and lowland. The study on the most optimum rehabilitation plan shows that the combination of lowland in Blocks A and C is justifiable from both technical and economic points of view. Finally, the proposed net irrigation area is 155 ha, which is the basis for preparation of the project rehabilitation plan. Irrigation is being practised by sprinkler to cultivate cash crops. However, all equipment for sprinkler irrigation such as pumps, pipelines, sprinkler heads, etc. is deteriorated because of long time use and only a very small area, about 20 ha, can be irrigated due to insufficient quantity of equipment. The proposed plan for rehabilitation of the irrigation system is to provide a new sprinkler system for blocks A and C. Each block will be served by one complete set of pump station, pipeline and sprinkler system, independently, instead of one large-scale pump set commanding the whole area. This is to avoid the risks in case of breakdown of the facilities.

4) Mankessim Project

This project is using a dam and reservoir for sprinkler irrigation for cultivation of cash crops at present. Since the dam and reservoir are in good condition, any rehabilitation work will not be required. The present land under irrigation is located on the left bank of the dam and could be expanded to 29 ha in total. In addition, there exist 57 ha of farmland being used for cultivation of cash crops by farmers on the right bank, and the farmland could also be irrigated by the reservoir. A comparative study justifies the expansion plan, and the total irrigation area at this project will be expanded to 86 ha net after rehabilitation. On the basis of the expansion plan justified, the proposed rehabilitation plan was prepared so as to provide 2 sepa-

rate sprinkler systems to serve the farmland on both the left and right banks. The pump stations will be electrified similarly to other pump projects.

5) Okyereko Project

This project is also using a dam and reservoir for gravity irrigation of 40 ha of existing paddy field. Since the dam and reservoir are maintained in good condition, no rehabilitation works will be required. Because the reservoir is fed by rainfall only, however, the present irrigation area is restricted to 40 ha due to water shortage, despite the fact that the area can be expanded to the land adjacent to the existing paddy field. To cope with this water shortage, GIDA has a plan to provide supplemental water source by installing pumps on the Ayensu river located near the project. Then, a study was conducted on the expansion of the irrigation area together with the construction of a new pump station. The expansion plan is justified from both technical and economic points of view, and the irrigation area after rehabilitation will be 81 ha net. Similar to other gravity irrigation projects, the present irrigation system is deteriorated, resulting in low productivity. Therefore, the proposed rehabilitation plan is to construct a new pump station and to replace the existing irrigation facilities by new ones.

(3) Rehabilitation Plan of the Drainage System

Out of 5 priority projects, Ashaiman, Aveyime and Okyereko have drainage systems. The existing drainage systems of these projects do not function well at present due to heavy sedimentation and grass in the canals. If maintenance works such as removal of sediment and grass are carried out properly, these drainage systems will function as originally designed, because there is not any constraint to smooth evacuation of excess water from farmland. The light salinity concentration observed in Ashaiman, Aveyime and Okyereko could also be settled by proper execution of such maintenance works. Therefore, the existing drainage systems of the above 3 projects will have to be rehabilitated by removing sediment and grass as well as by restoring the flow section of the drains to the original design, in order to recover the drainage function.

The Kpando-Torkor, and Mankessim project areas have undulating topography. This means that these projects are subject to possible soil erosion due to intensification of irrigation farming by the projects rehabilitation in the future. In order to prevent soil erosion, control measures will have to be provided for these projects. The proposed control measures include the construction of green belts and intercepting drains which will be provided along the contour lines at 200 m intervals. In addition, collector drains will also be required to evacuate excess rain water from the intercepting drains.

(4) Farm Road Network, Buildings and Related Facilities

All farm roads are generally poor and require improvement works for proper O&M of the project facilities as well as for conveyance of agricultural products. The road surface will be smoothed after grass cutting, and paved with gravel for main roads and with laterite for lateral roads.

The project offices, except for those in Ashaiman, are very poor. These offices are therefore proposed to be totally replaced by new ones. A new O&M office should be designed, taking into account the farmers' participation in the project operations.

Post-harvesting facilities such as storehouse, sorter house, dry yard and garage are not sufficient in most of the projects. These facilities will be newly provided on the basis of proposed crops and anticipated crop production in the projects where such facilities are not available at present or not functioning well because of deterioration.

(5) O&M Equipment

In order to operate and maintain the reactivated projects satisfactorily, additional O&M equipment consisting of vehicles, tractors, backhoes, grass cutters, radio communication equipment, etc. will be required.

6. Institutional Improvement Plan

(1) Organisation of Project Executing Agencies

The implementation of the Project is divided into three stages: (i) construction of rehabilitation works, (ii) handing-over of O&M, and (iii) O&M by the farmers themselves. The organisation of the executing agencies for construction and handing-over is proposed as follows:

1) Executing agency for rehabilitation works

GIDA under the Ministry of Food and Agriculture (MOFA) will be the executing agency for the rehabilitation of irrigation projects. GIDA will co-ordinate all activities of the relevant Government agencies and regional administrative organisations in connection with the Project implementation. The Department of Project Development under GIDA will have direct responsibility for the Project implementation including both the engineering and the construction works. The Regional and Project Management (PM) offices will manage and co-ordinate the construction of the Project at the district level on behalf of the Department of Project Development. The main tasks of GIDA and these offices will be as listed below.

- (a) Financial arrangements needed for the engineering and construction works of the Project.
- (b) Design and construction supervision of all the implementation works.
- (c) Co-ordination between the Government authorities concerned with the implementation of the Project.
- (d) Arrangement for staff required during the detailed design and construction stage (The head office of GIDA should despatch at least one civil engineer to each PM Office for supervision of construction works.)
- (e) Progress and quality control of the rehabilitation (construction) works.
- (f) Preparation of O&M manual.

2) Executing agency for handing-over of O&M

After completion of the rehabilitation works, all project facilities will be transferred to the Department of Project Operations, which will be responsible for the handing-over of O&M to the farmers' societies. The PM offices will have direct responsibility for O&M handing-over at the project site under the management and instruction of the Department of Project Operations. The organisation of these two offices should be strengthened in order to ensure successful O&M handing-over.

(2) Project Implementation and Management by GIDA

1) Handing-over of O&M

At present, GIDA has a plan on handing-over process. In this plan, the implementing period of handing-over to the farmers has been set at 3 years. Although the contents of this plan can be applied basically to the Project without problems, the period should be set up taking into account the actual situation of the societies' activities, farmers' ability and the experience of GIDA's front-line staff who will implement the handing-over directly. It is proposed to set about 5 years as a reasonable period, based on the result of field investigation and referring to the progress of the Dawhenya Irrigation Project.

2) Training programme for O&M and strengthening of the farmers' societies

Prior to the handing-over of O&M, the existing societies should be strengthened through a forced training programme. For this strengthening, a wide scale training programme will be introduced. Namely, the training programme will be implemented not only for the farmers in the project areas and the officers of GIDA, but also for the officers involved in O&M and the people including the district offices of the Department of Co-operatives, the extension offices of MOFA, village chiefs and elder groups in villages, because O&M by the societies needs a lot of co-operation

and support from them. The O&M Division and the Extension Division will be responsible for the training. The training contents consist of O&M and strengthening of the societies, but some other contents such as new agricultural extension system and promotion of the women in development will also be included in this training programme, because the officers and the people involved in O&M and strengthening of the societies should have those basic knowledge.

3) Establishment of a monitoring system

To sustain O&M by the farmer's societies, and to further improve of O&M and agricultural production after handing-over, it is proposed to establish a monitoring system in GIDA.

(3) Farmers' Societies

As the basic approach, the O&M should be handed over to the existing societies which are already established in each project area. Strengthening of the existing societies should be undertaken by GIDA, in co-operation with the Department of Co-operatives. The proposed strengthening plan for the existing farmers' societies is as follows:

The main objective of the farmers' societies will be to operate and maintain the irrigation facilities. In addition, other objectives such as marketing and credit services will also be included in order to meet the farmers' intention and to improve present agricultural support services.

All of the existing farmers' societies have no function of O&M of the irrigation facilities. The societies should therefore be reorganised to new societies which should have the functions of O&M with the agricultural support services such as marketing and credits.

A new society will consist of the following 4 components: (i) general meeting, (ii) executive committee, (iii) audit, and (iv) service sections including O&M, agriculture, marketing and credit, and women's group. This main functions and activities will be as follows:

- 1) A General Meeting will be held at least annually.
- 2) The Executive Committee will be composed of the following members: Chairman, vice chairman, general secretary, treasurer, and several members who are representatives of the service sections. Main tasks of the Committee will be (i) to prepare annual management plans and budget, (ii) to instruct and supervise activities which are implemented by the service sections, (iii) to manage complaints and grievance from the farmers, (iv) to arrange and appoint volunteers employed in the service sections, (v) to manage accounting and general affairs, (vi) to co-ordinate with other

agencies and associations, and so on. The committee members will take part in these works. A regular meeting will be held monthly for implementing these activities.

- 3) Service Sections: Under the instruction and supervision of the executive committee, the routine service works will be implemented by the following four sections: (i) O&M, (ii) agriculture, (iii) marketing and credit, and (iv) women's group. These sections will employ several volunteers.
- 4) Audit Section: At present, the staff of a society consists of a chairman, vice chairman, secretary, treasurer and several members of the Executive Committee as mentioned earlier, and no auditor is commonly assigned. Namely, the society has no auditing system in their accounting works, and this is one of the society's problems. To solve this problem, it is proposed to establish an auditing system.

(4) Training of Farmers' Societies

The PM office will prepare the training programme and train periodically the leaders of farmers' societies and the farmers themselves, in co-operation with the Department of Co-operatives. In order to solve the problems and constraints encountered during the transitional period of O&M, the PM office should closely monitor all the society's activities. The training items required for the society's management are (i) administrative work including book keeping, (ii) accounting work, (iii) marketing and credit services, etc. For this training, a co-operative officer will be appointed in each PM office during the transitional period.

(5) Irrigation Service Fees

All O&M costs for irrigation facilities will be covered by the irrigation service charges (ISC) collected from the farmers. The amount of ISC will be estimated by each farmers' society.

The proposed ISC collecting procedure is as follows: ISC will be collected before each cropping season. All members of the Executive Committee will collect ISC directly from the farmers, and the collected amount will be deposited immediately in the society's bank account. The treasurer will manage all these transactions.

The Executive Committee will be responsible for collection and management of ISC. The O&M costs are classified into two types: One is the recurrent costs such as electric charge and personnel cost, and the other is the costs for emergency and specific O&M works. The former will be paid by the treasurer after approval of the chairman and the general secretary, as a routine of the society's works. For the latter, a committee meeting will be held to assess its necessity and a fund will be released for such emergency works, if necessary.

(6) Articles and Bye-laws

Standard articles and bye-laws of farmers' society have been prepared by the Department of Co-operatives. But these are generally for co-operatives and do not specifically cover the new societies which will be responsible for the O&M of the projects. Although these standard articles and bye-laws will be applied basically to the new societies, it is necessary to enact several new articles. These are listed below:

- 1) The society has the right to collect ISC from the beneficiaries who receive irrigation services from the society, and the beneficiaries have the duty to pay ISC to the society.
- 2) The society can inflict a punishment on those people who use irrigation water and facilities illegally or fail to pay ISC.
- 3) The beneficiaries have the duty to participate in the co-operative works on O&M which are planned by the society.
- 4) The tenant beneficiaries have the right to join the society, and are bound to pay ISC and membership fees as proxies of the owner beneficiaries.

(7) Agricultural Support Services

1) Extension services

As a basic approach to agricultural extension, the strengthening of GIDA's activities is considered for this Project. The agricultural extension services in the project areas are undertaken by the Project Management Division under the Department of Project Operations, GIDA. At present, 2 agronomists are attached to this division to deal with all subjects including paddy, vegetables, and plant protection. It is suggested to appoint two more officers. Their main duties will be extension of improved irrigation farming, improvement of co-operatives, marketing and credit system, promotion of women's activities, and training.

Training programmes should be implemented for GIDA's officers as well as the farmers, in order to enable them to carry out their duties effectively. It is well understood that extension officers at field level should be competent to understand farming as a whole, possess diagnostic skills, and able to identify appropriate actions. The present extension officers in the project areas, however, have not so much experience in irrigation farming. The necessary training programmes for the officers are listed below. These programmes will be managed by the Extension Division in co-operation with IDC in Ashaiman.

The "T&V" (Training and Visit) extension system being adopted by MOFA is proposed to be introduced in the project areas. The farmers will form groups

consisting of 8-15 persons each, and the extension officers will visit each group at least once a week. Since all PM offices have almost no extension equipment and facilities at present, the equipment such as typewriter, printing machine, photocopy machine, and a pick-up is therefore recommended to be provided in each PM office, in order to carry out extension activities effectively.

2) Improvement of agricultural credits

At the initial stage of the Project, the farmers will need a considerable amount of loan for purchasing farm inputs for crop cultivation, especially for vegetables. At present, several credits are provided by the banks in and around the project areas. These credits have however serious problem on defaulting in payment of loans. To overcome this problem, it is proposed to introduce a group loan or revolving loan systems. These are comprehensive system covering agricultural credit, marketing and technical guidance, and are managed by the societies. The difference between them is financial sources; the former loan system obtains financing from banks and the latter from public agencies. A prevailing interest will be applied to these systems. These loans are managed by the farmers' societies, and the implementing agency of the project (GIDA) will arrange them. It is necessary that the bank provides supporting services to the society for management of loan, because the societies have no knowledge and experience on such banking business. The Agricultural Development Bank (ADB) is now providing loan management services for the irrigation project, if so required.

3) Improvement of marketing

Timely supply of farm inputs such as fertilisers and agro-chemicals is one of the important factors for improving crop yields as well as the dissemination of improved irrigation farming. To make smooth supply of farm inputs, a co-operative purchasing system is recommended to be introduced in the project areas. This system will be closely connected with loan services, technical guidance and organisations' activities. Farm inputs such as fertilisers and agro-chemicals would be supplied smoothly by the private suppliers through this system. As for the seed supply, the result of interview survey carried out by the Survey Team shows that most of the farmers in the project areas have no problems of purchasing seeds at present. Therefore supply of seeds for cereals has been entrusted to MOFA and that for vegetables to the private sector so far. The supply of quality seeds will however be necessary to increase crop yields in near future. It is expected that IDC will produce quality seeds and provide them to the farmers through the GIDA's extension system.

At present, dealers (market mummies) handle a lot of farm products in the project areas. Their marketing activities cover all the country and are connected from village to village and with urban areas. In the case of Mankessim, the project area is

under the buyer's market, and the farm gate prices of products are wrongfully controlled by the dealers who come from the Mankessim market. To overcome such a problem, the farmers in the Mankessim project sell their products directly to another market near Accra. It seems that the other projects have also such a problem more or less. As one of the countermeasures, it is proposed to introduce a co-operative shipping system managed by the societies.

7. Environment Conservation and Monitoring Plan

The model development approach is proposed for the environment conservation and monitoring procedures, because the environment problems identified in the IEE and EIA studies are not particular problems in the project areas but can be found in the whole country of Ghana. Through the field trials/demonstration, the farmers can learn and understand easily the conservation technologies and their effects. This approach is based on the philosophy that the farmers readily adopt new methods if they know how to do and the results are readily observed. The adoption should further be encouraged under extension services. Therefore, this project should be placed as the model development project for the future sustainable development.

The conservation measurements and monitoring works will be applied for the construction and operation stages. Therefore, the government staff as well as the beneficiary farmers in the areas have an important role for the success of the countermeasures. The monitoring works should also be carried out by government staff in co-operation with the beneficiary farmers. In this connection, it is proposed that a research, monitoring and evaluation unit (M&E unit) established in order to play a role as an engine for the environmental management and also for effective transfer and dissemination of technologies to the farmers.

(1) Reclamation Measures for Saline Soils

For the reclamation of saline soils, land management operations such as flushing, leaching and mulching are proposed. It is recommended to carry out flushing and leaching (irrigation) works in the salt-affected fields immediately after the construction of the drainage system and prior to the farming operations, if possible.

(2) Management of Water-born Diseases

The irrigation water resources in the project areas are already infested with schistosomes, especially in the Aveyime area. Therefore, countermeasures for prevention of expansion of diseases should be considered not only in the project areas but also along the upper reaches of the reservoirs. The adoption of chemical treatment is not recommended, because the contaminated area is so wide and the toxicity of chemicals may adversely effect the environment. The following countermeasures are considered as the extension programme to be taken.

1) For malaria and schistosomiasis

- a) Concrete canal lining to prevent growth of weed and water stagnancy
- b) Maintenance works including cleaning and weeding of canals
- c) Health education of local people

2) For malaria

- a) House spraying of residual effect insecticides, immediately after mosquitoes detection
- b) Biological control by introducing predator fish, such as *Tilapia zilli*
- c) Distribution of mosquito nets

3) For schistosomiasis

- a) Wear of rubber boots when going into water
- b) Prohibition of urination into water sources and provision of sanitary facilities

(3) Monitoring Plan

The proposed monitoring items for each project are water quality in downstream areas, salinity condition and farmers health in Ashaiman; water quality and farmers health in Aveyime; soil erosion and farmers health in Kpando-Torkor; water quality in downstream areas and farmers health in Mankessim; and water quality, salinity condition and farmers health in Okyereko. In addition, it is recommended to monitor the complaints from the beneficiary farmers as well as other local people at least once a year in order to check the unexpected environmental changes caused by the projects.

8. Implementation Schedule

A project-by-project implementation approach is proposed to be adopted for the selected 5 priority projects. The rehabilitation works required for the Project are scheduled to be completed in about 3 years, including project appraisal, financial arrangement, survey, design, tendering, and tender evaluation, taking into account the nature of the works, work quantities, and workable days. Two years would be necessary for construction of all the five projects. Each project could be completed in one year judging from the project scale, and thus five projects will be divided into two groups: The Ashaiman, Okyereko, and Mankessim projects in one group, and the Aveyime and Kpando-Torkor projects in the other group. This grouping is proposed taking into account the importance of early implementation of the Ashaiman project for early commencement of farmers' training for all the five projects, and easy and effective construction supervision due to the close location of the Mankessim and Okyereko projects, and also referring to the result of economic evaluation.

9. Cost Estimate

(1) Project Cost

The costs for the respective projects were estimated on the basis of the following conditions, mainly for the purpose of economic evaluation of each project:

- (a) The unit prices are based on the 1996 prices.
- (b) The exchange rate is US\$ 1.00 = Cedi 1,700 =¥110 (as of December 1996).
- (c) Construction works will be executed on a full contract basis through competitive bidding. The construction machinery and equipment required for construction will be provided by the contractors themselves. Therefore, the depreciation cost of machinery and equipment is considered in the estimate of construction unit rates.
- (d) The unit rates of the works are divided into the foreign and local currency portions. The respective currency portions basically include the following costs:
 - Local currency portion : local labour cost, cost of local materials, and machinery, inland transportation cost, etc.
 - Foreign currency portion : foreign labour cost, cost of imported materials, and machinery, contractor's general expenses, etc.
- (e) The unit rates of the works are estimated at the December 1996 price level on the basis of current prices prevailing in Ghana and data obtained from similar projects such as the Dawhenya Irrigation Project and Kpong Irrigation Project.
- (f) Engineering services cost is estimated at 15% of the direct construction cost. Administration cost of the implementing agency is estimated at 5 % of the direct construction cost.
- (g) Physical contingency, estimated at 10% of the direct construction cost and related costs, is included in the project cost of both foreign and local currency portions.
- (h) Price contingency is calculated on the basis of an annual escalation rate of 2.5% for the foreign currency portion and 25% for the local currency portion, based on the Quarterly Digest published by MOFA in March 1995 for the local currency and "G-5 MUV Index" of the World Bank for the foreign currency.

The following is a summary of the respective project costs thus estimated:

Summary of Project Cost

(Unit: Cedis million)

Item	Ashaiman	Aveyime	K-Torkor	Mankessim	Okyereko	Total
(1) Direct Construction Cost*1	887	1,852	4,400	2,350	1,761	11,250
(2) O & M Equipment*2	319	113	176	150	148	906
(3) Engineering Services*3	133	278	660	353	264	1,688
(4) Administration Cost*4	44	93	220	118	88	563
Sub-total	1,383	2,336	5,456	2,971	2,261	14,407
(5) Physical Contingency*5	89	185	440	235	176	1,125
Sub-Total	1,472	2,521	5,896	3,206	2,437	15,532
(6) Price Contingency	490	1,055	1,896	671	759	4,871
Total	1,962	3,576	7,792	3,877	3,196	20,403
Cost per ha in Cedis 1,000	35,036	37,642	50,271	45,081	39,457	43,135
Cost per ha in US\$	20,609	22,142	29,571	26,518	23,210	25,374

*1 Cost of training facilities is included in the Ashaiman and Okyereko projects.

*2 Cost of bus and backhoe is included in the Ashaiman project only.

*3 15% of direct construction cost.

*4 5% of direct construction cost.

*5 10 % of direct construction cost.

(2) O&M Cost

The O&M cost for the Project consists of (i) administration cost such as salary of project staff concerned and operation cost of the PM office, (ii) O&M cost for pumps and pumping stations, (iii) O&M cost for the command area, like cost for running, repair and maintenance of O&M equipment, labour cost for repair and maintenance works, material cost for repair and maintenance works, and contract cost for repair which could not be made by farmers' organisation. These costs were estimated for the respective projects as summarised below:

O&M Cost

(Unit: Cedi 1,000)

Description	Ashaiman	Aveyime	K-Torkor	Mankessim	Okyereko
(1) Administration Cost	4,200	4,200	4,200	4,200	4,200
(2) O & M of Pumps	-	23,800	62,100	32,800	14,200
(3) O & M of Command Area	3,629	4,326	4,575	2,759	3,309
Total	7,829	32,326	70,875	39,759	21,709
Cost per ha in Cedi	139,800	340,300	457,300	462,300	268,000
Cost per ha in US\$	82	200	269	272	158

10. Economic and Financial Evaluation

The objective of the project evaluation is to assess the economic and financial feasibility of the Rehabilitation of Irrigation Projects in the Republic of Ghana. For the economic evaluation, three measures of project worth, namely, economic internal rate of return (EIRR), benefit-cost ratio (B/C) and benefit minus cost (B-C) were examined. In addition, a sensitivity analysis in terms of EIRR was made to evaluate the economic viability of the Project against possible changes in project costs, benefits, and build-up period. For the financial evaluation, the financial capability of the farmers' societies and the capacity to pay of the farmers were analysed. The indirect benefits and socio-economic effects, which would impact on the regional and national economy, were also studied briefly.

(1) Economic Evaluation

EIRR of each project was estimated as shown below. The Ashaiman project indicates the highest EIRR, were followed by the Kpando-Torkor project. In addition, B/C and B-C at a discount rate of 10% were also estimated, and the result are summarised below:

Projects	EIRR (%)	B/C *	B-C * (Cedis Million)
Ashaiman	23.2	2.46	1,112
Aveyime	15.7	1.53	1,041
Kpando-Torkor	16.9	1.61	2,849
Mankessim	14.5	1.38	1,065
Okyereko	13.0	1.28	530
Whole Project	16.0	1.55	6,597

* Discount rate: 10%

In addition, project sensitivity in terms of EIRR was analysed in respect of changes in project costs and benefits. The Ashaiman project is still marginal if the costs increase 20% and the benefits decrease 20%, while the Okyereko project is less marginal under the same condition as the Ashaiman project.

(2) Financial Evaluation

In order to assess the capacity to pay of farmers for the irrigation services fees, an analysis of their farm budget was made under the future "with project" condition. The result of analysis is as follows:

(Unit: Cedis 1,000/farmer)

Items	Ashaiman	Aveyime	K-Torkor	Mankessim	Okyereko
(Holding Size: ha/farmer)	(0.45)	(1.00)	(0.40)	(0.40)	(0.60)
1) Gross Income*1	4,761	9,037	5,221	4,243	5,730
2) Gross Outgoing*2	4,478	5,989	4,002	3,487	4,955
3) Capacity to Pay	283	3,048	1,219	756	775
Annual Repayment of Irrigation Service Fees					
Annual O&M Cost	24	284	170	162	124
Annual Replacement Cost*3	120	620	509	516	287
Total	144	904	679	678	411
% to Capacity to Pay					
Annual O&M Cost	8%	9%	14%	21%	16%
Annual Replacement Cost	42%	20%	42%	68%	37%
Total	51%	30%	56%	90%	53%

*1 Non-farm income decreases 50% from present condition.

*2 Living expenses increase 30% from present condition.

*3 Procurement cost / Useful life

Note: 1996 Constant Prices

The result of analysis shows that the capacity to pay or net reserve of farmers would increase remarkably in the future "with project" condition compared to the present condition. As seen in the above table, the annual irrigation service fees occupy 30 - 50% of their capacity to pay, except for the Mankessim project. From this result, it may be concluded that the payment of annual irrigation service fees after implementation of the Project will be possible for the farmers in the 4 projects, excluding Mankessim. In the case of the Mankessim project, the

payment of irrigation service fees will hinder further improvement and growth of their living standards, though the amount of service fees is within their capacity to pay. It will be necessary therefore to give some subsidy to the farmers in the Mankessim project.

In addition, the farmers' capacity to pay of the irrigation service fees was studied on the basis of their intention on the amount to be paid. At a public meeting, the following amounts were accepted by the farmers.

	Ashaiman	Aveyime	K-Torkor	Mankessim	Okyereko
Amounts accepted by the farmers at public meeting*					
Cedis/ha/season	100,000	263,500	375,000	250,000	100,000
Cedis/year/farmer	90,000	527,000	300,000	200,000	120,000
Holding size of a farmer (ha)	0.45	1.00	0.40	0.40	0.60

* November 1996

As seen in the above table, all irrigation service fees estimated by the Study Team are over the amounts accepted by the farmers. Although the result of farm budget analysis shows a possibility to pay full amount of irrigation services fees by all farmers, the societies will have a difficulty to collect these fees fully from the farmers. Therefore, it will be necessary to fill the gap by the government subsidy.

In order to estimate reasonable amount of irrigation service fees and the Government's subsidy from the standpoint of the capacity to pay of farmers, farmers' intention and the Government's development budget, the following case studies were made: i) all replacement costs are subsidised by the Government, and farmers pay only annual O&M costs; ii) farmers pay the allowable amounts accepted at the public meeting; iii) farmers pay annual O&M costs and 30% of replacement costs; iv) farmers pay annual O&M costs and 50% of replacement costs. Based on the result of the studies, it is recommended to adopt the following subsidy for each project, though the amount of subsidy should be decided by the Government.

	Ashaiman	Aveyime	K-Torkor	Mankessim	Okyereko
Holding Size (ha/farmer)	0.45	1.00	0.40	0.40	0.60
Capacity to Pay of Farmers (Cedis 1,000/year/farmer)	283	3,048	1,219	756	775
Proportion of subsidy					
Farmers					
O&M Cost	100%	100%	100%	100%	100%
Replacement Cost	50%	100%	50%	30%	50%
Subsidy					
O&M Cost	0%	0%	0%	0%	0%
Replacement Cost	50%	0%	50%	70%	50%
Irrigation Service Fees (Cedis 1,000/year/farmer)					
O&M Cost	24	284	170	162	124
Replacement Cost	60	620	255	155	144
Total	84	904	425	317	268
% to Capacity to Pays	30%	30%	35%	42%	35%
Allowable Amounts of Farmers *1 (Cedis 1,000/year/farmer)	90	527	300	200	120

*1 Amounts accepted by farmers at public meeting. Note: 1996 Constant Prices

The farmers in the Aveyime project area will have a big payment capacity after

implementation of the rehabilitation project, while the Mankessim farmers will have a small capacity. It is recommended that full amount of irrigation service fees including annual O&M costs and replacement costs will be imposed on the farmers in the Aveyime project, and a considerable amount of subsidy will be provided to the farmers in Mankessim. As for the other 3 projects, a half of replacement cost is to be subsidised by the Government in order to secure successful O&M by the societies.

With the exception of the Aveyime project, all estimated irrigation service fees are over the allowable amounts accepted by the farmers at the public meeting, but these amounts are negotiable with farmers. They have judged these allowable amounts mainly based on the crop income obtained from the present irrigation farming in the project areas. However, the projects will provide complete and upgraded irrigation systems with powerful extension services to the farmers, and their crop incomes under the projects will increase over the farmers' estimates made on the basis of the present condition. The project executing agency should explain to them to get their full understanding on the irrigation service fees.

If the above government subsidy is provided to the projects, the estimated amounts would account for 3 - 20% of the government's development expenditures for agriculture (including forestry and fisheries) or 0.2 - 1.2% of total development expenditures for economic services, and it may be possible for the Government to invest these amounts.

11. Conclusions and Recommendations

(1) Conclusions

The Economic Internal Rate of Return (EIRR) of the priority projects ranges from 13% to 23.2%, and even in the case of the whole Project, it is 16%. It can be said that the Project is economically viable from the viewpoint of national economy, and technically feasible. Through the feasibility study, the Project is justified as summarised below:

- (a) The function and productivity of each of the projects will completely be recovered by rehabilitation of all the project facilities, and these reactivated projects will contribute to the achievement of key policies stipulated in the Medium Term Agricultural Development Programme (MTADP) of Ghana.
- (b) The farm economy will remarkably be improved and also stabilised as compared with the "without project" conditions. From the financial point of view, large benefit will accrue for the beneficiary farmers in each of the project areas after implementation of the Project.
- (c) The present irrigation area will be expanded to 473 ha in total under the projects rehabilitation plan, and the number of beneficiary farmers will increase to 950

households in the whole project area.

- (d) The Project would create a demand for farm labour due to the increased farming activities, more intensive land use, and increase in agricultural production. In addition, the construction of the Project would increase employment opportunities in each project area. All these would contribute to activating the regional economy. Further, the employees under the Project will gain more experience, technical know-how and skills in various working fields, and these would be useful for similar developments in the rural area.
- (e) After implementation of the Project, income of farmers in the project areas is expected to increase considerably as a direct result of the increase in crop production. Such increase in income would contribute to improving farmers' living standards.
- (f) Future marketing activities in the project area will expand as compared with the present condition, because more farm products could be marketed by the farmers, and the proportion of sales to consumption would also increase.

In addition, the following conclusions on the project sustainability were obtained. The farmers' self-reliance in project implementation will also be one of the essential factors to achieve the project sustainability. At the public meetings held at each project site, the farmers showed some self-reliance, in particular with regard to the farmers' participation in the rehabilitation works, land acquisition in the project areas, and final levelling of the extension area.

As for O&M by the farmers themselves, all farmers have agreed with this as well as the increase in irrigation services fees after the rehabilitation. They have a positive attitude toward the project implementation, and it may be said that such farmers' attitude will be very helpful to achieve the sustainable O&M of the Project. Moreover, all farmers have accepted the strengthening plan of the farmers' societies necessary for handing-over of O&M, and the farmers' positive participation in its implementation is expected.

(2) Recommendations

Because the projects rehabilitation will contribute to the national food security improvement, and realistic and practical approach to the achievement of the key policies set forth in MTADP, it is recommended to implement the Project as early as possible.

In addition, GIDA has a programme to transfer the O&M functions of the existing irrigation projects step by step to the farmers' organisations after reactivation of these existing projects. The key measures for successful promotion of this programme are to rehabilitate the deteriorated existing irrigation facilities as the first step and to establish a suitable water management plan and O&M system of the projects together with strengthening of the farmers' or-

ganisations through training and support from the government institutes concerned.

In order to meet these purposes and to achieve the sustainable O&M of the Project, the executing agency should undertake the following activities:

Activities up to the end of the rehabilitation works

- 1) Training of staffs involved in all of the project implementation stages including supervision of rehabilitation works, handing-over of O&M, support services for O&M, extension of irrigation farming, strengthening of the farmers' societies, improvement of marketing and credit, etc.
- 2) Training of the farmers and leaders of the societies in the project area
- 3) Strengthening of the organisational structure and staffing of the executing agency
- 4) Strengthening of the farmers' societies
- 5) Strengthening of the extension activities for irrigation farming

Activities after the rehabilitation works

- 1) Continuous support services for O&M, irrigation farming, and activities of the farmers' societies
- 2) Periodical monitoring and evaluation of the farmers' O&M works
- 3) Follow-up training of the farmers and staffs concerned
- 4) Financial support to the farmers for replacement of equipment

These are all prerequisite factors not only for achievement of the Project sustainability but also for implementation of the Project itself. For the activities up to the end of the rehabilitation works from items 1 to 5, the executing agency should start them immediately after the commencement of the rehabilitation works. In addition, it is recommended to prepare manuals for O&M of irrigation facilities as well as for irrigation farming practices for each crop proposed in this plan by the end of the rehabilitation works.

For the projects having pumping irrigation facilities, a considerable amount of replacement cost for their equipment will be required. However, repayment of this cost by the farmers will impede the improvement and growth of their living standards, even if they will have a good income from irrigation farming. It will be necessary that the Government give some subsidies on this replacement cost to the farmers.

THE STUDY ON THE REHABILITATION OF IRRIGATION PROJECTS IN THE REPUBLIC OF GHANA
SUMMARY TABLE (1/2)

Items	Projects	Ashaiman	Aveyime	Kpando-Torkor	Mankessim	Okyereko	Total/ Average	Remarks
1. Background								
(1) Location & topography	Coastal Savannah Lowland	Coastal Savannah Lowland	Coastal Savannah Lowland	Transitional Zone Sloping area	Coastal Savannah Undulating area	Coastal Savannah Lowland		See Location Map
(2) Administration	Great Accra	Volta Region	Volta Region	Volta Region	Central Region	Central Region		
(3) Project implementation	1966 - 1968	1962 - 1975	? - 1976	1974 - 1981	1976 - 1988	1976 - 1988		
(4) Climate	Coastal Savannah Zone	Coastal Savannah Zone	Coastal Savannah Zone	Transitional Zone	Coastal Savannah Zone	Coastal Savannah Zone		
a) Agro-ecological zone	750 - 1,270 mm	750 - 1,270 mm	1,270 - 1,500 mm	1,270 - 1,500 mm	750 - 1,270 mm	750 - 1,270 mm		
b) Average annual rainfall	148 (ha)	150	356	40	256	111	1,021	
a) Potential area	130 (ha)	63	40	40	17	40	290	
b) Developed area	120	62	118	118	89	68	457	
(6) No. of farm family	Not suitable for upland crops : 6 ha	Not suitable for paddy rice : 7 ha	Restricted suitable : 268 ha	Not suitable for paddy rice : 93 ha	All suitable			
(1) Land suitability for irrigation	Wet Rice	Dry Rice	Wet Rice	Dry Rice	Wet Rice	Dry Rice		
(2) Present agriculture	Okra	Rice	Okra	Okra	S.potato	Vegetables		
a) Cropping season & main crops	42 %	91 %	33 %	33 %	109 %	53 %		
b) Cropping intensity	59 ha	- ha	13 ha	13 ha	26 ha	22 ha		
c) Total irrigated area/year (ha)	0.49 ha	- ha	0.11 ha	0.11 ha	0.30 ha	0.32 ha		
d) Total irrigated area (family/ha)	Overfull river/dam	Volta river/pumps	Volta lake/pumps	Reservoir & pumps	Reservoir & pumps	Reservoir		
(3) Water source	High water shortage	No water problems	No water problems	Mostly no water problems	Mostly no water problems	Need of suppl. water		
a) Water source	82.4 km ²	Gravity irrigation	Gravity irrigation	Sprinkler irrigation	Sprinkler irrigation	Gravity irrigation		
b) Water balance study	Dam	1-pump	2-pumps	Dam	Dam	Dam		
(4) Reservoir (catchment area)	Mc. (4.8km)	Mc. (0.4km)	Pipeline	Pipeline	Pipeline	Mc. (1.3km)		Mc.: Main canal
d) Irrigation method	Lc. (11km)	Lc. (3km)	- Mp. (600m)	- Mp. (600m)	- Mp. (900m)	Lc. (2.8km)		Lc.: Lateral canal
(5) Main project facility	Ld. (6km)	Ld. (3km)	Road (2km)	Road (2km)	Road (3km)	Ld. (2km)		Md.: Main drainage canal
a) Irrigation & drainage system	Road (16km)	Road (5km)	Office (1)	Office (1)	Office (1)	Office (1)		Ld.: Lateral drainage canal
b) Farm road & buildings	Office (6)	Office (2)	Storage (1)	Storage (1)	Storage (1)	Storage (1)		Mp.: Main pipe
c) Deterioration of facility	Dry yard (1)	No project activity	Serious	Serious	Dam: good	Dam: good		Lp.: Lateral pipe
(6) Present O&M	Relatively good	No activity	Not enough	Not enough	Not enough	Not enough		
(7) O&M costs of GIDA (1995)	Cedis 260,400/ha/year	Cedis 279,020/ha/year	Cedis 701,960/ha/year	Cedis 366,940/ha/year	Cedis 163,940/ha/year	Cedis 163,940/ha/year		Including labour cost, etc.
a) Amount (1995)	Cedis 50,400/ha/crop	Cedis 260,400/ha/crop	Cedis 260,400/ha/crop	Cedis 99,400/ha/crop	Cedis 50,400/ha/crop	Cedis 50,400/ha/crop		Source: PM office
b) Payment ratio	12.3%	100%	100%	100%	50%	50%		
(8) Agricultural support services	Established (1983)	Established (1981)	Established (1974)	Established (1987)	Established (1994)	Established (1994)		As of December 1996
a) Farmers society	2 persons	2 persons	1 person	1 person	1 person	1 person		
b) Extension officer of GIDA	Salinity problem	Incidence of water-borne diseases	Land degradation		Salinity problem			
(9) Environment	Degradation of down-stream lagoon ecology							
(10) Farmers' requests for support services	70%	100%	93%	80%	100%	79%		Farm interview
a) Rehabilitation of irri. facility	45%	73%	93%	55%	50%	63%		survey by the
b) Supply of farm inputs	70%	60%	87%	50%	70%	69%		Study Team.
c) Imp. of credits system	20%	100%	100%	17%	10%	26%		To irrigation interval
a) Amount of water supplied	80%			83%	90%	74%		too.
b) Time of supply	25%	7%		33%	60%	36%		9. If the facilities are
Satisfied	75%	93%	100%	67%	40%	64%		rehabilitated by GIDA,
Not satisfied	15%	67%	100%	11%	30%	56%		farmers will agree to it.
(12) Farmers' intention of O&M transfer	85%	33%				44%		
(1) Agricultural development plan	Rice, okra	Rice, tomato, okra	Okra, tomato, onion	Watermelon, onion	Rice, tomato, okra			Including supplemental
a) Proposed crops	200%	200%	200%	200%	200%	300%		irrigation.
b) Cropping intensity	All lands in the irrigation projects will be allocated to farmers in accordance with L.I. 1350 of GIDA.							
c) Land allocation	Grav. irri.	Intake by pumps	6-movable pump	Fixed pump station	Grav. irri.	Grav. irri.		
(2) Rehabilitation plan of facility	Continuous irri.	Grav. irri.	Fixed main & lateral pipes	Fixed main & lateral pipes	Fixed pump station	Fixed pump station		
a) Irrigation plan	56 ha	95 ha	155 ha	86 ha	81 ha	473 ha		Out of them, 2 ha will be
b) Irrigable area (80% dependability)	Irrigation canal system	Pump & pump house	Movable pumps & foundation works	Intake facility	Pumps & pump house	used for experimental fields		by IDC at Ashaiman
c) Rehabilitation plan of facility	Drainage system	Irrigation system	Sprinkler system	Pumps and pump houses	Irrigation system	project.		
(3) Strengthening of GIDA	Farm road network	Sprinkler system	Soil conservation works	Sprinkler system	Related structures			
a) Strengthening of farmers' society	Buildings including training facility	Farm road network	Buildings	Soil conservation	Farm road network			
b) Family number	Improved and strengthening of the GIDA head office as well as the project offices, including training of the staff will be executed for successful transfer of O&M to the farmers' Societies.							
c) Land holding size per family	The existing farmer's society will be improved and strengthened as an executing body of O&M of the project and for improvement of agricultural support services.							
d) Number of farmers' society	120	95	388	216	135	954		
e) Number of irrigation group	0-45 ha/family	1-00 ha/family	0-40 ha/family	0-40 ha/family	0-60 ha/family	0-49 ha/family		
(4) Strengthening of GIDA	1	1	2	2	1	7		
a) Family number	13	4	64	36	17	134		
b) Land holding size per family								
c) Number of farmers' society								
d) Number of irrigation group								

**THE STUDY ON THE REHABILITATION OF IRRIGATION PROJECTS IN THE REPUBLIC OF GHANA
SUMMARY TABLE (2/2)**

Items	Projects	Ashaiman	Aveyime	Kpando-Torkor	Mankessim	Okyerako	Total/Average	Remarks
(5) Transition period of O&M transfer		5 years	5 years	5 years	5 years	5 years		
(6) Required staff of GIDA for O&M transfer								
a) Present staff (person)		4	6	3	5	2	20	Extension officer, O & M officer, Watchman, etc.
b) Transition period (person)		6	5	9	5	5	30	
c) After O&M transfer (person)		5	4	8	4	4	25	
(7) Required equipment for O&M								
a) Pump station (no.)		-	2	2	2	-	7	
b) GIDA project office (no.)		-	-	-	-	-	-	
- Rehabilitation (no.)		-	-	-	-	-	-	175 m ² /no.
- New (no.)		-	-	-	-	-	-	300 m ² /no.
c) Sorter house (no.)		-	-	-	-	-	-	300 m ² /no.
d) Garage (no.)		-	-	-	-	-	-	300 m ² /no.
e) Dry yard (no.)		-	-	-	-	-	-	300 m ² /no.
f) Store house (no.)		-	-	-	-	-	-	200 m ² /no.
g) Equipment for O&M (lot)		-	-	-	-	-	-	
h) Equipment for extension service (lot)		-	-	-	-	-	-	
(8) Farm economy with project								
a) Capacity to pay (Cedis 1,000/family)		283	3,048	1,129	756	775		Non-farm income: 50% down Living expenses: 30% up
b) Annual irrigation service fees per family (Cedis 1,000/family)		20	280	170	160	120		Excluding O & N cost of GIDA office
Replacement cost (Cedis 1,000/family)		120	620	510	520	290		
Total (Cedis 1,000/family)		140	900	680	680	410		
c) Annual irrigation service fees per ha (Cedis 1,000/ha)		50	280	430	410	200		Excluding O & M cost of GIDA office
Replacement cost (Cedis 1,000/ha)		260	620	1,270	1,300	480		
Total (Cedis 1,000/ha)		310	900	1,700	1,710	680		
d) Allowable amount of fees for farmers (ha/family)		100	264	375	250	100		Result of public meeting with farmers
Holding size (ha/family)		0.45	1.00	0.40	0.40	0.60		
Per family (Cedis 1,000/family/year)		90	527	300	200	120		
(9) Environment conservation and monitoring plan								
a) Environment conservation plan		Reclamation of salinity soil	Management of water-borne diseases	Conservation of soil erosion	Conservation of soil erosion	Reclamation of salinity soil Management of water-borne diseases		
b) Monitoring plan		Water quality of down-stream Salinity condition Farmers health	Water quality of down-stream Farmers health	Soil erosion Farmers health	Water quality of down-stream Farmers health	Water quality of down-stream Salinity condition Farmers health		
4. Cost for Project Rehabilitation								
(1) Total project cost (Cedis Million)		1,962	3,576	7,792	3,877	3,196		(US\$ 1.0 = Cedis 1,700 = ₵110)
(Cedis Million/ha)		35.0	37.6	50.3	45.1	39.5	20.403	Including physical and price contingencies.
1996 constant prices (Cedis Million)		1,472	2,521	5,896	3,206	2,437	15.532	Excluding price contingency from the above.
(Cedis Million/ha)		26.3	26.5	38.0	37.3	30.1	32.8	
(2) Annual O&M cost (1996)(Cedis 1,000/ha/year)		140	340	457	462	268		Includes cost of PM office.
5. Economic Evaluation								
EIRR =		23.2%	15.7%	16.9%	14.5%	13.0%	16.0%	
6. Project Effects								
IDC is essential as a core institute for research and extension works, training for successful implementation of O & M transfer and strengthening of GIDA as well as farmers' societies.			Project activities are stopped and farm income of farmers is low. Farmers strongly request possible early rehabilitation of project, and could be used as a model for combined farming of rice and cash crops.	Recommended as a model for irrigated farming of up-land crops, and will be stable supply centre of vegetables to urban areas.	Improvement of present low farm income and living standard of farmers by rehabilitation is essential.	High increase in crop production from 111 ha of expanded area. Recommended model for improved irrigated sloping area.		
(1) Number of attendants		66 persons	41 persons	64 persons	61 persons	68 persons	300	
a) Farmers in the existing irrigation area		0 persons	0 persons	37 persons	0 persons	37 persons	74	
b) Farmers outside		66 persons	41 persons	101 persons	61 persons	105 persons	374	
c) Total								
(2) Farmers' intention to rehabilitation plan								
a) Rehabilitation area (planned size)		Agreed	93 (%)	98 (%)	100 (%)	100 (%)	100 (%)	
Objcted		17 (%)	7 (%)	2 (%)	- (%)	- (%)	- (%)	
b) Facility rehabilitation plan		Agreed	100 (%)	100 (%)	100 (%)	100 (%)	100 (%)	
Objcted		- (%)	- (%)	- (%)	- (%)	- (%)	- (%)	
c) Irrigation method		Agreed	100 (%)	100 (%)	100 (%)	100 (%)	100 (%)	
Objcted		- (%)	- (%)	- (%)	- (%)	- (%)	- (%)	
(3) Farmers' intention to farming plan								
a) Cropping pattern		Agreed	100 (%)	100 (%)	100 (%)	100 (%)	100 (%)	
Objcted		0 (%)	- (%)	- (%)	- (%)	- (%)	- (%)	
b) Farmers' request to plan		Introduction of import crops and upland crops	Desire of cultivation of hot pepper, cabbage and carrot	Desire of cultivation of cowpea, hot pepper and eggplant	Desire of cultivation of soybean and cultivation of hot pepper	Desire of cultivation of hot peppe		
b) Land holding size Per family with project		1.0 acre/family	2.5 acre/family	2.5 acre/family	0.5 acre/family	1.0 acre/family	32%	
Farmers' desire		100%	3.0 acre/family	3.0 acre/family	1.0 acre/family	2.0 acre/family	29%	
							26%	
							13%	
(4) Farmers' intention to strengthening plan								
a) Organization & activity of farmers' society		Agreed	100 (%)	100 (%)	100 (%)	100 (%)	100 (%)	
Objcted		- (%)	- (%)	- (%)	- (%)	- (%)	- (%)	
b) Transfer of O & M works of project facility		Agreed	100 (%)	100 (%)	100 (%)	100 (%)	100 (%)	
Objcted		- (%)	- (%)	- (%)	- (%)	- (%)	- (%)	
c) Rise of irrigation fee after rehabilitation		As it is. (1996)	62,000;	20,000;	Agreed to rise of 100,000 Cedi/acre at maximum.	20,000;		
20% rise (Cedi/acre/season)		24,000;	74,000;	24,000;		24,000;		
50% rise (Cedi/acre/season)		30,000;	93,000;	30,000;		30,000;		
70% rise (Cedi/acre/season)		34,000;	105,000;	34,000;		34,000;		
100% rise (Cedi/acre/season)		40,000;	124,000;	40,000;		40,000;		
d) Enactment of Articles and Bye-Laws		Agreed	100 (%)	100 (%)	100 (%)	100 (%)	100.0 %	
(5) Confirmation with farmers								
a) Land ownership of project area		GIDA land	GIDA land	Village land	GIDA land	Village land	100%	
		100%	82ha	100%	29ha	57ha	100%	
		Private land	13ha	(agreed to release it.)	Village land	(agreed to release it.)		
		(agreed to release it.)						
b) Farmers number in project area		120 families	62 families	118 families	89 families	68 families		
Existing farmers		- families	200 families	672 families	1,400 families	82 families		
Candidated farmers								
7. Results of Public Meeting								

**THE STUDY
ON
THE REHABILITATION OF IRRIGATION PROJECTS
IN
THE REPUBLIC OF GHANA**

MAIN REPORT

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ABBREVIATIONS

1. Organisations/Names

ADRA	Adventist Development and Relief Agency
AGSAC	Agricultural Sector adjustment Credit
ASRP	Agricultural Services Rehabilitation Project
CEDEP	Centre for the Development of People
CIDA	Canadian International Development Agency
COCOBOD	Ghana Cocoa Board
CUSO	Canadian University Students Overseas
DA	District Assembly
DCA	Development Credit Assembly
DFR	Department of Feeder Road
DPBU	District Planning and Budgeting Unit
DWM	December 31st Women's Movement
EAP	Environmental Action Plan
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EMP	Environmental Management Plan
FY	Financial or Fiscal Year
FAO	Food and Agriculture Organisation of the United Nations
GAPVOD	Ghana Association of Private Voluntary Organisations in Development
GDP	Gross Domestic Products
GEPC	Ghana Export Promotion Council
GFDC	Ghana Food Distribution Corporation
GIDA	Ghana Irrigation Development Authority
GOG	Government of Ghana
GTZ	Ghana Technical Cooperation Agency
IAPSO	Inter-Agency Procurement Services Office
ICOUR	Irrigation Company of the Upper East Region
ICR	Implementation Completion Review
IDC	Irrigation Development Centre
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
MLG	Ministry of Local Government and Rural Development
MOF	Ministry of Finance
MOFA	Ministry of Food and Agriculture
MRH	Ministry of Road and Highways
MTADP	Medium Term Agricultural Development Strategy
MTR	Mid-Term Review
NORRIP	Northern Region Rural Integrated Project
NPV	Net Present Value
PAMSCAD	Program of Actions to Mitigate the Social Costs of Adjustment and Development
PCC	Project Co-ordination Committee
PCU	Project Co-ordination Unit
PNDC	Provincial National Defence Council
PPMED	Policy Planning, Monitoring, and Evaluation Department
PU	Project Unit
SOE	Statement of Expenditure
SAC	Structural Adjustment Credit
SPAC	Sub Project Approval Committee
UNESCO	United Nations Educational, Scientific and Cultural Organization
USADEP	Upper Region Agricultural Development Project

VORADEP Volta River Agricultural Development Project
 VRA Volta River Authority
 WB World Bank

2. Others

B	: Benefit	EIRR	: Economic Internal Rate of Return
C	: Cost	El.	: Elevation above Mean Sea Level
D	: Water Depth	GDP	: Gross Domestic Product
DFL	: Design Flood Level	GNP	: Gross National Product
dia	: Diameter	O&M	: Operation and Maintenance
Eq	: Equation	RD	: Reduced Distance
Fig.	: Figure	Ref.	: Reference

ABBREVIATIONS OF MEASUREMENTS

<u>Length</u>	<u>Time</u>	<u>Area</u>
mm = Millimetre	s = Second	cm ² = Square centimetre
cm = Centimetre	min = Minute	m ² = Square meter
m = Meter	h = Hour	ha = Hectare
km = Kilometre	d = Day	km ² = Square kilometre
	y = Year	

<u>Electrical Measures</u>	<u>Volume</u>	<u>Other Measures</u>
W = Watt	cm ³ = Cubic centimetre	% = Percent
kW = Kilowatt	lit = Liter	° = Degree
MW = Megawatt	m ³ = Cubic meter	' = Minute
kWh = Kilowatt hour	MCM = Million cubic meter	" = Second
V = Volt		°C = Degrees Celsius

<u>Weight</u>	<u>Derived Measures</u>	<u>Currency and Others</u>
mg = Milligram	m ³ /sec = Cubic meter per second	Cedis = Ghana's Currency
g = Gram	lit/sec = Litre per second	US\$ = US Dollar
kg = Kilogram	lit/s/ha = Litre per second per hectare	¥ = Japanese Yen
ton = Metric ton	md = Man day	
	M/M = Man Month	

CONVERSION FACTORS

<u>From Metric System</u>	<u>To Metric System</u>
1 cm = 0.394 inch	1 inch = 2.54 cm
1 m = 3.28 ft	1 ft = 30.48 cm
1 km = 0.621 mile	1 mile = 1.609 km
1 cm ² = 0.155 sq.in	1 sq.ft = 0.0929 m ²
1 ha = 2.471 acres	1 acre = 0.4047 ha
1 km ² = 100 ha	1 ha = 0.01 km ²
1 km ² = 0.386 sq.mile	1 sq.mile = 2.59 km ²
1 cm ³ = 0.0610 cu.in	1 cu.ft = 28.32 lit
1 m ³ = 35.3 cu.ft.	1 cu.ft = 0.0283 m ³
10 ⁶ m ³ = 811 acre-ft	1 acre-ft = 1,233.5 m ³
1 long ton = 1,016.05 kg	1 kg = 0.000984 long ton
1 m ³ /s = 35.3 cusec	1 cusec = 0.0283 m ³ /s

