JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GHANA IRRIGATION DEVELOPMENT AUTHORITY
THE REPUBLIC OF GHANA

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

Volume II

ANNEXES

MAY 1997

NIPPON KOEI CO., LTD.
TAIYO CONSULTANTS CO., LTD.

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1. INTRODUCTION

1.1 Authority

This Annex presents the results of all works performed in both Ghana and Japan during Phase-I Study, focusing the main activities on preparation of master plan study of all the twelve (12) existing irrigation projects, and evaluation and selection of priority projects, out of 12 projects, for which the feasibility study will be made during Phase-II Study of the Project.

1.2 Study Projects

Location of the 12 existing irrigation projects is illustrated in Location Map. Total potential area of these projects is estimated at 3,445 ha, of which 2,145 ha of land have already been developed (GIDA's information). The irrigated area, the present conditions of the project facilities, problems and constraints to the projects rehabilitation are mentioned in detail in Chapter 2 of this Annex.

1.3 Works performed in Phase-I Study

1.3.1 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 at 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 JICA study team, are mentioned in the Minutes of Meeting for Inception Report attached to this Annex.

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 farmer's 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. The 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 twelve (12) existing irrigation project sites, dividing the study team into six (6) working groups including the counterparts. In the beginning of the investigations, four (4) existing projects located in Guinea savanna and transitional zone, Bontanga, Subinja, Tanoso and Akumadan projects, were visited by all groups for investigations. Based on the experience in the beginning investigations, afterwards, some adjustment of working schedule for each group was made in order to carry out the investigations smoothly, avoiding the overlapping of visits by plural groups at the same time at one project site. Then, the field investigations by all working groups at the remaining eight (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 collection was made at 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. A questionnaire includes the following survey 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 operation and maintenance (O&M) of irrigation facilities
8) Farmers' intention for improvement of farming and farmer's society
9) Farmers' intention for O&M and its handing over to the beneficiaries, etc.

The interview to farmers was carried out by the Agricultural Extension Officers (MOFA), school teachers in the villages, etc. under the supervision by the Team. Total number of samples was 180 samples, and these are selected randomly from 12 project areas. The result of interview survey is presented in Table A-1. The Team reviewed all these data obtained through this survey and used fully for the study on the Interim Report, though it is necessary to implement some additional survey to confirm these data at the next stage.

1.3.2 Works in Japan

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 field investigation in Ghana, in order to make the study on various constraints and problems to reactivation of the existing 12 irrigation projects, as well as to execute the study on the development concept and the master plan level study on rehabilitation of each of the projects which will contribute to the achievement of key policies shown in the MTADP. All the results of Phase-I study works are compiled in this Annex. It is noted, however, that such study results, particularly on the selected priority projects, will be reviewed and finalised on the basis of the subsequent field works in Ghana as well as the office works in Japan during Phase-II study.

The member of study team and counterpart personnel engaged in Phase-I works was as follows :

(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 work)	:	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
Chris BENEE	:	Management and Agricultural Aspects
V.A. BOATENG	:	Meteo-hydrological Study
Kweku SEFA	:	Structure Design and Cost Estimate

2. STUDY PROJECTS

2.1 Location and Administration

Twelve (12) existing irrigation projects are scattered throughout the country (see Location Map). They are one each in Northern Region, Ashanti Region and Eastern Region, two each in Brong-Ahafo Region, Greater Accra and Central Region, and three in Volta Region, and the location of each project in terms of agro-ecology is as follows :

Project	District	Region	Agro-ecological Zone
1. Ashaiman	Tema	GT Accra	Coastal Savannah
2. Weija	GT Accra	GT Accra	Coastal Savannah
3. Amate	Mpreso	Eastern	Transitional Zone
4. Afife	Ketu	Volta	Coastal Savannah
5. Aveyime	North Tongu	Volta	Coastal Savannah
6. Kpando-Torkor	Kpando	Volta	Transitional Zone
7. Mankessim	Mankessim	Central	Coastal Savannah
8. Akumadan	Offinso	Ashanti	Transitional Zone
9. Tanoso	Techiman	Brong-Ahafo	Transitional Zone
10. Bontanga	Trion-Kumungu	Northern	Guinea Savannah
11. Subinja	Wenchi	Brong-Ahafo	Transitional Zone
12. Okyereko	Goma	Central	Coastal Savannah

2.2 Meteo-Hydrology

2.2.1 Climate

The climate in Ghana is characeterised by distinct wet and dry seasons. The mean annual temperature ranges from 26°C near the coast to 29°C in the north with daily variations of 4° - 5°C on an average. In the south, relative humidity exceeds 90% during night time and early morning, but during daytime along the coast it drops on average to 75 % on the southwest and 65 % on the southeast with variation of about 15 % between seasons. Lowest humidity occurs between December and February. In the north, night humidity averages 95 % and drops to about 70 % during daytime between April and October. Annual evaporation ranges from 1,650 mm to 1980 mm in the Savannah areas, while in the wetter areas it is between 1,370 mm and 1,650 mm. Generally, the climate varies with the agro-ecological zones, and the climatic characteristic in each zone is summarised as follows :

In the Guinea Savannah Zone, mean annual rainfall is about 1,100 mm mostly in one season beginning gradually from May and lasting till October with a peak in September. Potential evaporation is between 1,600 mm and 1,800 mm per year and exceeds precipitation during the 6 to 7 dry months. Natural vegetation is low quality savannah and scrub interspersed with hardy trees which survive regular bush fires.

The mean annual rainfall in the Transitional Zone ranges from 1,300 mm to 1,500 mm normally in two seasons between April and October with about 200 to 220 rain days. Potential evaporation is between 1,400 mm and 1,650 mm per year and exceeds rainfall in the five dry months. The vegetation is mainly secondary forests mixed with scrub which are affected by bush fires during the dry months. During the dry months short term crops cannot be grown without irrigation.

The 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. During the 6 to 7 rainy months, rainfall normally exceeds potential evaporation in only about two months. Irrigation could be valuable for crops in this zone.

2.2.2 Data Collection

Meteorological observation is carried out by the synoptic stations under the management of Meteorological Department and also by climatological stations. There are 20 synoptic stations in Ghana. Meteorological data such as rainfall, temperature, relative humidity and sunshine hours are available from these stations for long period. The reliability of the records is also high. Out of 20 stations, nine (9) stations are located relatively near to the projects. They are Accra, Tema, Ada, Koforidua, Saltpond, Tamale, Ho, Wenchi and Akuse stations. The data required for the Study are collected from these stations.

There exist about 100 climatological stations in the whole of Ghana, which observe rainfall in the main. However, some of them are not working well, and observation period is also short in general. In addition, the reliability of the records available from these stations is not so high. Therefore, careful attention should be paid, when the data from these stations are used for the study.

The observation of rainfall is being carried out also in Weija and Tanoso project areas. In addition, meteorological data are collected from the agricultural research stations located near Akumadan and Bontanga projects. The meteorological data collected and used for the projects study are summarised in Table A-2.

The Architectural and Engineering Service Corporation (AESC) has a hydrological section which observes river discharge and/or water level in the main river basins of Ghana. Some of the main river basins such as Tano, Ayensu and Ochi-Amisa basins, which are related to Tanoso, Akumadan, Okyereko and Mankessim projects, have hydrological observation stations, and available records are collected for the study. Since Ashaiman project is carrying out the daily observation of water level of the reservoir from the year 1992, such data are also collected for the study. Useful hydrological data for the remaining eight (8) projects are actually not available. Then, staff gages are newly installed to observe the water level in the rivers which are water sources for Afife, Aveyime, Akumadan, Tanoso, Bontanga and Subinja projects. In addition, V-notch weirs are installed on the rivers related to Akumadan project in order to measure the river discharge, because high water shortage is foreseen in the Akumadan watershed. Hydrological data collected are fully used for the study.

2.2.3 Rainfall Analysis

It is said that tendency of arid climate continues since 1983 when the whole of Ghana has had serious droughts. On the basis of rainfall records collected from the synoptic stations located near the projects, analysis of annual rainfall with 2-year return period at each station is made as shown below :

Project	Synoptic Station	Agroecological Zone	Annual Rainfall		
			Data Period		Proportion
			1960-1979	1980 to Date	%
Ashaiman	Tema	Coastal	773	588	76
Weija	Accra	Coastal	844	661	78
Amate	Koforidua	Transitional	1,384	1,323	96
Afife	Ada	Coastal	875	744	85
Aveyime	Akuse	Coastal	1,175	1,155	98
Kpando-Torkor	Ho	Transitional	1,359	1,286	95
Mankessim	Saltpond	Coastal	1,100	906	82
Akumadan	Saltpond	Transitional	1,217	1,220	100
Tanoso	Wenchi	Transitional	1,217	1,220	100
Bontanga	Tamale	Northern	1,107	1,055	95
Subinja	Wenchi	Transitional	1,217	1,220	100
Okyereko	Saltpond	Coastal	1,100	906	82

As seen in the above table, there is a tendency that rainfall is decreasing in recent 15 years at the stations located mostly in the coastal savannah area, particularly Ashaiman, Weija, Afife and Mankessim areas.

2.2.4 River Runoff Study

(1) River System

Ghana has five (5) main river basins, namely the Volta, Pra, Tano, Ankobra and the Coastal basins. The Volta river system is the dominant river basin which includes neighbouring countries such as Cote d'Ivoire, Togo and Burkina Faso. It occupies about 70 % of the country. The Volta basin is composed of big rivers such as White Volta, Black Volta, Ochi, Pru and so on. The second largest basin is the Pra basin which occupies 12 % of the country and followed by the coastal basin, the Tano and the Ankobra basin.

Most of the rivers have very gentle slopes and winding courses. In general, hydrological conditions of the river basin give moderate floods. Occasionally, however, very serious floods occur in some part of the country owing to drainage problem such as influence of back water of the main drain or sea. In addition, low or null discharge is observed in most small rivers in the dry season.

The water sources of the projects are as follows :

Project	River Basin	Water Source	Catchment Area (km2)
Ashaiman	Coastal	Gyorwulu river	82.4
Weija	Coastal, Densu	Weija lake	-
Amate	Volta	Volta lake	-
Afife	Coastal	Kplikapa and Agali rivers	334.0 and 54.9
Aveyime	Volta	Volta river	-
Kpando-Torkor	Volta	Volta lake	-
Mankessim	Coastal, Ochi-Amisa	Aprapon river	57.3
Akumadan	Tano	Acheche river	9.3
Tanoso	Tano	Tano river	224.9
Bontanga	Volta, White Volta	Bontanga river	165.0
Subinja	Volta, Black Volta	Subin river	188.1
Okyereko	Coastal, Ayence	Okyereko river	17.6

(2) Runoff Analysis

In order to estimate the available water for irrigation, analysis of the river runoff data is made for eight (8) projects such as Ashaiman, Afife, Mankessim, Akumadan, Tanoso, Bontanga, Subinja and Okyereko which may have water shortage problem.

Two (2) analysis methods are used to estimate the river runoff; one is the Tank Model method as shown in Figure A-1, and the other is the method prepared by the Water Resource Research Unit (WRRU) of Ghana. The tank model method is used for seven (7) projects, except Bontanga project for which the method prepared by the WRRU is used.

Three (3) types of tank models are prepared. The first one is based on a model developed for Ashaiman project, which is made by using the relationship between daily rainfall data observed at Ashaiman and runoff estimated from daily records of the reservoir water level. This type of tank model is used for two (2) projects, Ashaiman and Okyereko. The second type is based on a model developed for Afife project, which is prepared by using the relationship between monthly rainfall and runoff from the Kplikapa river. This type is adopted for two (2) projects such as Afife and Mankessim. The last one is developed for Tanoso project, using

relationship between monthly rainfall and runoff from the Tano river, and used for three (3) projects such as Tanoso, Akumadan and Subinja. The calibration results of tank model are given in Figure A-2. The method of WRRU is as follows :

$$Q = E + PF + GR$$

where,

Q	:	Monthly runoff (mm)
P	:	Monthly rainfall (mm)
R	:	Previous monthly rainfall (mm)
E,P,G	:	Coefficient

This method is adopted for Bontanga project. The coefficients are given in the report related to the Yeliyiri-ladayiri irrigation scheme located in the Black Volta basin, and are used for this study.

The runoff analysis is made for 10 years, and the results are summarised as follows :

Project	Rainfall (mm/year)	Runoff (mm/year)	Runoff Coefficient (%)
Ashaiman	583.7	19.7	3.4
Afife	814	83.8	10.3
Mankessim	894.9	96.3	10.8
Okyereko	894.9	46.1	5.2
Akumadan	1277.4	222.3	17.4
Tanoso	1277.4	188.4	14.7
Subinja	1277.4	188.4	14.7
Bontanga	1069.8	172.6	16.1

Since Okyereko project has a plan to supplement water to the existing reservoir from the Ayensu river located near the project, frequency analysis of Ayensu river discharge is made on the basis of the discharge records observed during the period from 1962 to 1982. The estimated discharges with 10-year non-exceeding period are summarised as follows :

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Discharge (m3/s)	0.65	0.69	2.01	10.4	2.01	10.4	4.58	1.36	1.41	2.24	2.36	1.35

The results of runoff analysis are fully used for water balance study to estimate the available amount of water for irrigation to the projects.

(3) Flood Discharge

Since Mankessim and Weija projects have a drainage problem caused by the rivers located near the projects, analysis of flood discharges is made on the Ochi-Amisa river and the Gyegyereku river, respectively. The method of analysis is as follows :

(a) Unit Graph method is used for the analysis.
(b) Unit Graph is prepared by using the Sato formula.
(c) Design rainfall is estimated for 3-day rainfall by using the Hyetograph method.
(d) Effective rainfall is estimated from four years records in the Ochi-Amisa river.

The results of the analysis which are graphed in Figure A-3, are summarised as follows :

1) Flood Discharge in Ochi-Amisa River (Catchment Area = 1,217 km^2)

Return Period	3-Day Rainfall (mm)	Flood Discharge (m3/s)
5-year	162	215
10-year	183	255
25-year	206	355
50-year	222	380

2) Flood Discharge in Gyegyereku River (Catchment Area = 93.5 km^2)

Return Period	3-Day Rainfall (mm)	Flood Discharge (m3/s)
5-year	140	38
10-year	172	47
25-year	216	80
50-year	253	98

2.3 Soil and Land Suitability

2.3.1 Soils

(1) Soil Classification

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. The laboratory test was carried out by the Department of Soil Science, the University of Ghana.

Based on the field survey, soils are classified into soil units according to the legend of "Soil Map of the World" produced by FAO/UNESCO (1988). The results of the soil classification for each project are summarised as follows :

	Project	FAO/UNESCO Classification
1.	Ashaiman	Dystric Planosols, Cambic Arenosols, Gleyic Cambisols, Dystric Vertisols
2.	Weija	Dystric Regosols, Dystric Planosols, Dystric Arenosols, Gleyic Cambisols
3.	Amate	Ferralic Arenosols, Skeletic-Chromic Cambisols*1, Cambic Arenosols
4.	Afife	Dystric Cambisols, Vertic Cambisols, Dystric Vertisols
5.	Aveyime <1	Ferralic Arenosols, Dystric Cambisols, Gleyic Cambisols
6.	Kpando-T	Skeletic- Humic Cambisols*1, Skeletic- Chromic Cambisols, Humic/ Vertic Cambisols, Humic Fluvisols, Humic Cambisols (Cambic Arenosols), Skeletic-Eutric Gleysols
7.	Mankessim	Skeletic-Haplic Acrisols*1, Eutric Gleysols, Haplic Luvisols, Chromic Luvisols, Gleyic Cambisols,
8.	Akumadan	Skeletic- Ferric Acrisols*1, Cambic Arenosols, Ferric Acrisols
9.	Tanoso	Petroferric-Eutric Leptosols*2, Skeletic- Ferric Acrisols*1, Ferric Acrisols
10.	Bontanga	Dystric Plinthosols, Gleyic Cambisols, Dystric Gleysols, Dystric Cambisols
11.	Subinja	Petroferric-Eutric Leptosols*2, Skeletic- Ferric Acrisols*1, Ferric Acrisols, Cambic Arenosols
12.	Okyereko	Skeletic-Haplic Alisols, Cambic Arenosols, Haplic Alisols, Dystric Cambisols, Gleyic Cambisols

Remarks: *1 "Skeletic" indicates the occurrence of accumulated layer of oxidic concretions or iron-stones, with a thickness of at least 25 cm.
*2 "Petroferric" indicates the occurrence of iron pan layer.
<1 In the Weija and Aveyime projects, the soil survey was carried out only about the existing developed area.

(2) Mapping Unit Description

The lands (soils) for each project are comprehensively classified based on the result of soil classification in consideration of the physiography, topography, texture, soil depth, and drainage condition, as the mapping units. Due to the lack of information such as accurate topographic maps and soil maps of the projects and time limitation, the soil maps are prepared at a reconnaissance to semi-detailed survey level. Especially, since no relation map is available in Amate project, the soil map is not prepared. The description of each mapping unit for the projects is presented in Table A-3, and the soil maps for each project are shown in Figures A-4 to A-14. The physical and chemical properties of each soil unit are presented in Table A-4.

2.3.2 Irrigation Suitability Evaluation

(1) Evaluation System

The irrigation suitability of each project area is assessed according to the USBR (US. Bureau of Reclamation) system, and the land is categorised into the following six (6) suitability classes in this system :

Suitable	: S1, S2 and S3
Restrictedly suitable	: S4
Non-suitable	: NS1, NS2

The land evaluation is made for each mapping unit (land unit) taking into consideration the following land qualities :

Soils	: Effective depth, texture
Topography	: Slope
Drainage condition	

The project areas could be classified into two (2) development types, i.e. upland crops (vegetables) development and wetland rice development. Therefore, the land evaluation is also made according to each development type, putting emphasis on the qualitative evaluation of each project area at this stage.

Project	Land Evaluation Type
1. Ashaiman	Wetland rice and upland crops
2. Weija	Wetland rice and upland crops
3. Amate	Upland crops
4. Aveyime	Wetland rice and upland crops
5. Afife	Wetland rice and upland crops
6. Kpando-Torkor	Wetland rice and upland crops
7. Mankessim	Wetland rice and upland crops
8. Akumadan	Upland crops
9. Tanoso	Upland crops
10. Bontanga	Wetland rice and upland crops
11. Subinja	Wetland rice and upland crops
12. Okyereko	Wetland rice and upland crops

(2) Result of Land Evaluation

The distributions of suitability classes of the project areas are shown in Table A-5, and summarised as follows :

1) For Wetland Paddy

Project	Suitable		Restricted 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		Restricted 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.

In Ashaiman, Weija, Aveyime, Afife, Bontanga and Okyereko projects, the existing land uses are applicable, and it is estimated that the soils of these areas are suitable for intensive farming under the proper irrigation and drainage works.

A significant area in Kpando-Torkor, Mankessim, Akumadan, Tanoso, and Subinja projects, is classified into the restricted suitable (Class S4) or into the non-suitable (NS), due to undulating topography and the existence of the accumulated layer of iron concretions or gravel within the shallow depth. Once the accumulated layer of iron concretions is exposed to repeated wetting and drying by the erosion of surface soil, the soils change irreversibly to iron hardpan. In fact, the abandoned fields by this cause are observed in Tanoso project area. Most of these areas are presently used for the cultivated land under rainfed condition or under sprinkler irrigation system. Although the sprinkler irrigation system is considered as an effective system to reduce soil erosion, the certain land conservation practices should be taken for the sustainable development. The significant attention needs to be paid for the land use planning at the development stage in these project areas.

(2) Others (Salt-effected soils)

In the project areas of Ashaiman, Weija, Afife and Okyereko, the salt effected soils have been reported in some reports and by the farmers. Based on the existing report and the field observation, the salt effected soils in each project area could be summarised as follows :

Project	Salt Type	Main Cause	Suspected Area*
1. Ashaiman	Sodic	Long term accumulation of Na, due to poor drainage ? but irrigation water is at suitable level for irrigation.	12 ha
2. Weija	Sodic or saline	Existing natric B horizon ?	10 ha
3. Afife	Sodic	Inclusion of brackish water into groundwater ,or into the field ?	142 ha
4. Okyereko	Saline or sodic	Accumulation of soluble salt from fertiliser, due to poor drainage ?	8 ha

Remarks: * : The suspected area is estimated based on the results of farmers' interview. Hence, the figures are different with the ones of the mapping unit classification.

At present, the salt-effected area has been expanding year by year according to the farmers and project staff observation. Since these salt-effected soils have been resulted from poor drainage condition, however, it is supposed that the expansion of the salt-effected area could be reduced under proper drainage works, and the present salt-effected areas will be improved by leaching of water.

2.3.3 Land Management Plan

The constraints of soils to more profitable agriculture in the project areas are mainly low fertility, shallow effective depth, and salinity condition. The proper and careful land management is essential for the improvement of these conditions as well as for prevention of the future soil degradation. Since the areas in Kpando-Torkor, Mankessim, Akumadan, Tanoso and Subinja projects have a high potentiality of soil degradation, in particular, the certain land conservation measures should be adopted.

The main objective of the land management plan is to attain the sustainable development and the proposed crop yield under appropriate application of agricultural inputs. Therefore, the main works in the management plan are to improve and maintain the soil fertility, and to conserve the surface soil.

(1) Soil Improvement

The following effects are expected through the soil fertility improvement :

(a) Construction of suitable aggregate structure
(b) High water retention capacity
(c) High nutrient contents
(d) Ecological diversification of micro-ecological condition in the root area

These effects would result in the suitable crop yields, high tolerance to soil erosion, and tolerance to soil related diseases. The ways of soil fertility improvement are to apply the following management :

(a) Introduction of the leguminous crops in the fallow season
(b) Introduction of appropriate crop rotation system
(c) Application of animal excretion and crop residues

(2) Soil Degradation

To avoid the future soil degradation such as soil erosion and soil salinisation, proper agronomic management needs to be taken at the farm. As mentioned above, the effective soil depth is too shallow in some project areas. Therefore, the mulching cultivation through introduction of cover crops in the fallow season is recommended to be adopted in each cropping season. Besides, the following measures are considered as the effective erosion control measures in the projects (The detailed information of the soil erosion control is presented in Sub-section 3.7 and Table A-36).

(a) Contour farming
(b) Contour hedgerow (strip cropping)
(c) Agro-forestry system

2.4 Present Agriculture

Potential and developed areas in each of the 12 projects have been examined based on the available drawings and site inspection. The results are as follows :

Project	GIDA's Information		Examination Results		Lowland	Upland
	Potential Area	Developed Area	Potential Area	Developed Area	(ha)	(ha)
Ashaiman	155 ha	135 ha	148 ha	130 ha	130	-
Weija	220 ha	220 ha	220 ha	220 ha	112	108
Amate	300 ha	100 ha	203 ha	101 ha	-	101
Afife	880 ha	880 ha	880 ha	880 ha	880	-
Aveyime	280 ha	60 ha	150 ha	63 ha	63	-
Kpando-Torkor	400 ha	40 ha	356 ha	40 ha	-	40
Mankessim	320 ha	20 ha	256 ha	17 ha	-	17
Akumadan	150 ha	80 ha	65 ha	65 ha	-	65
Tanoso	130 ha	60 ha	115 ha	64 ha	-	64
Bontanga	450 ha	450 ha	450 ha	450 ha	250	200
Subinja	60 ha	60 ha	121 ha	60 ha	-	60
Okyereko	100 ha	40 ha	111 ha	40 ha	40	-
Total	3,445 ha	2,145 ha	3,075 ha	2,130 ha	1,475	655

Most of lowland is used for cultivation of rice with gravity irrigation from the reservoirs, except for Weija and Aveyime projects which are served by pump irrigation. In upland, vegetables such as okra, tomato, onion, pepper, egg plant, etc. are cultivated by sprinkler irrigation because of undulating topography.

As can be seen in this table, there is not much difference between the GIDA's information and the examination results, although potential area informed by GIDA is about 10 % larger than the examined one.

Most of the projects have not been fully developed as originally planned, mainly due to financial constraint. In some projects such as Amate, Kpando-Torkor, Subinja and Okyereko projects, actually irrigated areas in recent years were further less than the developed areas because of lowering of pump efficiency and deterioration of pipeline and sprinkler systems. The actually irrigated areas in these projects are reported to be 81 ha in Amate, 13 ha in Kpando-Torkor, 13 ha in Subinja and 22 ha in Okyereko, respectively. In Aveyime project, no irrigation was compelled in 1995 due to totally damaged pumps and much water leakage from canals.

2.4.1 Main Crops

The main crops being grown under irrigated farming in each project are as follows :

Site	Lowland Area	Upland Area
1. Ashaiman	Rice (rs), Okra (ds)	-
2. Weija	Rice (rs & ds)	Okra, Tomato, Tinda, Cluster bean Long marrow, Round marrow, Pepper Sweet potato, Maize (all season)
3. Amate	-	Tomato (ds), Onion, Pepper (rs)
4. Afife	Rice (rs, ds)	-
5. Aveyime	Rice (rs, ds)	-
6. Kpando-Torkor	-	Okra (ds)
7. Mankessim	-	Watermelon, Egg plant (ds), Sweet potato (rs)
8. Akumadan	-	Tomato (ds), Maize (ws,ds)
9. Tanoso	-	Tomato (ds), Maize, Cowpea (rs)
10. Bontanga	Rice (rs, ds)	Okra,Tomato, Egg plant, Onion (ds)
11. Subinja	-	Egg plant, Pepper (ds), Maize, Cowpea (rs, ds)
12. Okyereko	Rice (ds)	-

rs : rainy season ds : dry season

Twenty four (24) crop species are planted in the 12 project areas, which are four (4) cereals, one root crop, two (2) legume and nut, and 17 vegetables crops. They are as follows :

1. Cereals :	
Rice	ITA 222, ITA304, IRRI2372, DS3, GK9, GK49, GK88, GR18, GR19, GRUG7, GRA1
Maize	Obatampa, Akomasa, Dorka
Sorgum	Local variety
Millet (Pearl millet)	Local variety
2. Root crop :	
Cassava	Local variety
3. Legume and nut :	
Cowpea	Asontem, Black eye, Ayiyi
Groundnut	Chinese
4. Vegetable :	
Tomato	Demah, Lorano50, Lorano70, Rinu, Power (=Rakky), Champion
Egg plant	Local variety, White beauty, Black beauty, Long purple
Pepper	Long finger, MI2, Local variety
Sweet pepper	California wonder, Yolo wonder
Aromatic pepper	Local variety
Okra	Lady finger, Labadi, Labadi dwarf, Lolobi, Local variety
Onion	Bauku red, Red creole
Watermelon	Sugar baby
Cucumber	Local variety
Long marrow	Introduced from India
Round marrow	Introduced from India
Sponge gourd	Introduced from India
Tinda	Introduced from India
Cluster bean	Introduced from India
Yard long bean	"Asparagus type"
Sweet potato	Local variety (white), Introduced from the Univ. of Ghana
Cabbage	KK cross, Auxilus

Although most of crops cultivated in the project areas are traditional ones, some Asian vegetables like long marrow, round marrow, sponge gourd, tinda and cluster bean are grown for export in Weija project. Crop varieties of paddy rice are those developed by IITA and IRRI, and the Crop Research Institute (CRI) in Kumasi. Maize and cowpea varieties are also developed by CRI. The tomato varieties of Italian origin and some developed by CRI are popularly grown in most of the projects. Local varieties are rather popular in okra and onion.

2.4.2 Cropping Patterns, Farming Practices and Agricultural Production

(1) Present Land Use

The present land use in each of the projects is shown in Figures A-15 to A-26. As seen in these figures, there are seasonal variations in land use among the projects, which depend on the field conditions, crops planted and water availability. The average cropping intensity in recent years is summarised as follows :

Land Use Season	Low Land Use (0-30%)	Medium Land Use (40-60%)	High Land Use (70-100%)
1. Mainly dry season	Kpando (0.33)		Okyereko (0.54) Bontanga (1.02) Mankessim (1.02)
2. Mainly rainy season	Ashaiman (0.46)	Afife (0.76)	Tanoso (1.3)
3. Both rainy & dry seasons		Amate (0.85) Subinja (0.87) Aveyime (1.0)	Weija (1.3) Akumadan (1.65)

Note : Figures shown in parenthesis mean average cropping intensity.

It is pointed out that the present land use of the project areas is generally low, particularly during the rainy season. According to the project managers, the reason for such a low land use ratio in the rainy season is due to the fact that most of the farmers wish to take care of crops grown in their farms located outside the projects.

(2) Cropping Pattern

There exists definite crop rotation pattern in most of the projects. In lowland, three (3) patterns are identified, and the basic pattern is paddy rice (dry season) - paddy rice (rainy season) and okra (dry season) - paddy rice (rainy season). In upland, two (2) patterns are observed, and the basic pattern is vegetables (dry season) - maize and cowpea (rainy season) - okra or tomato (dry season) - fallow (rainy season).

Some crops like tomato, egg plant and pepper are well known by the farmers as the crop that has low tolerance to the damages due to continuous cropping. Okra is also recognised as one of those crops because of soil born-disease. In case of Weija project where sprinkler irrigation system is available, however, many varieties of vegetables with short growing period mostly for export are planted two to three times a year. Therefore, continuous cultivation throughout the year would be possible without any definite rotation pattern.

The present crop rotation patterns in both lowland and upland are summarised as follows (for details, see Table A-6) :

Field Condition	Land Use Season	Rotation Pattern
(a) Lowland	dry and wet season	Rice (ds) --- Rice (rs) Rice (rs) --- Okra (ds)
(b) Lowland	dry season only	Rice (ds) --- Rice (ds) Rice (ds) --- Okra (ds)
(c) Lowland	wet season only	Rice (rs) --- Rice (rs)
(d) Upland	dry and wet season	Vegetable (ds) --- Maize & Cowpea (rs) --- Vegetable (ds) (Vegetable : Okra, Onion, Tomato, Pepper) Watermelon (ds) --- Sweet potato (wr)
(e) Upland	dry season only	Okra (ds) --- no crop (ds) --- no crop (ds) --- Okra (ds) Tomato (ds) -- no crop (ds) --- Onion (ds) --- no crop (ds) --- Tomato (ds)
(f) Upland	all season	Continuous cropping

rs : rainy season ds : dry season

(3) Farming Practices

Land preparation in lowland area is usually done by tractor (Ashaiman, Aveyime, Afife and Bontanga areas) and power tiller (Ashaiman and Weija areas). The tractor is also used for land preparation in upland area (Weija, Amate, Kpando, Bontanga and Subinja areas). In Akumadan and Tanoso areas, manpower is mainly used, because no tractor is available at present. Seeding, transplanting, ridging, fertilizing, weeding and harvesting are usually done by manpower.

(4) Crop Yield

Cultivated area, crop yield and production in the project areas are given in Table A-7. These data are available for recent three to four years in most of the projects. Average yield of crops being grown with irrigation in the project areas is summarized as follows :

Crop*1	Average Yield (ton/ha)	Range (max.- min.)*2 (ton/ha)
Paddy rice	4.5	5.7 - 3.1
Maize	2.6	5.8 - 1.2
Cowpea	1.5	2.0 - 0.7
Groundnuts	1.4	1.6 - 1.2
Tomato	8.2	23.0 - 2.0
Egg plant	12.8	28.0 - 2.0
Pepper	0.9	1.0 - 0.8
Okra	7.9	14.0 - 6.0
Onion	14.5	25.0 - 5.0
Watermelon	11.8	18.0 - 7.0
Tinda	14.6	22.1 - 6.0
Cluster bean	6.2	7.7 - 4.9
Roundmarrow	25.6	25.7 - 25.6

*1 Crops grown in the irrigated area
*2 Source: Farm interview survey and field investigation by the Study Team.

2.4.3 Use of Farm Inputs

(1) Fertiliser

The 15-15-15 compound fertiliser is commonly used by the farmers in the project areas. The 20-2-0 compound is also used, when the 15-15-15 compound is not available in the local markets. Urea is used for paddy rice, while sulfate of ammonia (SA) is popular in cultivation of upland crops. The amount of fertiliser and the number of split application vary with crop species. High rates are applied for paddy rice. Medium application rates are seen in cultivation of maize and most of vegetables. The present rates of application of fertiliser are generally low probably because of higher prices of fertiliser as compared with those of agricultural products. The use of 20-20-0 compound is not appropriate, because potassium is an essential element for increase in crop yield. Organic manure is not used at present in most of the projects, which is very important for increase of soil fertility and productivity as well as for sustainable crop production. The following shows the level of nitrogen application and split application being practiced in the project areas :

High rate (N: 90-100 kg/ha)	For paddy rice
Medium rate (N: 50-70 kg/ha)	Maize, Tomato, Egg plant, Pepper, Onion, Okra Watermelon
Low rate (N: 15 kg/ha)	Tinda
No fertilisation	Cowpea, Groundnut, Cluster bean, Cassava
3 - 4 times splitting	Rice
2 - 3 times splitting	Egg plant, Pepper, Okra, Watermelon
2 times splitting	Maize, Tomato
1 - 2 times splitting	Onion, Tinda

(2) Agro-chemicals

The following are serious diseases and insect pest which attack various crops at each project site. For rice plant, blast and stem borer are very common disease and pest. Stem borer is also common pest for maize. Caterpillars give serious damages to okra plant.

Crop	Serious Disease
Rice	Brast, False smut, Brown leaf spot
Maize	Streak, Leaf spot
Cowpea & Groundnut	Root rot
Tomato	Nematode, Fusarium wilt, Early leaf blight, Bacterial wilt, (many serious diseases)
Egg plant	Fusarium wilt, Cercospora leaf spot, Leaf curl
Pepper	Fusalium wilt
Okra	Nematode, Fusarium wilt, "Soil born disease"
Onion	Downy mildew, Fruit rot
Tinda, Sweet potato	no

Crop	Serious Insect Pest
Rice	Stem borer, Rice hispa, Case worm, Leaf roller, Leaf eater
Maize	Stem borer, Caterpillars, Army worm, Weevil, Termites
Cowpea & Groundnut	Weevil, Caterpillars, Grass hopper
Tomato	Aphid, Grass hopper, Boll worm, Army worm
Egg plant & Pepper	Aphid, Caterpillars
Okra	Caterpillars, Aphid, Poudadrica, Fly beetles
Onion	Thrips, Grass hopper, Cricket
Sweet potato	Poudadrica
Watermelon	Lady bird beetle, Poudrica
Tinda & Cluster bean	Lady bird beetle, Fruit borer, Caterpillars

In addition, the major animal damages are caused by grass cutter (big rat), mice (small rat), squirrel and toad. Grass cutter gives damages to maize, cowpea, groundnut and cassava, while mice attacks rice, maize, tomato, egg plant and sweet potato. Squirrel attacks young fruits of watermelon in Mankessim area, and toad (a kind of frog) attacks okra seed in soil in Kpando. Wild birds reduce yield of cereal crops. Rice is attacked by "Quelea Quelea", weaver bird, and sparrow. Maize is also damaged by weaver bird. Partridge, another wild bird gives damages to maize and cowpea.

The following is a summary of agro-chemicals such as fungicide, insecticide, herbicide and rodenticide being used in the project areas in order to reduce the crop damages due to serious diseases, insect pests, weed grass, grass cutters and mice. The present rate of application of agro-chemicals seems to be not so high because of higher prices of agro-chemicals. Hand weeding to clean farmland is one of effective methods for minimising plant diseases and pest proliferation.

Fungicides

(a) Kind of fungicide	Dithine M45, Topsin, Kocide, Fuji One, Champion
(b) Amount of application	
Heavy dose	Tomato
Medium dose	Egg plant, Onion, Watermelon
Small dose	Rice, Okra, Pepper, Tinda, Cluster bean
no application	Maize, Cowpea, Groundnut, Sweet potato

Insecticides

(a) Kind of insecticide	Karate 2.5E, Furdan, Diazinon, Attellic, Symbush
(b) Amount of application	

Heavy dose	Tomato, Okra, Egg plant, Pepper
Medium dose	Cowpea, Groundnut, Onion, Rice, Watermelon
Small dose	Maize
no application	Sweet potato

Herbicides

(a) Kind of herbicide	Basagram PL2, Satunil, Arrosolo 3-3E, Ronster
(b) Frequency of application	
Frequent	Rice
no application	Maize, Cowpea, Groundnut, Tomato, Egg plant, Okra, Pepper, Onion, Tinda, Cluster bean, Sweet potato, Watermelon

Rodenticides

(a) Kind of rodenticide	Yosodion, Warabin
(b) Frequency of application	
Frequent	Rice
In frequent	Tomato, Pepper, Okra, Tinda
no application	Maize, Cowpea, Groundnut, Egg plant, Onion, Cluster bean, Sweet potato, Watermelon

2.4.4 Animal Husbandry and Fish Pond

Animal husbandry is important not only for supplying protein food to local people, but also for source of organic manure at the project site. Trials of using chicken and cattle wastes for vegetable production is started already in Ashaiman and Weija areas.

Many cattle is found in Weija and Bontanga areas, but a few in Afife, Aveyime, Akumadan, Tanoso and Subinja projects. Many goat and sheep are very popular livestock and raised in Weija, Mankessim, Akumadan, Tanoso, Subinja and Bontanga. Chicken is most popular poultry. Guinea fowl is well adapted poultry in Guinea Savannah and Transitional Zone. Many guinea fowl is found in Amate and Bontanga. Duck and turkey are rather seldom. In general, animal husbandry is very popular in inland area, but not so popular in coastal area and Volta Lake area. Sea fishery is popular in coastal area, and inland fishery is popular in the areas facing the Volta Lake.

Fish pond is constructed in Ashaiman (0.8 ha), Afife (5 ha) and Bontanga (8 ha) projects. Fish species being raised are Tilapia and mud fish in Ashaiman, Tilapia and Clarias in Afife. In Bontanga, Tilapia spp. Clarias spp., Alestes spp., Bagrus spp., Auchenoglanis, Mormyridae, Heterotis spp., Hemichromis, Citharinus citarinus, Lates niloticus were reported in the fish pond and the reservoir. They are very similar fish species in the White Volta River (information from Fishery Department, Regional Office, Tamale, Northern Region).

2.4.5 Marketing, Processing and Storage

(1) Marketing

Most agricultural marketing at the project sites is conducted by small-scale operators. The principal agents are women coming from major cities and those who bring agricultural output and food products by headload to rural markets. The rural markets exist in most of the villages and are opened daily or every three to four days depending on crop season and the volume of goods to be traded. Most of food crops are traded in a form of raw material, except for cassava which is graded by hand grading machine or dried chips made by hand-chipper and dried under the sun. Rice is generally sold in a form of paddy to the middlemen or market women who are visiting individual farmers at the drying yards.

Selling of farm products to market mammies at the project gate is also popular in most of the project areas. In Afife and Bontanga areas, rice is sold directly to market mammies at drying floor. Market mammies from Kumasi and Accra buy dry season tomato from farmers in

Tanoso and dry season onion in Bontanga. In Mankessim area, watermelon is sold to market mammies at the project gate who are coming from Accra, Cape Coast and Sekondi. In Kpando-Torkor area, dry season okra is also sold directly to market mammies from Ho, Tema and Accra. Farmer's gate sell is usually made, when enough space for storage of farm products is not available at the project site, especially at the sites where maize is cultivated. In case of selling to local markets, farm products are transported by GIDA track in Mankessim, when market mammies do not come to buy their egg plant at the site.

In Weija area, exporters who are farmers engaged in farming in the project area collect the products of Asian vegetables like tinda, cluster bean, round marrow, long marrow, sponge gourd, and export directly to the Asian and Indian communities in London by air cargo from Accra International Airport.

(2) Post-harvest, Processing and Storage Facility

Regarding the processing facilities of farm products, there are no rice mills in the project areas as the project facility, except Ashaiman area. There are three (3) private rice mills with a very limited milling capacity in each of Weija, Aveyime and Afife areas. However, Bontanga and Okyereko projects where rice is grown have no rice mills.

Each project has warehouse and storage with a limited storage capacity to meet an immediate need to store agricultural inputs and equipment. Most of agricultural products are stored in the farmers' house. There are no special storage such as granary in the project areas. Although marketing and processing facilities are nearly sufficient for the present production, improvement of processing and storage facilities will be required for control of prices of farm products according to the market situations as well as for more farm income by the farmers.

2.4.6 Prices of Farm Products and Inputs

(1) Fluctuation of Market Price

The prices of farm products vary with the kind of crops, location of markets and cropping season, and fluctuate even in a week. The following table shows an example of monthly and seasonal fluctuation of the wholesale market prices of some farm products in Bontanga (northern area) and Tanoso (transitional zone) areas in 1994.

Month	Maize		Rice		Tomato		G'nuts	
	Bontanga	Tanoso	Bontanga	Tanoso	Bontanga	Tanoso	Bontanga	Tanoso
Jan.	8.0	9.2	20.0	19.7	3.0	3.2	23.0	28.8
Feb.	10.5	8.9	21.4	20.0	3.2	5.4	26.0	22.1
Mar.	10.0	10.0	21.0	20.0	10.5	5.6	32.0	31.5
Apr.	10.4	11.6	24.5	20.0	20.0	10.2	30.0	30.8
May	11.9	11.2	24.0	20.0	24.0	9.3	29.3	31.5
Jun.	12.0	9.8	28.0	21.2	20.0	15.1	30.0	32.8
Jul.	11.8	11.0	26.7	26.0	16.0	11.9	33.0	41.2
Aug.	14.5	6.9	28.0	32.0	12.0	5.7	30.0	31.6
Sept.	12.0	5.1	30.0	32.0	8.5	4.6	30.0	24.2
Oct.	10.2	5.7	46.0	32.0	12.5	5.0	28.0	22.0
Nov.	8.0	7.2	20.0	32.0	12.0	5.8	21.7	24.0
Dec.	8.0	8.0	19.8	32.0	11.0	18.2	21.0	25.0

Note: Figures shown in this table are expressed in 1,000 Cedis.
Sales units are 100 kg for maize and rice, 52 kg for tomato and 82 kg for groundnuts.

Generally, the market prices of farm products vary with three (3) seasons, namely off-crop season, pre-harvest season and harvest season. The prices during the off-crop season are the highest and followed by those during the pre-harvest and harvest seasons. Since the period from May to October in Bontanga and from April and August in Tanoso is the growing season

of maize, the market prices during a such season are high as compared with those in the harvest season

On the other hand, there was not much difference in the market price of milled rice in Bontanga. This tendency may be due to the availability of imported rice, because Bontanga is located near Tamale, the capital of Northern Region.

(2) Price of Farm Products

The farm gate prices of selected farm products in each of the project areas in the year of 1994/95 are shown in the following table. The farm gate prices of crops vary largely depending on the quality of products and the demand and supply of the market.

(Unit: Cedi/kg)

Project	Paddy	Maize	Onion	Tomato	Okra
Ashaiman	390	180	-	-	298
Weija	350	-	-	200	200
Amate	-	240	650	380	-
Afife	365	280	-	-	500
Aveyime	-	300	-	-	-
Kpando-Torkor	-	280	-	-	500
Mankessim	-	260	-	110	300
Akumadan	-	190	-	480	-
Tanoso	-	250	-	480	-
Bontanga	290	250	180	125	150
Subinja	-	150	-	350	270
Okyereko	480	230	-	200	-

Source: Field investigation and farm interview survey by the Study Team.

(3) Price of Fertiliser

The project gate prices of fertilisers in 1994/95 are as follows :

Project	15-15-15	20-20-20	15-15	A.Sulphate	Urea
Ashaiman	23,500	-	-	17,500	-
Weija	22,500	22,500	-	22,400	25,000
Anate	25,000	-	-	20,000	16,000
Afife	27,000	-	-	20,000	26,000
Aveyime	30,000	23,500	-	20,000	26,000
Kpando	26,000	-	-	26,000	-
Mankessim	22,500	-	-	15,000	-
Akumadan	25,000	24,000	-	17,000	29,000
Tanoso	25,000	23,000	-	17,500	14,500
Bontanga	30,000	23,000	21,000	20,000	26,000
Subinja	25,000	24,000	-	18,000	19,000
Okyereko	25,000	-	-	21,875	-

Note: Prices shown in this table are expressed in Cedi per 50 kg-bag.

Generally, fertilisers are procured in bulk by the project offices and distributed to farmers. The difference in price and place is due to the demand-supply conditions in the markets located near the project sites.

(4) Price of Agro-chemicals

The farm gate prices of the representative agro-chemicals such as fungicide, insecticide, herbicide and rodenticide being used in the project areas are summarised as follows :

Project	Diathine-M45	Karate	Fradan	Basagran	Yasodion
Ashaiman	7,000	25,000	3,000	15,000	10,000
Weija	5,000	-	3,000	-	10,000
Amate	6,000	18,000	-	-	-
Afife	-	-	6,000	15,000	-
Aveyime	-	25,000	6,000	-	-
Kpando-Torkor	-	-	-	-	-
Mankessim	-	-	5,000	-	-
Akumadan	6,500	21,000	-	-	-
Tanoso	6,800	22,500	-	-	-
Bontanga	-	16,000	-	15,000	-
Subinja	-	20,000	-	-	-
Okyereko	-	-	-	-	-

Note: Prices in this table are expressed in Cedi.
Unit in price is per kg for Diathine-M45, per litre for Karate, per kg for Fradan, per litre for Basagran and per kg for Yasodion.

2.5 Irrigation and Drainage Facility

The irrigation and drainage conditions of each of the projects have been examined through the site inspection, inventory survey and field measurements such as canal seepage measurement, cylinder intake rate test and observation of root depth of upland crops during Phase-I field work period. Table A-8 shows a summary of irrigation and drainage conditions of respective projects. In parallel to these field activities, the relevant project already rehabilitated has also been reviewed based on the collected data. The results of site inspection, field measurements, and review of the relevant project which are used for a preliminary study on rehabilitation plan of the project facilities, are given below :

2.5.1 Review of Relevant Project

The Dawhenya Irrigation Project (DIP) was reviewed as the most similar and recent case for the rehabilitation of the projects, since it was completed in 1993 and has launched into operation and maintenance stage.

DIP is located in the Greater Accra Region. The implementation of DIP was started from the construction of earth dam and spillway, both of which were completed in 1962. A small pump was installed on the dam crest and provided water eventually to an area of 60 ha. Water supply and land forming works proceeded and the diesel pump station was commissioned in 1974, and thus the command area were expanded upto about 200 ha by 1982. However, pump failures and consequent water shortage brought about a virtual shutdown of DIP by 1982/83. Thereafter, the pump station was recommissioned with electric pumps, and also improvement was made for the selected canals, roads, buildings and utilities. However, DIP still envisaged the severe water shortage due to deficiency in water management and the physical condition of the water supply network. Besides, inadequacies in the institutional arrangements for project operation and management, and support services to farmers prevented the full exploitation of the project potential. As for irrigation and drainage aspects, the major problems at that time were specified as follows :

(a) Lack of water control and measuring structures;
(b) Seepage and overtopping of canals;
(c) Poor in-field water management;
(d) Mixed stages of crop development within lateral units;
(e) Lack of training of water control staff;
(f) Absence of water control management system;

(g) Absence of suitable collector drains outlets through the reservoir flood protection dike; and
(h) Poor maintenance of drain leading to flooding and damage to the canal inspection roads.

In order to cope with these problems, further rehabilitation works and technical services were provided for DIP under the financial assistance of the European Economic Commission (EEC). The further rehabilitation works included reconstruction of the main canalisation system, lateral and header ditches, remedial land leveling and the drainage and flood protection works.

Site inspection was made for the completed rehabilitation works in order to grasp the present condition of DIP after completion of rehabilitation works and technical services. Generally, most of facilities such as pump station, night storage reservoir, main canal, inspection roads and related structures are well maintained and are in satisfactory condition. However, further effort would be required for proper water management, because a definite irrigation calendar is not available in spite of the exist of O & M Manual. In addition, it is still observed that much weeds are growing in drains which would prevent the smooth elimination of excess water from cultivation land. From these findings, it is essential to strengthen water management and O & M activities urgently, and also to execute monitoring activities for collecting and analysing actual data which will be used for effective project management.

2.5.2 Present Irrigation System

The present water sources, intake facility and irrigation type in each of the projects are as follows :

Project	Water Source	Facility	Irrigation Type
1. Ashaiman	Ashaiman reservoir	Dam/reservoir	Gravity
2. Weija	Weija reservoir	Pump	Sprinkler
3. Amate	Volta lake	Pump	Sprinkler
4. Afife	Agali&Kplikpa reserv.	Dam/reservoirs	Gravity
5. Aveyime	Volta river	Pump	Gravity
6. Kpando	Volta lake	Pump	Sprinkler
7. Mankessim	Apropong reservoir	Dam/pump	Sprinkler
8. Akumadan	Atwetwe river	Pump	Sprinkler
9. Tanoso	Tano river	Pump	Sprinkler
10. Bontanga	Bontanga reservoir	Dam/reservoir	Gravity
11. Subinja	Subin river	Pump	Sprinkler
12. Okyereko	Okyereko reservoir	Dam/reservoir	Gravity

(1) Irrigation Requirements

There are no estimate of irrigation requirements for the projects except for Ashaiman project. In Ashaiman project, the evaporation, transpiration and percolation at paddy field have been measured by the Irrigation Development Centre (IDC), of which results are as follows :

(a) Major season from July to September

- Evaporation : 1.9 mm/day
- Transpiration : 4.2 mm/day
  Total 6.1 mm/day
- Percolation : 1.3 mm/day
- Leakage from ridge : 19.2 mm/day

(b) Minor season from October to November

- Evaporation	:	2.5 mm/day
- Transpiration	:	2.9 mm/day
Total		5.4 mm/day
- Percolation	:	1.3 mm/day
- Leakage from ridges:		19.2 mm/day

From these results and effective rainfall, and assuming 20 % of loss, irrigation requirements for both major season and minor season have been estimated at 8,400 m3/ha and 7,400 m3/ha, respectively.

(2) Irrigation Schedule

Only Ashaiman project has an irrigation schedule which was prepared by IDC. While, other projects have no definite irrigation schedule, and thus irrigation is made only based on the past experience and visual judgment to soil condition in reply to the farmer's request. Irrigation period in the projects is generally November to March. Irrigation period for respective projects is given in Table A-9 .

(3) Intake and Water Distribution Methods

Table A-9 also reveals the intake and water distribution method for the respective projects. Out of 12 projects, 8 projects use the pumps for tapping water from the reservoir/river or delivering water to distribution facilities, although deterioration and frequent troubles of them lead to unstable water supply. The pump operation hours for the projects range from 6 hours to 12 hours per day.

The remaining four (4) projects are provided with intake gates or intake valve. There have not found severe problems in these gates and valve except leakage from intake gates in Bontanga project. In Kpando-Torkor and Amate projects, movable pumps are utilized for tapping water from the Volta lake. Since the water surface level of the Volta lake largely fluctuates throughout the year, say 2.33 m to 7.82 m during 10 years from 1984 to 1993 according to the Volta River Authority, these projects are obliged to move the pumps several times in one crop season. A study on pump intake for Kpando-Torkor and Amate projects should therefore be made taking into due consideration this phenomenon of the Volta lake.

Water distribution method for the projects is divided into a continuous and rotational methods. The former is applied for the Ashaiman project only. The latter is employed for the remaining 11 projects. As shown in Table A-9, irrigation interval ranged from 3 days to 10 days depending upon the soil conditions and kind of the crops. In water distribution by sprinkler system, one time irrigation varies between 45 minutes to 3 hours mainly according to the area to be governed and the growing stage of crops. These irrigation interval and one time irrigation are only by the past experience and the visual judgment by the projects, not in a logical manner based on the actual measurements on water requirement, soil moisture content, etc.

(4) Water Supply Record

Except for Ashaiman and Afife projects, no water supply records are available. The released water for irrigation from the reservoir in Ashaiman project has been estimated using the opening of intake valve since 1994. Afife project has estimated the released discharge using the record of the opening of intake gate since 1991. These estimates relate that the released discharge for irrigation in Ashaiman and Afife projects are 751,000 m^3 and 438,000 m^3 in May, 1994 to April, 1995, respectively.

Water supply record is indispensable for efficient water supply. The monitoring activities should be urgently strengthened. In addition, proper measuring device should be installed for the projects.

(5) Irrigation Facilities

The facilities provided for the projects are dam, weir, pump, sprinkler, canal, pipeline, and related structures. The present conditions of these facilities are given in Table A-10. The dams constructed in Ashaiman, Bontanga, Afife, Mankessim and Okyereko projects are in good conditions. Canals and related structures in Ashaiman project are severely damaged. Especially, the right main canal does not presently function due to much leakage and remarkably damaged structures. Okyereko project also presents the same damaged conditions as the Ashaiman project. Those for Bontanga and Afife projects are in good condition and provide the stable water distribution to the fields, although certain leakages have been observed in concrete block lined laterals. Aveyime project, of which water tapping is made by pump, is suffered from the severe damage of canals and structures and could not supply irrigation water to fields in 1995.

The remaining nine (9) projects are provided with the galvanized steel pipes and the movable sprinkler system. Most of them are deteriorated and cannot satisfy the required irrigation demand because of lack of proper maintenance and long time use, say 15 to 20 years. This means that sufficient water delivery to the fields could not be realized or more water supply would be required to meet the demand, which results in higher operation cost.

2.5.3 Drainage System

(1) Drainage Conditions

Out of 12 projects, Amate, Akumadan, Tanoso and Subinja projects are not provided with any drainage facility due to the inclined topographic condition. Although drainage problem is not found in these projects, careful attention should be paid for soil erosion. A green belt and intercepting drain would be to a certain extent useful for prevention of such soil erosion. The pump station of Subinja project is attacked by flood every year so that its location should carefully be considered, if it needs to be newly constructed.

The remaining projects have a drainage system, but it does not function well due to much sedimentation and grasses in drainage canals. Ashaiman, Aveyime and Okyereko projects present the light salinity concentration on some parts of the paddy fields because of poor drain. This salinity concentration would be settled by well maintaining the drains.

Afife project is suffered from the smooth drain because of backwater effect by the lagoon located downstream. Mechanical drainage system would be required when the water level in natural drainage stream is higher, although this matter will be studied in detail later after compiling the collected data.

The downstream area of Bontanga project is stagnant by backwater from the branch of the White Volta river. In order to protect this area, drainage gate and flood dike would be necessary. A staff gauge has been installed for collecting the necessary data for proper plan.

In Mankessim and Weija projects, the lowland area is flooded every year by overtopping from 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) Drainage Requirements

The drainage system is provided for Ashaiman Afife Aveyime, Bontanga, Okyereko and Weija projects. There has not found any drainage requirement in these projects.

(3) Drainage Method

In seven (7) projects such as Ashaiman, Afife, Bontanga, Aveyime, Okyereko and Weija projects, the drainage water is principally eliminated by gravity. In Afife project, however, the excess water from paddy fields is sometimes drained by movable pump due to effect of lagoon located downstream.

(4) Drainage Facilities

The drainage facilities constructed are the unlined drain, cross drain and drainage gate. The present conditions of drains are poor due to much sediments and weeds as shown in Table A-10. It is thus essential to make the drains clean on time, to protect the crops and project facilities from flood.

2.5.4 Farm Road Network and Buildings

The present conditions of the existing farm road network in the projects including short access to the main road are generally poor, except for Weija, Bontanga and Afife projects where the existing road networks are maintained moderately in good condition. In case of Amate project in particular, the access, the second class road, from Begoro town to the project site, about 50 km in length, is very poor.

The present poor road network in most of the projects will require cleaning by grass cutting and improvement of surface such as compacted gravel pavement, and in some projects additional construction of new farm roads would be required in connection with the expansion of irrigated land as well as the rehabilitation.

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

2.5.5 Present O & M Works

(1) Organisation

The number and kind of present staff for operation and maintenance of the projects are shown in Table A-15. As can be seen in this table, there are no water management staff in all projects. In order to approach to effective water use, it is urgently necessary to work out certain countermeasures such as assignment of water management staff, preparation of water management manual, execution of water management training and monitoring activities.

(2) Present Conditions of O&M Works

Except for Afife project, O&M manual is not available. Even for Afife project, it is so

rough and very preliminary. Accordingly, O&M works for the projects are in poor condition, which result in less efficient irrigation and frequent water stagnant in parts of project area in some projects.

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 three (3) years. However, maintenance is still in difficult situation due to financial constraint and lack of spare parts, because most of them were procured in 1970s and early 1980s, which has set spurs to deterioration of them.

At present, operation and maintenance works are mostly carried out by respective project offices. The farmers society is only executing the minor repairs of facilities, cleaning of canals, threshing of weeds in canals, movement and setting of movable pumps, distribution pipes and sprinkler heads. Farmers participation in O & M works is still at low level.

(3) O&M Costs

The O & M costs for the projects consist of staff allowance, office running costs, and operation and maintenance costs of the facilities. Those in 1995 are given in Table A-11. As can be seen in this table, O & M costs for pump schemes would be about 2 times those for gravity schemes. In addition, fuel cost would occupy about 70 % of total O&M cost. If electrification is made, the corresponding cost would largely be reduced.

2.6 Agricultural Support Services

2.6.1 Agricultural Research

Agricultural research activities in Ghana have centralised in national research institutes of the Council for Scientific and Industrial Research (CSIR) under the Ministry of Industry, Science and Technology (MIST). Those main institutions are listed as follows; i.e., (i) Crops Research, (ii) Food Research, (iii) Aquatic Biology, (iv) Oil Palm Research, (v) Soil Research, (vi) Water Resources Research, (vii) Cacao Research, (viii) Forest Products Research, and (ix) Renewable Natural resources. Of these, the research institute related to the irrigation farming is the Crops Research Institute in Kumasi.

As one of the problems on agricultural research in Ghana, it can be pointed out that their research programmes and activities have a poor linkage with needs of farmers and government agencies concerned to the agricultural development. For instance, the extension officers of GIDA and Ministry of Food and Agriculture (MOFA) in and around the project areas have a poor technology on irrigation farming such as optimum irrigation interval and proper application amount of fertilisers, and on the other hand, almost no research activity on this irrigation farming is shown in such institutions at present. 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 so called "Irrigation Development Centre (IDC)" in GIDA. This IDC was established in the Ashaiman Irrigation Project area in March 1991 under the financial and technical co-operation of the Japan International Co-operation Agency (JICA). The organisational structure and staffing of IDC are presented in Figure A-27. Total number of staff is 28 persons including two JICA experts and three volunteers (Japan Overseas Co-operation Volunteers). Main activities of IDC are rice and horticulture experiments, soil research and agro-environmental research. It is expected that IDC plays more important role in strengthening research activities for improving irrigation farming and its training to the extension officers and farmers in the project areas.

2.6.2 Agricultural Extension and Seed Supply

The MOFA is responsible for the agricultural extension to the farmers. Figure A-28 shows organisational structure of extension services by MOFA at district level. There are four basic offices for extension activities in each district. In addition, the offices of veterinary and fishery exist also in those active districts.

(a) Agricultural Extension Services
(b) Crop Services
(c) Plant Protection and Regulating Services (PPRS)
(d) Policy Planning, Monitoring and Evaluation Department (PPMED)

Of these, the Agricultural Extension Services office have linked directly with farmers, and disseminated new farming technology and information to them. Extension method adopted by this office is T&V (Training and Visit) system. Each district is divided into 14-15 operational areas and an operational area has 15-20 contact groups which consist of 8-15 farmers per one group. Each operational area is assigned one technical officer.

These MOFA's extension activities are concentrating on staple foods (maize, cassava, yam, cowpea, soybeans) in rainfed area, and they have almost no services to GIDA's irrigation project areas. To these irrigation areas, GIDA is responsible for extension services to the farmers. The present activities and staffing of GIDA's extension are presented in Table A-12. In general, each project has one to five extension officers. As the present problems of GIDA's extension services, the following three (3) matters may be pointed out; i.e. (i) poor knowledge of staff for irrigation farming, (ii) lack of vehicles/motorcycles to make mobile services, and (iii) no extension facilities and equipment such as printing equipment and OHP. In addition, a weak co-ordination is shown between the Project Management (PM) offices and MOFA's extension offices.

As for the seed supply, most of farmers have obtained seeds from markets, other farmers or products when harvested at last season, except for maize and tomatoes. Those original seeds have been supplied by the private companies (AGLOW, WEINCO, etc.) as well as fertilisers and agro-chemicals. The Government (MOFA and GIDA) supplies only new varieties of seeds. The present seed supply situation is estimated as follows, based on the farm interview survey.

Seed Supply of Main Crops grown in the Project Areas

(Unit: %)

	Cassava	Maize	Rice	E. Plant	Okra	Onions*2	H. Pepper	Tomatoes
a) Government agency*1	3	26	13	-	2	-	-	30
b) From extension worker	-	6	1	-	-	-	-	2
c) Purchased at market	8	20	6	15	35	-	27	14
d) From other farmers	39	17	28	30	48	100	27	21
e) Purchased from dealer	3	13	1	11	3	-	7	14
f) Own seed*3	44	18	50	44	13	-	40	19
g) Others	3	-	1	-	-	-	-	-

*1 Including seeds obtained through the GIDA's PM Offices.
*2 The farmers have obtained seeds of onions directly from the norther part (Upper East Region) of the country.
*3 From the last harvest.
Note: Figures indicate average percentage of total samples (180 farmers) of the farm interview survey.
Source: Farm interview survey by the Study Team.

For the present seed supply system, a result of farm interview survey indicates that almost no problem is shown in all project areas as shown in Table A-1 (Question Item 12.2 (10)). It seems that the farmers have no difficulty to obtain seeds in quantity. In order to improve crop yields and quality of products, it will however be necessary to improve present government supply system for introducing new varieties.

2.6.3 Agricultural Credits

A result of farm interview survey for the problems of present farming situation shows that about 80% of total samples has pointed out "credit facility" and 70% has desired its improvement (see Table A-1, Question Item 12.2 and 12.3). In the whole project areas, 40% of farmers have borrowed loans for purchasing farm inputs and hiring farm machinery, and of these loans, 57% is obtained from middlemen of farm products and 17% from banks (see Table A-1, Question Item 14.1 and 14.3).

(1) Bank Loans

There are following three (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. Others are for loans to co-operatives (including GIDA's societies) and rural industries including agro-processing. The loan amount is decided individually according to the following borrowers' condition; (i) security, (ii) borrower's bank account and some deposit amount, and (iii) grantee by authorised institutions/organisations/companies. As for security of loans, the banks request valuable properties such as houses and machinery, and lands are not evaluated.

The Banks are now hesitating to rent loan to the farmers because of their low repayment capability with recent inflation in the country. According to ADB in Tamale, a lot of farmers have made default in payment of loans. For the loan interest, it is now rising rapidly in accordance with the recent inflation of commodities, as shown below.

Movement of ADB Rending Interest to Smallholder	
January 1995	26 %/year
May 1995	31 %/year
September 1995	38 %/year
ADB Rending Interest by Each Category (As of Nov.1995)	
Category	
Smallholder (Agric.)	38 %/year
Forestry	40-45 %/year
Export Trade	45-48 %/year
Manufacturing	46-50 %/year
Constriction	46-50 %/year
Commerce	48-52 %/year
Others including personal loan	46 %/year

Source: ADB Tamale

(2) Loans of Middleman

At present, the farmers are now obtaining private loans from middlemen (market mummy) of products. As of December 1995, their interest is very high rate which is estimated at 50-100% per season, except for Ashaiman. The interest of middlemen in the Ashaiman area is less than 20% per season. For the repayment of loan, there are two methods of "by cash" and "in kind," and a half of borrowers have paid loans by cash. In case of payment in kind, the middlemen purchase borrowers' products with a good condition, and in this case, an actual interest rate will over the above 50-100%.

2.7 Farmer's Organisation and Handing Over of O&M

2.7.1 General Background

As the important strategy of the water resources and irrigation development in MTADP,

the Government has envisaged to develop small-scale and micro-scale irrigation schemes, and its common element is the emphasis given to the implementation and management of the schemes by the farmers themselves. It means that considerable time and effort will have to be given to the promotion of effective farmers' groups, and operation and maintenance (O&M) of existing irrigation projects are handed over to them. The role of GIDA will be to plan the implementation and assist the farmers' groups.

In line with this strategy, farmers' societies were established in all the projects area up to the present, and a federation (Irrigation Rice and Vegetable Co-operative Farmers and Marketing Association) which consists of all societies on GIDA's irrigation projects was organised at Ashaiman in 1994. In parallel with the above activities, GIDA is now planning the handing over of O&M of the irrigation facilities to the farmers' societies.

2.7.2 Farmers' Societies in Project Areas

In each irrigation project area, a farmers' organisation had been established under the guidance of the Project Management Office (PM Office) and the Department of Co-operative. Outline of these societies are shown in Table A-13, and several typical structures are presented in Figure A-29. A society has a executive committee which consists of a chairman, a vice-chairman, a secretary, a treasurer, an organiser and several staff. They are all elected from the members. All beneficiaries of the irrigation project automatically become member of the society.

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 necessity to its members, (v) to provide for educate and other - like amenities to the community as a whole, and (vi) to procure collectively and distribute equally among members essential commodities.

Of 12 societies in the project areas, seven (7) societies have a bye-laws which consists of the following articles, and the remaining five (5) societies have no completed bye-laws.

Articles of Bye-Laws

PART-I PRELIMINARY
(1) Interpretation
(2) Title
(3) Objectives

PART-II GENERAL PROVISIONS
(4) Funds of Society
(5) Liability of Members
(6) Disposal of Surplus
(7) Accounts and Books
(8) Register of Members
(9) Seal of Society
(10) Division of Society
(11) Loans and Deposit from Persons
(12) Loans to Members
(13) Production and Marketing of Produce
(14) Admission to Membership
(15) Withdrawal from Membership
(16) Removal from Membership
(17) Expulsion from Membership
(18) Re-admission of Membership

PART-III GENERAL MEETINGS
(19) General Meeting
(20) Special General Meeting
(21) Quorum at General Meeting
(22) Voting at General Meeting
(23) Minutes of General Meeting

Part-IV Committee of Management
(24) Election of Committee
(25) Removal of Committee
(26) Filling of Committee
(27) Chairman of Committee
(28) Duties of Committee
(29) Procedure at Committee Meeting
(30) Minutes of Committee Meeting

PART-V OFFICERS OF THE SOCIETY
(31) Appointment of Secretary
(32) Security by Secretary
(33) Suspension of Secretary
(34) Absence of Secretary
(35) Payment of Secretary
(36) Duties of Secretary
(37) Treasurer and Assistant Treasurer
(38) Duties of Treasurer

Source: Bye-laws of Amate Co-operative (IDA) Irrigation Development Authority Vegetable Growers and Marketing Society Ltd. registered in 1993.

These bye-laws were prepared in accordance with a form of the Department of Co-operative, and no article on O&M of irrigation facilities is shown in the above bye-laws. It means

that almost all societies have no function as a water users' association in institutional view point.

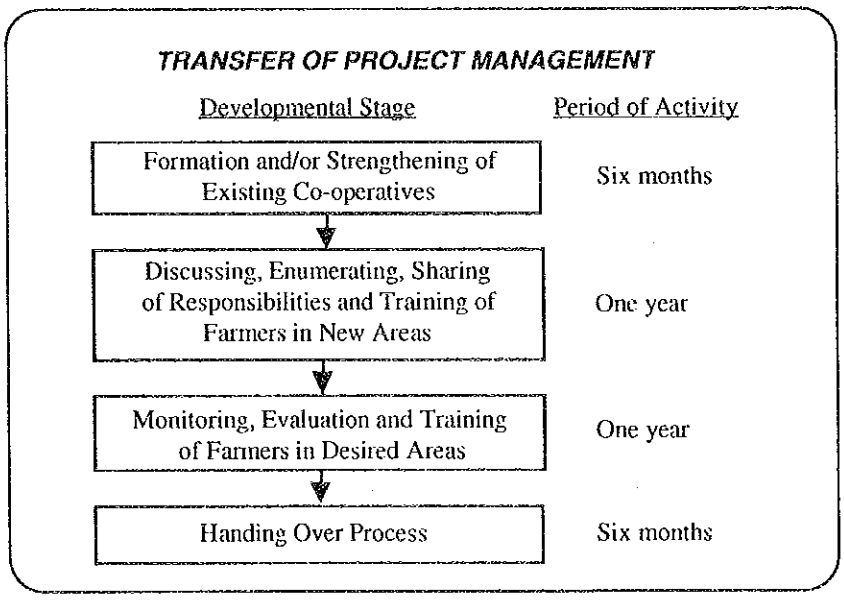
The present activities of the societies are mainly to discuss amount of irrigation service charge and land allocation with the project offices. In addition, the societies established in the pump irrigation areas are arranging the installation of sprinkler systems under the guidance of the PM Offices. With the exception of Tanoso and Akumadan which are now arranging some credit services to the members, the societies have no any other activities shown in the objectives mentioned in their bye-laws.

2.7.3 Handing Over of O&M Works

In accordance with the strategies of MTADS, GIDA has envisaged the handing over of O&M to the farmers' societies established in each project area, as mentioned earlier. Basic concepts of this handing over are :

(a) To gradually train the farmers to take over the management of the project, and transfer of appropriate technologies to them through IDC in Ashaiman;
(b) To provide extension services to the farmers;
(c) To assist in the operation and maintenance of the irrigation systems and other structures where possible; and
(d) To provide technical advice to farmers' groups, co-operative societies after transfer of project management responsibilities.

Based upon the above concepts, GIDA has a plan of the following handing over process. The details are shown in Table A-14.



In 1994, GIDA had announced these concepts on handing over to all societies through the PM Offices with a rehabilitation plan of irrigation facilities. Up to the present, all irrigation projects have been managed by GIDA and its plan is not yet commenced, except for the Dawhenya Irrigation Project[1]. The farmers in all project areas have well known the handing

[1] The handing over of the Dawhenya Irrigation Project has been planned in 1995-1996. This project was rehabilitated by GIDA in co-operation with EC, and the training programme about O&M to society and GIDA's staff was carried out by consulting experts despatched by EC from 1991 to 1994.

over of O&M to the farmer's societies, at present. In order to grasp their intention on this handing over, the interview survey was carried out to them. A result indicates that about half of total samples (180 farmers) do not agree to its handing over, as shown below.

Farmers' Acceptance for Handing Over of O&M

(Unit: %)

Questions	ASH	WEI	AMA	AFI	AVE	KPA	MAN	AKU	TAN	BON	SUB	OKY	Whole
If GIDA will hand over the operation and maintenance of the irrigation facilities:													
a) Do you agree ?													
Yes	15	73	80	40	67	-	89	90	-	85	100	70	56
No	85	27	20	60	33	100	11	10	100	15	-	30	44
b) If your village chief agreed its hand over, do you agree also ?													
Yes	20	73	60	48	67	-	88	89	-	90	100	50	56
No	80	27	40	52	33	100	12	11	100	10	-	50	44

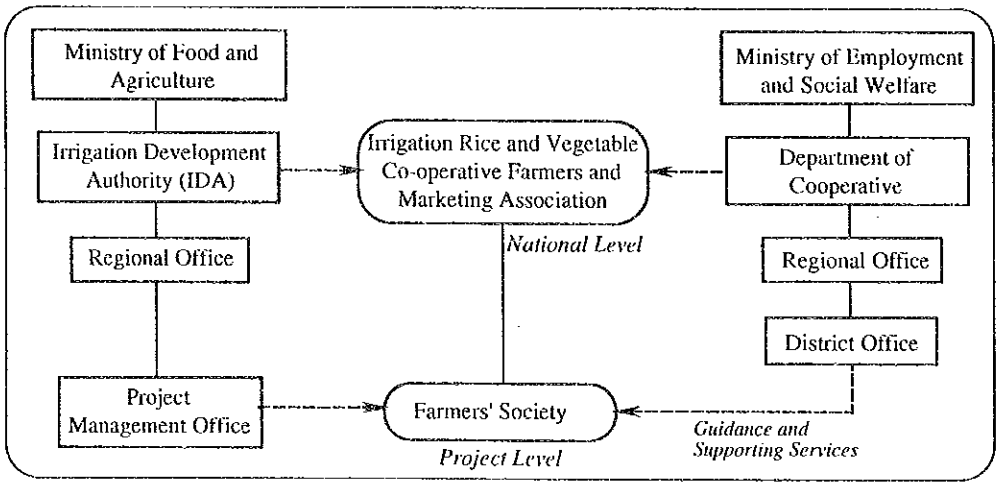
Note: Interview on handing over was made 2 times (Question Items 16.4 and 17.4) within a questionnaire in order to obtained accurate information. The figures mentioned in this table present a result obtained from Question Item 17.4.
Source: Farm interview survey by the Study Team.

As one of the reasons, it may be said that the farmers cannot accept the GIDA's handing over plan without question, because they have confronted with serious problems on existing irrigation facilities such as insufficient water supply and very high costs for operation and maintenance of facilities. As another reason, the farmers pointed out technical difficulty in O&M by the farmer's society. For the general farmers' response to this survey, it seems that they do not know its actual content on the handing over, and it is necessary to carry out more detailed survey on this matter at the next stage.

2.7.4 Executing Agencies for Promoting Farmers' Societies and Handing Over of O&M Works

(1) Farmers' Societies

Basically, the Department of Co-operative 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 also responsible for the promotion and supporting to the societies for O&M, and its front line office is the PM Office. A schematic structure of these services by both agencies is presented as below :



With the exception of Weija and Afife, inactive promoting services of the Department Co-operative and GIDA are shown in 10 irrigation projects, and both agencies have a weak co-ordination between them. In case of Weija, the District Office of Department of Co-operative 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-operative (Denu District).

(2) Project Management and Handing Over of O&M

The executing agency of handing over is GIDA, though it is the matter of course. The organisational structure of this GIDA is presented in Figure A-30. The Project Management Division under the Department of Project Operations is responsible for promoting services of societies, project management and its handing over. The number of staff in this Division is only two officers.

The Project Management Office headed by a Project Manager has direct responsibility for operation and maintenance of the irrigation project and promoting societies. The PM Office is very simple organisational structure and has only several staff and labourers, except for Weija, Afife and Bontanga. The number of staff of each PM Office is shown in Table A-15.

In accordance with the Regulations of IDA (L.I. 1350), 1987, a PM Office has basically following four (4) committees; i.e., (i) Land Allocation Committee, (ii) Agricultural Committee, (iii) Disciplinary Committee, and (iv) Appeals Committee.

1) Land Allocation Committee[2],: As the basic policy of GIDA, all farm lands in the irrigation project areas are allocated permanently to the farmers, and its allocation is implemented by the Land Allocation Committee. The Committee consists of the following 7 members :

   (a) District Secretary (chairman),
   (b) A representative of the Chief Executive of the Authority,
   (c) The Project Manager (secretary)
   (d) A representative of the Traditional Council with in the area,
   (e) A representative of the District C.D.R.; and
   (f) Two representatives of the farmers' association of the Project.

2) Agricultural Committee: This Committee consists of the representatives of PM Office and the farmers' society. This Committee is :

   (a) responsible for the planning and implementation of agronomic practices;
   (b) to ensure that no person tampers with irrigation network; and
   (c) to ensure that farmers use the land for the purpose specified in the Irrigation Development Authority Land Allocation Agreement (Agreement), and do not transfer or sublet land allocated to them.

3) Disciplinary Committee: The Committee investigates any infringement or alleged infringement of the terms of the Agreement and impose the appropriate penalty when necessary.

4) Appeals Committee: The Committee considers cases of appeal arising out of the decisions of the Disciplinary Committee.

All these committees have several representatives of farmers who are beneficiaries of the projects, and the projects are managed through these committees. As far as the existing organisational structure of PM Office is concerned, it can be said that GIDA has introduced a joint management system with farmers for the Project management.

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[2] This land allocation means that GIDA gives the cultivation right to the farmers. and property itself is not handed over to them.

(3) Restructuring of GIDA

The Government of Ghana has a plan on privatisation of GIDA. In 1993, the Parliament enacted a government ordinance[3] on privatisation of 32 national institutions and public corporations including GIDA. In response to this ordinance, GIDA prepared a study report[4] on privatisation in November 1995. This report recommends that most part of GIDA still remains as an implementing agency for supporting services to irrigation sector. On this privatisation, however, the report includes no definitive and detailed schedule. In addition, MOFA which is upper institution of GIDA has also a reorganisation plan[5], and the GIDA's privatisation is unsettled on its materialisation so far.

Apart from the above government ordinance, the number of staff in GIDA has been reduced from year to year. The staff in 1995 was reduced to about one third of the total number in 1985, as shown below.

Year	No. of Staff
1985	1,116
1988	986
1990	735
1995	377

Note: Including all staff in head, regional and PM offices.
Source: GIDA

2.7.5 Land Allocation

The status of land tenure in each project area and land allocation at present are presented in Table A-16. As of 1995, the irrigation projects which already allocated land to the farmers are only the following four (4) projects; Weija, Mankessim, Tanoso and Okyereko. As for Afife project, the land is not yet allocated officially to the farmers, but they have cultivated continuously at same plot. Other projects have allocated by each season, because the PM Offices cannot supply enough irrigation water to the area fixed through the land allocation due to problems of irrigation facilities.

All lands in the project area are originally community lands which are governed traditionally by the village chives, and are managed by GIDA at present. According to the PM Offices, most of them are not government land, though it is necessary to carry out more detailed survey on those land tenure. These lands were developed by GIDA under the agreement with the village chives[6], but GIDA dose not compensate yet to them. Prior to implementation of the projects, the Government should acquire these lands.

2.7.6 Irrigation Service Charge

GIDA is collecting irrigation service charge from the beneficiaries in all of the irrigation projects. Table A-17 shows the unit amount and collecting situation of irrigation service charge in 12 irrigation projects in 1995. The unit amount is calculated by each project. A highest amount is Cedis 414,500/ha/season (sprinkler irrigation) of Subinja and lowest one is Cedis

[3] Statutory Corporations (Conversion to Companies) Act, 1993 (Act 461).

[4] Memorandum from the Irrigation Development Authority on the Proposed Conversion of the Authority to a Limited Liability Company under the Statutory Corporations (Converion to Companies) Act 1993 (Act 461), GIDA, November 1995.

[5] Report of the Task Force Set Up to make Recommendations for the Decentralization of the Ministry of Food and Agriculture, MOFA, August 1995.

[6] All village chievs related to the lands in the project areas have agreed to the land acquisition by the Government.

50,000/ha/season (gravity irrigation) of Ashaiman, Afife and Okyereko, though the condition of estimation differs between them. Basically, the irrigation services charge includes the costs for operation and maintenance of irrigation facilities (electric charge, fuel and lubricants, repair cost, parts and replacement cost, etc.), and staff salaries and administrative charge are not included.

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 other projects range from 50 to 80%. With the exception of Ashaiman and Weija projects, all projects have collected the irrigation service charge before cropping, and farmers who do not pay charge can't cultivate in the project areas. However, Ashaiman project has collected after harvesting, and a lot of farmers have refused to pay its charge because of problems of water shortage. The Weija project has collected throughout the year, but shows a good collecting ratio. The movement of collecting ratio in these two projects is presented below :

Payment Situation of Irrigation Service Charge
in Ashaiman and Weija Projects

Year	Ashaiman		Weija	
	Unit Amount (CD/ha/year)	Collecting Ratio (%)	Unit Amount (CD/ha/season)	Collecting Ratio (%)
1991	22,500	39.2	-	-
1992	22,500	30.4	90,000	65
1993	22,500	21.1	90,000	87
1994	50,000	12.3	180,000	97.6
1995	50,000	-	280,000	71*1

*1 As of Nov. 1995
Source: Ashaiman and Weija PM offices

For this irrigation service charge, interview survey to farmers was carried out in order to grasp their understanding on its purpose/meaning and amount. A result of the survey on purpose shows that almost all farmers have a good and correct understanding (see Table A-1, Question Item 16.3). Namely, they made answer that irrigation service charge is necessary to operate and maintain the irrigation facilities, and that all farmers who received irrigation water should pay its charge. As for the amount of irrigation services charge, over 80% of farmers in Weija, Mankessim, Akumadan, Tanoso, and Okyereko project areas made answer of "expensive" to "very expensive" as shown below.

Farmers' Impression to Amount of Irrigation Service Charge

(Unit: %)

	ASH	WEI	AMA	AFI	AVE	KPA	MAN	AKU	TAN	BON	SUB	OKY	Whole
How do you think about amount of irrigation service charge ?													
a) Very cheep	-	-	-	-	-	-	-	-	-	-	-	-	-
b) Cheep	-	-	-	-	13	7	-	-	-	5	-	-	2
c) Moderate	95	7	67	96	47	73	24	10	-	65	67	-	53
d) Expensive	5	27	33	4	27	20	38	90	-	20	22	70	26
e) Very expensive	-	66	-	-	13	-	38	-	100	10	11	30	19

Source: Farm interview survey by the Study Team.

2.8 Farm Economy

2.8.1 Farm Management Size

Farm management size of irrigation area varies with the projects and ranges from 0.11 ha in Kpando-Torkor area to 2.81 ha in Weija area, as shown below. The details of irrigated area and cultivation area of crops in each project are presented in Table A-18.

Projects	Project Areas						Total Farm Size *2 (ha/farmer)
	Potential Area (ha)	Developed Area (ha)	Annual Total Irrigated Area (ha)	Cropping Intensity *1 (%)	No. of Farm Household (ha)	Irrigated Area per a Farmer (ha/farmer)	
Ashaiman	148	130	59.0	45	120	0.49	1.37
Weija	220	220	323.3	147	115	2.81	3.09
Amate	203	101	85.2	84	63	1.35	2.16
Afife	880	880	694.6	79	533	1.30	3.85
Aveyime	150	63	-	-	62	-	2.21
Kpando-Torkor	356	40	13.0	33	118	0.11	1.34
Mankessim	256	17	26.4	155	89	0.30	0.95
Akumadan	65	65	50.2	77	101	0.50	5.44
Tanoso	115	64	46.8	73	188	0.25	4.36
Bontanga	450	450	461.1	102	525	0.88	3.43
Subinja	121	60	12.6	21	25	0.50	3.49
Okyereko	111	40	21.6	54	68	0.32	1.42
Total/Average	3,075	2,130	1,793.8	84	2,007	0.89	2.66

*1 Annual total irrigated area / Developed area
*2 Including farm land located at outside project areas. Data obtained from the farm interview survey by the Study Team (1995).

As seen in the above table, the highest cropping intensity, 1.55 or 155 % is seen in Mankessim area, and the lowest one, 0.33 or 33 % in Kpando-Torkor area. The average cropping intensity over the whole project areas is estimated at 0.84 or 84 %. The lowest intensity in Kpando-Torkor area is due to insufficient supply of irrigation water because of deterioration of pump facility.

2.8.2 Crop Budget

Crop budget for 1994/1995 crop year is analysed for selected major crops grown in the project areas. The Bontanga and Subinja projects are selected as a representative of gravity irrigation project and pump-sprinkler irrigation project, respectively. The crop budgets in these projects are summarised as shown below, and the details are presented in Table A-19.

(Unit: Cedi 1,000/ha)

Items	Bontanga					Subinja			
	Paddy *1	Okra	Onion	Tomato	Maize	Egg Plant	Hot Pepper*2	Tomato *3	Maize
1. Gross Income									
(1) Unit yield (t/ha)	5.45	9.42	14.5	16.02	1.5	11.3	0.8	1.8	1.94
(2) Unit price (Cedi/kg)	290	150	180	125	250	230	1,610	350	150
(3) Gross income	1,581	1,413	2,610	2,003	375	2,599	1,288	630	291
2. Gross Outgoing									
(1) Seed	27	8	200	5	5	6	7	5	12
(2) Fertilizers	191	196	198	112	96	197	181	69	111
(3) Agro-chemicals	28	52	12	36	6	65	80	39	1
(4) Farm machinery	73	71	117	81	37	80	91	15	53
(5) Labour	128	272	379	205	91	652	539	271	111
- Family	38	137	86	89	59	440	284	228	27
- Exchange	5	2	-	4	2	-	6	-	3
- Hired	85	133	293	112	30	212	249	43	81
(6) Other charges*4	82	90	105	82	12	465	460	227	14
Total	529	689	1,011	521	247	1,465	1,358	626	302
3. Net Income per ha	1,052	724	1,599	1,482	128	1,134	-70	4	-11

*1 Both wet and dry seasons *2 Dry
*3 Inter cropping with other crops. *4 Irrigation service fee and miscellaneous.
Source: Farm interview survey by the Study Team and data obtained from the PM Offices.

As seen in the above table, the highest net income, 1.6 million Cedis per ha, is obtained from the cultivation of onion and followed by 1.5 million Cedis of net income by tomato in

Bontanga area. In case of Subinja area, the highest net income comes from the cultivation of egg plant. Also in other project areas, higher net incomes are expected from the cultivation of vegetables in general.

2.8.3 Farm Household Budget

The main farm income of average farm family in five (5) gravity irrigation projects, Ashaiman, Afife, Aveyime, Bontanga and Okyereko, is derived from rice cultivation and supplemented by vegetables production. In the remaining seven (7) pump-sprinkler irrigation projects, the major income sources depend on vegetable production of tinda and cluster bean in Weija, onion in Amate, okra in Kpando-Torkor, water melon in Mankessim, and tomato in Akumadan, Tanoso and Subinja areas. The farm household budget is studied on gross income, gross outgo and net reserve. The gross income includes crop income, livestock income and off-farm income. The gross outgo covers crop production costs and living expenses. The farm household budget of average farming size is summarised as follows, and the details are presented in Table A-20.

Farm Budget Analysis

(Unit: Cedi 1,000/farmer)

Projects	Gross Income	Gross Outgo				Net Reserve
		Production Cost	Living Expenses	Loan Pepayment	Total	
Ashaiman	2,403	329	2,065	9	2,403	-
Weija	5,667	1,671	2,843	7	4,521	1,146
Amate	6,805	2,485	2,818	511	5,814	991
Afife	3,465	932	2,016	517	3,465	-
Aveyime	1,694	85	1,602	7	1,694	-
Kpando-Torkor	2,060	262	1,796	2	2,060	-
Mankessim	1,821	223	1,598	-	1,821	-
Akumadan	2,394	522	1,844	28	2,394	-
Tanoso	2,072	291	1,780	1	2,072	-
Bontanga	2,237	451	1,778	8	2,237	-
Subinja	2,858	907	1,951	-	2,858	-
Okyereko	2,128	310	1,794	24	2,128	-

Source: Farm interview survey by the Study Team (Nov.-Oct. 1995).

Farmers are getting their income mainly from farming, side job such as labour in other farms, remittance from their relatives and others. According to the farm survey, the farmers in Ashaiman, Afife and Kpando-Torkor areas gain more than one million Cedies of income from off-farm works. In case of farmers in Ashaiman area, some of family members are working in Tema, the main industrial zone of Ghana. Many of peasant farmers in Afife are working as labour in other farms, and those in Kpando-Torkor area are working in fish factories to get cash income.

The above table shows that farmers in Weija and Amate areas enjoy the highest net reserve per capita per year. The reasons for such a highest net reserve seem to be due to 1.3-2.8 ha (irrigation area) of large farming size with cultivation of profitable crops such as tomato and onion. On the contrary, farmers in Afife, Subinja, Aveyime and Okyereko areas live in poverty as compared with those in other areas.

2.9 Environment

2.9.1 Environmental Impact Assessment

(1) Environmental Impact Assessment (EIA) Procedure

Under the Environment Protection Agency (EPA) Act 490, the project proponents are

obligated to submit an Environmental Impact Statement (EIS : EIA report) , Preliminary Environmental Report (PER : IEE report) or Environmental Assessment Preliminary Registration Form on the planning of any project. According to the "Environment Impact Assessment Procedure" issued by the EPA, the EIA procedures shall be taken the following paragraphs, and Figure A-31 shows the administrative flow chart of the EIA procedure in Ghana.

1) For the projects that may have an impact on the environment, the project proponents must register with the EPA by submitting the Environmental Assessment Preliminary Registration Form to the EPA offices.

2) After receiving the registration form, the EPA with the assistance of a cross-sectional technical committee, including the Ministry of Environment, Science & Technology (EST), will classify the project into one of the following four (4) decisions :

   (a) Objection to the undertaking
   (b) No objection to the undertaking
   (c) Preliminary Environmental Assessment required
   If the Preliminary Environmental Report (PER) foresees significant adverse environmental impacts which may result from the undertaking of the project, the EIA is required and Environment Impact Statement will be prepared.
   (d) Environmental Impact Assessment required

3) If the proponent be required to submit an EIS, the proponent must prepare the "Terms of Reference" (TOR) for the EIA study and submit it to the EPA. After receiving the EPA's approval for the TOR, the proponent can start work immediately on the EIA.

4) In the course of gathering data for the EIS preparation, the proponent is required to initiate a public information programme of the project for the area likely to be affected by the undertaking (through such a programme, local residents will fully be informed of the nature of the projects and its effects on the environment.). The proponent must incorporate the concerns of the public into the EIS report.

5) The EPA with a cross-sectional technical committee will assess and review the draft EIS prepared by the proponent. If the EPA judges that the draft EIS is acceptable, the proponent shall be issued a Provisional Environmental Permit for the proposed project. But if the EIS is not acceptable, the proponent must be required to re-submit a revised statement or to conduct further studies to modify the statement.

(2) EIA Requirement for Agricultural Project

According to the "Environment Impact Assessment Procedure", the proponent is required to submit the environmental registration form to the EPA about the following agricultural project :

   (a) management area of agricultural land involving the clearing of land of greater than 40 ha in area, and
   (b) management area of agricultural land involving the clearing of land located in an Environmentally Sensitive Area.

In addition, the following agricultural project shall be required to implement EIA study :

(a) Land development for agriculture purpose not less than 40 ha, and
(b) Agricultural programmes necessitating the resettlement of 20 families or more.

Consequently, if the projects include the new development of more than 40 ha of the potential area, the GIDA shall be required to undertake the EIA study and to submit the EIS report to the EPA office before the development.

2.9.2 Present Environmental Condition

The present environmental issues are identified for each project, based on the information obtained from the field reconnaissance and interviews to the farmers, project staff, pubic health unit, etc. The issues, its causes, significance and countermeasures to be considered are summarised in Table A-21. By the application of proper countermeasures throughout the project stage, the issues would be mitigated and would become minor ones in terms of the magnitude and the extent. The following section explains about the present environmental conditions in the project areas.

(1) Watershed Condition (Siltation in reservoir)

This is one of the major problems commonly observed in the irrigation reservoirs in Ghana. Due to the cultivation without taking soil conservation measures and deforestation caused by the shifting cultivation, bush fires, felling of forest trees for timber exports, removal of vegetation for firewood, etc. along the reservoirs and in the watersheds, the land degradation occurs, and it results in silt deposition in the reservoirs. In fact, many cultivated lands along the reservoirs were observed in the reconnaissance survey. Due to the silt deposition, the capacity of the reservoirs would substantially be reduced, and this would result in the shortage of water. According to the fishermen around the reservoirs, the water of the reservoirs has become muddy, and the products by fishing have also decreased year by year.

In order to reduce silt sedimentation in the reservoirs, the watershed management such as reforestation and restriction of land use by the government should be taken. In addition, the soil conservation practices should be introduced to the farmers by the government staff.

(2) Deforestation

Major energy sources for rural life are fire wood and charcoal. In addition to the use of fire wood, farmers are using woods for fences, handling of tools, poles, etc. Charcoal produced from fire woods is also one of the main income for the local people, especially in Aveyime project. The forest is necessary and important for the rural life. Since the consumption of forest resources has increased with increase of rural population, however, the forest has been decreased gradually due to stripping by the local people. In addition, the forest clearing such as bush fire spurs forward deforestation.

(3) Wildlife

Wildlife are rarely observed in and around the project areas due to the depletion of the forest by the human activities such as forest clearing for agriculture, logging and timber extraction, construction of the reservoirs, etc. In addition, hunting of animals as a source of protein ("bush meat") is also a main reason for the decrease of the wildlife. At present, only small animals such as grass cutters, squirrels are found commonly in and around the project areas. In Mankessim, Tanoso, Akumadan and Subinja areas, the crocodiles are observed in the reservoirs, according to the farmers and project staff. However, the number and conditions of crocodiles are not confirmed exactly.

(4) Wetland

In the downstream of Ashaiman, Weija and Afife projects, there are lagoon areas named as Sakumo, Nyanyano and Keta lagoon, respectively. Out of them, the Sakumo and Keta lagoons are proposed as the Ramsar sites. The present conditions of these lagoons are summarised as follows :

Name of Lagoon	Location	Present Condition			Ramsar Site
		using for	area	mangrove	
Sakumo lagoon	Ashaiman	fishing	small	none	proposed
Nyanyano lagoon	Weija	salt pond	small	none	none
Keta lagoon	Afife	fishing	large	sparse forest	proposed

(5) Soil Degradation

Because of undulating topography and the existence of accumulated layer of iron concretions or gravel within the shallow soil layer, the lands in some projects (Kpando-Torkor, Mankessim, Akumadan, Tanoso and Subinja) have a high potential of future land degradation. In fact, the abandoned fields due to soil erosion are observed in Tanoso project area. Although sprinkler irrigation system considered as an effective system for mitigation of soil erosion is applied in these project areas, certain land conservation practices should be taken for the sustainable agricultural development.

(6) Water Logging

Due to poor drainage works, water logging and also salinity problems result in lowering of crop yields and often in abandonment of lands. These problems are found in Ashaiman, Weija, Aveyime, Afife and Okyereko projects. In Mankessim project, the seasonal flood from the Ayensu river which flows out in the project area results in water logging. Therefore, the improvement of drainage facility and system is a necessary work at the implementation stage of the former five (5) projects, and the construction of river dike is necessary in Mankessim project.

(7) Water Borne Diseases

It is reported that about 90 % of total population of Ghana has been infected by malaria disease, and most of farmers in and around the project areas, too. Bilharzia is also popular disease among the farmers in and around the project areas. The farmers know the importance of medical treatment of these diseases, and think a serious problem for them. The problem is, however, that they have no knowledge about the causes of diseases, especially bilharzia. Health education and sanitary programme should be taken to prevent and control the problem. In paddy cultivation area, maintenance works of weeding in the canals and field bunds are also necessary for control of stagnant water and snails.

2.9.3 Future Environmental Issues with the Project

The future environmental impacts to be caused by the implementation of the Project are examined and tentatively assessed at this stage. Further, the environmental impacts from the area expansion are also examined for the projects which have potential area for expansion of irrigated land in the future. The following seven (7) issues including negative and positive impacts are identified in each of the project areas.

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 on the downstream, i.e. lagoon area and volta lake	+	+	-	+	-	-	-	-	-	-	-	-
4 Beneficial impacts on farm and local economy	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
5 Land degradation (at area expansion)	-	-	+	-	-	++	+	+	++	-	++	-
6 Incidence of water-bone *1 diseases (at area expansion)	-	-	-	-	++	-	-	-	-	-	-	-
7 Decrease in forest in and around the project areas (at area expansion)	-	-	++	-	++	++	+	+	++	-	+	-

The marks indicate the significance of the impacts such as, - : none, + : minor, ++ : moderate, +++ : major
Remarks : *1 excluding malaria disease.

The probable issues and their significance are summarized in Table A-22 and explained in the following paragraph :

(1) Health Hazard from Agro-chemicals

The use of agro-chemicals would increase in the future due to intensification of vegetable cultivation, which is susceptible to pests and diseases. Although some farmers have an experiences and knowledge for the usage of agro-chemicals, it is likely that misuse or mishandling of agro-chemicals and improper disposal of used bottles will cause health hazards. Therefore, the farmers should be informed about knowledge of the proper handling and usage of agro-chemicals through the extension services at the development stage.

(2) Deterioration of Downstream Water Quality

The level of fertiliser use will increase under the future intensive agriculture to obtain higher yields. This might result in nutrient load in drainage water and/or groundwater, and affect the downstream aquatic ecology, especially fish culture. However, the risk to water quality could be minimised by the proper measures such as increased use of compost and green manure, and proper water management at field.

(3) Ecological Changes in the Downstream (wildlands)

As mentioned in the above (1) and (2), careful usage of chemicals and fertilisers should be taken to prevent the downstream cultures. Improvement of drainage conditions might also influence the mangrove forest in Keta lagoon. At present, the mangrove forest has decreased gradually due to cutting by local people and drying of the area. Therefore, both of negative and positive impacts could be supposed by the improvement of drainage conditions.

- Positive impact : recovery of mangrove by reduction of drought
- Negative impact : decrease of present mangrove forest due to incursion of a mass of fresh water

The negative impacts could be minimised by applying the proper water management. In addition, it is recommended that continuous monitoring of the mangrove forest be taken at the development stage.

(4) Beneficial Impacts on Farm and Local Economy

The major beneficial effect of the Project will be the uplift of farmers economy as a result of the increase in crop production. In addition, the increase in agricultural production will induce economic activities in other sectors through a linkage effect. Besides, a large number of farmers and villagers will be involved in construction works of the Project, though not permanently.

(5) Land Degradation (by area expansion)

Kpando-Torkor, Mankessim, Akumadan, Tanoso and Subinja projects have a high potential of future land degradation. Therefore, the introduction of certain land conservation practices are indispensable at the development stage.

If the proper countermeasures are introduced and the profitable farming which has also a significant sustainability is carried out in the projects, it would be the best model for development of similar upland areas extending in the whole of Ghana . However, it is difficult to predict the effects of soil conservation measures at present, because it is still at the trial stage. It is recommended, therefore, that a significant verification study and monitoring should be carried out prior to and at the development stage.

(6) Incidence of Water-borne Diseases (especially Bilharzia : in expanded area)

According to the hospital staff in Battor town near Aveyime area, the snails have been propagated drastically and the number of patient has increased along the Volta river, since the Kpong dam had been constructed. Therefore, it is predicted that the expansion of paddy field in Aveyime project would result in the increase of the incidence of water-borne diseases, especially Bilharzia. The proper countermeasures should be taken at the development stage as mentioned above.

(7) Decrease in Forest around the Project Area

At present, the local people are collecting fire woods from the potential areas. When the agricultural land is expanded in the potential areas, they may sift to other forest areas. It might hasten the forest decreasing and make an adverse impact on the forest ecosystem there.