1. INTRODUCTION

1.1 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 Cooperation Agency (JICA) on 19 April 1995. The Study on the Project was divided into two parts, Phase-I and Phase-II. Phase-I Study is consisted of the preparation of a rehabilitation plan for 12 existing irrigation projects at master plan level for the purpose of evaluating and selecting priority projects for feasibility study. Phase-II Study dealt with the feasibility study on the rehabilitation of 5 priority projects selected in Phase-I Study. The Report presents the results of all works performed in both Ghana and Japan during Phase-I and Phase-II studies.

1.2 Background of the Project

In the Plan of Public Investment (1988-1990) and Restructuring Plan (1992-1994), the Government puts priority on increasing of agricultural productivity of smallholder farmers and raising living standards of small farmers in rural areas. Besides, in the 10-year Middle Term Agricultural Development Programme (MTADP: 1991-2000) launched in recent years, the Government has placed a high priority on agriculture to satisfy the country's food needs, to create rural employment opportunities, to generate foreign exchange through export promotion of agricultural products, to promote balanced regional development, and to improve the existing irrigation projects.

GIDA has constructed and been managing small and medium-scale irrigation projects with a command area ranging from 100 to 2,000 ha at about 20 locations over the whole country. The total area already developed is about 6,700 ha. However, most of these projects are showing 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 problem, and weakness of support services from the related institutions. The irrigation review report prepared by the World Bank in 1986 proposed to put priority on rehabilitation of existing irrigation systems and strengthening of the operation and maintenance (O&M) systems rather than promotion of new development of large-scale irrigation projects. Then, the Government gives a high priority to rehabilitation of existing irrigation projects, as an important measure, to achieve the key polices set out in MTADP.

The rehabilitation of the existing irrigation projects will contribute largely to the food security improvement by the increase of agricultural productivity with the extension of year-round irrigated agriculture through effective use of available water sources and existing facilities to be rehabilitated. It can be said that this is a realistic and practical approach to the achievement

of the key polices set out in the 10-Year Programme with optimum economic investment.

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' organisations through training and support from the government institutes concerned.

Against this background, the Government of the Republic of Ghana requested the Government of Japan on 27 October 1993 for the execution of feasibility study on the existing irrigation projects under GIDA's management, for their rehabilitation and for expansion of the irrigation area. JICA responded to this request by dispatching the Preparatory Study Team in April 1995 to confirm the request and conclude the Scope of Work for the Study.

1.3 Objective of the Study

The existing irrigation projects operated and managed by GIDA should play an important role in development of more productive agriculture under the main polices set forth in the MTADP. Unfortunately, however, most of them are not functioning well, suffering from various constraints. GIDA has already examined the existing projects and listed up 12 projects for early rehabilitation. It is considered that the reactivation of these small to medium-scale projects is a very realistic and practical approach to the achievement of key policies under the MTADP, because higher economic returns could be expected with lower investment and shorter development period. In addition, institutional provisions related to irrigation development should also be substantially strengthened. The basic concept for project formulation should therefore be focused on reactivation of these existing irrigation projects together with strengthening of related institutions including farmers' organisations.

It is also essential for the project formulation that attention should be paid to the improvement of existing irrigated agriculture at farm level to increase the agricultural productivity at an early time in connection with the projects rehabilitation. The required improvements will include those of marketing, price arrangement, farm input services, available credits and technology transfer to farmers. The optimum agricultural development plan suited to the reactivated projects should be formulated together with the facility rehabilitation.

The objective of Phase-I Study is therefore to conduct a field investigation and the master plan level study of the 12 existing irrigation projects for selection of the priority projects. All the study results including selection of the priority projects are compiled in Chapter 3 of this Report and Annex 1 for details. During Phase-II, feasibility study was conducted through formulation of the optimum rehabilitation plan, including proposed agricultural development in connection with the projects rehabilitation, of each of the 5 priority projects.

1.4 Works Performed for Master Plan Level Study (Phase-I)

1.4.1 Works in Ghana

The study works including field investigations and office works in Ghana lasted from the middle of October to the end of December 1995, and the works performed are summarised as follows :

Immediately after the JICA Study Team arrived in Accra, the inception report was submitted to GIDA for the discussion which was held on 20th October. The main issues discussed and agreed upon by both parties, GIDA and the JICA Study Team, are mentioned in the Minutes of Meeting for Inception Report (see Attachment-2).

Prior to the execution of field investigations at project sites, a short text book was prepared for the counterpart personnel for field investigations and office works related to Phase-I Study. The text book covers seven (7) technical sections which are related to (i) irrigation and drainage system, (ii) social and farmers' organisation, (iii) management and agricultural aspects, (iv) agro-economic study and project evaluation, (v) meteo-hydrological study, (vi) structure design and cost estimates, and (vii) pedology and environment. Each section shows the purpose, procedure and analysis of technical items for field investigations and office works carried out by each expert of the Study Team. Discussions with the counterparts in each section were made by each expert using this text book.

Field investigations including data collection were carried out at each of the 12 existing irrigation project sites, dividing the Study Team into 6 working groups including the counterparts. In the beginning of the investigations, 4 existing projects located in the Guinea, savannah and transitional zone - Bontanga, Subinja, Tanoso and Akumadan projects - were visited by all groups for investigations. Based on the experience in beginning investigations, some adjustment of working schedule for each group was made afterwards in order to carry out the investigations smoothly, avoiding the overlapping of visits by plural groups one project site. Then, the field investigations by all working groups at the remaining 8 projects, Kpando-Torkor, Amate, Afife, Aveyime, Ashaiman, Mankessim, Okyereko and Weija projects, were made smoothly and ended by 7th December 1995.

The existing data and information related to the Project were collected mainly from GIDA head office, IDC, project site offices and the government institutes concerned. In addition, data were collected from the Dawhenya project which was rehabilitated very recently.

In addition to the field investigation and data collection, the farm interview survey was carried out by the Team in co-operation with GIDA's counterpart, in order to grasp more practical information and farmers' intention to the Project. The Survey questionnaire included the following items:

1) Size of household, land holding size and land tenure
2) Social infrastructure and living situation
3) Crop production, production cost, and crop damage
4) Livestock raising and holding of farm machinery and equipment
5) Marketing of products and seeds
6) Off-farm income, living expenses, credits and loan repayment
7) Irrigation water supply and O&M of irrigation facilities
8) Farmers' intention on improvement of farming and farmers' societies
9) Farmers' intention on O&M and its handing over to the beneficiaries, etc.

The interview survey of farmers was carried out by the Agricultural Extension Officers from MOFA, school teachers in the villages, etc. under the supervision of the Team. Total number of samples was 180, and these were selected randomly from 12 project areas. The Team reviewed all the data obtained through this survey and used them fully for the master plan level study of the Project.

1.4.2 Works in Japan

The Phase-I works in Japan, during one and a half months from the beginning of January to mid-February 1996, were carried out mainly to analyse data, information and findings obtained from the field investigation in Ghana, in order to study various constraints and problems to reactivation of the existing 12 irrigation projects, as well as to study the development concept and Master Plan for rehabilitation of each of the 12 projects which will contribute to the achievement of key policies shown in the MTADP. All the results of the Phase-I Study works are compiled in this Report.

1.5 Works Performed for Feasibility Study (Phase-II)

1.5.1 Works in Ghana

The study works including field investigation and office work in Ghana were carried out at two stages.

The works in the first stage lasted from the 21st June to the end of July 1996. The works performed at this stage are summarised as follows:

The irrigation and drainage engineering group including structure design expert carried out the additional field survey in the five project areas mainly to confirm the potential and existing irrigated area in each project and the location of the main facilities such as pumping stations, using new aerial photographs taken in April this year. In order to calculate the irrigation water requirement for paddy rice cultivation, measuring devices were set in paddy fields in Aveyime

and Okyereko, and the measurements were continued for 3 months. In addition, supplemental data collection was made to estimate the Project cost for feasibility study.

The meteo-hydrological group made supplemental collection of meteo-hydrological data and some analysis of the data in order to check the study results obtained during Phase-I.

The agricultural group made supplemental data collection particularly during the wet season in order to make further study on the proposed agricultural development plan.

The social and farmers organisation group carried out additional farmers interview survey for the purpose of (i) clarifying farmers' intention on the proposed rehabilitation plan shown in the Interim Report, (ii) obtaining the farmers opinion/suggestion and request to the plan, and (iii) collecting additional data and information in order to make further study on the suitable rehabilitation plan from the standpoint of farmers' capability.

The environmental group discussed with the Environmental Protection Agency to finalise the specification for the Environmental Impact Assessment (EIA) study. Besides, additional field survey was carried out for EIA study as well as for further study on the environment conservation plan.

In the second stage of the feasibility study, the irrigation and drainage engineering group including structure design expert carried out field survey to prepare detailed topographic maps of the proposed pumping sites in 4 project areas, Aveyime, Kpando-Torkor, Okyereko, and Mankessim. The field survey team also checked the profile elevation and cross sections of the main irrigation and drainage canals in each of the five projects. On the basis of the data obtained from these field surveys, preliminary designs of the proposed irrigation and drainage networks, and the rehabilitation works of the facilities required for each project were prepared for discussion with GIDA.

The agricultural group made further field investigation and study on the proposed agricultural development plan for each of the reactivated projects.

The social and farmers organisation group carried out additional investigation through public meetings with farmers at each project site for the purpose of (i) clarifying the farmers' intention to the proposed rehabilitation plan, (ii) obtaining the farmers' opinion/suggestion and request to the projects rehabilitation, and (iii) confirming of the rehabilitation plan by both parties (farmers and GIDA) through discussions in the public meetings. In addition, further collection of data and information is made to study the proposed plan and programme for improved extension services, effective support from the Department of Co-operatives and improved credit facility.

The Project evaluation group collected further data and information required for feasibility study on each of the five priority projects from economic and financial viewpoints.

1.5.2 Works in Japan

The feasibility study works in Japan, during one and a half months from the beginning of January to mid-February 1997, were carried out concentrating all the activities on preparation of feasibility study of the five priority projects of Ashaiman, Aveyime, Kpando-Torkor, Okyereko and Mankessim. All the results of feasibility study are compiled in this Draft Final Report for discussions with GIDA.

The member of the Study Team and counterpart personnel engaged in all the study works during Phase-I and Phase-II were as follows:

(1) Phase-I Study

1) JICA Study Team

Kunio IRIE	: Team Leader
Hitoshi SHIMAZAKI	: Irrigation and Drainage Engineer
Tadaharu MURONO	: Socio/Institutional Expert
Noboru MOCHIZUKI	: Agronomist
Kisaku YAMADA	: Agro-economist
Mototaka NISHI	: Meteo-hydrologist
Yashushi OSATO	: Design Engineer
Yoji MIZUGUCHI	: Soil/Environmental Expert
Shigeya OTSUKA (field works)	: Coordinator

2) Counterpart Personnel (field works in Ghana)

Kwabena WIAFE	: Chief Counterpart / Deputy Chief Executive (Engineering)
M.A.K. AFFRAM	: Social and Farmer Organisation/Dupty Chief Executive (Agronomy)
Nana Kofi KODUAH	: Structure Design and Cost Estimate (Pumps)/ Deputy Director
Sammy AKAGBOR	: Pedology/ Deputy Director
Peter M. ABUGAH	: Environment
James AKATSE	: Social and Farmer Organisation
Victor ANKORA	: Irrigation and Drainage System
Christ BENEE	: Management and Agricultural Aspects
Lawrence KUWORNU	: Meteo-hydrological Study
Kweku SEFA	: Structure Design and Cost Estimate
Joseph ACHEAMPONG	Agro-economy

(2) Phase-II Study

1) JICA Study Team

Kunio IRIE	: Team Leader
Hitoshi SHIMAZAKI	: Irrigation/Drainage Engineer
Tadaharu MURONO	: Social/Institutional Expert
Noboru MOCHIZUKI	: Agronomist
Mototaka NISHI	: Meteo-hydrologist (first stage only)
Yasushi OSATO	: Design Engineer
Kisaku YAMADA	: Agro-economist (second stage only)
Yoji MIZUGUCHI	: Environmental Expert (first stage only)
Shigeya OTSUKA	: Coordinator (second stage only)

2) Counterpart Personnel

Kwabena WIAFE	: Chief Counterpart/Deputy Chief Executive (Engineering)
Nana Kofi KODUAH	: Structure Design (Pumps)/Deputy Director
Kweku SEFA	: Structure Design and Cost Estimate
James AKATSE	: Social and Farmer Organisation
Lawrence KUWORNU	: Meteo-hydrological Study/Irri.& Drainage
Peter M. ABUGAH	: Environment
Christ BENNEE	: Agricultural Aspects
Victor ANKORA	: Irrigation and Drainage
Vincent GBEDZI	: Irrigation and Drainage
S.K. AKABOR	: Pedology and Environment
Samuel Danso ASARE	: Structure Design
Joseph ACHEAMPONG	: Economist
Cephas AMETEFEE	: Agro-economy

1.6 Acknowledgement

During the works in Ghana, the Study Team received generous assistance and co-operation from the counterpart personnel dispatched by GIDA and those at the project sites. The Team should whould like to express many thanks for kind support and co-operation given the Team by the counterpart and GIDA as well as by the site offices concerned, without which the works could not be successfully completed.

2. GENERAL ECONOMIC AND AGRICULTURAL BACKGROUND

2.1 Land and Population

The Republic of Ghana lies on the west coast of Africa between latitudes 4°} and 11°} north. Its southern boundary is formed by the Gulf of Guinea and to the north, east and west lie the states of Burkina Faso, Togo and Cote d'Ivoire, respectively. Its area covers about 239,460 km^2. The land area is divided into 10 administrative regions.

Ghana has a coastline of about 550 km facing the Atlantic Ocean. The coastal area consists of mostly scrub land which gives way to open plains on the east of Accra. At the western end, the forest belt comes close to the sea. Inland, this forest belt extends northwards along the western border of the country and into Ashanti. North of the forest belt is an area of orchard bush which dwindles to an open park land in the north.

There are some mountains in Ghana, half of which have an elevation of less than 150 m above sea level, but in the south-western forest belt these are broken up into ridges and valleys, the ridges raising from 180 m near the coast to over 600 m between Abetifi and Begoro, which lie at the eastern end of the forest belt. The southeastern end of the country is formed by the Akwapim ranges, which form a boundary to the scrub of the Accra plain. Most of the ranges are about 450 m high. But individual peaks reach to heights of approximately 750 m.

Rivers and streams are plentiful in this country, but most are seasonal. The Volta River is the largest river in Ghana. Its length from the sea to the junction of the Black and White Volta is about 500 km. Both rivers take their sources in Burkina Faso.

The climate of Ghana is tropical and has a greater variety than most countries in West Africa. Rainfall varies from south to north. April to June are the months of the major rains in the south, whereas September to October are the months of the minor rains. The northern area has one wet season, that is, June to November. The rainfall ranges from about 800 mm to over 2,200 mm per annum. The highest rainfall is in the southwest where over 2,200 mm of rain and about 150-160 rain days per year are common. In the rest of the forest zone, rainfall varies from 1,270 mm to 1,500 mm annually. The coastal plains and northern part of Ghana are dry with less less than 1,150 mm of rain per year.

As it is to be expected in a tropical country, the temperatures are high and have little variation throughout the year. The annual mean maximum temperature is greatest (34°C) in the extreme north and least on the coastal area (29°C to 30°C). The annual mean minimum temperature is about 24°C in the north and 21°C in the coast.

There are three main types of vegetation in Ghana, savannah, forest and scrubland. The

savannah areas are found along the coastal and northern parts of the country. The coastal savannah or grassland belt stretches inland, and it is practically non-existent in the extreme west coast, but predominant in the extreme east. A vast savannah occupies the south of Northern Ghana. Most part of Upper Ghana is scrubland. Between the coastal and northern savannahs is the forest.

The total population of Ghana in 1994 is estimated at 16.5 million, with an assumed population growth rate of 3.0% per annum. This gives a population density of 69 per km^2. Ghana is not densely populated. However, the density of population of Ghana appears to be fairly high as compared with the average population density of 80.5 per km^2 in 1994 for all low-income countries. Although Ghana's population density is at present relatively low, the population is increasing rapidly. It is estimated that the annual rate of growth is at least 3%. If this rate is maintained, the population would reach about 19.5 million by 2000.

2.2 National Economy

Ghana is mainly an agricultural country. About 70% of its working population is engaged in agriculture which includes crops, livestock, fisheries, forestry and cocoa sub-sectors. According to the statistical data of the country, cocoa, forestry, sawmilling and other agriculture outputs made up about 40% of the Gross Domestic Product (GDP) in 1994 and this proportion is declining in recent years. The agricultural sector earns foreign exchange for the country through exports of traditional commodities (US$ 509 million equivalent in 1994). The two agricultural products, cocoa and timber, have provided over 42% of the country's total foreign exchange earned in 1994.

However, agriculture is not able to keep up with the growing domestic demand for food and part of the demand for food has been met by increased imports. So the Government is now making great efforts to meet the growing demand for agricultural products by increasing the agricultural production of this country.

Besides agriculture, the industrial sector which consists of manufacturing, mining and quarrying, electricity, water and gas, and construction, follows the development of agriculture as the second major driving force in economic growth of the country. The sector's contribution to GDP was around 29% in 1994. It is expected that industrial development will not only make a great contribution to the increase in employment and income, but will also improve the balance of foreign trade, and lay the foundation for the future development of Ghana as a primary industrial country. Particularly, with the completion of the Volta River Project, much effort has been paid to the development of the industry and manufacturing. However, the share of the industrial sector in GDP has stagnated since 1987.

The growth rate of the economy of Ghana declined from 5.0% in 1993 to 3.8% in 1994. This is consistent with a trend in the performance of the economy that emerged from

1989. From that year a typically 5% growth rate in one year was followed by a decline the following year. The downturns are usually associated with low agricultural growth which in turn is determined by rainfall. Thus, the fluctuating growth performance indicates the continuing vulnerability of the economy to external shocks and a failure to sufficiently diversify the productive base of the economy. Fluctuations in agricultural output therefore cannot be compensated by better performance in other sectors of the economy. Indeed both agriculture and industry have been subject to a decline in growth performance since 1989.

As mentioned above, the Government is now making a great effort to increase productivity in all sectors of the economy, particularly in agriculture, and an expansion of the range of goods and services, produced at internationally-competitive prices. This will be assisted by major improvements in all types of economic infrastructures.

2.3 Agriculture in Ghana

Out of 23.9 million ha of total land area, about 22% is cultivated and 7% is under perennial crops such as cocoa, oil palm and rubber. Agriculture is predominantly on a small holder basis, although there are some large farms and plantations particularly for rubber, oil palm and coconut and to a lesser extent, rice, maize and pineapple. The mean farm size is less than 1.6 ha. Small and medium size farms of up to 10 ha account for 95% of all cultivated land.

Common factors in agriculture are the use of bush fallow to restore soil fertility, mixed cropping to minimize the risks and, in the north of the country, the widespread integration of livestock into farming system. The main system of farming is traditional with the use of hoe and cutlass. While there is little mechanized farming, bullock farming is increasingly practiced, especially in the north. Agricultural production varies with total rainfall distribution and soil factors with strong regional diversity.

The greatest production emanates from root and tuber crops such as cassava, yam and cocoyam. These crops contribute about 46% of agricultural GDP with yam exhibiting the largest growth rate in area planted and coming third after groundnut, maize and cowpeas in production rate. Plantations account for 9% of agricultural GDP. Cocoa is the second largest subsector which contributes about 15% of agricultural GDP. The third largest sub-sector is forestry with a contribution of 12% of agricultural GDP. Cereals such as maize, rice, sorghum and millet contribute 7%, livestock 5%, fisheries 4%, fruits and vegetables 3% and others 2%.

Although the share of the agricultural sector in GDP has a declining trend in recent years, the sector still remains a very important one of the economy and its performance therefore continues to have a considerable impact on the overall performance of the economy. The production of food still depends heavily on rainfall and is likely to continue the regular shortfall to demand, and therefore some imports would be required, particularly, animal products, rice

and vegetable oils. Food prices would continue in the upward trend due partly to the expected shortfalls in the supply of some major food crops, increase in the costs of production and distribution, and higher inflation in the country.

The Government is aware that real food security can only be achieved if an increasing drive to boost food production is matched by equal investment in storage, distribution processing and international markets. The goal of MOFA is to provide an environment enabling efficient production of food and agricultural raw materials at world competitive prices, by encouraging those commodities and value-added activities where Ghana has both comparative and competitive advantages.

The strategies to achieve this goal can be found in Ghana's Medium Term Agricultural Development Programme (MTADP: 1991-2000). The key policies in this Programme are to:

1) provide food security for all population by way of adequate and nutritionally balanced diets at affordable prices;
2) create rural employment opportunities to reduce rural unemployment;
3) generate foreign exchange through export promotion of cash crops and timber; import substitution (rice, palm oil and cotton) and export diversification (horticulture, rubber, coffee and tobacco) and thereby improve the balance of payments;
4) provide raw materials for industrial development; and
5) promote balanced regional development.

2.4 Government Policy and Plan for Irrigation Development

The Government of Ghana has placed irrigated agriculture in high priority for satisfying the country's food demand and producing much of its industrial raw materials. It is also expected to contribute significantly to social stability by creating employment opportunities and raising living standards in rural areas. To this end, the Government established GIDA in 1977 with the primary purpose of accelerating the development of irrigation.

Modern irrigation was started mainly in the early 1960s. GIDA has constructed and been operating small and medium scale irrigation projects with service areas ranging from 100 to 2,000 ha at about 20 locations throughout the country. The total area already developed is about 6,700 ha. In addition, there are a number of very small irrigation schemes, developed through the initiatives of community or farmers groups, who are responsible for all aspects of land allocation and management. There are no data on total area of land being irrigated by these micro-scale schemes.

However, many projects constructed and being operated by GIDA have been suffering from low performance due to a combination of various factors. The prevailing constraints are represented by low productivity due to deterioration of irrigation facilities, water shortage, soil

problems and weak linkage with institutional supporting services.

In order to overcome these unfavorable situations, GIDA is directed to concentrate on improving the management and operation of existing irrigation projects before embarking on the development of any new large-scale schemes on the basis of the World Bank's review of irrigation in 1986. Similarly, the optimum use of existing irrigation projects is focused in MTADP. The reactivation of existing irrigation projects is therefore a very important component of MTADP.

The strategy to overcome the above unfavourable situation as mentioned in MTADP is to:

1) make the best use of existing investments by reducing operation costs substantially and completing the development of schemes where this can be shown to be economically justified;
2) focus on the development of small-scale and micro-scale irrigation schemes; the common element is the emphasis given to the implementation and management of the schemes by farmers themselves;
3) give support to the development of schemes in the areas, in which farmers and use small pumps to draw water from shallow tubewells sunk in alluvial deposits in which aquifers are recharged annually; and
4) give priority to schemes, mainly rice, that are aimed at controlling water in areas that are inundated during the wet season as well as valley bottom areas that are subject to seasonal flooding and where the construction of simple bunds and structures would enable some measure of water control to be established.

3. EVALUATION AND SELECTION OF PRIORITY PROJECTS

This Chapter 3 presents all the results of the study on the 12 existing irrigation projects at a master plan level for the purpose of evaluating and selecting priority projects for which feasibility study is made during Phase-II. ANNEX-A gives the study results in detail.

3.1 Study Projects

Potential and developed areas, intake facility and irrigation type in each of the 12 projects are summarised as follows:

Project	Potential Area (ha)	Developed Area (ha)	Facility	Irrigation Type
Ashaiman	148	130	Dam	Gravity
Weija	220	220	Pump	Sprinkler
Amate	203	101	Pump	Sprinkler
Afife	880	880	Dam	Gravity
Aveyime	150	63	Pump	Gravity
Kapndo-Torkor	356	40	Pump	Sprinkler
Mankessim	256	17	Dam/Pump	Sprinkler
Akumadan	65	65	Pump	Sprinkler
Tanoso	115	64	Pump	Sprinkler
Bontanga	450	450	Dam	Gravity
Subinja	121	60	Pump	Sprinkler
Okyereko	111	40	Dam	Gravity
Total	3,075	2,130		

Most of the projects have not been fully developed as originally planned, mainly due to financial constraint. About a half of the 12 existing projects depend on pump and sprinkler systems which are severely deteriorated at present. These projects are not able to supply sufficient irrigation water even for the developed areas because of deterioration of the facilities.

3.1.1 Meteo-hydrology

(1) Climate

Generally, the climate in Ghana varies with 4 agro-ecological zones, and the climatic characteristics in each zone are summarised as follows:

1) North Savannah Zone

In the North Savannah Zone including Guinea Savannah, mean annual rainfall ranges from 950 mm to 1,270 mm in one season beginning gradually from May and lasting till October with a peak in September. Potential evaporation is between 1,600 mm and 1,700 mm per year, and irrigation is required for crop cultivation

during the dry season. Natural vegetation is low quality savannah and scrub interspersed with hardy trees which survive regular bush fires. The Bontanga project is located in the Guinea Savannah zone.

2) Transitional Zone

Mean annual rainfall in the Transitional Zone ranges from 1,270 mm to 1,500 mm normally in two wet seasons. Potential evaporation is between 1,460 mm and 1,650 mm per year, and irrigation is required for crop cultivation during the dry season. The vegetation is mainly secondary forests mixed with scrub. There exist 5 projects in this zone, i.e. Amate, Kpando-Torkor, Akumadan, Tanoso, and Subinja.

3) Coastal Savannah Zone

Mean annual rainfall in the Coastal Savannah Zone varies from 750 mm in the coast to 1,270 mm inland. The rainfall distribution is bimodel, giving a major period between March and June and minor season between September and November. Rainfall normally exceeds potential evaporation in only about two months. Irrigation could be valuable for crops in this zone. The Ashaiman, Weija, Afife and Aveyime projects are located in this zone.

4) South Tropical Zone

Mean annual rainfall in this zone ranges from 1,700 mm to 2,100 mm normally in two seasons. The major wet season lasts from March to August and the minor season from September to November. No projects are located in this zone.

(2) Present Water Source

The irrigation water being used for all of the projects is surface water, and the projects are classified into the following groups in terms of type of water sources.

(a) Dam and reservoir	: Ashaiman, Weija, Afife, Bontanga, Okyereko and Mankessim: 6 projects
(b) Volta lake	: Amate and Kpando-Torkor: 2 projects
(c) Volta river	: Aveyime: 1 project
(d) Other rivers	: Akumadan, Tanoso and Subinja: 3 projects

The present conditions of water sources for each projects are summarised as follows:

1) Ashaiman Project

Mean annual rainfall in the catchment area where the reservoir of this project is

located, is recorded as the lowest one among all catchment areas of the projects. In addition, this project is experiencing a serious water shortage at present, because there are 7 small dams upstream of the project dam. Mean annual runoff coefficient is estimated at 3 - 5% only from the observation records, also taking into account topography, soil conditions and vegetation. In fact, it is reported that the reservoir is full with water once several years. The records also shows that the runoff coefficient will increase to some extent, when rainfalls with high intensity are observed. Evaporation from the reservoir surface is also high as compared with the effective water depth of the reservoir, which accelerates the present water shortage in the project area.

2) Weija Project

The water source of this project is Weija lake which is constructed for city water supply to Accra, and the storage capacity is 120 million m^3. The water amount supplied to Accra is 181,600 m^3/day and 272,400 m^3/day at maximum. The lake is under the control of the Ghana City Water Supply Authority, and the water level of the lake is controlled, taking into consideration the design water level of the pumps being used for sprinkler irrigation at this project. It can be said that available water from the lake for the project operations is sufficient in terms of irrigation area and storage capacity of the lake.

3) Afife Project

Although mean annual rainfall in the catchment area of the Kplikpa reservoir of this project is low as seen in the Ashaiman project site, the water shortage problem is not so serious at present, because the storage capacity of the reservoir is relatively large. There is one more reservoir, Agali, as a supplemental water source for this project. Since this reservoir is not used mostly for the project operations, effective use of this reservoir is recommended.

4) Bontanga Project

The water source of this project is the Bontanga river with a gentle river bed slope, and the project has also a gentle topography. Although the Bontanga reservoir on the river is full with water during the wet season, runoff from the catchment area is not expected mostly in the dry season. This means that the runoff into the reservoir in the wet season is the important factor to determine the irrigation area in the next cropping season.

5) Okyereko Project

The water shortage problem in this project area is serious as seen in Ashaiman. The

catchment area of the existing reservoir is very small, 17.6 km^2, and runoff into the reservoir is expected only when rainfall comes in the wet season. It is therefore reported that the reservoir is full with water once several years. 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. However, the plan is still on the paper, and it is recommended to realize the plan.

6) Mankessim Project

Presently, there exists serious water shortage problem in this project area and the irrigation area is small, 17 ha only. The present irrigation area could be expanded in view of the potential water source in the area.

7) Amate, Kpando-Torkor and Aveyime Projects

The water source for the Amate and Kpando-Torkor projects is the Volta lake with a storage capacity of 150 billion m^3 created by the Akosonbo dam which is used mainly for power generation. The water level of the lake fluctuates from season to season and is regulated between El.75.59 m and El.84.73 m by the Volta River Authority. The water released from the Akosonbo dam is stored in the Kpong dam once, and then it is released again to the downstream under the water level control by the Authority. The water from the Kpong dam and the inflow from the downstream basins can be used for project operations at Aveyime. The amount of water released from the Kpong dam is estimated from the relationship between the water level records and rating curve. The minimum release is estimated at about 100 m^3/sec which corresponds to the discharge with 10-year non-exceedence return period. The water level fluctuation at the Aveyime pump site would be within 3 m, because the water level at the tail site of the Kpong dam is regulated between El.0.77 m and El.3.77 m. The Amate, Kpando-Torkor and Aveyime projects have no constraints to irrigation development in terms of available water, because their water sources are the Volta lake and Volta river which have ample water.

8) Akumadan Project

The Acheche river which is the water source for this project has a very small catchment area of 10 km^2 only. This river has 4 tributaries, Komesua, Drobito, Trofodwo and one more tributary, and spring water from their catchment area is their origin. According to discharge measurements, total discharge from the four rivers is estimated at about 10 lit/sec. Since such discharge would not fluctuate so widely in a year, the water could be used for irrigation purpose. Spring water will be an essential factor for planning irrigation schedule, because the existing reservoir of this project is small in size and inflow into the reservoir from its catchment area could not be expected in the dry season.

9) Tanoso Project

This project is located in the catchment basin of the Tano river, the third largest one in Ghana. There is an intake weir for city water supply, which is located about 5 km upstream of the pumping station for this project. The water volume supplied by pumps to Wenchi and Techiman is 4,540 m^3/day at maximum. Because such city water supply is made constantly throughout the year, available water for this project would be restricted in the dry season. This means that the amount of available water in the dry season will be the essential factor for irrigation development in this project area.

10) Subinja Project

The water source for this project is the Subin river which has a steep river bed slope, about 1/100. The river is characterised by sudden increase in water level at the flood time and by quick go-down of water level. Although the river does not dry up even in the dry season because of dense forest in its catchment, the amount of water available during the dry season will be the essential factor for irrigation development for this project, because the project has no reservoir.

(3) Water Balance Study

The water balance study was conducted mainly to examine water availability and irrigable area on the basis of river discharges and irrigation requirements for the Ashaiman, Afife, Mankessim, Akumadan, Tanoso, Bontanga, Subinja and Okyereko projects which have constraint to irrigation development in terms of available water. The study was made on a 10-day basis and under the condition that the reservoir is at the full water level when the study is commenced. The study results are one of the parameters for selection of priority projects.

The available water and irrigable area with 80% irrigation dependability for the above projects are as follows:

Project	Aailable Water (MCM) (a)	Crop Water Requirement (m3/ha) (b)	Irrigable Area (ha) (a)/(b)	Standard Year
Ashaiman	0.524	11,767	44	1990
Afife*1	12.600	27,097	465	1986
Afife*2	14.497	27,097	535	1986
Mankessim*3	2.241	19,488	115	1991
Mankessim*4	2.550	8,643	295	1993
Akumadan	0.253	8,148	31	1987
Tanoso	0.236	7,858	30	1987
Bontanga	10.789	21,155	510	1989
Subionja	0.579	8,278	70	1987
Okyereko	0.258	23,418	11	1993

Note: *1 shows irrigable area when only Kplikpa reservoir is used.
*2 shows irrigable area when both Kplikpa and Agali reservoirs are used.
*3 shows irrigable area in case that rice is the main crop.
*4 shows irrigable area in case that upland crops are cultivated.
The irrigable area of Okyereko is that in case the Ayensu river is not considered as supplement water source.

From the above table, the following are pointed out for each of the projects:

(a) Ashaiman project: the irrigable area with 80% irrigation dependability is estimated at 44 ha, which corresponds to about 34% of the whole developed area of this project. The unstable rainfalls in recent years is the cause of decrease in available water.

(b) Afife project: the irrigable area with 80% irrigation dependability in case that the Aglai is also used, is estimated at 535 ha, which corresponds to about 60 % of the whole developed area.

(c) Mankessim project: the irrigable area estimated is larger than 17 ha of irrigated land at present. This means that there is a possibility to expand the present irrigation area.

(d) Akumadan and Tanoso projects: the irrigable area with 80% irrigation dependability at both projects will be restricted to about 30 ha due to the limited available water during the dry season, which corresponds to 50% of the developed area.

(e) Bontanga project: the irrigable area with 80% irrigation dependability is estimated at 510 ha which is larger than the developed area. It may be said that there is no constraint in terms of available water source.

(f) Subinja project: Similarly to the Akumadan and Tanoso projects, the irrigable area with 80 % irrigation dependability is estimated at 70 ha which corresponds to the developed area. It may be said that there will be no constraint in terms of available water, if the present irrigated land is not expanded.

(g) Okyereko project: the irrigable area with 80% irrigation dependability is estimated at 11 ha only, because inflow into the reservoir would be small due to small catchment area. Therefore, the use of Ayensu river as a supplemental water source is recommended, and in this case the irrigable area will depend on pump capacity to be installed. Potential area to be developed is estimated at 111 ha, and could be irrigated using river water from the Ayensu.

3.1.2 Soil and Land Suitability

The soil description survey was carried out in each of the project areas at a density of one pit per about 25 ha. A total of 118 soil pits were observed and described in accordance with the FAO criteria in "Guidelines for Soil Profile Description." At the same time, soil samples were collected from all test pits for clarification of the chemical and physical properties of soils. Based on the field survey, soils were classified into soil units according to the FAO/UNESCO system. The irrigation suitability for both wetland paddy and upland crops at

each project is assessed, taking into account soil classification, topography, land slope, soil texture, drainage conditions, etc., as summarised below:

1) For Wetland Paddy

Project	Suitable		Restrictedly Suitable		Non-Suitable		Total	
	ha	%	ha	%	ha	%	ha	%
(1) Ashaiman	158	96	6	4	0	0	164	100
(2) Weija	194	84	0	0	38	16	232	100
(3) Amate	-	-	-	-	-	-	-	-
(4) Afife	820	84	158	16	0	0	978	100
(5) Aveyime	63	90	0	0	7	10	70	100
(6) Kpando-Torkor	-	-	-	-	-	-	-	-
(7) Mankessim	71	26	105	39	93	35	269	100
(8) Akumadan	-	-	-	-	-	-	-	-
(9) Tanoso	-	-	-	-	-	-	-	-
(10) Bontanga	500	100	0	0	0	0	500	100
(11) Subinja	38	30	0	0	89	70	127	100
(12) Okyereko	122	99	0	0	2	1	123	100

Remarks: The area is the gross area including roads, river, canals, etc.

2) For Upland Crops

Project	Suitable		Restrictedly Suitable		Non-Suitable		Total	
	ha	%	ha	%	ha	%	ha	%
(1) Ashaiman	158	96	0	0	6	4	164	100
(2) Weija	232	100	0	0	0	0	232	100
(3) Amate*1	n.d.	70-80	n.d.	20-30	0	0	n.d.	100
(4) Afife	820	84	0	0	158	16	978	100
(5) Aveyime	70	100	0	0	0	0	70	100
(6) Kpando-Torkor	107	28	268	72	0	0	375	100
(7) Mankessim	80	30	158	59	31	11	269	100
(8) Akumadan	54	80	14	20	0	0	68	100
(9) Tanoso	49	41	11	9	61	50	121	100
(10) Bontanga	500	100	0	0	0	0	500	100
(11) Subinja	82	64	30	24	15	12	127	100
(12) Okyereko	123	100	0	0	0	0	123	100

Remarks: The area is the gross area including roads, river, canals, etc.
*1 The base map of Amate project is not available . The dominant portion of the area is roughly estimated.

Generally, soils in the project areas are those with low fertility and productivity due to weathering. Soils with the existence of accumulated layers of iron concretions or gravel within a shallow depth (about 30 cm) were confirmed in some areas of the Kpando-Torkor, Mankessim, Akumadan, Tanoso, and Subinja projects. These soils were generally seen in the areas with undulating topography, and high possibility of soil erosion and degradation in the future is foreseen. Therefore, countermeasures for control of such soil erosion and degradation will have to be studied at the projects rehabilitation stage. In addition, salt-effected soils are seen in the Ashaiman, Weija, Afife and Okyereko project areas. Since these salt-effected soils result from poor drainage condition, it is supposed that the expansion of the salt-effected areas could be reduced by proper drainage works, and the present salt-effected areas will be improved by leaching of water.

In order to improve soil fertility, it is recommended to apply appropriate soil management through (i) introduction of leguminous crops in the fallow season, (ii) introduction of appropriate crop rotation system, and (iii) application of animal excretion and crop residues.

3.1.3 Present Agriculture

(1) Main Crops

The main crops cultivated at present vary with the topography of the project areas, and the projects are broadly divided into two type; one is the projects where paddy rice is the main crop, and the other with upland crops. In the lowland of the Ashaiman, Afife, Bontanga and Okyereko project areas, paddy rice is cultivated as a main crop, and upland crops are grown with irrigation in the dry season. However, only paddy rice is grown in the Aveyime project area. The main upland crops are okra, tomato, onion, egg plant, hot pepper, and watermelon. In the case of the Weija project where sprinkler irrigation system is available, many varieties of vegetables preferred by Asian/Indian people such as Tinda, Cluster beans, etc. are planted for export to London by air cargo.

(2) Cropping Pattern

There exists definite crop rotation patterns in most of the project areas. In lowland, 3 patterns are identified, and the basic pattern is paddy rice - paddy rice or vegetables - paddy rice. In upland, 2 patterns are observed, and the basic pattern is rotational cultivation of vegetables and monoculture of one vegetable. Crop damage due to continuous cultivation is seen in the monoculture of vegetable.

(3) Marketing, Storage and Price

Agricultural marketing at the project sites is mostly conducted by small-scale operators. The principal agents are women (called market mummies) coming from major cities and those who bring agricultural outputs and food products by headload to rural markets. Most of farm products are traded in the form of raw materials, except for cassava. Most of market mummies come with trucks from the cities located near the projects and purchase farm products directly from the farmers. Since these market mummies play an important role in marketing of farm products, a study should be made on how to avoid unnecessary conflict with the market mummies, when the marketing system by farmers' societies themselves is established in the future.

Regarding the processing facilities for farm products, there are no rice mills in the project areas, except in Ashaiman. Therefore, paddy rice is sold directly to market mammies who are visiting individual farmers at the drying yards. Afife and Bontanga projects where paddy rice is the main crop, have storages, but they are already deteriorated. The remaining projects also have warehouses and storages with limited storage capacity only to store project equipment in most cases.

Generally, the market prices of farm products vary with 3 seasons, namely off-crop

season, pre-harvest season and harvest season. The prices during the off-crop season are the highest, followed by those during the pre-harvest and harvest seasons.

3.1.4 Irrigation, Drainage and Related Facilities

(1) Existing Irrigation and Drainage Facilities

1) Irrigation Facilities

The existing irrigation facilities are dam, reservoir, intake weir, irrigation canals with related structures, pipeline, and sprinkler. The projects served by dams and reservoirs, except for the Mankessim project, are cultivated with paddy rice and vegetables under gravity irrigation. In the Mankessim project area, vegetables are cultivated with sprinkler irrigation, using water boosted up by pumps after release from the dam. The existing dams and reservoirs are all maintained in good condition, and no rehabilitation works will be required, except minor repair of intake gates. However, the existing irrigation canals (the canals are lined with concrete in situ or concrete blocks, except earth canal at Ashaiman) are generally deteriorated, and water leakage from the canals as well as at canal structures is seen in many projects. In addition, the present O&M condition of the canal network is poor in most of the projects because of luxuriant grasses along the canals. Although paddy rice was grown at Aveyime using water lifted up from the Volta river, the irrigation services have been stopped since 1995, because severe deterioration of pumps and canals as well.

In upland project area irrigated by with sprinkler systems, the main pipelines are connected directly to pumps in order to supply irrigation water to sprinkler systems. At Weija, however, irrigation water lifted up by the main pumps at the Weija lake is supplied to the regulation pond through an open channel and boosted up again to supply water to the main pipelines. Except for the Amate and Kpando-Torkor projects, the projects have fixed pumping stations combined with intake weirs. The sprinkler system of these projects consists of a main pipeline buried in the ground and movable pipes with sprinkler heads. For the former two projects, however, movable pumps and pipelines are used, because the pumps have to be moved according to the fluctuation of water level in the Volta lake. Movable sprinkler sets are used at farm plots, and operations of these sets are practised by farmers themselves. These existing sprinkler systems including the pumps in all the project areas are deteriorated, which results in low irrigation efficiency. Such existing systems will lost their function completely in the near future, unless appropriate measures are taken to recover its function. O&M of the equipment for sprinkler irrigation are also poor in all of the projects.

All of the projects have no basic data and information to be used for calculation of irrigation requirements, irrigation schedule, O&M manual, etc., except the Ashaiman where various data and information were collected and kept at the Irrigation Development Centre. Most of the project managers are agronomists whose experience in irrigation engineering is not sufficient to give proper guidance to the farmers, and actual supply of irrigation water is practised upon request from the farmers and based on the irrigation schedule, irrigation time and rotation determined only by eye-observation of soil moisture.

2) Drainage Facilities

Of the 12 existing projects, the Amate, Akumadan, Tanoso and Subinja projects are not provided with any drainage facilities due to their inclined topographic condition. Although no drainage problem is found in these projects, careful attention should be paid to soil erosion which is expected to occur due to introduction of intensified farming in the future. The existing drainage facilities in the remaining 8 project areas are not functioning well because of sedimentation and luxuriant water-loving grasses in the drains due to poor O&M at present.

The Ashaiman, Aveyime and Okyereko projects have light salinity concentration in some parts of paddy fields because of poor drain. This salinity concentration would be settled by good maintenance of the drains.

The Afife project is suffering from poor drainage because of the backwater effect caused by the lagoon located downstream. A mechanical drainage system would be required when the water level in the natural drainage stream is higher. This matter will be studied in detail later after compiling the collected data.

In the Mankessim and Weija project areas, the lowland is flooded every year by water overtopping the natural rivers. Judging from the frequency of flood and scale of the rivers, it is unlikely that the application of river training would be economically feasible. Instead, alternative plans such as provision of flood dike, deletion of lowland area from the project area and route change of inland drains will be studied based on the collected data.

(2) Farm Roads and Buildings

The present conditions of the existing farm road network in the project areas including short accesses to main road are generally poor, except for the Weija, Bontanga and Afife projects where the existing road networks are maintained in moderately good condition. The present poor road network of most of the projects will require cleaning by grass cutting and improvement of surface such as compacted gravel pavement, and for some projects, construction

of new farm roads would be required in connection with the expansion of irrigated land as well as the rehabilitation. In the case of the Amate project, in particular, the access, a second class road, from Begoro town to the project site, about 50 km long, is very poor.

Offices and quarters for the O&M staff of GIDA are available in the Ashaiman, Weija, Afife and Bontanga project areas. Although these buildings are maintained in relatively good condition, small rehabilitation works would be required. The existing buildings in the remaining project areas are mainly offices and are in very poor condition. Such buildings should be replaced by new ones, and additional buildings such as offices for farmers' organisations, storages, etc. would also be required in connection with the projects rehabilitation.

(3) Present O&M Condition and Cost

Except for the Afife project, O&M manuals are not available. The present O&M works for the facilities and agricultural machines are executed by the O&M office at each project site under the control of GIDA, and the farmers' participation in O&M works is still limited to cleaning of canals and removal of grasses. As for the pumps, sprinkler systems and farm machinery, GIDA has made maximum efforts for maintenance of them through monthly mechanical check and overhaul every 3 years. However, maintenance is still in a difficult situation due to financial constraint and lack of spare parts, because most of them were procured in the 1970s and early 1980s.

GIDA is collecting irrigation service charge (ISC) from all of the beneficiaries, say farmers. The amount of ISC varies with the projects and is determined by the O&M office with the approval of GIDA. ISC at Subinja is the highest, Cedi 414,500/ha/crop (equivalent to US$ 296), and the lowest one is Cedi 50,000 (equivalent to US$ 36) at Ashaiman, Afife and Okyereko. Basically, ISC is the costs for O&M of the irrigation facilities such as electric charge, fuel, lubricant, repair and spare parts, not including staff allowance and office costs of GIDA.

As for collecting situation, the irrigation projects of Weija, Amate, Kpando-Torkor, Mankessim and Akumadan have collected almost 100% of irrigation service charge from the farmers. The collecting ratio of Ashaiman was only 12.7% in 1994, and that of other projects ranges from 50% to 80%. With the exception of the Ashaiman and Weija projects, all projects collect ISC before cropping, and farmers who do not pay charge can not cultivate in the project areas. The Ashaiman project, however, collects after harvesting, and a lot of farmers have refused to pay the charge because of problems of water shortage. According to the farmer interview survey results, most of the farmers show understanding for ISC collection which is prerequisite for O&M of the project facilities.

3.1.5 Agricultural Support Services

(1) Agricultural Research

Agricultural research at national level is practised mainly by the Crop Research Institute of the Council for Scientific and Industrial Research (CSIR) under the Ministry of Industry, Science and Technology (MIST). In addition, some research institutes belonging to the Ministries and Universities concerned are carrying out some research. As one of the problems in agricultural research, it can be pointed out that their research programmes and activities have a poor linkage with needs of farmers and government agencies concerned with agricultural development. This problem is due to the fact that the CSIR institutes are governed mainly by MIST, and MOFA has a limited say in the formulation of research programmes and research priorities.

In addition to the above CSIR institutes, there is a research institute for irrigation farming called "Irrigation Development Centre (IDC)" in GIDA. Its main activities are (i) collection of basic data and information required for planning of irrigated agriculture, (ii) development and introduction of farming techniques suitable for irrigated agriculture, (iii) preparation of guidelines for irrigated agriculture, (iv) services to farmers in farming techniques, and (v) activities for demonstration of various farming practices. It is expected that IDC plays more important role in strengthening research activities for improving irrigation farming and training of extension officers and farmers in connection with the projects rehabilitation.

(2) Extension Services

MOFA is responsible for agricultural extension to the farmers. However, MOFA's extension activities are concentrating on staple foods (maize, cassava, yam, cowpea, soybeans) in rainfed areas, with almost no services in GIDA's irrigation project areas. In the irrigation projects, GIDA is responsible for extension services to the farmers, despatching extension workers to each project office. As present problems of GIDA's extension services, the following 3 matters may be pointed out: (i) poor knowledge of staff on irrigation farming, (ii) lack of vehicles/motorcycles to provide mobile services, and (iii) no extension facilities and equipment. In addition, a weak co-ordination is shown between the Project Management (PM) offices and MOFA's extension offices.

(3) Agricultural Credits

There are following 3 banks for agricultural credits; (i) Agricultural Development Bank (ADB), (ii) Co-operative Bank, and (iii) Rural Bank. Of these, ADB is common for individual farmers. The loan amount is decided individually according to the following borrowers' conditions: (i) security, (ii) borrower's bank account and some deposit amount, and (iii) guarantee by authorised institutions/organisations/companies. According to the farmer interview survey results, most of the farmers point out the problems of the present agricultural credits. The banks

are now hesitating to extend loan to the farmers because of their low repayment capability with recent inflation in the country. The loan interest is rising rapidly in accordance due to the recent inflation of commodity prices. The interest in November 1995 ranged from 38% to 50% per year. At present, many of the farmers are obtaining private loans from middlemen (market mummies) of products. As of December 1995, their interest was very high, 50-100% per season. There was two methods of loan repayment "by cash" and "in kind," and a half of borrowers at the projects have paid loans by cash.

3.1.6 Farmers' Organisation and Handing-over of O&M

(1) Farmers' Societies in the Project Areas

GIDA has envisaged the handing-over of O&M to the farmers' societies established in each project area. Then, farmers' societies have been established under the guidance of the PM Office and the Department of Co-operatives. All of the beneficiaries of the projects become the members of the societies, and the executive committee members are elected from the society's membership. Of the 12 societies in the project areas, 7 have bye-laws, and the remaining 5 societies have not completed bye-laws. These bye-laws are prepared in accordance with the form of the Department of Co-operatives, and no articles on O&M of irrigation facilities are stipulated in the above bye-laws. It means that almost all societies have no function as a water users' association from the institutional viewpoint.

The objectives of these societies are (i) to produce crops on a collective farming basis, (ii) to arrange for the sale of such products, (iii) to provide facilities for the processing of products, (iv) to arrange for the supply of farming and domestic necessities to their members, and (v) to procure collectively and distribute essential commodities equally among members. The present activities of the societies are mainly to discuss the amount of irrigation service charge and land allocation with the project offices. In addition, the societies established in the pumped irrigation areas are arranging the installation of sprinkler systems under the guidance of the PM Offices. With the exception of the Tanoso and Akumadan societies which are arranging some credit services to the members, the societies have no other activities shown in the objectives mentioned in their bye-laws.

(2) Executing Agencies for Promoting Farmers' Societies and Handing-over of O&M

1) Strengthening of Societies' Activities

Basically, the Department of Co-operatives under the Ministry of Employment and Social Welfare is responsible for promotion and guidance to all co-operative activities in the whole country including GIDA's irrigation project areas. GIDA is responsible for the promotion and support to the societies for O&M, and its front line

office is the PM Office. With the exception of the Weija and Afife projects, inactive promoting services of the Department of Co-operatives and GIDA are observed in 10 irrigation projects, and both agencies have a weak co-ordination between them. In the case of Weija, the District Office of the Department of Co-operatives in Amasaman Ga District has despatched a Co-operative Officer to the PM Office, and he is now implementing services for strengthening of the society. The Afife irrigation project has also one co-operative officer despatched by the Department of Co-operatives (Denu District).

2) Project Management and Handing-over of O&M

The executing agency for O&M handing-over is naturally GIDA. In accordance with the Regulation of GIDA (L.I. 1350), 1987, a PM Office has basically the following 4 committees: (i) Land Allocation Committee, (ii) Agricultural Committee, (iii) Disciplinary Committee, and (iv) Appeals Committee.

As the basic policy of GIDA, all farmlands in the irrigation project areas are allocated permanently to the farmers, and the allocation is implemented by the Land Allocation Committee. As of 1995, the land allocation to the farmers has been completed only for the following 4 projects: Weija, Mankessim, Tanoso and Okyereko. In other projects, lands have been allocated in each season, because the PM Offices cannot supply enough irrigation water to the areas fixed through the land allocation procedure due to problems of irrigation facilities.

The Agricultural Committee is responsible for (i) planning and implementation of agronomic practices, (ii) ensuring that no persons tamper with the irrigation network, and (iii) ensuring that farmers use the land for the purpose specified in the Irrigation Development Authority Land Allocation Agreement (Agreement), and do not transfer or sublet the land allocated to them.

3) Restructuring of GIDA

The Government has a plan to privatise GIDA. In accordance with the plan, the number of staffs in GIDA has been reduced from year to year. However, no definitive and detailed schedule for the privatisation is prepared at present.

3.1.7 Environment

(1) Environmental Impact Assessment

Under the regulation of the Environment Protection Agency (EPA), the project proponents are obligated to submit an Environmental Impact Statement, Preliminary Environmental

Report or Environmental Assessment Preliminary Registration Form on the planning of any project. After receiving the registration form, EPA will give the project one of the following 4 decisions; (a) objection to the undertaking, (b) no objection to the undertaking, (c) preliminary Environmental Assessment required, (d) Environmental Impact Assessment required. In the case of (c) and (d), EPA requests the project proponent to carry out IEE or IEA.

According to the "Environment Impact Assessment Procedure" of EPA, the proponent is required to submit the environmental registration form to EPA in the following conditions: (i) management area of agricultural land involving the clearing of land greater than 40 ha in area, and (ii) management area of agricultural land involving the clearing of land located in an Environmentally Sensitive Area. In addition, an EIA study must be performed for the following agricultural projects: (i) land development for agriculture purpose not less than 40 ha, and (ii) agricultural programmes necessitating the resettlement of 20 families or more.

(2) Preliminary Environmental Evaluation

The present environmental problems identified in the project areas are (i) silt accumulation in the reservoirs, (ii) deforestation in the catchment, (iii) soil erosion and degradation in farmland, and (iv) water-born diseases. The future eventual environmental impacts of the implementation of the Project were examined and tentatively assessed as summarised below.

Environmental Issues	As.	We.	Am.	Af.	Av.	Kp.	Ma.	Ak.	Ta.	Bo.	Su.	Ok.
(1) Health hazard from chemicals	+	+	+	+	+	+	+	+	+	+	+	+
(2) Deterioration of downstream water quality	+	+	+	+	+	+	-	-	-	+	-	+
(3) Ecological change in downstream areas, i.e. lagoon area and Volta lake	+	+	-	+	-	-	-	-	-	-	-	-
(4) Beneficial impacts on farm and local economy	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
(5) Land degradation (in expansion area)	-	-	+	-	-	++	+	+	++	-	++	-
(6) Incidence of water-born * diseases (in expansion area)	-	-	-	-	++	-	-	-	-	-	-	-
(7) Decrease in forest in and around the project areas (in expansion area)	-	-	++	-	++	++	+	+	++	-	+	-

The marks indicate the significance of the impacts: - : none, + : minor, ++ : moderate, +++ : major
Remarks: * excluding malaria disease.

3.2 Study on Projects Rehabilitation

3.2.1 Basic Concept for Projects Rehabilitation

On the basis of data and findings obtained from field works in Ghana as well as the study made at this stage, the study on the 12 existing irrigation projects at a master plan level was made as presented in this Section. The study covered the main components of the Project

such as rehabilitation plan of the project facilities, and agricultural and institutional development plans in connection with the projects rehabilitation. The study also formed the basis for evaluation of each project as well as for selection of priority projects.

(1) Basic Concept for Agricultural Development

The final target of the proposed agricultural development under the reactivated projects can only be achieved through comprehensive development of not only direct measures for increase of agricultural productivity 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. The essential policies to be taken for this purpose are as follows:

(a) Increase and stabilisation of agricultural productivity
(b) Rehabilitation and improvement of agricultural production infrastructure
(c) Establishment of an effective marketing system
(d) Improvement and strengthening of GIDA, farmers' societies, and other institutes concerned
(e) Environmental conservation plan

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 factor contributing to the achievement of the key policies defined in MTADP. The essential policies to achieve this purpose are (1) intensification of farming and crop production, (2) rehabilitation and improvement of agricultural production infrastructure, (3) extension of improved farming, and (4) improvement and strengthening of government institutes and farmers' societies related to the development of irrigated agriculture.

(2) Basic Concept for Rehabilitation of Project Facilities

The rehabilitation and improvement of the existing agricultural production infrastructures 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 basic concept for this purpose is as follows:

1) Elimination or alleviation of constraints to smooth O&M of the existing systems
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 O&M of the project facilities
5) Soil erosion control measures for steep topography areas in connection with the drainage system.

(3) Basic Concept for Institutional Development

The objectives of the institutional development plan are to establish successful and sustainable O&M of irrigation facilities by the farmers themselves and improve 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 executing agency. For this strengthening, the number of staffs and facilities necessary for implementing O&M handing-over and support services to the farmers should be minimised as much as possible, taking into account the restructuring plan of GIDA.
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) Successful and sustainable O&M by the farmers needs a lot of support services from various agencies concerned. The institutional plan should therefore cover the improvement and co-ordination of all the activities involved in O&M.
4) The strengthening of agricultural support services such as marketing and credits is also a prerequisite factor as well as the rehabilitation of irrigation facilities. These support services should also be strengthen in order to achieve the final target of the Project.
5) In order to arouse the farmers' sense of belonging and responsibility to 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.

3.2.2 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, cowpea and vegetables. The production of rice still does not satisfy the increasing national demand. Maize 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 varieties of crops. They will be tomato, onion, okra, hot pepper, egg plant, watermelon and vegetables for export. Those are being grown in the Weija project area. Crop diversification is proposed particularly in lowland rice areas.

The proposed cropping patterns for the respective projects were prepared taking into consideration (i) full and effective use of existing farmland particularly in the wet 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, 1.0 or less, in most project areas. The proposed cropping patterns were therefore prepared so as to use fully the possible irrigable area delineated through the water balance study in both the wet and dry seasons. Consideration was also paid to elimination or alleviation of crop damage due to continuous cultivation as well as to ensure higher crop yields and production of quality crops, especially for tomato, pepper, egg plant, and okra. It is recommended to cultivate these vegetables once every three to four years. In order to increase farm income, appropriate combination of a variety of crops was taken into consideration in preparing the proposed cropping patterns, particularly in the lowland rice cultivation areas.

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

Drying floors are available in most project areas where paddy rice is cultivated. Since broken rice after threshing and milling is often seen in these projects, technical guidance will be required to improve this situation. In other projects 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 projects where 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, tomato, egg plant, onion, okra, etc. Although some storage houses are available in most of the rice growing projects, no storages are provided in the projects where upland crops are mainly grown, and the farmers usually store the products in their houses. Storage houses are required for these projects.

Presently, most farm products are sold at farm gate to middlemen, market mummies 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 vegetable fluctuate with the demand-supply situations and constitute 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. Under the free market system, it is also essential to produce the products with 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.

3.2.3 Rehabilitation Plan for Project Facilities

(1) Irrigation Plan and Water Requirements

1) Proposed irrigation method

Of the 12 existing projects, seven projects (Weija, Amate, Kpando-Torkor, Mankessim, Akumadan, Tanoso and Subinja) where upland crops are cultivated, are irrigated with sprinkler systems. A study was made on the possibility of applying furrow irrigation, taking into account the cylinder intake rate, topography of the project areas, water availability, etc. As a result, sprinkler irrigation will be applied for these projects, as presently practised. The remaining 5 projects where the main crop is paddy, are irrigated by gravity system.

2) Irrigation water requirements

On the basis of the proposed cropping patterns and meteorological data, evapo-transpiration (ETo) was calculated using the modified Penman equation which is adopted for many projects in estimating the reference crop evapotranspiration with the most satisfactory results. The result is summarised as follows:

(Unit: mm)

Project	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
(1) Ashaiman	155	151	174	165	158	123	121	127	138	161	156	146	1,775
(2) Weija	158	160	180	174	158	129	133	146	153	164	153	149	1,857
(3) Amate	127	123	140	135	136	105	96	102	105	124	123	121	1,437
(4) Afife	155	157	180	168	158	132	133	136	150	171	162	152	1,854
(5) Aveyime	143	148	167	153	146	117	121	127	126	140	135	130	1,653
(6) K.-Torkor	149	143	158	150	146	117	112	112	117	140	144	136	1,623
(7) Mankessim	136	134	155	147	143	114	112	109	117	143	141	130	1,580
(8) Akumadan	164	168	180	159	152	126	118	118	114	127	135	136	1,697
(9) Tanoso	164	168	180	159	152	126	118	118	114	127	135	136	1,697
(10) Bontanga	211	216	233	201	186	147	140	130	129	161	132	186	2,071
(11) Subinja	164	168	180	159	152	126	118	118	114	127	135	136	1,697
(12) Okyereko	136	134	155	147	143	114	112	109	117	143	141	130	1,580

On the basis of ETo, cop coefficient (Kc) and percolation loss measured at Ashaiman, irrigation water requirements for the respective projects were estimated on a 10-day basis, also taking into account effective rainfalls and on assumption that puddling water for paddy field preparation is 200 mm and that pre-irrigation requirement for upland is 60 mm. Irrigation efficiency used for this estimate is 60% for gravity irrigation, 50% for furrow irrigation, and 70% for sprinkler irrigation. The effective rainfall in paddy field and upland was calculated separately. The effective rainfall in paddy field was calculated on the basis of the daily water balance using correlation between the 10-day rainfall and 10-day effective rainfall.

The U.S.Department of Agriculture Soil Conservation Service has developed a pro-

cedure for estimating effective rainfall by processing long-term climatic and soil moisture data from 50 years of rainfall records at 22 experimental stations. A daily balance in the soil profile was calculated, and the following relationship was derived from monthly rainfall and crop consumptive use.

$$ER = 0.95 \times R^{0.95} \times Cu^{0.81}$$

Where,

ER : Effective rainfall in mm
R : Rainfall in mm
Cu : Crop water requirement in mm

The 80% probable irrigation water requirements on 10-day basis for the respective projects were calculated for 10-day period using the rainfall data discussed above.

3) Proposed irrigation system

a) Paddy field: five projects (Ashaiman, Afife, Aveyime, Bontanga and Okyereko) are mainly cultivated with paddy. Irrigation water is supplied to each field by gravity system after intake. At present, it is reported that continuous supply of irrigation water is practised under the Ashaiman project and that irrigation water supply in the remaining four projects is made intermittently. However, water demand is not calculated logically as mentioned previously, and also water supply is not made based on a reasonable irrigation calendar. Water supply system should be simple. Taking into account the present situations surrounding the projects, it is proposed to apply the continuous water supply method.

b) Upland: the proposed irrigation system for upland is tentatively determined as follows for the purpose of selecting priority projects, using crop water requirements, intake rate, and root zone depth measured at field.

- Irrigation water at one time : 40 mm and 30 mm only for Weija project
- Irrigation interval : 6 days and 5 days only for Weija project
- Semi-permanent sprinkler system

(2) Delineation of the Project Area

A water balance study was made for each of the Ashaiman, Afife, Mankessim, Akumadan, Tanoso, Bontanga, Subinja and Okyereko projects where available water resources are limited to serve potential irrigable areas. The results of water balance study thus obtained were used for probability analysis to delineate the possible irrigable area with 80 % irrigation dependability in each of the projects, as shown below:

(Unit: ha)

Project	Potential Area	Developed Area	Possible Irrigable Area
(1) Ashaiman	148	130	44
(2) Weija	220	220	220
(3) Amate	203	101	203
(4) Afife	880	880	535
(5) Aveyime	150	63	150
(6) Kpando-Torkor	356	40	356
(7) Mankessim	256	17	176
(8) Akumadan	65	65	31
(9) Tanoso	115	64	30
(10) Bontanga	450	450	450
(11) Subinja	121	60	70
(12) Okyereko	111	40	111
Total	3,075	2,130	2,376

(3) Alternative Plans

For the Mankessim and Okyereko projects, there are alternative irrigation plans as mentioned below:

1) Mankessim Project

The total potential area of 256 ha of land is classified into 80 ha for paddy and 176 ha for upland crops. In the original plan, paddy field is located in the lowland area along the Ochi river. Presently, this lowland area is severely inundated about one meter every year by flood from the Ochi river. A flood analysis of the river indicates that 255 m^3/s of flood would attack the river with a 10-year probability. Judging from the cross-section of the river near the area, this flood would bring more than two meters of inundation in the lowland area. In order to protect the area from flood, a flood protection dyke is considered as one of the countermeasures. It would need about US$ 340,000 of investment, equivalent to US$ 1,330/ha. When paddy is cultivated in this area, total irrigable area of the project would be restricted to 115 ha instead of 256 ha of potential land, according to the water balance study results. From such results, it is proposed that this lowland area be excluded from the project area and that the project rehabilitation should be made aiming at cultivating of upland crops which would be more profitable than rice.

2) Okyereko Project

The Okyereko project was developed for cultivating paddy in a command area of 111 ha. Since its water resource, the Okyereko reservoir, is fed by rainfall only, the irrigated area is severely restricted at present. In fact, the irrigated area in the past five years from 1991 to 1995 ranged from 7.3 ha to 30.9 ha and averaged 21.6 ha only. In addition, the water balance study shows that the irrigable area with 80% irrigation dependability would only be 11 ha, out of 111 ha. GIDA has already been aware of this water shortage, and has a plan to provide a supplemental water source by installing pumps on the Ayence river which is located near the project. Then, the study of an alternative plan was made so as to include the new pumping

station in the proposed rehabilitation works of this project.

(4) Irrigation Facilities

For the purpose of selecting the priority projects, the rehabilitation plan of existing project facilities was prepared based on the results of the inventory survey and irrigation plan mentioned above. The rehabilitation plan for the respective projects is summarised below.

1) Ashaiman project

According to the water balance study, the irrigable area will be limited to 44 ha, out of the developed area of 148 ha, and in this case there would be no spilling water from the dam. Even if the storage capacity of the reservoir is increased by heightening the crest elevation of the spillway or dam, the increased amount of water would be consumed mostly by evaporation due to increase in water surface area in the reservoir. For this reason, heightening of the spillway or dam crest is not proposed. Since the dam itself is in good condition, no rehabilitation will be required. As for improvement of the existing intake valve, a new valve is proposed to be installed at the outlet of the existing conduit, considering the life time of the existing conduit and easy construction. This project has various facilities not only for irrigation but for agricultural research activities under the guidance of the IDC. In addition, it is strongly expected that IDC should play a more important role in strengthening the research activities for improving irrigation farming and training of extension officers as well as farmers in the irrigation project areas. The existing project facilities are already available to serve the whole developed area. Because all irrigation canals and related structures are severely damaged, these facilities will therefore be rehabilitated totally.

2) Weija project

Except the main canal, pumps, all pipes and sprinklers are proposed to be replaced by new ones due to water leakage. The layout of the pipeline will be left as it is, because it does not present any problem.

3) Amate and Kpando-Torkor projects

All pumps, pipes and sprinklers are severely deteriorated. These are therefore proposed to be replaced by new ones. In connection with the replacement of pumps, those for the Kpando-Torkor project will be electrified to lower the operation cost as well as for easy operation. For both projects, consideration is to be also paid to stable supply of irrigation water regardless of the fluctuation of water level in the Volta lake, 8 m at maximum. It is then proposed that a set of pump and motor be mounted on a movable stand and it will be moved on the sloped concrete slab ac-

cording to fluctuations of water level. A delivery pipe will be installed on the sloped slab and be equipped with hydrants at proper intervals, to which a pump delivery pipe will be connected. The project area will be divided into two to three blocks, and each of them will be served by one complete set of pump, pipeline and sprinkler system, instead of one large-scale pump set commanding the whole project area, in order to avoid the risk in case of breakdown of the facilities.

4) Afife project

No rehabilitation will be made for the dam, but the intake gate will have to be repaired to eliminate water leakage. As for the canal system, the main canal will be left as it is, but measuring devices such as broad crested weir and parshall flume should be installed for efficient water management. Laterals will be partially repaired, and sub-laterals should be totally re-shaped.

5) Aveyime project

Because the pump, main canal, laterals and related structures are seriously damaged, no irrigation services were provided in 1995. These irrigation facilities should be rehabilitated. In connection with the rehabilitation of these facilities, a farm pond is proposed to be provided after the intake by pumping in order to adjust in-flow and out-flow of irrigation water.

6) Mankessim project

The required facilities will newly be provided so as to serve 176 ha of the project area, excluding the lowland as already mentioned. There are two intake gates on both banks of the dam. Since the right intake gate is installed at a higher position, water could not be tapped effectively from the dam. It is therefore proposed to connect the both two intake gates.

7) Akumadan, Tanoso and Subinja projects

The existing weir of the Akumadan project will be replaced by new one with bridge and crossing pipe for easy operation of both the right and left bank pumps. The weir of the Subinja project will be renewed, since the existing one is severely damaged. All pumps, pipes and sprinklers will be replaced by new ones because of their serious deterioration condition.

8) Bontanga project

Intake gates, laterals and related structures such as turnout, check and measuring device will be repaired, but others will not require any rehabilitation work.

9) Okyereko project

In order to supply water to the reservoir from the Ayensu river located nearby, it is proposed to construct a pumping facility including electric supply line, delivery pipe and pumping station. The canal network will be rehabilitated totally.

(5) Drainage Plan and Drainage Requirements

1) Drainage requirements

Drainage requirements for the respective projects were estimated as shown below.

(a) Paddy field

The drainage requirements for paddy field were calculated on a basis of 3-day consecutive rainfall with a 10-year probability and on assumption that the allowable submergence depth in paddy fields is 150 mm. The results are as follows:

- Ashaiman project : 1.0 lit/sec/ha
- Afife project : 2.5 lit/sec/ha
- Aveyime project : 1.5 lit/sec/ha
- Okyereko project : 3.0 lit/sec/ha
- Bontanga project : 2.5 lit/sec/ha

(b) Upland

Drainage water requirements for upland were estimated using the 10-year probable daily rainfall and the MacMath equation. The results are summarised below:

- Weija : $Qd = 0.104\ A^{4/5}$
- Amate : $Qd = 0.138\ A^{4/5}$
- Kpando-Torkor : $Qd = 0.159\ A^{4/5}$
- Mankessim : $Qd = 0.131\ A^{4/5}$
- Akumadan : $Qd = 0.147\ A^{4/5}$
- Tanoso : $Qd = 0.147\ A^{4/5}$
- Subinja : $Qd = 0.147\ A^{4/5}$

Where,

Qd : Drainage discharge (m^3/s)
A : Drainage area (ha)

(6) Drainage Facilities

Drainage facilities have been provided only for the six Ashaiman, Weija, Afife,

Aveyime, Bontanga and Okyereko projects. These facilities do not function properly due to much sedimentation and grass. It is therefore essential to remove sediment and grass and to maintenance work regularly. For this purpose, it is planned to provide some equipment for O&M of the drainage facilities.

In the Afife project area, inundation is seen in some parts of the downstream area. According to the water balance study results, the irrigable area would be limited to 535 ha, which is about 60% of the whole developed area of 880 ha. On the basis of the water balance study, such inundation parts will be used as retarding basins in the wet season, also taking into consideration the inundation period and inundation depth. Therefore, no improvement works are proposed.

For the Bontanga project, a gated drainage culvert and flood protection dyke are proposed to avoid water stagnancy in the lowland area due to backwater from the branch of the White Volta river. The Weija project is suffering from inundation by water overtopping the Gyegyereku river and flowing along the project area. In order to protect part of the project area from inundation, it is proposed to construct a flood protection dyke, about 2 km long.

For the upland irrigation projects, intercepting drains and collector drains are proposed in connection with soil erosion control measures. Intercepting drains will generally be provided in the same direction along contour line, and be connected with collector drains. As collector drains will cross contour lines, they will be lined with concrete to avoid erosion of the inside surface of canal and to minimise canal flow section.

(7) Farm Roads

All farm roads are generally poor and require improvement works for proper O&M of the project facilities and for transport of agricultural products. The road surface will be smoothened after grass cutting, and paved with gravel for main roads and with laterite for lateral roads. The preliminarily estimated lengths of roads to be improved would be as follows:

(Unit: m)

Project	Main Road	Lateral Road	Total
(1) Ashaiman	5,000	11,000	16,000
(2) Weija	0	14,000	14,000
(3) Amate	2,000	15,000	17,000
(4) Afife	9,000	25,000	34,000
(5) Aveyime	7,000	7,000	14,000
(6) Kpando-Torkor	2,000	27,000	29,000
(7) Mankessim	3,000	12,000	15,000
(8) Akumadan	3,000	6,000	9,000
(9) Tanoso	2,000	4,000	6,000
(10) Bontanga	17,000	19,000	36,000
(11) Subinja	3,000	8,000	11,000
(12) Okyereko	2,500	4,500	7,000
Total	55,500	152,500	208,000

(8) Buildings

1) O&M office

The project offices, except for those of the Ashaiman, Weija and Bontanga projects, 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.

2) Pump houses

The existing pump houses at Amate, Aveyime, Kpando-Torkor, Mankessim, Akumadan, Tanoso, Subinja and Okyereko, except that of the Weija project, are in poor condition. All pump facilities also need replacement due to deterioration. From these situations, it is proposed to replace them with new ones. Especially, a pump house for the Subinja project should be constructed at a suitable site free from flood from the Subin river.

3) Post-harvesting facilities

The required post-harvesting facilities are planned as shown below.

Project	Store House	Sorter House	Dry Yard	Garage
(1) Ashaiman	Not need	1 No.(300 m2)	Not need	Not need
(2) Weija	1 No.(200m2)	2 Nos.(600 m2)	Not need	Not need
(3) Amate	2 Nos.(400m2)	2 Nos.(600 m2)	Not need	1 No.(300 m2)
(4) Afife	Not need	Not need	10 Nos.(3000 m2)	1 No.(300 m2)
(5) Aveyime	1 No.(200m2)	1 No.(300 m2)	1 No.(300 m2)	1 No.(300 m2)
(6) Kpando-Torkor	1 No.(200m2)	4 Nos.(1200 m2)	Not need	1 No.(300 m2)
(7) Mankessim	3 Nos.(600m2)	3 Nos.(900 m2)	Not need	1 No.(300 m2)
(8) Akumadan	3 Nos.(600m2)	1 No.(300 m2)	Not need	1 No.(300 m2)
(9) Tanoso	1 No.(200m2)	1 No.(300 m2)	Not need	1 No.(300 m2)
(10) Bontanga	5 Nos.(1000m2)	5 Nos.(1500 m2)	5 Nos.(1500 m2)	Not need
(11) Subinja	2 Nos.(400m2)	1 No.(300 m2)	Not need	1 No.(300 m2)
(12) Okyereko	2 Nos.(400m2)	Not need	1 No.(300 m2)	1 No.(300 m2)

(9) Water Management and O&M of Project Facilities

1) Water management

The preparation of proper water supply and irrigation programmes is essential for the required water management activities. This requires various basic data such as topographic maps, meteorological data, soil maps, and cropping areas. Because these data are presently not available for all of the projects, they should be collected and compiled at an early time under the technical guidance of IDC in Ashaiman. Then, monthly crop water requirements and irrigation needs should be calculated to

determine the water requirements at both intake sites and turnouts. On the basis of these requirements, programmes for opening and closing the gates should be prepared for proper water delivery to each farm plot. Water supply for upland crops will be conducted using pipes and sprinkler systems. The water supply amount will be controlled by time. Therefore, moving and setting of lateral pipes and sprinklers should be executed smoothly in line with the water delivery and application programme. In this study, irrigation at one time was calculated to be three hours based on the one time water supply amount and basic intake rate measured at field. In addition, another important issue is to monitor, analyse and evaluate the actual activities, and to reflect the results on the water delivery and application programme in the next year. Hence, staffing and organisation should be ensured for effective execution of the monitoring activity.

2) O&M of Facilities

Operation of the irrigation project facilities means the execution of water management programme mentioned above. It includes activation of pumps and gates so that the desired discharge can be supplied at the appropriate time. In the continuous water supply method, the supply amount will be regulated by opening and closing the gates in the light of water delivery and application programme. To simplify the gate operations, a measuring device is indispensable, and it should be provided for the respective projects. Water supply for upland crops will be conducted using pipes and sprinkler system. The water supply amount will be controlled by time. Therefore, moving and setting of lateral pipes and sprinklers should be executed smoothly in line with the water delivery and application programme.

In parallel with proper operation, suitable and continuous maintenance of the project facilities is indispensable to secure proper and stable functions of the facilities as well as to ensure the realisation of economic life of the facilities. The maintenance work broadly consists of:

- regular maintenance work which is carried out regularly to maintain and improve the project facilities;
- periodic maintenance work including repair of minor damage;
- emergency repair work which is conducted to repair the occasional damage of the project facilities caused by flood, heavy rainfall or other causes; and
- annual maintenance which involves a large work quantity or requires special skills.

In order to operate and maintain the projects satisfactorily, the following O&M equipment is tentatively proposed.

Project	Vehicle (4 x 4)	Tractor (60 Hp)	Backhoe (0.3m3)	Grass cutters	Radio Communication
(1) Ashaiman	1 no.	1 no.	1 no.	3 nos.	1 set
(2) Weija	1 no.	1 no.	1 no.	3 nos.	1 set
(3) Amate	1 no.	1 no.	-	4 nos.	1 set
(4) Afife	2 nos.	3 nos.	1 no.	8 nos.	1 set
(5) Aveyime	1 no.	1 no.	-	3 nos.	1 set
(6) Kpando-Torkor	1 no.	1 no.	-	4 nos.	1 set
(7) Mankessim	1 no.	1 no.	-	3 nos.	1 set
(8) Akumadan	1 no.	1 no.	-	2 nos.	1 set
(9) Tanoso	1 no.	1 no.	-	2 nos.	1 set
(10) Bontanga	1 no.	2 nos.	1 no.	4 nos.	1 set
(11) Subinja	1 no.	1 no.	-	3 nos.	1 set
(12) Okyereko	1 no.	1 no.	1 no.	3 nos.	1 set

3.2.4 Institutional Improvement Plan

(1) Organisation of Project Executing Agency

The implementation of the Project will be divided into three stages: (i) rehabilitation works, (ii) handing-over of O&M, and (iii) O&M by the farmers. GIDA will be the executing agency for the rehabilitation of irrigation projects. Therefore, GIDA should 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 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 works 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 implementation of the Project.
d) Progress and quality controls of the rehabilitation (construction) works.
e) 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, GIDA, 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 implementation of O&M handing-over. The proposed organisational structure and

staffing of both offices are shown in Figure A-43 in Annex-A. In addition, it is proposed to establish the following project implementation and agricultural co-ordinating committees to implement the rehabilitation works and handing-over of O&M, successfully.

(a) Project implementation committee

As an executing agency of the Project, it is recommended to establish a task force in the GIDA's head office during the period of rehabilitation works and transition of O&M. The members of the task force will consist of the Chief Executive, Deputy Chief Executives and Directors of Departments, and IDC in GIDA. All activities on the rehabilitation works and handing over of O&M will be monitored. And the problems and constraints identified through this monitoring will be settled immediately by the task force.

(b) Agricultural co-ordinating committee

In order to keep a close co-ordination between the agencies related to the agricultural support services, it is proposed to establish an Agricultural Co-ordinating Committee in each project area. The members of the Committee will consist of the representatives of the following agencies: (i) Farmers' Society; (ii) PM office of GIDA; (iii) district offices of Agricultural Extension Services (PPMED, PPRS and Crop Services); (iv) district office of the Department of Co-operatives; (v) Banks; and (vi) NGO, etc. The Department of Project Operations will make necessary arrangements to establish this committee.

(3) Project Implementation and Management

According to the GIDA's plan, the implemention period of O&M handing-over to the farmers has been set at 3 years. The period should be set up taking into account the actual situations of societies' activities, farmers' ability and the experience of GIDA's frontline staff who will directly implement handing-over. 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. The GIDA's basic plan for handing-over will include preparation of O&M manual, strengthening of institutes related to handing-over and training of the staff concerned. In addition, it will be necessary to carry out farm interview survey, explanation meeting (public meeting), general meeting of farmers' societies, and joint inspection of the facilities.

(4) Land Allocation

All lands in the irrigation project areas will be allocated to the farmers, in accordance with L.I. 1350 and traditional custom of land holding in the country. The land allocation proce-

dures include (i) land acquisition by GIDA, (ii) establishment of the Land Allocation Committee, and (iii) land allocation to the farmers by the Committee. The Committee will consist of the regional chief, representative of GIDA, representative of the project office, rural chief, and representative of the farmers' society.

In land allocation, the Committee will give priority to the following farmers: (i) farmers who have been displaced as a result of the construction of the Project; (ii) farmers who are resident in the surrounding villages; and (iii) farmers who are resident in other villages and wish to settle near the Project area and accept small holdings. As for the area of a plot to be allocated to a farmer, GIDA will suggest its optimum area based on the farm budget analysis and the labour balance study, but its final decision will be entrusted to the Land Allocation Committee.

(5) Training Programme for O&M and Strengthening of 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 the O&M by the societies needs a lot of co-operation and support from them. In addition, it is recommended to establish an O&M Division and Extension Division in the GIDA head office in order to carry out the training programmes and support services.

1) 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. Establishment of new societies is not considered by reorganisation of the existing societies should be done, if necessary. The strengthening of the existing societies should be undertaken by GIDA, in co-operation with the Department of Co-operatives. The proposed strengthening plan to the existing farmers' societies is described below:

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 be also included in order to meet the farmers' intention and to improve present agricultural support services. At present, a farmers' society has been established in each project area, but all these societies have no function of O&M of the irrigation facilities. These existing societies should therefore be reorganised to new societies which have the functions of O&M with agricultural support services such as marketing and credits. The proposed organisation consists of Type-A and -B. Type-A is for the small projects, and Type-B is for the larger projects. A new society will consist of the following 4 components: (i) general meeting, (ii) executive commit-

tee, (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:

a) General Meeting: A general meeting will be held at least annually, as a top unit for decision making.

b) Executive Committee: The committee will be composed of the following members: chairman, vice chairman, general secretary, treasurer, and several members who are representatives of the service sections. The 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 service sections, (v) to manage accounting and general affair, (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.

c) Service Section: Under the instruction and supervision of the executive committee, the route 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.

d) Audit Section: At present, the staff of a society consists of a chairman, vice chairman, secretary, treasurer and several members of the Executive Committee 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.

2) Training of farmers' societies

The PM office will prepare the training programme and train periodically the leaders of the farmers' societies and the farmers, 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 monitor intensively 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

3) Irrigation service charge

All O&M costs of irrigation facilities will be covered by ISC collected from the

farmers. 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. To achieve smooth collection of ISC, it is recommended to apply the following punishment rule and incentive to the farmers.

a) Farmers who fail to pay ISC on time will be imposed a fine of some percentage of the total ISC per month during the non-payment period.
b) Farmers who pay the full ISC amount and on time will receive reimbursement of some percentage of the amount paid, as an incentive.

The Executive Committee will be responsible for the collection and use 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 emergency works, if necessary.

4) Articles and bye-laws

Standard articles and bye-laws of the farmers' societies have been prepared by the Department of Co-operatives. But these are for the general co-operatives and do not cover the new societies which will be responsible for 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.

a) 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.
b) The society can inflict a punishment on these people who use irrigation water and facilities illegally or fail to pay ISC. The beneficiaries have the duty to participate in the co-operative works on O&M which are planned by the society.
d) The tenant beneficiaries have the right to join the society and to be elected executive members. They are bound to pay ISC and membership fees as proxies of the owner beneficiaries.

5) Irrigation meeting

The crop production activities are linked with various agricultural support activities including machinery service, supply of farm inputs, credit services, etc., which are implemented by the Government and private sectors, and all these should be co-or-

dinated closely with the farming. In this context, it is proposed to hold an irrigation meeting under the presidency of the farmers' society. The attendants will be all farmers, members of the Executive Committee, government institutes concerned and banks, private sectors, etc. The agricultural co-ordinating committee will make necessary support for the meeting to be held by the society. In this meeting, the following items will be discussed among the attendance, and based on the result of these discussions, the society will request the related agencies for necessary support services.

a) Recommended crops to be cultivated in the season
b) Cropping schedule including land preparation, seeding, transplanting, harvesting, etc.
c) Irrigation schedule
d) Required quantity of farm inputs such fertilisers and agricultural credits, and their supplying periods, etc.

6) Agricultural support services

a) 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 2 more officers. Their main duties will be improvement of irrigated agriculture, co-operative works, marketing and credits, and promotion of women's activities.

Since the extension workers in the project areas have insufficient experience in irrigated agriculture, it is necessary to provide training to them. The training programmes should be implemented for the GIDA's officers as well as the farmers, in order to enable them to carry out their duties effectively, with the support of IDC in Ashaiman. As for the extension system, the "T&V" system 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 officer will visit each group at least once a week.

At present, all PM offices have almost no extension equipment and facilities. The following equipment is therefore recommended to be provided in each PM office, in order to ensure effective extension activities: printing machine, overhead projector, pick-up trucks, etc.

b) Research activities on irrigation farming

In order to achieve the final target of the Project and further develop agricultural production in the project areas, it is proposed to strengthen agricultural research activities for irrigation farming. The main activities will be (i) crop adaptability and variety tests, (ii) research data on water management, (iii) fertilisation by each crop, (iv) pest and disease control, (v) specific cultivation techniques such as mulching practice for vegetable cultivation and preparation of organic fertilisers, and (vi) seed production. It is expected that these activities will be undertaken by IDC in Ashaiman.

c) Improvement of agricultural credits

At the initial stage of the Project, the farmers need a considerable amount of loan for purchasing farm inputs for crop cultivation, especially for vegetables. At present, several credits have been extended by the banks in and around the project areas. These credits have however serious problems as discussed in Sub-section 3.1.5 (3). To overcome these problems, several counter measures are proposed to be implemented in the project areas: (i) agricultural credits with technical guidance, (ii) adoption of ceiling to loan amount, and (iii) group loan. This is a comprehensive programme including marketing, agricultural credit, technical guidance, and so on. This group loan is outlined below:

i) The loan is limited only to purchasing farm inputs, and its ceiling amount is set depending on crops.
ii) For borrowing loan, the farmers form a group and select a representative. The members of group are jointly and severally responsible for loan repayment for any defaulter in the group.
iii) Farm inputs requirement is estimated by the group with required loan amount. At this time, the extension officer in the PM office gives technical guidance such as recommended fertilisation and pest and disease control with recommended agro-chemicals to be used.
iv) The bank provides a loan for the group in a lump sum or dividing into two portions, after examination. The group purchases farm inputs in one lot.
v) The bank releases the loan amount only to the supplier of farm inputs, and the group receives farm inputs from the supplier. Namely, the group and its representative do not touch cash money, except for the bank cheque to be issued to the supplier.
vi) The PM office provides transportation services to the group, if necessary.
vii) The representative collects payment from each farmer, and repay it to the bank in a lump sum. The bank does not collect payment from individual farmers.

This group loan system is proposed to be managed by the societies. At present,

the societies in Tanoso and Akumadan have borrowed some loans from the banks under the joint and several liability of the members, which is similar to the proposed loan system. It seems that all societies can manage such a new credit system without problems.

d) 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. Through this system, the farmers can arrange all necessary farm inputs before the crop season, and they can use those inputs on time according to those necessity.

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 to purchase 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 qualified seeds will however be necessary to increase crop yields in near future. It is expected that IDC will produce such quality seeds and provide them to the farmers through the GIDA's extension system.

At present, the dealers (market mummies) have handled a lot of farm products in the project areas. Their marketing activities cover all over the country and have been connected from village to village and with urban areas. With the exception of the Mankessim project, no information on marketing problems is available from the project areas. In the case of Mankessim, the project area is under the buyer's market, and the farm gate prices of products have been wrongfully controlled by the dealers who come from the Mankessim market. To overcome such a problem, the farmers in the Mankessim project area have sold 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 society.

7) Women in development

The Project will induce activation and strengthen crop production, marketing of farm inputs and products, post harvest, transportation, society's services, etc. In parallel with such economic and social development in the rural area, women farmers will have much opportunity to join these activities. In this context, it is recom-

mended that (i) women leaders be appointed in the farmers' societies, (ii) promotion of value-added processing of tomato and groundnuts by women's groups, and (iii) homestead development and wide scale livestock raising of chicken, rabbit, etc. by women's groups.

The farmers' societies should play an important role in promoting these activities, and GIDA should provide necessary guidance to them. Establishment of a women's group in each society is proposed. A representative of the women's group will join the Executive Committee as member, and will participate in all society's management. In addition, it is proposed to appoint a specialist in the Project Management Division of the head office of GIDA to promote these activities. At the field level, intensive promoting activities will be undertaken by the co-operative officer stationed in the PM office during the transitional period of handing-over, and after the handing-over of O&M, the extension officer will conduct some follow-up services.

3.2.5 Environment Conservation Plan

The environment problems identified in the IEE study are not only particular problems in the project areas, but also they can be found in the whole country. Therefore, this Project should be placed as a model development one for the future sustainable development. This subsection explains the basic concepts of conservation plans for the major future environmental issues.

(1) Soil Conservation

There are three types of control measures for soil degradation and erosion: (i) vegetative measure, (ii) structural measure, and (iii) cultural measure. In general, vegetative measures are easy and less expensive than structural measures. On the other hand, they are less effective in very steep slopes and difficult to attain erosion control effect immediately after their implementation. Structural measures have the characteristics almost opposite to vegetative measures, i.e. difficult and expensive to construct and maintain, but become effective right after the establishment. Cultural measures are the ones already or potentially mingled in the vegetative and structural measures.

In order to effectively transfer and disseminate technologies to the farmers, it is proposed to establish a research and monitoring station or centre. It is recommended that this station will have functions of research on land conservation, monitoring of soil erosion and the effects of protection measures, extension to farmers, and producing and providing tree seedlings for farmers. GIDA should have a responsibility for O&M of the proposed research and monitoring centre. To establish and provide integrated conservation measures for the farmers, the station should be operated with co-operation of other agencies.

(2) Measures for Water-born Diseases

In the case of the Aveyime project, the irrigation water sources are already infested with parasites that cause Bilharzia. Countermeasures for prevention of expansion of this disease should be considered not only in the project area but also along the upper reaches of the Volta river. The contaminated area is so wide that the adoption of chemical treatment would not effective. The following health programme is recommended to be taken:

1) Monitoring of the condition
2) Education of local people
3) Installation of sanitary facilities, if required

(3) Deforestation

Necessary actions to be taken by the Government for forest conservation are not only land use restriction, but also integrated support services to improve the present conditions. Therefore, the installation of irrigation facilities is one of the effective measures through the stabilisation of farmers' life to expect the effects of reduction of slash-and-burn cultivation, illegal cultivation and charcoal production. In addition, the following approaches are proposed to be considered to reduce the deforestation:

1) Improvement of local energy	: improvement of cooking stove
	: introduction of biogas
2) Reforestation	: participation of farmers in reforestation
	: establishment and extension of community forests
	: supply of seedlings by government service

3.3 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:

1) The exchange rate is US$ 1 = Cedi 1,700 = Yen 110 (as of December 1996)
2) Costs for civil works are estimated by updating those in the contract documents used for the Dawenya Irrigation Project where rehabilitation works similar to these of the Project were completed in 1993.
3) Costs for pumps, pipes and sprinkler equipment are estimated at CIF Accra.
4) Administration costs for the executing agency of the Project are estimated at 5 % of the direct construction costs.
5) Cost for engineering services are estimated at 10% of the direct construction cost.
6) The Project cost includes physical contingency, which is estimated at 10% of the direct construction costs, but does not include price contingency because of the

recent high inflation.

The estimated construction costs for the respective projects are as shown below.

(Unit : Cedi 1,000)

Project	Project Cost	Project Area (ha)	Cost/Ha*2
(1) Ashaiman*1	2,219,000	148	15,000
(2) Weija	7,524,000	220	34,000
(3) Amate	6,330,000	203	31,000
(4) Afife*1	6,475,000	880	7,000
(5) Aveyime	2,961,000	150	20,000
(6) Kpando-Torkor	11,253,000	356	32,000
(7) Mankessim	4,811,000	176	27,000
(8) Akumadan	1,442,000	31	47,000
(9) Tanoso	1,143,000	30	38,000
(10) Bontanga	2,666,000	450	6,000
(11) Subinja	2,113,000	70	30,000
(12) Okyereko	2,466,000	111	22,000

*1 Rehabilitation works are planned to be executed for whole the area because there are existing facilities.
*2 Rounded number.

3.4 Economic Evaluation

In order to clarify the economic feasibility of the Project and to prepare the basis for evaluation of each project, economic evaluation was made by calculating Economic Internal Rate of Return (EIRR), Benefit-Cost ratio (B/C) and benefit minus Cost (B-C), under the following conditions:

a) The useful life of the Project was taken as 50 years from project implementation;
b) For calculation of EIRR, only direct benefits are counted, and no indirect and intangible benefits are taken into account; and
c) The exchange rate is Cedi.1,400 = US$ 1.00 (as of November-December, 1995).

The result of evaluation is summarised below:

Project	IRR (%)	B/C*1	B-C*1 (Cedi million)
Ashaiman	4.2	0.54	-861
Weija	6.9	0.81	-1,432
Amate	16.9	1.50	3,207
Afife	16.3	1.60	3,236
Aveyime	13.6	1.31	808
Kpando-Torkor	20.2	1.81	8,680
Mankessim	16.0	1.48	2,146
Akumadan	0.4	0.48	-756
Tanoso	-3.4	0.43	-694
Bontanga	17.7	1.68	1,649
Subinja	7.1	0.82	-400
Okyereko	13.0	1.23	540

*1 Discount rate: 10%

3.5 Evaluation and Selection of Priority Projects

3.5.1 Evaluation Method

For evaluation and selection of priority projects, the following 6 parameters were applied on the basis of the findings obtained from the site investigations and the master plan level study on the existing 12 projects:

(1) Parameter 1 : Deterioration and Problems of Present Project Facilities
(2) Parameter 2 : Effect to the Downstream Area
(3) Parameter 3 : Present Participation in O&M of Projects
(4) Parameter 4 : Present Activities and Performance of Farmers' Organisations
(5) Parameter 5 : Present Farmers' Economy
(6) Parameter 6 : Environmental Effects

Each of these parameters was evaluated by a scoring method. Further explanation of these parameters is given below:

(1) Deterioration and Problems of Present Project Facilities

This parameter was used for evaluation of the need of urgent rehabilitation of project facilities by grasping the extent of deterioration and problems of the following facility groups, and the works and equipment to be required for their rehabilitation.

(a) Dam and reservoir (dam embankment, intake and outlet structures including gates)
(b) Weir, pumping station, pumps including auxiliary equipment
(c) Irrigation network (sprinkler system, canals and canal structures)
(d) Drainage network (drains and related structures)
(e) Farm road network and need of access to main roads
(g) Buildings for O&M of the Project and farming (offices for project and farmers' organisation, garage, repair shop, storage, drying yard, etc.)

The following scoring was applied for each facility group included in this parameter:

Deterioration & Need of Rehabilitation	Score
Very high or no existing facilities	5
High and facilities not functioning	4
Moderate and small rehabilitation	3
Low and minor repair	2
In good condition	1

(2) Effect on Downstream Areas by Additional Use of Available Water

This parameter was used for evaluation for adverse effects on the existing water supply

service schemes or other irrigation schemes located downstream of the Project, due to additional use of available water for irrigation to the expanded area including increase of crop intensity.

The following scoring was applied for this parameter:

Water Availability	Score	Adverse Effects	Score
Much more than Req'ts	5	None or negligible	5
More than Req'ts	4	Very small	4
Equal to Req'ts or so	3	Moderate	3
Less than Req'ts	2	High	2
Much less than Req'ts	1	Very high	1

(3) Present Farmers' Participation in O&M of Projects

This parameter was used to evaluate the present farmers' participation in partial O&M works of the projects and the needs for strengthening of farmers' organisation for proper O&M of the rehabilitated projects by the farmers themselves. This parameter was evaluated mainly on the basis of findings obtained from site investigations and questionnaire survey. The following scoring was applied for this parameter:

Participation in O&M Work	Score
No participation or very limited	3
Partial participation	2
Full participation	1

(4) Present Activities and Performance of Farmers' Organisations

This parameter was used for evaluation of the present activities and performance of the farmers' organisations in each project. At the same time the needs for strengthening of the organisation for achievement of more profitable irrigated agriculture were assessed, using the findings from the questionnaire survey. The scoring applied for this parameter is as follows:

Activities and Performance	Score
Nearly no activity	5
Slightly active and low	4
Moderate	3
Active and good	2
Very active and very good	1

(5) Present Farmers' Economy

This parameter was taken as one of the parameters to evaluate the present farmers' living conditions in the project areas, which will be useful for project evaluation in terms of increase of their living standards by the projects rehabilitation. The following scoring was applied for this parameter:

Present Living Condition	Score
Very poor	5
Poor	4
Moderate	3
Good	2
Very high	1

(6) Environmental Effects

There would be six impacts on the environment and human health: (i) soil erosion in the watersheds, (ii) decrease of wildland, (iii) effects on water quality and ecology due to agricultural intensification, (iv) spread of water-born diseases due to expansion of irrigated land, (v) decrease of firewood forest, and (vi) decrease of grazing areas. Although analysis of data on these effects due to the projects rehabilitation is still under way, this parameter was taken up as one of the main parameters because of its importance. The scoring for this parameter is as follows:

Environmental Effect	Score
None or negligible	5
Very small	4
Moderate	3
Large	2
Very large	1

3.5.2 Result of Evaluation

Details of evaluation and selection of the priority projects from the 12 existing irrigation projects are shown in ANNEX - A of this Report, and summarised as follows:

Parameter	Full Mark	Ashaiman	Weija	Amate	Afife	Aveyime	K.-Torkor	Mankessim	Akumadan	Tanoso	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.

3.5.3 Selection of Priority Projects

As seen in the above table, the highest score (42 points) is given to the Mankessim project, followed by the Okyereko 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 standard in the project area are still low compared with those in other projects. In addition, these projects could be used as models for demonstration of improved irrigation farming in gentle sloping 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, the 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. This project will also have an effect of demonstration of combined cultivation of paddy rice and cash crops in lowland.

As for 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, the 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%. These low score and EIRR are mainly due to the present serious water shortage. However, consideration should be paid to the existence of IDC in this area. As already mentioned, 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 societies 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 proposed for feasibility study.

As a result, the above five projects, Ashaiman, Kpando-Torkor, Aveyime, Mankessim and Okyereko, are proposed for feasibility study.

The Amate project also has a high score (38 points), and its EIRR of 16.9% would be

acceptable, but the main problem is that the access roads, about 50 km, to this project site from both the northern and southern sides are very poor, which will make the construction of rehabilitation works, marketing of farm products and timely supply of farm inputs difficult. Rehabilitation of access roads will be the basic requisite for this project.

The total scores given to the Afife and Bontanga are nearly the same and on the marginal line, but EIRRs of both projects are high, 16.3% and 17.7%, respectively. However, the existing facilities in both projects, particularly the main facilities such dam and main canal, are well maintained. Though some rehabilitation works will be needed, they would be rather small in construction quantity.

The Weija project is given the lowest score of 32, and its EIRR is on the lower line. However, the project is well operated, though some rehabilitation works will be required, and the gross farm income and living standards of the farmers are very high among the projects.

The total scores given to the Akumadan, Tanoso and Subinja projects ranges from 37 points to 39, which are relatively high. However, EIRRs of these projects are low, and the irrigable areas are small in general, ranging from 30 to 70 ha. Under these conditions, a higher effect on rural economy by the increase in agricultural production would not be expected from these projects.

As a result, the above 7 projects are proposed as candidate projects for rehabilitation in the future stage.

Further discussions with GIDA on the priority projects thus selected were made at the official meeting in Ghana, and the above 5 projects proposed by the study team were finally accepted by GIDA. Then, all works during Phase-II were concentrated on the feasibility study of these five priority projects.