# 4. PRIORITY PROJECTS

As discussed in the previous Chapter 3, the five priority projects were selected for the feasibility study in order to prepare the comprehensive rehabilitation plan for them. The present conditions of the priority projects and discussions on various constraints to profitable agricultural development in connection with the projects rehabilitation are presented in this Chapter.

## 4.1 Location and Population

### 4.1.1 Location and Project Area

Of the 5 priority projects, four are located in the Coastal Savannah Zone, and one in the Transitional Zone (see Location Map), as shown below:

| Project | Disttrict | Region | Agro-ecological Zone |
|---|---|---|---|
| 1. Ashaiman | Tema | GT Accra | Coasta Savannah |
| 2. Aveyime | North Tonguu | Volta | Coasta Savannah |
| 3. Kpando-Torkor | Kpando | Volta | Trasnsitional Zone |
| 4. Mankessim | Mankessim | Central | Coasta Savannah |
| 5. Okyereko | Goma | Central | Coasta Savannah |

Potential and developed areas of each of the five priority projects under the present conditions were examined based on the available information obtained from GIDA and site inspection made by the Study Team. The results are as follows:

(Unit: ha)

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

Note: The area shown in the above table is gross area.
* shows the land area located on the left bank of the project being irrigated at present.

Most of lowland is used for cultivation of rice under gravity irrigation with water from the reservoirs, except for the Aveyime project which is served by pump irrigation. In upland, vegetables such as okra, watermelon, egg plant, etc. are cultivated by sprinkler irrigation because of undulating topography.

Most of the projects have not been fully developed as originally planned, mainly due to financial constraint. In some projects such as Kpando-Torkor and Okyereko projects, actually

irrigated areas in recent years were smaller 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 13 ha in Kpando-Torkor and 22 ha in Okyereko. In the Aveyime project area, no irrigation was possible since 1995 due to total damage of pumps and serious water leakage from canals.

### 4.1.2 Population and Farm Households

On the basis of the farm interview survey results, the population, number of farm households, and average family size were estimated as follows:

| Projects | | Ashaiman | Aveyime | K-Torkor | Mankessim | Okyereko | Total |
|---|---|---|---|---|---|---|---|
| Population | (persons) | 850 | 470 | 770 | 580 | 450 | 3,120 |
| No of Household | (No.) | 120 | 62 | 118 | 89 | 68 | 457 |
| Family size | (persons) | 7.1 | 7.5 | 6.5 | 6.5 | 6.6 | 6.8 |
| % of labour force*1 | | 70% | 51% | 57% | 50% | 52% | 58% |
| Labour/family*2 | (persons) | 5.0 | 3.8 | 3.7 | 3.2 | 3.4 | 3.9 |
| Total labour force*3 | (persons) | 600 | 240 | 440 | 290 | 230 | 1,800 |

*1 Percentage of the age group covering 15-59 year old to the total population.
*2 For instance in the Ashaiman project area, an average size is 7.1 persons. 70.2 % of the family members are economically active person. This group is regarded as labour force.
*3 70 % (600 persons) of the total population is estimated as labour force in the Ashaiman Project.

The total population and the number of farm households in the whole Project area was estimated to be 3,120 and 457, respectively. The size of farm family averages 6.8 persons in the whole area.

## 4.2 Meteo-Hydrology

Analysis of meteo-hydrological data is required mainly for the purpose of preparing the basis for irrigation planning and drainage improvement in connection with the projects rehabilitation. Data on rainfall, temperature, relative humidity, sunshine hours and evaporation are the prerequisite for the study on irrigation water requirements. Hydrological data are also required for the water balance study in order to clarify the water shortage problem as well as the study on drainage problem in some of the priority projects. Details of the analysis are given in ANNEX - B of this Report.

### 4.2.1 Climate

The climate in Ghana is characterised 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% in the Southwest and

65% in the Southeast with a 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 characteristics in each zone are summarised as follows:

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. There exists only the Kpando-Torkor project in this Zone.

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 wet months, rainfall normally exceeds potential evaporation in only about two months. Irrigation could be valuable for crops in this zone. Four projects (Ashaiman, Aveyime, Mankessim and Okyereko) are located in this Zone.

### 4.2.2 Data Collection

Metcorological observation was carried out by synoptic stations under the management of the 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 a long period. Reliability of the records is also high. Among the 20 stations, 4 stations are located relatively near the priority project areas. They are Tema, Saltpond, Ho, and Akuse stations. The data required for the Study were collected from these stations.

There exist more than 700 climatological stations in whole Ghana, which observe rainfall mainly. However, some of them are not working well, and the observation period is also short in general. In addition, reliability of the records available from these stations is not so high. Therefore, careful attention should be paid when using the data from these stations for the Study.

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 Ayensu and Ochi-Amisa basins, which are related to the Okyereko and Mankessim projects, have hydrological observation stations, and available records were collected for the Study. Since the Ashaiman project office has been carrying out

daily observation of water level of the reservoir from 1992, such data were also collected for the Study. Useful hydrological data for the remaining 2 projects are actually not available. Then, a staff gage was installed to observe the water level in the Volta river which is the water source for the Aveyime project.

### 4.2.3 Rainfall Analysis

(1) Rainfall Tendency

It is said that the tendency of arid climate has continued 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 project areas, analysis of annual rainfall with a 2-year return period at each station was made and the results are shown below:

| Project | Rainfall Station | Climate Zone | Rainfall with 2-Year Period (mm) | | |
|---|---|---|---|---|---|
| | | | 1960 - 79 [1] | 1980-Latest [2] | Ratio [2]/[1] |
| Ashaiman | Tema | Coastal Savannah | 773 | 588 | 76% |
| Aveyime | Akuse | Coastal Savannah | 1,175 | 1,155 | 98% |
| Kpando-Torkor | Ho | Transitional Zone | 1,359 | 1,286 | 95% |
| Mankessim | Saltpond | Coastal Savannah | 1,100 | 906 | 82% |
| Okyereko | Saltpond | Coastal Savannah | 1,100 | 906 | 82% |

The analysis shows that there was no significant difference of annual rainfall between the period of 1960-1979 and that of 1980 to date in the Transitional Zone. On the other hand, there is a tendency that rainfall has been decreasing in recent 15 years at the stations located in the Coastal Savannah Zone where the Ashaiman, Aveyime, Mankessim and Okyereko projects are located. This means a decrease in water resources that can be used for domestic water supply projects as well as irrigation projects.

(2) Rainfall Intensity

In order to estimate the drainage requirements for the respective projects, probability analysis of the maximum daily rainfall and the maximum 3-day continuous rainfall was made on the basis of more than 10-year series of daily rainfall data. The result of analysis is summarised as follows:

| Project | Observation Site | Data Period | Probable Rainfall (mm) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Max. Daily Rainfall | | | Max.3-Day Conti. Rainfall | | |
| | | | 2 yrs | 5 yrs | 10 yrs | 2 yrs | 5 yrs | 10 yrs |
| Ashaiman | Tema | 1976-1995 | 72.4 | 94.4 | 108.5 | 87.6 | 111.9 | 128.0 |
| Aveyime | Aveyime | 1980-1994 | 70.4 | 92.6 | 109.6 | 91.5 | 127.3 | 156.1 |
| Kpando-Torkor | Kpando | 1976-1995 | 76.9 | 116.8 | 152.9 | 105.7 | 152.0 | 187.5 |
| Mankessim | Saltpond | 1976-1995 | 93.5 | 120.5 | 135.4 | 121.0 | 152.3 | 171.4 |
| Okyereko | Saltpond | 1976-1995 | 93.5 | 120.5 | 135.4 | 121.0 | 152.3 | 171.4 |

### 4.2.4 Potential Water Source

The water sources of the priority projects are as follows:

| Project | River Basin | Water Source | Catchment Area (km2) | Tyoe of Intake Facility |
|---|---|---|---|---|
| Ashaiman | Coastal | Gyorwulu river | 82.4 | Dam |
| Aveyime | Volta | Volta river | - | Pump |
| Kpando-Torkor | Volta | Volta lake | - | Pump |
| Mankessim | Ochi-Amis | Aprapon river | 57.3 | Dam |
| Okyereko | Ayensu | Okyereko river | 17.6 | Dam |
| | | Ayensu river | 1659.0 | Weir/Pump* |

*: Supplemetal water source for the Okyereko project.

(1) Ashaiman Project

Since IDC in the Ashaiman project area carries out meteo-hydrological observations such as rainfall, water level fluctuation in the reservoir, pan evaporation and amount of water released from the reservoir, the runoff into the reservoir was estimated through a water balance study under the present project condition, using these daily data.

The result of the runoff study is summarised in the table below, which shows that the estimated average runoff ratio is 6.8%, which is very small compared with those in other river basins.

| Period | Rainfall | Runoff | | | Intake | Evaporation |
|---|---|---|---|---|---|---|
| | (mm) | (mm) | (%) | (MCM) | (MCM) | (MCM) |
| Feb. to Dec., 1994 | 673.7 | 28.9 | 4.3 | 2.38 | 0.540 | 1.246 |
| Jan. to Dec., 1995 | 902.5 | 90.0 | 10.0 | 7.414 | 0.343 | 1.795 |
| Jan. to Jun., 1996 | 602.8 | 29.7 | 4.9 | 2.447 | 0.189 | 1.373 |
| Total | 2,179.0 | 148.6 | 6.8 | 12.241 | 1.071 | 4.416 |

MCM : million cubic meters

Such a small runoff ratio may be due to the hydrological conditions such as topography, soils and vegetation in the chatchment area. In fact, water level records show that the dam becomes rarely full. This is the main cause of serious water shortage in this project area. In addition, high evaporation rate, about 2,000 mm per year from the dam water surface, and shallow effective water depth of the reservoir may aggravate the water shortage problem.

(2) Aveyime Project

The water released from the Akosonbo dam is stored in the Kpong dam once, and then it is released again from the Kpong dam under the supervision of the Volta River Authority (VRA). The water released from the Kpong dam and the inflow from the downstream basin become the water source for the Aveyime project.

The amount of water released from the Kpong dam can be estimated from the relationship between the water level records and the rating curve. The minimum release was estimated at about 200 $m^3$/sec, which corresponds to the discharge with a 10-year non exceedence return period. The water available for the Aveyime project with about 100 ha of irrigable area would be enough for its rehabilitation.

The water level at the tail side of the Kpong dam is managed by VRA and ranges from 0.77 m (Low Water Level) to 3.77 m (High Water Level) in elevation above sea level. When the water level at the tail side is operated within such a range, the rive water level at the Aveyime project site fluctuates within a range between 1.7 m (High Water Level) and nearly sea water level ( 0 m in elevation).

(3) Kpando-Torkor Project

The water source of this project is the Volta lake. Its capacity is up to 150,000 million cubic meters (MCM). Although the lake water is used for electric power generation, available water in the lake is sufficient for irrigation use in this project area.

The water level of the lake fluctuates from season to season, while irrigation water for this project will be lifted from the lake at pumping stations to be constructed on the lake shore. This means that a study on water level fluctuation in the lake is required for design of pumping stations. Then, the water level records of the lake were collected from VRA. The water level of the lake is managed by VRA so as to be within the upper-lower water level regulation, with 8 m fluctuation in height.

(4) Mankessim Project

This project has a reservoir constructed on the Aprapon river which is a tributary of the Ochi-Amisa main river, and serious water shortage problem does not occur at present, because the irrigated area is very small, about 20 ha, compared with the storage capacity of the reservoir. The catchment area of the reservoir is estimated at 57.3 $km^2$. Since the Aprapon river is not perennial one, the reservoir becomes full only once in a 10-year period approximately. According to the discharge records of the Ochi-Amisa river, the discharge becomes null in the drought years. In this case, the water released from the Mankessim reservoir is used not only for irrigation but also for domestic purpose in the downstream areas. Therefore consideration should be paid to domestic water use, in the water balance study.

(5) Okyereko Project

Since the water source of this project is the existing Okyereko reservoir fed by rainfall

only, the irrigated area is severely restricted at present. In fact, the irrigated area in the past 5 years from 1991 to 1995 ranged from 7.3 ha to 31 ha and averaged 21.6 ha. In addition, the water balance study shows that the irrigable area with 80% dependability would only be 11 ha, out of 110 ha of potential irrigable area. GIDA has a plan to provide supplemental water source by installing pumps on the Ayensu river located near the project site. Then, study of an alternative plan was made so as to include a new pumping station in the proposed rehabilitation works of the project.

To study the plan, an analysis of discharge records in the Ayensu river was made, and the estimated discharges of the Ayensu on a monthly basis were obtained. The following is a summary of the estimated discharges:

(Unit: m3/sec.)

| Return Period | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 years | 0.52 | 0.32 | 0.42 | 0.84 | 2.01 | 16.18 | 10.37 | 5.46 | 3.97 | 6.04 | 3.69 | 2.03 |
| 5 yeras | 0.23 | 0.11 | 0.11 | 0.37 | 0.59 | 10.03 | 4.06 | 1.67 | 1.2 | 2.77 | 1.85 | 1.24 |
| 10 years | 0.12 | 0.01 | 0.06 | 0.23 | 0.33 | 7.78 | 2.59 | 0.98 | 0.72 | 1.72 | 1.18 | 0.91 |

The pumps required for supply of the necessary amount of water to the Okyereko reservoir were designed on the basis of the estimated discharges and irrigation water requirements for this project. In this case, consideration should be paid to the release of city water to Winneba, which was estimated at 1 million gallons per day. As a result, pumps could be operated during the period from June to November in a year.

### 4.2.5 River Runoff Study

River runoff study is required to estimate the available amount of water for irrigation through a water balance study for the Ashaiman, Mankessim and Okyereko projects whose water sources are reservoirs. Since the river discharge records related to the projects were not sufficient in terms of observation period and number of gauging stations, the study was made using the rainfall data.

The water balance study was carried out under the present Ashaiman project condition, using daily data on rainfall, water level fluctuation in the reservoir, pan evaporation, and amount of water released from the reservoir. This water balance study for the Ashaiman project gave useful information for river runoff study for the Mankessim and Okyereko projects for which the tank model method was applied. The model was composed of 4 tanks combined vertically, and each tank had two types of outlets, one for runoff and the other for percolation. At first, rainfall was stored in the upper tank, which was divided into runoff and percolation through each outlet by multiplying with coefficients which vary depending on water depth. Finally, the runoff was estimated as total water volume passing through the runoff outlets of the four tanks.

The coefficients to be applied to the tank model were determined using the daily rainfall data at Ashaiman and runoff into the reservoir obtained from the water balance study. Using such input data as daily rainfall and the estimated runoff, calibration of the tank model method was made.

The runoff study was made for 10 years from 1985 to 94, using rainfall data at Mankessim and Okyereko and the above tank model method. The results of the study are summarised as follows:

| Project | Rainfall (mm/year) | Runoff (mm/year) | Runoff Coefficient (%) |
|---|---|---|---|
| Ashaiman | 610.6 | 26.728 | 4.38 |
| Mankessim | 885.7 | 49.319 | 5.57 |
| Okyereko | 778.1 | 36.784 | 4.73 |

The above results were fully used for water balance study to prepare the optimum rehabilitation plan for the Ashaiman, Mankessim and Okyereko projects.

### 4.2.6 Flood Discharge

A drainage problem caused by floods from the rivers located adjacent to the Project was observed in the Mankessim and Okyereko projects. The flood discharge of the Ochi-Amisa river at Mankessim and the Ayensu river at Okyereko was analysed to study the drainage problem in both projects areas. In addition, the analysis was also required for design of pumping station to be constructed on the Ayensu river for the Okyereko project.

Discharge observation at both rivers was being carried out by AESC. However, the observation period of daily data was too short to make the frequency analysis. Then, the method applied for flood discharge analysis is as follows:

a) Unit graph method is applied for the analysis.
b) Rainfall data are used for the analysis.
c) Unit graph is made by using the Sato formula which is a function of flood concentration time.
d) Flood concentration time is calculated by the Kraven formula.
e) Design rainfall is calculated from three consecutive days rainfall observed at Saltpond for both rivers.
f) Effective rainfall is estimated using the observation data at the Ochi-Amisa river.

The results of the analysis are summarised in the following table. In addition, a comparative study of the Unit Graph method with the Rational formula was made in order to confirm the reliability of this flood analysis.

For Ochi-Amisa River (Catchment Area: 1,217 km2)

| Return Period | 3-Day Rainfall (mm) | Flood Dischrage (m3/sec) |
|---|---|---|
| 2-year | 121.0 | 130 |
| 5-year | 152.3 | 200 |
| 10-year | 171.4 | 230 |
| 25-year | 194.0 | 330 |
| 50-year | 210.0 | 360 |

For Ayensu River (Catchment Area: 1,659 km2)

| Return Period | 3-Day Rainfall (mm) | Flood Discharge (m3/sec) |
|---|---|---|
| 2-year | 121.0 | 145 |
| 5-year | 152.3 | 220 |
| 10-year | 171.4 | 255 |
| 25-year | 194.0 | 370 |
| 50-year | 210.0 | 400 |

## 4.3 Soil and Land Suitability

### 4.3.1 Soils

(1) Soil Classification

A soil description survey was carried out in each of the project areas at a density of one pit per about 25 ha. 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, University of Ghana.

On the basis of field survey records and laboratory test results, the soils were classified into the following soil units according to the legend of Soil Map of the World (FAO/UNESCO, 1988). The dominant soil units in the each project area are presented below.

| Project | FAO/UNESCO Classification |
|---|---|
| (1) Ashaiman | Distric Planosols, Cambic Arenosols, Gleyic Cambisols, Dystric Vertisols |
| (2) Aveyime | Ferralic Arenosols, Dystric Cambisols, Gleyic Cambisols, Dystric Vertisols |
| (3) Kpando-T | Skeletic- Vertic Cambisols *1, Skeletic- Chromic Cambisols, Dystric Fluvisols / Cambic Arenosols, Skeletic-Distric Gleysols, Dystric Vertisols |
| (4) Mankessim | Eutric Gleysols, Haplic Alisols, Ferric Alisols, Gleyic Cambisols, Skeletic-Haplic Alisols *1 |
| (5) 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 ironstones, with a thickness of at least 25 cm.

(2) Mapping Unit Description

The lands (soils) for each project were 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.

### 4.3.2 Irrigation Suitability Evaluation

(1) Evaluation System

Irrigation suitability of each project area was assessed according to the USBR (US. Bureau of Reclamation) system, according to which the land is categorised into the following 6 suitability classes:

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

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

| | |
|---|---|
| Soils | : Effective depth, texture |
| Topography | : Slope |
| Drainage condition | : Internal and external |

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

| Project | Land Evaluation Type |
|---|---|
| Ashaiman | Wetland rice and upland crops |
| Aveyime | Wetland rice and upland crops |
| Kpando-T. | Upland crops |
| Mankessim | Upland crops |
| Okyereko | Wetland rice and upland crops |

(2) Result of Land Evaluation

The distribution of suitability classes in the rehabilitation area of each project is summarised as follows:

1) For Wetland Paddy

| Project | Suitable | | Restrictedly Suitable | | Non-Suitable | | Total | |
|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % |
| 1. Ashaiman | 59 | 88 | 8 | 12 | 0 | 0 | 67 | 100 |
| 2. Aveyime | 87 | 78 | 0 | 0 | 25 | 22 | 112 | 100 |
| 3. Okyereko | 82 | 86 | 13 | 14 | 0 | 0 | 95 | 100 |

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

2) For Upland Crops

| Project | Suitable | | Restrictedly Suitable | | Non-Suitable | | Total | |
|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % |
| 1. Ashaiman | 59 | 88 | 8 | 12 | 0 | 0 | 67 | 100 |
| 2. Aveyime | 112 | 100 | 0 | 0 | 0 | 0 | 112 | 100 |
| 3. Kpando-Torkor | 263 | 57 | 192 | 43 | 0 | 0 | 461 | 100 |
| 4. Mankessim | 92 | 96 | 4 | 4 | 0 | 0 | 96 | 100 |
| 5. Okyereko | 94 | 98 | 0 | 0 | 2 | 2 | 95 | 100 |

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

As a basic rule, non-suitable areas were not selected for future rehabilitation. Therefore, non-suitable areas for both crop types are not shown in the rehabilitation area, however, NS can be seen in the above tables. In the Kpando-Torkor, 40% of the area was classified into Class IV. Since these lands have only 20 cm effective soil depth and a skeletic layer is observed below 20 cm, they have a high potential of land degradation. If the lands are used for agriculture purpose, careful attention and proper conservation works should be taken. In addition, monitoring of the soil erosion effect are also needed to ensure sustainable use. The saline areas found in the Ashaiman and Okyereko project areas were also classified into Class IV, because the project will have a proper drainage system and the salinity condition will be improved. As mentioned in the following section, it was estimated that about 70% of salt in the area will be leached out after 1-year irrigation with a proper drainage system. Hence the lands even strongly affected by salt were considered to be possible to get the expected yields.

### 4.3.3 Development Constraints from Soil Aspect

The following problem soils were identified in the priority projects through the Study.

(1) Saline Soil

Twelve ha in Ashaiman and 2 ha in Okyereko were considered as saline soils. The saline soils in both areas were observed in poorly drained fields along the drain. The area of saline soils is small and just found at some spots in the areas, however both project areas have still potential lands which may be affected by poor drainage. As the following table shows, the ECe values of surface soils are high and they are classified into saline to strongly saline soil (saline soil: 8-15 mS/cm, strongly saline soil: over 15 mS/cm), and also some of these also show a sodic property. Presently, most of these salt-affected lands are not used for rice cultivation.

| Project area | | Texture | pH | ECe *1 (mS/cm) | ESP (%) |
|---|---|---|---|---|---|
| Ashaiman | Surface-1 | L | 6.6 | 16.5 | 18 |
| | Surface-2 | SCL | 7.2 | 6.8 | 7 |
| Okyereko | Surface-1 | SL | 4.9 | 23.0 | 14 |
| | Surface-2 | SiCL | 6.0 | 7.5 | 8 |

Remarks: The values of ECe were calculated from data of EC (1:5)

(2) Shallow Soil

The soil which has a "skeletic" phase is dominant in the Kpando-Torkor project area

Since the effective depth of soil to the skeletic layer is about 20 to 50 cm, the soil is assumed to be a high potential for land degradation. Once the surface soil is removed, the lands will be changed to unusable land for any purposes. The slope of the area is, however, as gentle as 2% to 3% , and the rain intensity is relatively high in the rainy season. In fact, the depth of soils in present irrigated fields is shallower than the one under secondary forest. Therefore, it is apparent that the land use and farming practice are key factors for the sustainability.

## 4.4 Present Agriculture

### 4.4.1 Main Crops and Cropping Patterns

(1) Ashaiman Project

Although the developed area of this project is 130 ha on both left and right banks of the project area, crop production under irrigation is limited to the left bank only at present. It is mainly because of irrigation water shortage and canal leakage. The crops cultivated are paddy rice in both the dry and wet seasons and okra in the dry season only. The varieties of paddy rice are GK88 (growing period: 110 days), ITA222 (120 days), and GRUG7 (125 days). The okra variety is Labadi. Regarding the soil condition , clay soil is generally distributed in downstream area (40% in area) of the left bank. The area has high production potential of paddy rice. Okra is adapted to clay soil and used as a rotation crop of paddy rice. Sandy soil (30% in area ) and sandy clay soil (30% in area) are distributed in the upstream area of the left bank. These soils would be suitable for upland crops including vegetables, though paddy rice and okra are also grown at present.

The average crop area, crop yield and crop production are summarised below. The crop area of paddy rice is 18.8 ha and 18.6 ha in the dry and wet seasons, respectively. Average yield is still low, 3.35 - 3.40 ton/ha, because of sandy soil, irrigation water shortage and poor farming practices. Lodging of paddy rice at the harvesting time is frequently observed in the wet season. It is because of overseeding by broadcasting farming. Okra is cultivated in 17.0 ha of land in the dry season. The yield is low, 6.00 t/ha. Cropping intensity in the Ashaiman project area is 0.42 or 42 %, which means a low level of land use.

| Crop | Ave. Crop Area | | Ave. Crop Yield | | Ave. Crop Production | |
|---|---|---|---|---|---|---|
| | ds (ha) | ws (ha) | ds (ton/ha) | ws (ton/ha) | ds (ton) | ws (ton) |
| Paddy rice | 18.8 (15%) | 18.6 (14%) | 3.4 | 3.4 | 62.98 | 63.24 |
| Okra | 17.0 (13%) | - | - | 6.0 | 102.00 | - |
| Total | 35.8 (28%) | 18.6 (14%) | | | | |

Note : 1) ds: dry season, ws: wet season.
2) Figures in parentheses indicate percentage of crop area to developed area (130 ha) in the dry or wet season.

The land on the right bank is used to grow rainfed maize, okra and cassava by the farmers. The present land allocated for the research works by IDC at Ashaiman is about 1.0 ha, mainly for the trials of varietal evaluation and seed multiplication. When the research activities are accelerated, two to three hectares of land will be necessary in the future.

(2) Aveyime Project

In the Aveyime project area, only paddy rice is planted in both the dry and wet seasons. Although irrigation services by GIDA have been stopped at present because of deterioration of pump facilities, the farmers continue to grow paddy rice with irrigation water from small streams using their own small pumps. The soil condition in this project area is rather poor, because sandy soil is distributed in most of the area. Clay soil which is suitable for paddy rice production, is limited to the downstream area.

The average crop area, crop yield and crop production are summarised as follows: Average crop area of paddy rice is 28.9 ha and 28.5 ha in the dry and wet season, respectively. Average crop yield in the dry season is very low, 2.55 t/ha. It may be due to sandy soil and poor farming practices. Cropping intensity in the Aveyime project area is 0.91 or 91 %, which means medium level of land use.

| Crop | Ave. Crop Area | | Ave. Crop Yield | | Ave. Crop Production | |
|---|---|---|---|---|---|---|
| | ds (ha) | ws (ha) | ds (ton/ha) | ws (ton/ha) | ds (ton) | ws (ton) |
| Paddy rice | 28.9 (46%) | 28.5 (45%) | 2.55 | 4.08 | 72.68 | 117.91 |
| Total | 28.9 (46%) | 28.5 (45%) | | | | |

Note : 1) ds: dry season, ws: wet season.
2) Figures in parentheses indicate percentage of crop area to developed area (63 ha) in the dry or wet season.

Farmers grow rainfed maize, cassava, groundnut, cowpea, and hot pepper in and outside the project area in the wet season.

(3) Kpando-Torkor Project

Okra is the only crop being grown under irrigation in the dry season in the Kpando-Torkor project area. Since damage of okra by continuous cropping is caused by soil-born diseases (nematode and fungus root rot disease), farmers grow okra under a land rotation system. Farmers do not use the project land for any crop cultivation in the wet season, because very small land (0.1 ha per family) is allocated to the farmers by the project. They plant their main food crops such as maize, cassava, yam and cowpea in their own land, in the wet season which is located outside the project.

The average crop area, crop yield and crop production in the Kpando-Torkor project area are summarised below. Average crop area is 13.0 ha, i.e. 33% of developed area. The okra varieties are Labadi and Lolobi. Cropping intensity in the Kpando-Torkor project area is 0.33, which means a very low level of land use.

| Crop | Ave. Crop Area | | Ave. Crop Yield | | Ave. Crop Production | |
|---|---|---|---|---|---|---|
| | ds (ha) | ws (ha) | ds (ton/ha) | ws (ton/ha) | ds (ton) | ws (ton) |
| Okra | 13.0 (33%) | - | 10 | - | 130 | - |
| Total | 13.0 (33%) | - | | | | |

Note : 1) ds: dry season, ws: wet season.
2) Figures in parentheses indicate percentage of crop area to developed area (40 ha) in the dry or wet season.

The present agricultural production in the Kpando-Torkor project area has two problems; one is mono-culture in upland field, and the other is marketing of okra. Okra is sold at the markets in Kpando, Hohoe and Ho by market mammies and middlemen. No market mammies come from Accra recently, because the transportation cost becomes higher than before. Therefore, over production will take place, if farmers continue to grow only okra even after project rehabilitation.

It is made clear that the damage of okra by continuous cropping is caused by the infection of certain soil-born diseases and nematode. Crop rotation is the most practical method for alleviation of such a damage.

(4) Mankessim Project

The main crop grown in the dry season in this project area is watermelon which is intercropped with egg plant and/or okra under irrigated condition. After watermelon, sweet potato is planted mostly under rainfed condition. Although intercropping is favourable for farmers whose land holding is small, the problem foreseen is continuous cropping of egg plant and okra under the present cropping system. Separate cultivation of watermelon, egg plant and okra is recommended in order to avoid crop damage due to continuous cropping.

The average crop area, crop yield, crop production and cropping pattern are summarised below. The crop area of watermelon is 13.8 ha, i.e. 81% of the developed area. Egg plant and okra are seeded between hills of watermelon after one month of watermelon seeding. Since the fruits of watermelon are harvested all at once, the field can fully be used for cultivation of egg plant or okra. The varieties of watermelon, egg plant and okra are Sugar Baby, local variety (purple) and White Beauty, and Lady Finger, respectively. Cropping intensity in the Mankessim project is 1.09 or 109 %, which is a medium level of land use.

| Crop | Ave. Crop Area | | Ave. Crop Yield | | Ave. Crop Production | |
|---|---|---|---|---|---|---|
| | ds (ha) | ws (ha) | ds (ton/ha) | ws (ton/ha) | ds (ton) | ws (ton) |
| Watermelon | 13.8 (81%) | - | 9.5 | - | 131.0 | - |
| Egg plant | 10.7 (62%) | - | 12.1 | - | 129.8 | - |
| Okra | 4.9 (29%) | - | 5.1 | - | 25.1 | - |
| Sweet potato | - | 4.7 (28%) | - | 9.0 | - | 42.3 |
| Total | 25.8 (28%) | 18.6 (14%) | | | | |

Note : 1) ds: dry season, ws: wet season.
2) Figures in parentheses indicate percentage of crop area to developed area (17 ha) in the dry or wet season.

Farmers grow rainfed maize, cassava and groundnut in the wet season in their own farm located outside the project area.

(5) Okyereko Project

Paddy rice is planted under irrigation only in the dry season in the Okyereko project

area. The soil condition is mostly sandy and sandy clay. Clay soil is distributed in a limited area on the downstream side of the project.

The average crop area, crop yield, crop production and cropping pattern are summarised below. The crop area of paddy rice is 21.1 ha, i.e. 53% of the developed area. The paddy rice varieties are ITA222, GK88 and GRUG7. Average yield is still low, 3.75 tons/ha because of severe water shortage, minimum application of farm inputs and poor farming practice. Broadcasting of dry seed is practised as the traditional method of paddy rice farming in this area. It is like a sort of dry farming. Farmers do not use any agro-chemicals. Cropping intensity in the Okyereko project area is 0.53 or 53 %, which indicates a low level of land use.

| Crop | Ave. Crop Area | | Ave. Crop Yield | | Ave. Crop Production | |
|---|---|---|---|---|---|---|
| | ds (ha) | ws (ha) | ds (ton/ha) | ws (ton/ha) | ds (ton) | ws (ton) |
| Paddy rice | 21.1 (53%) | - | 3.75 | - | 79.50 | - |
| Total | 21.1 (53%) | - | | | | |

Note : 1) ds: dry season, ws: wet season.
2) Figure in parentheses indicate percentage of crop area to developed area (40 ha) in the dry or wet season.

Usually, farmers grow rainfed maize, cassava, groundnut, okra and cabbage without fertiliser in the wet season in their own farm located outside the project area.

As mentioned above, paddy rice is grown only in the dry season. The reason why the farmers do not grow any crops in the project area in the wet season is as follows: (a) farmers want to grow crops in their own land without any fertiliser in the wet season ; (b) farmers do not have enough money to buy seed and fertiliser for the next dry season cropping, and they will collect money from their wet season harvest ; and (c) tractors owned by the project are very old and not powerful to plough the wet and heavy soil in the wet season.

### 4.4.2 Farming Practices and Farm Inputs

(1) Farming Practices

Detailed information on farming practice of crops being grown (field preparation, seeding, transplanting, irrigation and drainage, fertiliser and agro-chemical application, weeding, harvesting, use of agricultural machinery and labour force), post-harvest and marketing practices in the project area were collected. The crops surveyed are broadcasting and transplanting paddy rice, egg plant, okra, watermelon, and sweet potato.

Farming practices of tomato and onion in the Amate project area, one of the 12 existing projects studied during Phase-I, were also investigated, because these crops are not cultivated on a large scale in the priority project areas. Tomato and onion in the Amate project area are very profitable cash crops in both the dry and wet seasons. Farming practice of transplanted paddy rice in the Dawhenya project area was also surveyed, because advanced farming practice

will be adopted to achieve higher yield of about 6.0 t/ha, after the project rehabilitation in this area.

Land preparation of lowland is usually done by tractors owned by the projects in the Aveyime and Okyereko areas, and rented power tiller in the Ashaiman project area. The project tractors are also used for preparation of upland in the Kpando-Torkor and Mankessim project areas. Seeding, transplanting, ridging, fertiliser application, weeding and harvesting are usually done by man power. Nap sack sprayer is used for agro-chemicals application in all projects.

It is a traditional practice that basic fertiliser (N-P-K compound fertiliser) is applied two to three weeks after seeding or transplanting. The basic fertiliser should be applied, at least at a half rate, before seeding or transplanting to be more effective, especially for P and K fertiliser. This method of fertiliser application is already practised in the Dawhenya project area.

Regarding agricultural machinery, power tiller with operator rented from private companies is very powerful and handy for ploughing and harrowing in the Ashaiman project area. The old project tractors with 44 - 65 Hp are used for ploughing and harrowing in other four project areas.

As for manual labour requirements for farming, maize, groundnut and cowpea are the most labour saving crops. Broadcasting paddy rice is less laborious than transplanting paddy rice. Vegetables are, in general, more labour intensive than food crops. Onion and tomato are the most labour intensive among vegetables. Therefore, one acre or one and a half acre of land may be optimum area for vegetable cultivation for a farmer household of standard size without any powerful agricultural machinery.

(2) Farm Inputs

1) Seed and seed supply

The following are the varieties being used in the project areas:

| Crop | Project | Variety |
|---|---|---|
| Paddy rice | Ashaiman, Aveyime Okyereko | GK88, GK9, ITA222, GRUG7 |
| Okra | Ashaiman, Mankessim | Labadi, Lolobi, Lady finger |
| Egg plant | Mankessim | White beauty, local variety |
| Watermelon | Mankessim | Sugar baby |
| Sweet potato | Mankessim | Local variety (White) |

Seed of paddy rice is obtained from the previous crop in the Ashaiman, Aveyime and Okyereko project areas. When the seed of a variety is mixed with those of other varieties and the purity is lost, new seed is obtained from the seed multiplication plot of the Ashaiman research centre. Among vegetables, egg plant seed is ob-

tained from the previous crop. Watermelon seed is mainly purchased from seed shops in the market. Okra seed is purchased from seed shops in the market and from other farmers. Vine of sweet potato for transplanting in the Mankessim project is taken from the nursery plots in the project area.

2) Fertilisers

The 15-15-15 compound fertiliser is commonly used as basic fertiliser for all crops in all of the project areas. Urea is used for top dressing of paddy rice, while sulphate ammonium (SA) is popularly used for top dressing of maize and vegetables. No fertiliser application is usually practised for cultivation of groundnut and cowpea because of short growing period. The present application rate in the projects is summarised as follows: Higher rates of nitrogen fertiliser are applied for paddy rice, egg plant, okra, and watermelon. Medium rates of nitrogen are applied to maize and other vegetables.

| Application Rare | Crop |
|---|---|
| High rate (N: 100-80 kg/ha) | Paddy rice, Egg plant, Okra, Watermelon |
| Medium rate (N: 70-50 kg/ha) | Maize*, Tomato*, Hot pepper*, Onion* |
| No fertilization | Groundnut & Cowpea* |

Note * : Data taken from Master Plan Study in 1995

The application rate of fertiliser is generally low, because the prices of fertiliser are still high compared with those of agricultural products. Organic manure is not applied in most of the project areas, except for the Ashaiman project, though they are very important to increase soil fertility and productivity, and for saving chemical fertilisers as well.

3) Agro-chemicals

Various diseases, insect pests, wild birds and animals which are harmful to crops are observed at the projects. For paddy rice, blast and brown leaf spot is common disease, while stem borer, rice hispa, case worm and leaf roller are serious insect pests in the project areas. Stem borer is also a common insect pest for maize. Caterpillars and paudadrica cause serious damage to okra plant. Nematode damages tomato and okra.

Wild birds reduce the yield of cereal crops. Paddy rice is attacked by *Quelea quelea*, weaver bird and sparrow. Maize is also damaged by weaver bird. Partridge, another wild bird, causes damage to maize and cowpea. Major animal damage is caused by grass cutter (big rat), mice (small rat), squirrel, and toad (a kind of frog). Grass cutter damages maize, cowpea, groundnut, and cassava, while mice attacks paddy rice, maize, tomato, egg plant, and sweet potato. Squirrel attacks young fruits of watermelon at Mankessim, and toad attacks okra seed in the soil at Kpando-Torkor.

To control serious diseases and pests, various kinds of agro-chemicals are applied at present. Higher rates of various fungicides are applied for tomato. Egg plant and hot pepper also need higher application rates of insecticides to control damage by insect pests. Application of herbicides is made only for paddy rice to control the weeds. Rodenticides are used frequently for paddy rice, and infrequent by tomato, hot pepper and okra to protect them against grass cutters and mice.

Plant protection against diseases, insect pests, weed grass, wild animals, and birds is important to ensure higher yields and good quality of farm products. The present application rate of agro-chemicals is still not so high because of higher prices of agro-chemicals. Hand weeding to clean farmland is an effective method for minimising diseases and pests proliferation as well as for saving the use of agro-chemicals.

### 4.4.3 Crop Yield and Production

Average yields of crops being grown in the project areas are summarised as follows:

| Crop | Average Crop Yield (ton/ha) | |
|---|---|---|
| | Phase-II Study | Phase-I Study |
| Paddy rice | 3.43 | 4.47 |
| Maize | - | 2.59 |
| Cowpea | - | 1.52 |
| Groundnut | - | 1.36 |
| Tomato | - | 8.17 |
| Egg plant | 12.30 | 12.78 |
| Hot pepper | - | 5.30 |
| Okra | 7.04 | 7.86 |
| Onion | - | 14.50 |
| Watermelon | 9.50 | 11.86 |
| Sweet potato | 9.00 | 9.00 |

### 4.4.4 Animal Husbandry and Fish Pond

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

Cattle grazing is seen in the Aveyime project area. Goat and sheep are very popular livestock. Chicken is most popular poultry. Guinea fowl is well adapted poultry in the Transitional Zone. Duck and turkey are rather seldom. In general, animal husbandry is very popular in the inland area, but not so popular in the coastal area and the Volta Lake area. Sea fishery is popular in the coastal area, and inland fishery is popular in the areas facing the Volta Lake.

A fish pond has been constructed in Ashaiman (0.8 ha in area). Fish species being raised in Ashaiman are Tilapia and mud fish.

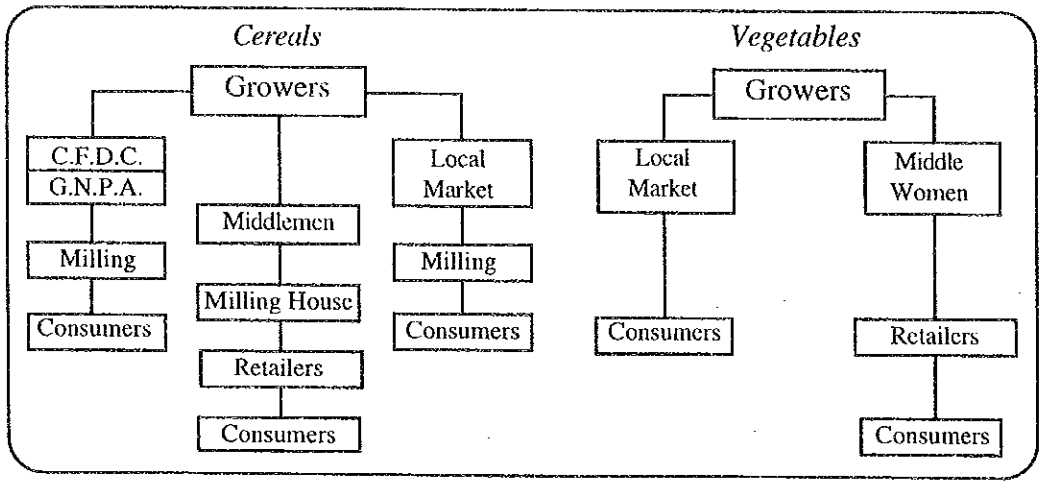
### 4.4.5 Marketing, Processing and Storage

(1) Marketing

Agricultural marketing at the project sites is conducted mostly by small-scale operators. The principal agents are women coming from major cities and those who bring agricultural outputs and food products by headload to rural markets. 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 the 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 the form of paddy to the middlemen or market women who visit 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 the Mankessim area, watermelon is sold at the project gate to market mammies who come from Accra, Cape Coast, and Sekondi. In the Kpando-Torkor area, dry season okra is also sold directly to market mammies from Ho, Tema and Accra. Selling at farm gate is usually practised when space for storage of farm products is not sufficiently available at the project site, especially at the sites where maize is cultivated. In the case of selling to local markets, farm products are transported by GIDA trucks in Mankessim, when market mammies do not come to buy their egg plant at the site.

The prevailing channels of marketing cereals and vegetables related to the projects are illustrated in the following figure. The marketing route of cereals is separated into three channels. The main route is from the procedures through middlemen or market mammies, milling houses and retailers, to the consumers, as its terminal. Rice and maize are marketed through the Cereal Food Distribution Corporation, National Procurement Authority, milling house, and finally to the consumers. The retailers are not included in this channel. The Cereal Food Corporation and National Procurement Authority are both corporate bodies. Therefore, they have no function of controlling market prices. In the case of vegetable, fresh vegetables are sold by market women at the local markets. The market channel of root vegetable and fruit vegetables such as yam, cassava, onion, shallot, tomato, eggplant, etc. is through market mammies and retailers. The retailers take part in marketing services between market women and consumers.



The locations of the major markets related to the projects are listed below:

| Projects | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Kpando | Ho | Hohoe | Kpond market | KpondoTorkor |
| Ashaiman | Tema | Ashaiman | Kpondo | Suhum |
| Aveyime | Kasseh | Aveyime | Battor | Ashaiman |
| Mankessim | Mankessim | Keneahi | Agbogboloahie | La,Trad fair area |
| Oyereko | Swedry | Aki oda | Winneba | Kasoa |

Note: The major markets are ranked in order in the table above.
One (1) means the most important market and four (4) the less important market.

The marketing channels of fertilisers and agricultural chemicals are separate. Imported fertilisers are handled by importers at the sea port. Then, fertilisers are transported through local agents and wholesalers. The marketing route of imported fertilisers is separated into two routes: The first route is from farmers' groups to individual farmers as terminal consumers. The second route is from retailers to consumers.

The marketing channel of agricultural chemicals is the same as that for imported fertilisers. The only difference is the importer license.

(2) Post-harvest, Processing and Storage Facilities

Regarding the processing facilities of farm products, there are no rice mills in the project areas, except for the Ashaiman project. There is a private rice mill with a very limited milling capacity at Aveyime. However, the Okyereko project where rice is the main crop has no rice mill.

Each project has warehouses and storage with a limited storage capacity to meet the immediate need to store agricultural inputs and equipment. Most of agricultural products are stored in the farmers' houses. 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.

## 4.5 Present Irrigation and Drainage Facilities

The existing irrigation and drainage facilities were investigated through inventory survey at each project site, and an inventory of the facilities is given in Table-1.

### 4.5.1 Present Irrigation System

(1) Irrigation Type

The present water sources, intake method and irrigation type for the selected five projects are as follows:

Present Irrigation System

| Project | Water Source | Facility | Irrigation Type |
|---|---|---|---|
| 1. Ashaiman | Ashaiman reservoir | Dam/Intake valve | Gravity |
| 2. Aveyime | Volta river | Pump | Gravity |
| 3. Kpando-Torkor | Volta lake | Pump | Sprinkler |
| 4. Mankessim | Apropong reservoir | Dam/pump | Sprinkler |
| 5. Okyereko | Okyereko reservoir | Dam/Intake gate | Gravity |

(2) Irrigation Requirements

The Ashaiman project has data on irrigation requirements for paddy, which have been measured by IDC, but other projects have no data. The measurement results in the Ashaiman project are given below:

(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

(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

From these results and effective rainfall, and assuming a 20% loss, irrigation water requirements for both the major and minor seasons were estimated at 8,400 $m^3$/ha and 7,400 $m^3$/ha, respectively. These requirements which would be equivalent to 1.1 lit./s/ha and 1.4 lit./s/ha, respectively, are judged to be within a reasonable range.

(3) Irrigation Schedule

Only the Ashaiman project has an irrigation schedule which has been prepared by IDC. The other four projects have no definite irrigation schedule, and thus irrigation is made only based on the past experience and visual judgement of soil condition, in reply to the farmers' request. Since the farmer's idea on water supply is generally conservative, it is likely that the volume of water supplied is unnecessarily larger than the actually required volume.

### 4.5.2 Intake Facilities and Capacity

As mentioned above, the Aveyime and Kpando-Torkor projects are provided with pumps to tap irrigation water from the Volta river and Volta lake, respectively, but these are

severely deteriorated and will be totally replaced with new ones. On the other hand, the Ashaiman, Mankessim and Okyereko projects are equipped with either intake valves or gates for supplying the required discharge to subsequent canals and finally to each field. The existing intake gates and valves are still in good working condition, therefore no rehabilitation will be required. The intake capacity is as follows:

Existing Intake Capacity

| Projects | Intake Capacity (m3/s) | Potential Area (ha) | Unit Discharge (lit/s/ha)* |
|---|---|---|---|
| Ashaiman | 0.560 | 148 | 3.78 |
| Mankessim | 0.364 | 256 | 1.42 |
| Okyereko | 0.546 | 111 | 4.92 |

* : Calculated by dividing intake capacity by potential area at this time.

The above table indicates that all the existing intake gates and valves have enough capacity to feed irrigation water even for whole potential area.

### 4.5.3 Water Delivery System

Water distribution for the Project is made by two methods: Continuous and rotational methods. The former is applied for Ashaiman project only, and the latter for the remaining four projects. As tabulated below, the irrigation interval and daily irrigation time in rotational method ranges from 2 to 10 days and 6 to 12 hours, respectively.

Water Distribution Method

| Project | Irrigation Method | Irrigated Crops | Water Distribution Method |
|---|---|---|---|
| Ashaiman | Gravity | Paddy, Okra, Tomato | Daily irrigation time: 10.5 hours<br>Continuous water supply |
| Aveyime | Gravity | Paddy | Daily irrigation time: 8 hours for 8 acres<br>Irrigation interval : 10 days |
| Kpando-Torkor | Sprinkler | Okra | Daily irrigation time: 6 hours<br>Irrigation interval : 2 to 3 days |
| Mankessim | Sprinkler | Okra, Gardenegg | Daily irrigation time: 6 hours<br>Irrigation interval : 5 days |
| Okyereko | Gravity | Paddy | Daily irrigation time: 12 hours<br>Irrigation interval : 10 days |

### 4.5.4 Structures

An inventory survey was carried out for the existing structures, to grasp their present conditions. In general, most of them are severely deteriorated, and require new construction or replacement accordingly. Besides, these structures are insufficient in number for proper operation of the canal systems. Measuring devices which are important to ensure accurate water distribution, are not provided at all for the projects, except the Ashaiman project. It was found in all the project areas that crossing structures such as bridges and culverts are also inadequate in number to execute suitable agricultural activities.

### 4.5.5 Problems in Irrigation System

(1) Available Water Source

Of the selected five priority projects, the Ashaiman, Mankessim and Okyereko projects have limited water source. These projects are provided with a reservoir, but the in-flow to the reservoir is absolutely insufficient for year-round irrigation with 80% dependability, according to the master plan level study.

In particular, a serious water shortage is foreseen for the Ashaiman project. The main reasons for such water shortage are (a) small catchment area against the present developed area, and (b) low runoff coefficient which is observed by IDC. Even if the storage capacity of the reservoir is increased by heightening the crest elevation of the spillway or dam, the increased amount of water would be consumed mostly by evaporation due to increase in water surface area in the reservoir. Any other supplemental water source could be found near the project site.

The Okyereko project would also be subject to water shortage. In order to cope with this issue, GIDA has a plan to exploit a supplemental water source by installing pumps on the Ayensu river flowing near the project area. Then, the Study has taken into account the exploitation of this supplemental water source.

A preliminary water balance study was also executed for the Mankessim project. The study result shows that the Mankessim project could be provided with year-round irrigation with 80% dependability if all areas are cultivated with upland crops. Further water balance study will be made for these three projects based on the proposed cropping patterns and additionally collected hydrological data.

(2) Deterioration of Project Facilities

Most of existing facilities are severely deteriorated, which finally result in low productivity of crops. In particular, the projects being served by pumps such as the Aveyime, Kpando-Torkor and Mankessim projects, are suffering from insufficient water supply due to their serious deterioration. Pipes and sprinklers are also in poor condition. These pumps, pipes and sprinklers are required to be urgently replaced in order to recover their performance and thereby productivity.

In the case of the Ashaiman, Aveyime and Okyereko projects, irrigation canals and related structures have some problems mainly due to serious water leakage from them as a result of poor construction and long time use. However, the dam and reservoir of the Ashaiman and Aveyime projects are in good condition although regular minor maintenance work is required. Anyhow, it is judged that these canals and structures shall be newly constructed.

(3) Lack of Basic Technical Information on Irrigation Practice

There exist technical problems in irrigation practice. The major problem is the lack of basic technical information on irrigation practice. All the projects except, the Ashaiman project, have no technical data and information to estimate irrigation requirements, and to prepare irrigation schedule including water management at farm level. In addition, no records on how much irrigation water is actually supplied to the field, which is indispensable for efficient use of available water, are available for the projects. It is therefore essential to assign an officer in-charge and also to strengthen the monitoring section of GIDA, aiming to settle such technical problems in irrigation practice.

### 4.5.6 Drainage Facilities

Drainage systems are provided for the Ashaiman, Aveyime and Okyereko projects, and the remaining two projects have no drainage systems due to their sloped topography. The existing drainage system generally consists of laterals and a main drain of unlined type.

The excess water in the project area is eliminated by gravity through the said drainage system, and no mechanical drainage method is employed.

The Study Team could not find any definite design discharge of the drainage system. In the Ashaiman and Okyereko project areas, the existing main drain is connected with the spillway of the dam, but does not follow the design capacity of spillway.

The existing drainage canals are in poor condition due to lack of proper maintenance, therefore water logging and light salinity problem occur in the Ashaiman, Aveyime and Okyereko project areas. It is thus necessary to execute the maintenance activities such as desilting and grass cutting on time, aiming to settle such water logging and salinity problem.

There is a possibility of future land degradation in the Kpando-Torkor and Mankessim project areas because of their undulating topography and the existence of accumulated layers of iron concretions or gravel within the shallow soil layer. In order to mitigate or avoid soil erosion in advance, certain land conservation practices shall be applied for the sustainable agricultural development.

### 4.5.7 Road Network and Project Buildings

The present conditions of the existing farm road network in the project areas including short access to the main road, are generally poor. The present poor road network in most of the project areas require cleaning by grass cutting and improvement of surface such as by compacted gravel pavement, and in some projects construction of new farm roads would be

required in connection with the expansion of irrigated land as well as the rehabilitation.

The Ashaiman project only has a good project office and quarter for O&M staff. The remaining projects are provided with an office only, but is in very poor condition now. Such office will be replaced with new one, and additional buildings such as office for farmers' organisation, store house, garage, sorter house will also be required in connection with the project rehabilitation. Training facilities such as dormitory and lecture hall are to be considered for the Ashaiman and Okyereko projects.

## 4.6 Review of Relevant Projects

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 been launched into the operation and maintenance stage.

DIP is located in the Greater Accra Region. The implementation of DIP was started from the construction of the 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 pumping station was commissioned in 1974, and thus the command area was expanded up to about 200 ha by 1982. However, pump failures and consequent water shortage brought about a virtual shutdown of DIP by 1982/83. Thereafter, the pumping station was recommissioned with electric pumps, and also improvement was made for the selected canals, roads, buildings, and utilities. However, DIP was still subject to serious water shortage due to deficiency in water management and the physical condition of the water supply network. Besides, inadequacy in the institutional arrangements for project operation and management, and support services to farmers prevented the full exploitation of the project potential. As regards the 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 drain outlets through the reservoir flood protection dike; and
(h) Poor maintenance of drains 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 to DIP under the financial assistance of the European Economic Community

(EEC). The further rehabilitation works included reconstruction of the main canalisation system, lateral and header ditches, remedial land levelling, and the drainage and flood protection works.

A 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 pumping 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 existence of an O&M Manual. In addition, it is still observed that much weeds are growing in drains, which would prevent 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.

## 4.7 Agricultural Support Services

### 4.7.1 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 (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 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 with agricultural development. For instance, the extension officers of GIDA and MOFA in and around the project areas have a poor knowledge of irrigation farming practices such as optimum irrigation interval and proper application amount of fertilisers, and on the other hand, almost no research activity on irrigation farming is observed 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 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 Cooperation Agency (JICA). IDC consists of research and production wings, and has 43 staffs in total including one JICA expert and three volunteers (Japan

Overseas Co-operation Volunteers) as of November 1996. Main activities of IDC are research and experimental activities on rice, horticulture, soil, farm machinery, water management and agro-environment.

Basic research activities on agronomy have been made by CSIR, but applied research activities such as application method of fertilisers and irrigation method are inactive. It is expected that IDC plays a more important role in strengthening such research activities, especially for improving irrigation farming and O&M of irrigation facilities. In addition, IDC is required to implement training of extension officers and farmers in irrigation farming and O&M because of the absence of such training facilities in Ghana.

At present, IDC has the following two research programmes under the financial support of the National Agricultural Research Programme (NARP).

| | | |
|---|---|---|
| 1) | Project Title | : The development of an efficient water scheduling programme to ensure continuous cropping on irrigation projects using Ashaiman as a case study |
| | Objective | : To enhance water use for continuous cropping in the Ashaiman Irrigation Project |
| | Project Period | : 3 years (1996-1998) |
| 2) | Project Title | : Agro-forestry systems for sustainable land use in the catchment area of Irrigation Projects, using Ashaiman as a case study |
| | Objective | : To promote sustainable land use and to increase income of farmers in the catchment areas of GIDA projects using agro-forestry systems to produce fruit, fuelwood and electric poles. |
| | Project Period | : 5 years (1996-2000) |

### 4.7.2 Agricultural Extension and Seed Supply

(1) Agricultural Extension of MOFA

MOFA is responsible for agricultural extension to farmers. There are the following four basic offices for extension activities in each district. In addition to the above, a veterinary office and a fishery office also exist 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 has direct links with farmers, and disseminates new farming technology and information to them. The 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 group. Each operational area is assigned one technical officer. MOFA's extension activities are concentrating on staple foods (maize, cassava, yam, cowpea, soybeans) in rainfed areas, and it provides almost no services to GIDA's irrigation project areas.

(2) Agricultural Extension of GIDA

In the irrigation areas, GIDA is responsible for agricultural extension services to farmers. In general, each project has one to five extension officers. As present problems of GIDA's extension services, the following three matters may be pointed out: (i) poor knowledge of staff on irrigation farming, (ii) lack of vehicles/motorcycles to make mobile services, and (iii) no extension facilities and equipment such as printing equipment and overhead projector (OHP). In addition, a weak co-ordination between the Project Management (PM) offices and MOFA's extension offices is observed.

(3) FAO Training Programme for Extension of Irrigation Farming

MOFA and GIDA have a strengthening project of the extension system for irrigation farming under the technical and financial co-operation of FAO. It is the "Development of Support Structure for Irrigated Agriculture," and the executing agencies of the project are GIDA and the Department of Agriculture Extension Services (DAES).

The objectives of the project are (i) to develop a support structure for irrigated agriculture, particularly effective irrigation extension services, and (ii) to make recommendations aiming at helping the Government in formulating sound policies to promote irrigation management transfer to farmers and to develop sustainable irrigated agriculture.

The expected outputs of the project are as follows:

- A consolidated approach and methodology for the establishment of an effective irrigation service.
- A consolidated training programme and training approach to adequately prepare relevant staff to provide effective support to farmers in irrigated agriculture.
- Key staff in the Departments of Irrigation, Agricultural Production and Extension trained to effectively assist farmers in a viable and sustainable irrigated farming system.
- An evaluation of the role and functions of GIDA and DAES in supporting farmers and the institutional framework required to improve the performance of the irrigation sector.

This project has just been commenced in July 1996, and the project staffs are now preparing the implementing schedule, curriculum on training, and so on. In addition, this strengthening project of the extension system has a plan to establish a national workshop aiming at the following specific outcomes:

- assisting the Government in the formation of national irrigation policy; and
- providing conditions for the extension of a pilot programme at regional and national

levels, and specific proposals for its adoption by the outgoing irrigation investment programmes.

(4) Seed Supply

As for the seed supply, most of farmers obtain seeds from markets or other farmers or use products harvested in the last season, except for maize and tomato. Those original seeds are supplied by 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 for Main Crops Grown in the Project Areas

(Unit: %)

| | Cassava | Maize | Rice | E. Plant | Okra | Onions*2 | H. Pepper | Tomato |
|---|---|---|---|---|---|---|---|---|
| a) Government agency*1 | 3 | 26 | 13 | - | 2 | - | - | 30 |
| b) From extension workers | - | 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 dealers | 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 GIDA's PM Offices.
*2 Farmers obtain onion seeds directly from the norther part (Upper East Region) of the country.
*3 From the last harvest.
Note: Figures indicate the average percentage of total samples (180 farmers) of the farm interview survey.
Source: Farm interview survey by the Study Team.

The result of farm interview survey indicates that there is almost no problem of seed supply in all the project areas . It seems that farmers have no difficulty in obtaining seeds in sufficient quantity. In order to improve crop yields and quality of products, however it will be necessary to improve the present government supply system for introducing new varieties.

### 4.7.3 Agricultural Credits

The result of farm interview survey on the problems of present farming situation shows that about 80% of total sample farmers pointed out "credit facility" and 70% desired its improvement. 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.

(1) Bank Loans

There are the following three 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' conditions: (i) security, (ii) borrower's bank account and some deposit amount, and (iii) guarantee 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 farmers because of their low repayment capability affected by recent inflation in the country. According to ADB in Tamale, a lot of farmers have made default in payment of loans. The loan interest is rising rapidly in accordance with the recent inflation of commodity prices, as shown below.

Loan Interest of ADB

| | |
|---|---|
| Movement of ADB Loan Interest to Smallholders | |
| January 1995 | 26 %/year |
| May 1995 | 31 %/year |
| September1995 | 38 %/year |
| ADB Loan Interest by Category (as of Nov.1995) | |
| 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 by Middlemen

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

## 4.8 Farmers' Organisation and Handing-over of O&M Function

### 4.8.1 Farmers' Societies in the Project Areas

As the important strategy of 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 devoted to

the promotion of effective farmers' groups, and 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 in 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.

In each irrigation project area, a farmers' organisation has been established under the guidance of the PM Office and the Department of Co-operatives. An outline of these societies is shown in the following table, and the details are presented in Figure-1.

Existing Farmers' Societies

| Projects | Name of Farmers' Societies | No. of Member *1 | Executive Staff*1 | Year Established | Year Registered | Bye-Laws *2 |
|---|---|---|---|---|---|---|
| (1) Ashaiman | Ashaiman Co-operative Irrigation Rice Farmers Society Ltd. | 120 | 9 | 1983 | 1983 | A |
| (2) Aveyime | Aveyime Irrigation Farmers Association | 62 | 7 | 1981 | 1990 | B |
| (3) Kpando-Torkor | Kpand-Torkor Co-operative Farmers' Society Ltd. | 118 | 7 | 1974 | None | None |
| (4) Mankessim | Beefikrom Cooperative Irrigation Vegetable Growers and Marketing Society Ltd. | 89 | 7 | 1987 | None | None |
| (5) Okyereko | Okyereko Irrigation Rice Farmers Co-operative | 68 | 6 | 1994 | None | None |

*1 As of December 1995.
*2 A: Bye-Laws prepared on the basis of the form of the Department of Cooperative.
B: Bye-Laws not coincide with the form of the Department of Cooperative.
Source: Data and information obtained from each society.

A society has an executive committee which consists of a chairman, a vice-chairman, a secretary, a treasurer, an organiser and several staffs. They are all elected from the member farmers. All beneficiaries of the irrigation projects automatically become members 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 necessities to their members, (v) to provide education and others - like amenities - to the community as a whole, and (vi) to procure collectively and distribute essential commodities equally among members.

Of the five societies in the priority projects, two have bye-laws which consist of the following articles, and the remaining three have not completed bye-laws.

Articles of Bye-Laws

| | |
|---|---|
| Part-I Preliminary | (20) Special General Meeting |
| (1) Interpretation | (21) Quorum at General Meeting |
| (2) Title | (22) Voting at General Meeting |
| (3) Objectives | (23) Minutes of General Meeting |
| Part-II General Provisions | Part-IV Committee of Management |
| (4) Funds of Society | (24) Election of Committee |
| (5) Liability of Members | (25) Removal of Committee |
| (6) Disposal of Surplus | (26) Filling of Committee |
| (7) Accounts and Books | (27) Chairman of Committee |
| (8) Register of Members | (28) Duties of Committee |
| (9) Seal of Society | (29) Procedure at Committee Meeting |
| (10) Division of Society | (30) Minutes of Committee Meeting |
| (11) Loans and Deposit from Persons | Part-V Officers of the Society |
| (12) Loans to Members | (31) Appointment of Secretary |
| (13) Production and Marketing of Produce | (32) Security by Secretary |
| (14) Admission to Membership | (33) Suspension of Secretary |
| (15) Withdrawal from Membership | (34) Absence of Secretary |
| (16) Removal from Membership | (35) Payment of Secretary |
| (17) Expulsion from Membership | (36) Duties of Secretary |
| (18) Re-admission to Membership | (37) Treasurer and Assistant Treasurer |
| Part-III General Meetings | (38) Duties of Treasurer |
| (19) General Meeting | |

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-operatives, and no articles on O&M of irrigation facilities are stipulated in the above bye-laws. It means that almost all societies have no function as a water users' association from the institutional view-point. The present activities of the societies in O&M of the projects are mainly to discuss the amount of irrigation service charge and land allocation with the project offices. In addition, the societies established in the pumped irrigation areas are arranging the installation of sprinkler systems under the guidance of the PM Offices. The societies have not any other activities shown in the objectives mentioned in their bye-laws.

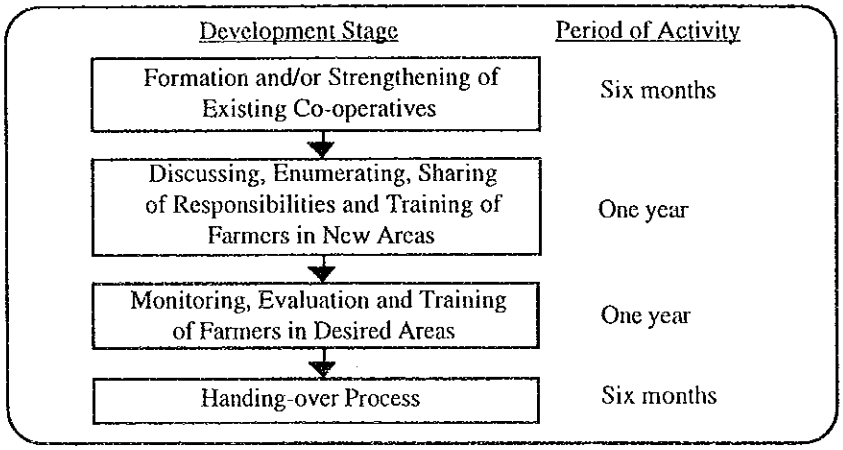
### 4.8.2 Handing-over of O&M Function

In accordance with the strategies of MTADP, GIDA has envisaged the handing-over of the O&M function 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 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 to apply the following handing-over process.

Transfer of Project Management




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 implemented, except for the Dawhenya Irrigation Project . The farmers in all project areas have well known the handing-over of O&M to the farmers' societies, at present. In order to grasp their intention on this handing-over, an interview survey was carried out. The result indicates that about half of total samples (180 farmers) do not agree to with the handing-over, as shown below.

Farmers' Acceptance of Handing-over of O&M

| Questions | Ashaiman | Aveyime | K. Torkor | Mankessim | Okyereko | Whole |
|---|---|---|---|---|---|---|
| If GIDA hands over the operation and maintenance of the irrigation facilities: | | | | | | |
| a) Do you agree ? | | | | | | |
| Yes | 15% | 67% | - | 89% | 70% | 48% |
| No | 85% | 33% | 100% | 11% | 30% | 52% |
| b) If your village chief agrees with the handing-over, do you also agree ? | | | | | | |
| Yes | 20% | 67% | - | 88% | 50% | 45% |
| No | 80% | 33% | 100% | 12% | 50% | 55% |

Source: Farm interview survey by the Study Team (November-December 1995).

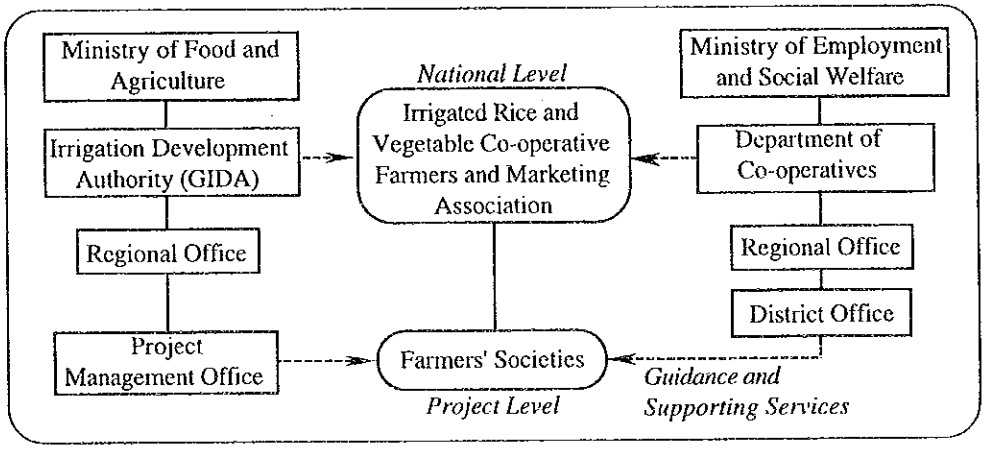
As one of the reasons, it may be said that the farmers cannot accept the GIDA's handing over plan without question, because they have confronted serious problems on existing irrigation facilities such as insufficient water supply and very high costs for O&M of facilities. As another reason, the farmers pointed out technical difficulty in O&M by the farmers' society. Considering of the general farmers' response to this survey, it seems that they did not know the actual content the handing-over.

### 4.8.3 Executing Agencies for Promoting Farmers' Societies and Handing-over of O&M

(1) Farmers' Societies

Basically, the Department of Co-operatives under the Ministry of Employment and

Social Welfare is responsible for promotion and guidance of all co-operative activities in the whole country including GIDA's irrigation project areas. The organisational structure of GIDA is presented in Figure-2. GIDA is also responsible for promotion and support of the societies in O&M, and its front line office is the PM Office. A schematic structure of the services by both agencies is presented below:




It is observed that the promoting services of the Department of Co-operatives and GIDA for the irrigation projects are not active, and both agencies have a weak co-ordination between them. In the case of the Weija, which is one of the 12 existing irrigation projects, the District Office of the Department of Co-operatives in Amasaman Ga District has despatched a Co-operative Officer to the PM Office, and he is now implementing services of strengthening of the farmers' society.

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

The executing agency of O&M handing-over is naturally GIDA. The present organisation of GIDA is shown in Figure-2. The Project Management Division under the Department of Project Operations in GIDA is responsible for promoting services of societies, project management and its handing over. This Division is staffed with only two officers.

The PM Office headed by a Project Manager has direct responsibility for O&M of the irrigation projects and promoting the societies. The organisational structure of PM Office is very simple, and the Office has only a few staffs and labourers.

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

1) Land Allocation Committee: as the basic policy of GIDA, all farmlands in the irrigation project areas are allocated permanently to the farmers, and the allocation pro-

cedure is implemented by the Land Allocation Committee. The Committee consists of the following seven 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 within the area,
(e) A representative of the District C.D.R.; and
(f) Two representatives of the farmers' association in the Project area.

2) Agricultural Committee: this Committee consists of the representatives of PM Office and the farmers' society. This Committee's duties are:

(a) to be responsible for the planning and implementation of agronomic practices;
(b) to ensure that no person tampers with the 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 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.

(3) Restructuring of GIDA

The Government of Ghana has a plan to privatise GIDA. In 1993, the Parliament enacted a government ordinance on privatisation of 32 national institutions and public corporations including GIDA. In compliance with this ordinance, GIDA prepared a study report on privatisation in November 1995. The report recommends that most part of GIDA will still remain as an implementing agency for supporting services to the irrigation sector. However, the report gives no definitive and detailed schedule of privatisation. In addition, MOFA which supervises GIDA has also a reorganisation plan , but GIDA's privatisation is has not been materialised so far.

Apart from the above government ordinance, the number of staffs in GIDA has been reduced from year to year. In 1995 it was reduced to about one third (377 staffs) of the total number in 1985 (1,116 staffs).

### 4.8.4 Land Allocation

Land has already been allocated to farmers only under the following two irrigation projects: Mankessim and Okyereko. Unde other projects, the land use right is allocated only in each cropping season, because when the land is permanently allocated to the farmers, the PM Offices are not confident of supplying enough irrigation water to the land mainly due to problems of deteriorated irrigation facilities.

All lands in the project areas are originally community lands which had been governed traditionally by the village chiefs, 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 the land tenure. These lands were developed by GIDA under agreement with the village chiefs , and in some projects GIDA has not yet settled the land compensation cost to them. Prior to the implementation of the projects, the Government should acquire these lands.

### 4.8.5 Irrigation Service Charge

GIDA is collecting irrigation service charge (ISC) from the beneficiaries in all irrigation projects. The unit amount and the collection situation of ISC in 5 selected project areas in 1996 are summarised below:

| Projects | Irrigation Method | Amount of Irrigation Service Fee in 1996 (CD/ha/season) | Collection Situation in 1994*1 (%) |
|---|---|---|---|
| (1) Ashaiman | Gravity | 50,000 | 12.3 |
| (2) Aveyime | Pump/Gravity | 155,000 | - |
| (3) K.-Torkor | Sprinkler | 250,000 | 100.0 |
| (4) Mankessim | Sprinkler | 100,000 | 100.0 |
| (5) Okyereko | Gravity | 50,000 | 50.0 *2 |

*1 Ratio to total amount to be collected.
*2 Estimated by the Project Manager. No detailed figure is available.
Source: Information obtained from PM Offices and the existing societies.

An interview survey of farmers was carried out in order to grasp their understanding on the purpose/meaning and amount of ISC. The survey result shows that most farmers have a good and correct understanding. Namely, they answered that ISC is necessary for O&M of the irrigation facilities, and that any farmers who receive irrigation water should pay its charge. As for the amount of ISC, over 80% of farmers in Mankessim and Okyereko projects indicated it is "expensive" to "very expensive."

## 4.9 Present Farmers' Economy

### 4.9.1 Farm Management Size

The farm management size of irrigation areas varies with the projects and ranges from 0.11 ha for the Kpando-Torkor project to 0.57 ha for the Aveyime project as shown below:

| Projects | Project Areas | | | | | | Farm Size Including Outside Project Area*2 (ha/household) |
|---|---|---|---|---|---|---|---|
| | Potential Area (ha) | Developed Area (ha) | Total Annual Irrigated Area (ha) | Cropping Intensity *1 (%) | No. of Farm Household (ha) | Irrigated Area per a Farmer (ha/household) | |
| Ashaiman | 148 | 130 | 59.0 | 45 | 120 | 0.49 | 1.37 |
| 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 |
| Okyereko | 111 | 40 | 21.6 | 54 | 68 | 0.32 | 1.42 |
| Total/Average | 1,021 | 290 | 120.0 | 41 | 457 | 0.26 | 1.40 |

*1 Total annual irrigated area / Developed area
*2 Including farm land located outside project areas. Data obtained from the farm interview survey by the Study Team (December1995).

As shown in the above table, the highest cropping intensity, 1.55 or 155 % is seen in the Mankessim area, and the lowest one, 0.33 or 33 % in the Kpando-Torkor area. The average cropping intensity over the whole project areas was estimated at 0.41 or 41 %. The lowest intensity in Kpando-Torkor area is due to insufficient supply of irrigation water because of deterioration of pumping facilities.

### 4.9.2 Crop Budget

Crop budget for the 1994/1995 crop year was analysed for the selected major crops grown in the project areas. The results are summarised as follows:

(Unit: Cedis 1,000)

| Projects | Crops | Gross Income | Production Cost | Net Return |
|---|---|---|---|---|
| Ashaiman | Maize | 138 | 181 | -43 |
| | Paddy | 1,813 | 892 | 921 |
| | Okra | 2,160 | 1,094 | 1,066 |
| Aveyime | Cassava | 779 | 375 | 404 |
| | Maize | 228 | 298 | -70 |
| | H. Pepper | 750 | 1,292 | -542 |
| K-Torkor | Cassava | 700 | 307 | 393 |
| | Yam | 2,173 | 464 | 1,709 |
| | Maize | 700 | 520 | 180 |
| | Okra | 6,300 | 2,214 | 4,086 |
| Mankessim | Cassava | 2,080 | 229 | 1,851 |
| | S. Potato | 2,500 | 361 | 2,139 |
| | Maize | 627 | 345 | 282 |
| | Eggplant | 3,712 | 772 | 2,940 |
| | Okra | 1,835 | 1,184 | 651 |
| | H. Pepper | 2,500 | 936 | 1,564 |
| | Tomato | 308 | 411 | -103 |
| | Watermelon | 2,301 | 630 | 1,671 |
| | Sugarcane | 813 | 231 | 582 |
| Okyereko | Cassava | 572 | 418 | 154 |
| | Maize | 667 | 459 | 208 |
| | Paddy | 2,250 | 752 | 1,498 |
| | Tomato | 1,100 | 515 | 585 |
| | Groundnut | 338 | 466 | -128 |

Source: Farm Interview Survey by the Study Team

As seen in the above table, the highest net income, 4 million Cedis per ha, is obtained from the cultivation of okra in Kpando-Torkor, followed by 2.9 million Cedis by egg plant in Mankessim. In addition to these representative areas, higher net income is also expected from the cultivation of vegetables in general.

### 4.9.3 Present Farm Household Economy

The main farm income of an average farm family is derived from rice cultivation and supplemented by vegetables production. The farm household budget study was based 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 an average farm household is summarised as follows:

| Items | | Ashaiman | Aveyime | K-Torkor | Mankessim | Okyereko |
|---|---|---|---|---|---|---|
| (Farm Management Size)*1 | (ha) | 0.55 | 1.10 | 0.64 | 0.82 | 1.30 |
| Irrigated | (ha) | 0.49 | - | 0.11 | 0.30 | 0.32 |
| Rainfed | (ha) | 0.06 | 1.10 | 0.53 | 0.52 | 0.98 |
| 1) Gross Income | | 2,994 | 2,129 | 2,588 | 2,277 | 2,487 |
| - Farm Income*2 | | 981 | 722 | 1,200 | 1,548 | 1,403 |
| - Non farm income*5 | | 2,005 | 1,403 | 1,387 | 729 | 1,072 |
| - Loans | | 8 | 4 | 1 | - | 12 |
| 2) Gross Outgoing | | 2,994 | 2,129 | 2,588 | 2,277 | 2,487 |
| - Production Cost*3 | | 404 | 119 | 341 | 280 | 220 |
| - Living Expenses*4 | | 2,581 | 2,003 | 2,245 | 1,997 | 2,243 |
| - Loan Repayment | | 9 | 7 | 2 | - | 24 |
| 3) Net Revenue*5 | | 0 | 0 | 0 | 0 | 0 |

*1 Including not only the farm lands in the project areas but also the farm land located outside project areas.
*2 Including farm incomes obtained from the outside project areas.
*3 Excluding family labour force.
*4 Including products consumed at home.
*5 According to the farm interview survey, minus values of net revenues were obtained from 5 projects. It seems that figures of non-farm income obtained from the farmers have indicated lower side, because they could not make the answer on its actual amount due to no record. As actual situation of the farmers economy in the project areas it seems that the farmers have almost no or a little revenue.
Source: Result of farm interview survey by the Study Team.

Farmers are earning 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 the Ashaiman and Kpando-Torkor areas gain more than one million Cedi of income from off-farm works. In the case of the farmers in the Ashaiman area, some of their family members are working in Tema, the main industrial zone of Ghana. Many peasant farmers in the Kpando-Torkor area are working in fish factories to get cash income.

## 4.10 Environment

### 4.10.1 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 EPA, the EIA procedures are as follows:

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, 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 implementation of the project, EIA is required and an EIS must be prepared.
   (d) Environmental Impact Assessment required

3) If the proponent is required to submit an EIS, it must prepare the "Terms of Reference" (TOR) for the EIA study and submit it to EPA. After receiving the EPA's approval of 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 project and its effects on the environment). The proponent must incorporate the concerns of the public into the EIS report.

5) EPA with a cross-sectional technical committee will assess and review the draft EIS prepared by the proponent. If 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 is required to re-submit a revised statement or to conduct further studies to modify the statement.

### 4.10.2 Present Environmental Issues

The present environmental issues were identified for each project, based on the information obtained from the field reconnaissance and interviews of farmers, project staff, pubic health units, etc. The issues, their causes, significance and countermeasures to be considered

are summarised in ANNEX - G. By the application of proper countermeasures throughout the project stage, the issues would be mitigated and would become minor ones in terms of magnitude and extent. The following section explains the present environmental conditions in the project areas.

(1) Sedimentation in reservoir: Ashaiman, Mankessim, Okyereko

This is a major problem commonly observed in the irrigation reservoirs in Ghana. Due to the cultivation without applying soil conservation measures and deforestation caused by the shifting cultivation, bush fires, removal of vegetation for firewood, etc. along the reservoirs and in the watershed areas, land degradation has occurred and resulted in silt deposition in the reservoirs. In fact, the many cultivated lands along the reservoirs were observed in the field survey. Due to the silt deposition, the capacity of the reservoirs has been substantially reduced, and this would result in the shortage of water. In order to reduce sedimentation in the reservoir, watershed management such as reforestation and restriction of land use should be taken by the Government. In addition, the soil conservation practices should be introduced to the farmers under the government extension works.

(2) Deforestation: Aveyime

Major energy sources in rural life are firewood and charcoal. In addition to their use for energy, farmers are using woods for fences, handling of tools, poles, etc. Also, charcoal is one of the main incomes for the local people, especially in the Aveyime project area. Therefore, the forest can be considered as necessary and important for the rural life. Since the consumption of forest resources has increased with the increase of rural population, however, the forest has been reduced gradually due to stripping by the local people. In addition, forest clearing such as bush fire also spurs forward deforestation.

(3) Degradation of downstream lagoon ecology: Ashaiman

One Ramsar site namely Sakumo lagoon is located downstream of the Ashaiman project. The general features of the lagoon are shown below:

| Location | Lagoon Area | Catchment Area | Fishery activity | Present conditions |
|---|---|---|---|---|
| Tema | 300 ha | 3,500 ha | High | Sedimentation and pollution have occurred due to inflow of waste water from surrounding towns. |

The Sakumo lagoon is used by fishermen who catch Tilapia, crab and shrimp with cast nets and traps at present. This area has considerable value as an urban "green space" for recreational activities of inhabitants of the metropolitan region. However, the Sakumo lagoon

has been extremely polluted by the inflow of waste water from surrounding towns due to increasing population density. In fact, the following issues were observed in the Sakumo lagoon at present.

1) Siltation in the lagoon

According to study report prepared by Department of Game and Wildlife in 1995, heavy siltation in the lagoon was found through examination of the lagoon bed and river line portion. In fact, it is reported that the lagoon has lost a great part of its storage capacity as a result of siltation.

2) Pollution of water

Inflow of the waste water from the densely populated areas, especially from Tema town, into the lagoon is a major reason for the pollution of water. In fact, the waste water from Ashaiman town also joins the Gyorwulu river in the project area and flows into the lagoon. Data on water quality of the Gyorwulu river (downstream of the project area) and of the lagoon are summarised below:

| Water Quality in Dry Season | Temp | pH | EC | SS | Cd | Pb | Cu | Zn | Mn | Fe | PO4-P | NO3-N | NH3-N | DO | BOD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Dzorwulu river | 35.0 | 7.5 | 1.9 | 796 | 0.08 | 0.12 | 0.38 | 1.57 | 1.17 | 1.24 | 3.69 | 0.63 | 0.79 | 0 | 109 |
| 2. Sakumo Lagoon (Low Tide) | 29.3 | 7.7 | 49.0 | 116 | 0.18 | 0.10 | 0.18 | 0.55 | 0.56 | 0.78 | 1.38 | 0.41 | 0.30 | 17 | 34 |
| 3. Sakumo Lagoon (High Tide) | 29.7 | 7.3 | 57.0 | 46 | 0.02 | 0.17 | 0.19 | 0.29 | 0.43 | 1.70 | 0.14 | 0.26 | 0.18 | 11 | 10 |

Source : Ghana Coastal Wetlands Management Project (1995), Department of Game and Wildlife

As mentioned before, the Ashaiman project area is located in the catchment area of the Sakumo lagoon. Even it is considered that the project would not affect the lagoon's environment and that the main adverse impacts come from towns, expansion of the irrigation area is not recommendable in order to minimise unexpected negative impacts to the lagoon.

(4) Waterlogging and Salinity Problems: Ashaiman, Aveyime, Okyereko

Due to poor drainage works, waterlogging and also salinity problems result in lowering of crop yields and often in abandonment of lands. These problems are found in the Ashaiman, Aveyime and Okyereko project areas. Therefore, the improvement of drainage facilities and systems is a necessary work for the projects.

(5) Water-born diseases: All projects

It is reported that about 90 % of the total population of Ghana has been infected with malaria, and most of farmers in and around the project areas, too. Schistosomiasis (Bilharzia) is also a popular disease among the farmers in and around the Project areas. The main problem is that they have no knowledge about the causes of these two diseases. Hence, a health education and sanitary programme is required to prevent and control the problem. For instance, maintenance works of weeding in the canals and field bunds are also necessary for control of water stagnancy and snails in paddy fields.