5. STUDY ON PROJECTS REHABILITATION PLAN

On the basis of the study on the 12 existing irrigation projects at master plan level carry out in the first stage (Phase-I), 5 priority projects have been selected, and the feasibility study on these priority projects was conducted as presented in this Chapter. The Study covered the main components of the Project such as rehabilitation plan of the project facilities, and agricultural and institutional development plans in connection with the projects rehabilitation. The Study also formed the basis for economic and financial evaluations of each priority project.

5.1 Basic Concept for Projects Rehabilitation

The overall development strategy and policy for profitable agricultural development in connection with the projects rehabilitation were discussed to formulate the basis for feasibility study on the five priority projects. The discussions were made on the basis of all the study results obtained from both Phase-I and Phase-II as well as from analysis of various data and information. In addition, data and information obtained through the investigation of other existing irrigation projects recently rehabilitated were also fully used.

5.1.1 Agricultural Development Policy and Strategy

The final target of the proposed agricultural development under the reactivated projects can only be achieved through comprehensive development of not only direct measures for increase of agricultural productivity but also other supporting measures such as strengthening and improvement of GIDA as well as the existing farmers' organisations, particularly in terms of efficient O&M of the projects and provision of sufficient support services to the farmers, and improvement of linkage with other government institutes concerned. This suggests that the Feasibility Study be formulated in a form of "integrated and balanced agricultural development." The essential policies to be taken for this purpose are as follows:

1) Increase and stabilisation of agricultural productivity; and
2) Rehabilitation and improvement of agricultural production infrastructure

(1) Rehabilitation and Improvement of Agricultural Production Infrastructure

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

As already mentioned, most of the existing project facilities need rehabilitation including some improvement works, except for the dams and reservoirs. The facilities to be rehabilitated are the irrigation and drainage systems, farm road network, and project buildings for both O&M woks and farming. The rehabilitation plan and preliminary design of the facilities should be prepared taking into consideration the following:

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

(2) Increase and Stabilisation of Agricultural Productivity

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

1) establishment of an integrated agricultural base station or more effective use of the existing station such as IDC for field trials of crop varieties, fertiliser use, pest and disease control, etc. as well as for demonstration of improved farming practices for the purpose of increasing crop production in both lowland and upland areas;
2) promotion and extension of crop diversification particularly in lowland paddy fields; and
3) improvement and strengthening of extension services, especially for transfer of packaged farming information and technology, necessary actions to encourage the farmers to increase their crop production, and on how to promote the farmers' participation in crop diversification.

5.1.2 Basic Concept for Institutional Development

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

1) Prior to the handing over of O&M, GIDA should be strengthened as an O&M executing agency. For this strengthening, the number of staffs and facilities necessary for the implementation of handing-over of O&M and support services to the farmers should be minimised as much as possible, taking into account the restructuring plan of GIDA.

2) The managing system of O&M and its supporting system by GIDA should be simplified in order to make the related activities efficient and smooth.

3) The implementing period of handing-over should be set up, taking into account the actual situations of the societies' activities, farmers' ability and the experience of GIDA's front line staff.

4) Successful and sustainable O&M by the farmers needs a lot of support services from the various agencies concerned. The institutional plan should therefore cover the improvement and co-ordination of all the activities involved in O&M.

5) In order to ensure sustainable O&M by the farmers, a farmers' participatory implementation should be adopted in the O&M handing-over plan, with the establishment of a monitoring system in the executing agency.

6) Strengthening of agricultural support services such as marketing and credits is as well as the rehabilitation of irrigation facilities also a prerequisite factor to achieve the final target of the Project.

7) O&M by the farmers should be realistic and possible from the financial view-point. With this in view, the O&M cost should be minimised as much as possible.

8) In order to arouse the farmers' sense of belonging and responsibility for the O&M of facilities, all lands in the project areas should be allocated permanently to the farmers, in accordance with L.I. 1350 of GIDA and traditional custom of land holding in the country.

5.2 Agricultural Development Plan

In line with the policy and strategy for profitable agricultural development, the practical and productive agricultural development plan suited to the rehabilitated projects is formulated in consideration of the following main items:

1) Priority in formulating proposed crops and cropping patterns is given to the production of crease in paddy rice and vegetables so as to meet the policy for agricultural development set forth in MTADP.

2) Optimum combination of food crops and vegetables as cash crops to expect higher returns which will result in the increase in farm income of the farmers.

3) Full and effective land use in the rehabilitated project areas, especially in the wet season.

4) Consideration is given to optimum crop rotation systems to avoid crop damage due to continuous cropping. It is recommended to cultivate upland crops including vegetables in the proposed crop rotation systems with a four year cycle.

5) Formulation of proposed crops and cropping patterns is made in consideration of available storage and processing facilities of farm products.

5.2.1 Proposed Crops, Cropping Patterns and Crop Rotation System (Refer to Figures 3 - 7)

(1) Ashaiman Project

Crops being grown in this area are paddy rice and okra. Paddy rice is cultivated in both the wet and dry seasons, and okra in the dry season. As already discussed, this project has a water shortage problem, and as a result the project lands to be rehabilitated will be restricted to those on left bank only, covering 56 ha of land (refer to Section 5.3.3). This also means that the land holding size of a farm household will be reduced to one acre (0.4 ha) after rehabilitation. In such a case, more profitable crops such as vegetables will have to be introduced to recover the reduction of land holding size. In addition, introduction of vegetables will contribute to the saving of irrigation water especially during the dry season.

The proposed land use is 11 ha for lowland farming and 45 ha for upland crops. The proposed crops and cropping pattern are summarised below. In lowland, okra could be cultivated in the dry season and paddy rice in the wet season under irrigation every year. In upland, vegetables such as tomato, onion and watermelon will be cultivated under irrigation in the dry season. To avoid damage due to continuous cropping, the upland field will be divided into 4 blocks, and tomato, onion and watermelon will be planted in one and two blocks every year. The cultivation of these crops in the blocks will be rotated in a four year cycle. Food crops such as maize and groundnut/cowpea will be cultivated in the wet season. These crops will also be planted under a four-year rotation cycle.

Field Condition	Crop Area (ha)	Dry Season	Wet Season
Lowland	11	Okra (20%)	Paddy rice (20%)
Upland	45	Tomato (20%), Onion (20%)	Maize (20%)
		Watermelon (40%)	Groundnuts/Cowpea (40%)
Total	56		

Note : Figures in parenthesis indicate % of crop area to reactivated project area (56ha).

(2) Aveyime Project

The present cropping pattern in this area is simple: paddy rice only is grown in both the wet and dry seasons. The soil condition of this project area is rather poor, because sandy soils are distributed in most of the area. According to the rehabilitation plan, the existing project area could be expanded to adjacent areas.

After full expansion, the area of the reactivated project would be increased to 95 ha net from the present 63 ha. The expanded area is covered with sandy soils in general which are suitable for cultivation of vegetables. The proposed land use after rehabilitation is 48 ha for lowland farming and 47 ha for upland farming. The proposed crops and cropping pattern are summarised below. In lowland, paddy rice will be cultivated in both the dry and wet seasons every year. In upland, vegetables such as tomato/hot pepper, okra and onion will be cultivated under irrigation in the dry season. To avoid damage due to continuous cropping, the upland field will be divided into 4 blocks, and tomato/hot pepper, okra and onion will be planted in one and two blocks every year. The cultivation of these crops will be rotated in the blocks in a four year cycle. Food crops such as maize and groundnut/cowpea will also be cultivated in the wet season under a four-year rotation cycle.

Field Condition	Crop Area (ha)	Dry Season	Wet Season
Lowland	48	Paddy rice (50%)	Paddy rice (50%)
Upland	47	Tomato/Hot pepper (13%)	Maize (25%)
		Okra (12%), Onion (25%)	Groundnuts/Cowpea (25%)
Total	95		

Note : Figures in parenthesis indicate % of crop area to reactivated project area (95ha).

Although most of farmers in this area have no experience so far in growing vegetables, they are already familiar with cultivation of rainfed okra, hot pepper, maize and groundnuts in their own farms. Since onion is a new crop to farmers, they will need guidance on suitable farming practices for onion cultivation.

(3) Kpando-Torkor Project

Only okra is cultivated in this area, and its cropped area is also very small, only 8 ha in the 1996 dry season because of serious deterioration of pumps and sprinkler equipment,. The potential irrigable area of this project would be 461 ha gross, and is divided into 4 irrigation blocks, A, B, C and D. Among them, farming activities in Block-A are more active compared with those in the other 3 blocks. Each block will be served by one complete set of pump, pipeline and sprinkler system independently, instead of one large-scale pump set commanding the whole project area, in order to avoid the risks in case of breakdown of the facility.

The result of soil survey and study show that about 42 % of the total project area is classified into the restrictedly suitable (Class S4), due to undulating topography and the exis-

tence of accumulated layers of iron concretions or gravel within a shallow depth. Once the accumulated layers of iron concretions are exposed due to repeated wetting and drying by the erosion of surface soil, soils change irreversibly to iron hardpan. In fact, accumulated layers of iron concretions are seen in part of Block-A due to active farming.

Block A is located near Dzigbe village which closely concerns the project rehabilitation, because all the lands in the project area belong to this village, and other blocks B, C and D are located in sequence from downstream to upstream. This means that Block-D would require rather long approach from the village for farming and for electricity supply to the pump house as well.

The present land holding per family in this project area is 0.28 acre only. At the public meetings, discussions were made with the member farmers on optimum land holding size per family. Most of them requested one acre of land holding at least in order to grow cash crops under irrigation during the dry season. In addition, they said they need more land to grow their main food crops such as maize and cassava mainly under rainfed condition in the wet season, in order to secure their food security. This suggests that a sufficient area of land should be left as it is around the project area to meet this purpose.

The proposed crops and cropping patterns are as summarised below, taking into consideration the above situation such as soil and topographic conditions, and farmers' request for land holding. As a result, vegetables such as okra, tomato/hot pepper and onion/shallot are proposed to be cultivated under irrigation in the dry season. To avoid damage due to continuous cropping, these vegetables should be cultivated under irrigated rotational cropping system. Food crops such as maize and groundnut will also be cultivated with supplemental irrigation in the wet season under rotational cropping system.

Field condition	Crop Area (ha)	Dry season	Rainy season
Upland	155	Okra (25%), Tomato/Hot pepper (25%) Onion/Shallot (50%)	Maize (50%) Groundnut (50%)
Total Area	155	100%	100%

Note : Figure in parenthesis indicate percentage of crop area to reactivate project area (155ha).

Hot pepper and egg plant could be planted along with tomato. Groundnut is more favourable than cowpea, because cowpea does not produce fruit after flowering in this area. Dry season onion may be competitive with the onion produced in the Northern Region, because the Kpando-Torkor project has a marketing advantage due to shorter transportation to Accra and Tema. Shallot is another alternative of onion because of its very short cropping period which is suited to small area production. It can be grown twice in a dry season. Since the land slope in this area is about 3%, consideration should be paid to mitigation of soil erosion. Construction of green belt, contour line cultivation, soil mulcting by dried wild tall grass are advisable to protect the land from gully soil erosion.

(4) Mankessim Project

The present area irrigated by the existing pump and sprinkler set is limited to 17 ha of upland located on the left bank of the dam, because the pump and sprinkler set is seriously deteriorated. The present irrigated land could be expanded to 29 ha in total within the same area, when new pump and sprinkler sets are provided in connection with the project rehabilitation. In addition, there exist 57 ha net of upland being cultivated by farmers on the right bank of the dam for which sprinkler irrigation could be applied, using water from the Mankessim reservoir. Therefore, the command area of this project would be 86 ha net in maximum after project rehabilitation.

The proposed crops and cropping pattern for the new command area of 86 ha are summarised below.

Field condition	Crop Area (ha)	Dry season	Rainy season
Upland	86	Watermelon (25%) Onion (25%) Egg plant (25%) Okra (25%)	Maize (25%) Groundnut/Cowpea (25%) Sweet potato (50%)
Total Area	86	100%	100%

Note : Figure in parenthesis indicate percentage of crop area to reactivate project area (86ha).

Vegetables such as watermelon, egg plant and okra will be cultivated under irrigation in the dry season. To avoid damage due to continuous cropping, the land is divided into four blocks, and watermelon, egg plant and okra will be planted separately in two, one and one blocks every year. The cultivation of these crops will be rotated in the blocks in a four year cycle. Food crops such as maize and groundnut/cowpea will be cultivated with sweet potato in the wet season. Maize, groundnut/cowpea and sweet potato will be planted under the rotational cropping system.

(5) Okyereko Project

Since the project's water source is the Okyereko reservoir fed by rainfall only, the irrigated area is restricted to 40 ha at present. Therefore, GIDA has a plan to provide supplemental water source by installing pumps on the Ayensu river which is located near the project site. When the supplemental water source is secured, the command area of the project could be expanded to 81 ha net after project rehabilitation. Then, the proposed crops and cropping pattern are studied on the basis of such a future command area, as summarised below.

Field Condition	Crop Area (ha)	Dry Season	Wet Season
Lowland	39	Paddy rice (48%)	Paddy rice (48%)
Upland	42	Tomato (13%), Okra (13%) Onion (26%)	Maize (26%) Groundnuts/Cowpea (26%)
Total	81		

Note : Figures in parenthesis indicate % of crop area to reactivated project area (81ha).

In lowland, paddy rice will be cultivated in both the dry and wet seasons every year. In upland, vegetables such as tomato, okra and onion will be cultivated under irrigation in the dry season. To avoid the damage due to continuous cropping, the upland field is divided into four blocks, and tomato, okra and onion will be planted in one, one and two blocks every year. The cultivation of these crops will be rotated in the blocks in a four year cycle. Food crops such as maize and groundnut/cowpea will also be cultivated with supplementary irrigation in the wet season as well as under a rotational cropping system. Onion, okra and tomato crops are very popular in this area. There will be no problems of marketing of these vegetables, because the project area is located near main roads and has short access to Accra.

5.2.2 Proposed Farming Practice and Farm Inputs

(1) Farming Practice

Among various farming practices, land preparation should be made very carefully in both lowland and upland. Since cultivation of paddy rice by broadcasting is preferable because of labour-saving practice, land levelling after ploughing and harrowing is one of important farming operations to ensure uniform and perfect germination and healthy seedling growth, to assist weed control, and to use irrigation water effectively. Careful levelling is also essential to expect higher crop yield, because uniform and perfect germination and seedling growth will result directly in high standability, logging resistance and higher yield at harvest.

Weeding is also one of important farming practices to expect higher crop yield. Manual weeding should be practised especially when crops are at the young growing stage, which will also be effective for control of the incidence of diseases and insect pests.

Harvest at optimum time is essential to reduce field loss of cereal and legume crops and vegetables, particularly for paddy rice and cowpea which easily fall down when they are over-ripened. Care should also paid to harvesting time of vegetables to ensure quality marketable products.

(2) Farm Inputs

The proposed application rates of fertiliser for main crops on N:P:K kg/ha basis, and compound and nitrogen on kg/ha basis are summarised below.

Crop	Proposed Application Rate of Fertilizer				
	N:P:K (kg/ha)	Compound (kg/ha)		Nitrogen (kg/ha)	
Paddy rice	152:60:60	15-15-15	300	Urea	200
Maize	98:45:45	15-15-15	150	SA*	125
Groundnut / Cowpea	no application	no application			
Tomato	123:45:45	15-15-15	400	SA	300
Egg plant	117:45:45	15-15-15	300	SA	250
Onion	98:45:45	15-15-15	300	SA	250
Okra	117:45:45	15-15-15	300	SA	300
Watermelon	98:45:45	15-15-15	300	SA	250
Sweet potato	15-15-15	15-15-15	100	no application	

Note * : sulphate ammonium

The importance of fertiliser application is the time as well as the rate. It is recommended that a half amount of basic fertiliser, 15-15-15 compound, be applied just before ploughing and harrowing, and another half amount after seeding or transplanting in the proposed farming practices. Likewise, a half amount of top dressing Fertiliser, urea or sulphate ammonium, is proposed to be applied at the seedling stage, and another half at the full-growing and flowering stage. Presently, traditional application time of basic fertiliser is two to three weeks after seeding or transplanting. It causes low efficiency of fertilisers, especially P and K.

5.2.3 Anticipated Crop Yield and Production

Crop yields in the reactivated project areas would increase through introduction of improved irrigated farming, effective use of farm inputs as well as more intensive supporting services from IDC and other government institutes concerned. The anticipated yields of main crops were estimated as follows, based on the analysis of the present crop yields and data available from the institutes concerned.

Crop	Present Yield (ton/ha)	Anticipated Yield (ton/ha)
Paddy rice	3.4	6.0
Maize	2.6	3.0
Groundnut / Cowpea	1.5	2.0
Tomato	8.2	15.0
Egg plant	12.1	15.0
Okra	7.0	12.0
Onion	14.5	18.0
Sweet potato	10.0	15.0
Watermelon	9.0	20.0

Crop production in each of the project area was estimated based on the proposed cropping area and anticipated crop yield, and is shown in ANNEX-E.

5.2.4 Post-harvest, Agro-processing, Storage and Marketing

Drying floor is one of the essential post-harvest facilities for paddy rice, maize, groundnut and cowpea. Construction of new drying floors will be necessary for the Aveyime, Kpando-Torkor and Mankessim projects where drying floors are very old and narrow, or not provided.

Presently, most of vegetables are sold in fresh condition to markets located near the project areas. A house for selecting vegetables will be required for post-harvest and marketing of vegetables in all the project areas. The house, which should have an appropriate floor space and a simple roof can be used for grading products and for selecting marketable products. In the Amate project area, for example, tomato and onion harvested from the field are graded, and selected as marketable fruit or bulb. In the Weija project area, the Asian fruit such as tinda and long marrow with optimum size, color and maturing stage, and the fruit without scars of dis-

eases and pest infection are severely selected at the vegetable selecting house, in order to meet market requirements in London community.

Rice miller is an important post-harvest equipment for paddy rice production. Construction of rice millers in the Aveyime and Okyereko project areas where the main crop is rice will be required.

Since the existing threshers and millers of the rice growing projects are generally deteriorated, they should be replaced by new ones. In addition, it is advisable to provide the floors with simple roofs for selecting marketable products with good quality, such as tomato, egg plant, onion, okra, etc. for processing. Although some storehouses are available in most of the rice growing project areas, no storage is provided in the areas where upland crops are mainly grown, and farmers usually store the products in their houses. Storehouse will be required for these projects.

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

5.3 Irrigation Plan

5.3.1 Irrigation Plan and Water Requirements

(1) Proposed Irrigation Method

Of the five selected priority projects, the Kpando-Torkor and Mankessim project areas, where upland crops are cultivated, are presently irrigated with the sprinkler systems. The remaining three project areas where the main crop is paddy, are irrigated by gravity type. For the former projects, a study was made of the possibility of applying the furrow irrigation method. Application of drip irrigation is not included in this comparative study, because it is not used in the country at all and such a water supply system will have to be operated and maintained by farmers' organisation after projects rehabilitation. Application conditions of the sprinkler and furrow irrigation systems are described below:

According to the results of cylinder intake rate test, the Mankessim project has a high basic intake rate, more than 50 mm/hr, and therefore application of furrow irrigation could not be recommended. Also in Kpando-Torkor project, it is difficult to apply furrow irrigation because of a high possibility of soil erosion due to steep land slope ranging from 1/30 to 1/50, when the present irrigated agriculture is intensified in the future. From these findings and study results, the sprinkler system is recommended to be applied for these two projects as it is. But for the Aveyime and Okyereko projects where paddy is mainly cultivated, furrow irrigation will be applied because the upland crop area is limited due to the present irrigation method, and also considering the soil condition and low construction cost.

(2) Irrigation Water Requirements

ETo estimated by the modified Penman method is slightly higher than that by the Blaney-Criddle. The daily ETo for the respective projects is summarised below:

Daily Evapo-Transpiration

(Unit: mm)

Project	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1 Ashaiman	5.0	5.4	5.7	5.6	5.2	4.1	3.8	4.0	4.5	5.3	5.3	4.8
2 Aveyime	4.8	5.6	5.7	5.4	4.9	4.0	3.9	3.3	4.3	4.7	4.8	4.4
3 Kpando-Torkor	5.0	5.4	5.5	5.4	5.0	4.1	3.7	3.7	4.1	4.8	5.1	4.7
4 Mankessim	4.5	5.1	5.3	5.2	4.8	3.8	3.6	3.6	4.0	4.8	4.9	4.4
5 Okyreko	4.5	5.1	5.3	5.2	4.8	3.8	3.6	3.6	4.0	4.8	4.9	4.4

Net irrigation water requirements were calculated for 10-day periods, using evapo-transpiration (ETo), deep percolation loss measured at Ashaiman, Aveyime and Okyereko (0.8 mm/day to 2.4 mm/day), puddling water requirements (ranging from 140 mm to 190 mm), pre-irrigation requirements in upland, and effective rainfall. Overall irrigation efficiency was estimated to be 60 % for paddy cultivation, 50 % for furrow irrigation and 70 % for sprinkler irrigation, using the results of measurement of canal seepage rate at the field. The effective rainfall in paddy field was calculated on the basis of the daily water balance using daily rainfall data. The U.S. Department of Agriculture Soil Conservation Service has developed a procedure for estimating effective rainfall by processing long term climatic and soil moisture data from 50 years of rainfall records at 22 experimental stations. Daily water balance in the soil profile was studied, and the following relationship was derived from monthly rainfall and crop consumptive use.

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

Where,

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

The irrigation water requirements for respective projects were thus calculated as summarised below.

(Unit: lit/sec/ha)

Project	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1 Ashaiman												
1-10	0.76	0.14	0.37	0.67	0.69	0.73	0.71	0.00	0.00	0.38	0.65	1.00
11-20	0.45	0.06	0.53	0.84	1.11	0.83	0.42	0.00	0.00	0.53	0.81	1.14
21-end	0.19	0.18	0.57	0.86	0.87	0.97	0.10	0.00	0.15	0.64	1.04	1.06
2 Aveyme												
1-10	1.18	1.34	0.83	0.07	0.80	0.81	0.91	0.90	0.63	0.04	1.01	1.16
11-20	1.14	1.25	0.44	0.11	1.26	1.01	1.00	0.88	0.31	0.05	1.47	1.22
21-end	1.14	1.25	0.06	0.41	1.18	1.01	0.98	0.86	0.05	0.42	1.45	1.07
3 Kpando-Tokor												
1-10	0.59	0.36	0.13	0.03	0.38	0.38	0.46	0.14	0.00	0.03	0.43	0.49
11-20	0.49	0.28	0.05	0.09	0.44	0.36	0.25	0.06	0.00	0.08	0.51	0.54
21-end	0.39	0.21	0.00	0.25	0.53	0.44	0.25	0.00	0.00	0.22	0.58	0.58
4 Mankessim												
1-10	0.42	0.66	0.71	0.21	0.00	0.01	0.37	0.47	0.67	0.31	0.00	0.20
11-20	0.56	0.75	0.52	0.08	0.00	0.03	0.51	0.54	0.62	0.14	0.00	0.26
21-end	0.57	0.75	0.35	0.00	0.00	0.18	0.51	0.60	0.51	0.00	0.08	0.31
5 Okyereko												
1-10	1.11	0.70	0.00	0.70	0.79	0.55	0.94	0.42	0.00	0.65	1.01	1.18
11-20	1.09	0.36	0.00	1.04	0.98	0.86	0.86	0.23	0.00	0.94	1.19	1.19
21-end	0.94	0.03	0.24	0.96	0.77	0.99	0.69	0.03	0.26	0.99	1.20	1.12

5.3.2 Determination of Optimum Rehabilitation Area

(1) Alternative Plans

In the previous study, preliminary water balance study was made for each of the Ashaiman, Okyereko and Mankessim projects where available water sources are limited to serve the whole potential irrigable area. On the basis of the water balance study, a first probability analysis was conducted to delineate the possible irrigable area with 80 % irrigation dependability. The results are as shown below.

Possible Irrigable Area at Master Plan Level Study

Project	Potential Area (ha)	Developed Area (ha)	Possible Irrigable Area (ha)
Ashaiman	148	130	44
Aveyime	150	63	150
Kpando-Torkor	356	40	356
Mankessim	256	17	176
Okyereko	111	40	111 *
Total	1,021	290	837

* : As the existing water resource is so small, supplimental one will be developed by installing other necessary facilities on Ayensu river.

Since the topographic maps on a scale of 1 to 5,000 covering each of the five priority project areas were made available for further study on the whole project area, field investigation was executed at each project site using these maps. In parallel with such field investigation, public meetings were held, and the project boundaries were confirmed with the farmers concerned at each project site. As a result, alternative plans of the project study area were formulated in order to prepare the most optimum rehabilitation plan for each project from both technical and economic points of view, as explained below:

1) Aveyime Project (refer to Figure-8)

In the Aveyime project area, there are three small blocks of land being cultivated by farmers, and they are located adjacent to the existing paddy fields on the northern side (Extension Area-1), southern side (Extension Area-2), and the western side (Extension Area-3). Topographically, Extension Areas -1 and 3 could be irrigated by extending the existing irrigation network. In the case of Extension Area-2, a small scale pump will be required to boost up the water again to irrigate higher land by sprinkler. Extension Area -1 is owned by one large farm family at present, and the family head is already a member of the Aveyime farmers' society. At the public meeting, discussions with the family head and member farmers on whether this land can be included in the project were made, and finally the family head agreed to allocate his family land to other farmers after project rehabilitation. Extension Areas-2 and 3 are already owned by the project authority. Then, comparative study was made on the following three alternatives:

(a) Alternative 1 : Rehabilitation of existing paddy field only, covering 63 ha of land
(b) Alternative 2 : Rehabilitation of existing paddy field + Extension Areas -1 and 3, covering 80 ha of land
(c) Alternative 3 : Rehabilitation of existing paddy field + Extension Areas-1, 2 and 3 covering 95 ha of land

2) Kpando-Torkor Project (refer to Figure-9)

The potential irrigable area of this project which is divided into 4 irrigation blocks, A, B, C and D, was preliminary estimated at 356 ha, but remeasured at 415 ha using topographic maps of 1/5000 scale. The actual irrigated area at present is however 13 ha only (in Block-A) because of high deterioration of pumps and sprinkler equipment. The additional site inspection made in the wet season this year showed that farming activities in Block-A are more active compared with those in the remaining 3 blocks. Each block will be served by one complete set of pump, pipeline and sprinkler system independently, instead of one large-scale pumping set commanding the whole project area, in order to avoid the risks in case of breakdown of the facilities.

On the other hand, soil survey and study show that about 70 % of the total project area is classified as restrictedly suitable (Class S4), due to undulating topography and the existence of an accumulated layer of iron concretions or gravel within a shallow soil depth. Once the accumulated layer of iron concretions is exposed due to repeated wetting and drying by erosion of the surface soil, soils change irreversibly to iron hardpan. In fact, the accumulated layer of iron concretions is seen in part of Block-A due to active farming.

Block A is located near Dzigbe village which closely concerns the project rehabilitation, because all the lands in the project area belong to this village, and other blocks B, C and D are located in sequence from downstream to upstream. This means that Block-D would require rather long approach from the village for farming and electricity supply to the pump house as well.

The present land holding per family at this project is 0.28 acre. At the public meetings, discussions were made with the member farmers on optimum land holding size per family. Most of them requested one acre of land least in order to grow cash crops under irrigation during the dry season. In addition, they said they need more land to grow their main food crops such as maize and cassava mainly under rainfed condition in the wet season, in order to secure their food security. This suggests that a sufficient area of land should be left as it is around the project area to meet this purpose.

The potential irrigable land in each block can be divided into two parts, lower part and upper part, from topographic point of view. The lands in the upper part generally have more steep land slope than those in lower part. This means that the lands in the upper part will require the provision of green belts and intercepting drains for soil erosion control at a higher density per acre or hectare than those in the lower part. When sprinkler irrigation is introduced into these lands, two separate pipeline systems, one for lower lands and the other for higher lands, will be required, because higher lands need more high water pressure than lower lands. If both lands are served by one pipeline system, operations of such a pipeline will become very complicated and difficult. The construction costs per acre or hectare of the pipeline system for higher lands will also be higher than those for lower lands. Preliminary design of the pipeline system shows that the lands in the lower part have an elevation lower than 96 m above sea level, and the higher lands have an elevation between 96 m and 106 m.

Then, comparative study was made on a combination of lower and higher lands and on development of lower lands only for the respective blocks.

3) Mankessim Project (refer to Figure-10)

According to the original plan, the Mankessim project is planned to be developed for both paddy and upland crops cultivation. Its total potential area of 256 ha is classified into 80 ha for paddy and 176 ha for upland crops. In the original plan, paddy field is located in lowland along the Ochi river. Presently, this lowland is severely inundated about one meter every year by flood water from the Ochi river. According to the interview with inhabitants living nearby and levelling survey on flood marks, the flood water level with about 10-year probability is around El. 14.5 m. Judging from the survey result, this flood would bring more than two meters of

inundation in the lowland. In order to protect the lowland from flood, a flood protection dyke is considered as one of the countermeasures. It would need about US$ 340,000 of investment, equivalent to US$ 1,330/ha. When paddy is cultivated in this area, in addition, the total irrigable area of the project would be restricted to 115 ha instead of 256 ha of potential land, according to the result of water balance study. From such study results, it is proposed that this lowland be excluded from the project area and that the project rehabilitation be made, aiming at cultivation of upland crops which would be more profitable than rice.

Then, upland irrigation by sprinkler system is considered in the existing upland located downstream of the dam and undulating upland on the right bank of the dam. However, an additional site inspection made in the wet season this year shows that the Ghana Export Promotion Company has a right to use 167 acres (about 67 ha) of land located in the existing upland on the right bank. This private company's land will have to be excluded from the alternative study of rehabilitation plan.

The present irrigated land by the existing pump and sprinkler set is limited to 17 ha of upland located on the left bank of the dam, because the pump and sprinkler set is seriously deteriorated. The present irrigated land could be expanded to 29 ha in total within the same area, when new pump and sprinkler sets are provided in connection with the project rehabilitation. In addition, there exist 80 ha of upland being cultivated by farmers on the right bank of the dam for which sprinkler irrigation could be applied, using water from the Mankessim reservoir. However, the right bank area includes upland with a steep land slope of more than 10 %, and soil erosion due to intensified irrigation farming will be expected in this case. Moreover, because such a steep slope land is generally located on higher portion of the hills, pumps with a high lifting head and high water pressure pipeline will be required to supply water to the sprinkler system. The area of steep slope land is estimated at 23 ha.

Then, the following two (2) alternative plans are considered for comparative study to determine the most optimum rehabilitation plan:

Alternative 1 : Existing Area and Extension Area - 1 (net irrigated land: 29 ha in total)
Alternative 2 : Alternative 1 + Extension Area - 2 excluding elevated land with steep land slope of more than 10 % (net irrigated land: 86 ha in total)

4) Okyereko Project (refer to Figure-11)

Although the potential irrigable area is estimated at 111 ha, the developed area is 40 ha. Since its water source is the Okyereko reservoir which is fed by rainfall only,

the irrigated area is restricted at present. In fact, the irrigated area in the past five years from 1991 to 1995 ranged from 7.3 ha to 30.9 ha and averaged 21.6 ha. As already reported, a preliminary water balance study shows that irrigable area with 80 % irrigation dependability would be 11 ha only. Therefore, GIDA has a plan to provide supplemental water source by installing pumps on the Ayensu river which is located near the project. This plan is prerequisite for comparative study of all the alternatives. According to the topographic maps and site inspection, there are two blocks which could be irrigated by extending the existing irrigation network. These blocks are located downstream of the existing paddy field and on the left bank. Then, comparative study was made on the following three alternatives:

(a) Alternative 1 : Rehabilitation of existing area + construction of a new pumping station as a supplemental water source
(b) Alternative 2 : Alternative 1+ development of downstream block (Extension Area - 1)
(c) Alternative 3 : Alternative 2 + development of left bank block (Extension Area - 2)

The total irrigation area in the case of Alternatives 1, 2 and 3 would be 39 ha, 63 ha and 81 ha, respectively.

5.3.3 Water Balance Study

The water balance study was conducted in order to estimate irrigable area with 80% irrigation dependability at Ashaiman and Mankessim, and also clarify the required pump capacity at Okyereko. The results of the water balance study are summarised as follows:

Project	Irrigation Dependability (%)	Irrigable Area (ha)	Pump Capacity (m3/sec)
Ahsiman	100	29	-
	90	39	-
	80	53	-
	70	56	-
Mankessim	100	114	-
	90	139	-
	80	142	-
	70	158	-
Okyereko			
- Alternative 1	80	39	4
- Alternative 2	80	63	5
- Alternative 3	80	81	6

The existing irrigation system on the left bank area covers 56 ha net. If irrigation at 80 % dependability is practised, an area of 3 ha must be curtailed from the project area to be rehabilitated and will become rainfed area. Considering that this balance area is too small and is presently irrigated by one irrigation unit, it is proposed that the rehabilitation be carried out for all the existing irrigation system covering 56 ha, though irrigation dependability will become 70 %. The available area for the Mankessim project is narrowed down to 86 ha including the ex-

pansion area, taking into account the flood and topographic conditions. This corresponds to about 60 % of the possible irrigable area with 80 % irrigation dependability.

5.3.4 Determination of Optimum Rehabilitation Area

(1) Aveyime Project

Three alternative plans were elaborated for rehabilitation of Aveyime project. The project facilities to be required for the respective alternative plans were designed for the purpose of cost comparison. Their estimated costs are summarised as follows:

(a) Alternative-1 : 1,232 million Cedis, equivalent to US$ 11,506 /ha
(b) Alternative-2 : 1,523 million Cedis, equivalent to US$ 11,203/ha
(c) Alternative-3 : 1,852 million Cedis, equivalent to US$ 11,467/ha

Of the three alternatives, Alternative-2 is the lowest, although the difference with the second lowest, Alternative-3 is small. Meanwhile, Alternative-3 presents the highest incremental benefit per ha as shown in the same table, and also the largest ratio of incremental benefit and cost per ha. From these study results, Alternative-3 is recommended as optimum rehabilitation area for the Aveyime project.

(2) Kpando-Torkor Project

The possible irrigable area for the Kpando-Torkor project was estimated at 415 ha net using the new topographic maps with 1 to 5000 scale. The project area is divided into the following 4 blocks which are further divided into lower and higher areas, except Block-D:

Block	Possible Development Area (ha)		
	Lower Part	Higher Part	Total
A	70	50	120
B	31	33	64
C	85	65	150
D	81	-	81
Total	267	148	415

In order to determine the scale of development area, a comparative study of the blocks was carried out from the following viewpoints:

(a) Priority of development

The basic concept of the project rehabilitation is to rehabilitate the existing facilities. Therefore, the area served by the existing irrigation system will be given top priority for development.

(b) Topography and present land use

There are no definite different topographic conditions in the four blocks. The project area is inclined toward the Volta Lake with a slope ranging from 1/50 to 1/60, and block boundaries are formed by small streams flowing into the lake.

Of the four blocks, only Block-A is irrigated, although the irrigation area is so small 40 ha, and the remaining area is cultivated with maize and cassava under rainfed condition. Both Blocks-B and C are moderately utilised for crop cultivation under rainfed condition, where cultivated crops are maize, sugarcane, and tomato. Block-D which is located at northern part of the project area, is cultivated to a very small extent due to its isolated location.

(c) Possibility of soil erosion

All the blocks have a similar topographic condition for both lower and higher lands, similar soil condition. From these natural conditions, it can be said that soil erosion will occur at all blocks at a similar degree, although the longer areas perpendicular to contours are subjected to more severe soil erosion.

(d) Ensuring of cultivation area for staple foods (maize, yam and cassava)

It is necessary to ensure additional cultivation area of staple foods such as maize, yam and cassava, for the relevant farmers around the project area to be developed. The required cultivation area per farmer is 0.3 ha. Accordingly, when the project area to be developed is determined, such additional cultivation area should be provided in the surrounding area. Namely, in case the project area to be developed is 270 ha, additional cultivation will require 609 ha of land, and the total required land will come to 879 ha which is larger than the total net arable area of about 770 ha including the Kpando-Torkor project area.

(e) Intake method

The Akosonbo dam is presently operated within a water level fluctuation of 9.14 m from El.75.59 m to El.84.73 m. On the other hand, the land surface of the project area is sloped toward the Volta Lake with a 1/50 to 1/60 gradient. Taking into consideration such a dam operation rule and topographic condition, irrigation water is required to be pumped up from the lake to the project area. In order to select the optimum pump intake method, the following three alternative plans were studied from technical and economic viewpoints:

- Floating pump plan
- Slantingly movable pump plan

- Fixed pump plan

Although a submergible pump plan was also considered, it was omitted from the study plan due to much difficulty in its maintenance work, especially for the mechanical seal portion. The fixed pump plan requires more difficult installation and maintenance works than the others, though its operation is easier. The movable pump on an inclined strip presents easier construction, installation and maintenance, but slight difficulty in operation due to change of position of the delivery pipe and electricity distribution panel according to the seasonal fluctuation of water level of the Volta Lake. The floating pump plan is slightly difficult and complicated as a whole, but does not show any decisive ones. It can be said that the floating and movable pump plans are technically at a similar level, but actually the fixed one is rather in a lower position. The floating pump plan requires the lowest construction cost per ha, followed by the movable pump plan. Judging from the study results from overall viewpoints, it is proposed to select the floating pump plan. A cost comparison for determination of the project area to be developed was therefore made by applying this floating pump plan for the respective blocks.

(f) Cost comparison

The cost comparison results are as follows:

Block	Lower Area			Lower and Higher Areas		
	Area (ha)	Construction Cost (Cedi 1,000)	(US$)	Area (ha)	Construction Cost (Cedi 1,000)	(US$)
A	70	29,171	17,160	120	28,167	16,569
B	31	48,839	28,729	64	34,063	20,037
C	85	29,082	17,107	150	26,987	15,875
D	81	29,444	17,320	81	-	-

As can be seen in the above table, the lowest construction cost per ha is for development of both lower and higher areas in Block-C, and the second lowest one is for lower and higher areas in Block-A, though the difference among them is not so large.

The study on construction cost per ha shows that development of the lower and higher areas of Blocks -A and C is more attractive due to their lower cost as mentioned above. In the case of development of both blocks, the total development area will become 270 ha. As previously discussed on the cultivation area to be ensured for staple foods, about 812 ha will be additionally required at full development of both blocks under a crop area rotation cycle of once in four years, and then the total required arable land will come to 1,082 ha which is larger than the net arable land of 770 ha. From this viewpoint, development of both blocks could not be proposed.

In the four blocks, irrigation is being executed only for the lower area of Block-A.

Since the development cost for the lower area of Block-A is not high and also considering the basic concept of project rehabilitation mentioned above, it is proposed to give a top priority to the lower area of Block-A. This plan coincides with farmers' request at the public meeting, too. Thus, the remaining selection was narrowed down to either the higher area (50 ha) of Block-A or the lower area (85 ha) of Block-C, because Blocks-B and D present higher development cost. Finally, it is proposed to develop the lower area of Block-C, together with the lower area of Block-A, for the following reasons:

- Development is proposed for lower areas to mitigate possibility of soil degradation, since some steeply sloped places are found in higher areas.
- Soil condition of Block-C is more suitable for crop cultivation.
- In the case of development lower and higher areas of Block-A, four pumps will be installed in one pumping station, and operation will become complicated due to larger command area and increase of pipe connection of pumps with delivery pipes which should be made at every two-meter interval according to the water level fluctuation.
- Balanced development with environment in the Kpando-Torkor area.

3) Mankessim Project

The Mankessim project has two alternative plans. Alternative-1 is to rehabilitate the irrigation facilities for the existing area and also to provide new irrigation facilities for the Extension Area-1 (net irrigated land: 29 ha in total); and Alternative-2 is to provide new irrigation facilities for Extension Area-2 in addition to Alternative-1 (net irrigated land: 86 ha in total). The construction cost for Alternative-1 and Alternative-2 are as follows:

(a) Alternative-1 : 802 million Cedi, equivalent to US$ 16,275 /ha.
(b) Alternative-2 : 2,350 million Cedi, equivalent to US$ 16,075 /ha.

Incremental benefit per ha for both alternatives will be the same since the same cropping pattern is applied. From these study results and the viewpoint of maximum use of available water and land sources, and also considering the farmers' request at the public meeting, it is recommended to apply Alternative-2 for rehabilitation of the Mankessim project.

4) Okyereko Project

In order to determine the optimum rehabilitation area for the Okyereko project, three alternatives were worked out. The pump capacity was estimated through water balance study as mentioned above. The required construction costs for the respective alternatives were calculated as follows:

(a) Alternative-1 : 1,322 million Cedi, equivalent to US$ 19,936 /ha.
(b) Alternative-2 : 1,506 million Cedi, equivalent to US$ 14,058 /ha.
(c) Alternative-3 : 1,761 million Cedi, equivalent to US$ 12,789 /ha.

It is sure that incremental benefits per ha for Alternative-3 become higher than others, because upland crops are cultivated. Thus, it is concluded that Alternative-3 is the most attractive case for rehabilitation of the Okyereko project.

5.3.5 Irrigation Method

(1) Paddy

Of the five selected priority projects, three (Ashaiman, Aveyime, and Okyereko) are mainly cultivated with paddy. Irrigation water is supplied to each field by gravity system after intake. At present, it is reported that continuous supply of irrigation water is practised in the Ashaiman project and that irrigation water supply in the remaining four projects is made intermittently. However, water demand is not calculated logically and also water supply is not made based on a reasonable irrigation calendar.

Except Aveyime, other projects have rather limited water resources. Although the Aveyime project has rich water source, irrigation water is tapped by pumping. This means that water supply should be made carefully to minimise water loss for efficient pump operations. In the case of limited water source, rotational irrigation is sometimes employed, but it requires some conditions such as definite irrigation calendar and active water users association, especially for open canal network. If conditions are not matured, it would bring about more water loss and thus water conflicts among farmers, too.

The water supply system should be simple. Taking into account the present situations surrounding the projects, it is proposed to apply the continuous water supply method, but rotational water supply will be practised at puddling time.

(2) Upland Crops

The Kpando-Torkor and Mankessim project areas are presently irrigated by sprinkler systems. These sprinkler systems will be rehabilitated. The water supply amount at one time was calculated to be 28 mm, which correspond to water amount at one time. Irrigation interval for both the Kpando-Torkor and Mankessim projects was determined at 6 days. The following sprinkler system is proposed, taking into consideration the existing system, easy operation, topographic condition, soil condition, etc.:

- Semi-permanent system

- Arborescent pipeline system (galvanized steel pipe)
- Intermediate sprinkler
- Extent of sprinkling (15 m x 12 m)

One sprinkler unit consisting of 8 sprinkler heads, 8 riser pipes, 93 m of movable lateral pipe (70 mm dia.), will cover 2.4 ha in a 6-day rotation.

According to the soil survey results, Extension Area -1 and Extension Area -2 of the Aveyime project are covered with loamy sand and sandy clay loam, respectively. Extension Area -1 and Extension Area - 2 of the Okyereko project are covered with clay loam and clay/sandy loam, respectively. From these soil conditions, these areas are planned to be irrigated by furrow system. The proposed furrow length is as follows:

- Aveyime project
  Extension Area - 1 : 100 m
  Extension Area - 2 : 50 m

- Okyereko project
  Extension Area - 1 : 100 m
  Extension Area - 2 : 100 m

5.4 Drainage Plan

Drainage facilities exist in the 3 projects of Ashaiman, Aveyime and Okyereko. These facilities do not function properly due to much sedimentation and grasses. It is therefore essential to remove them and to keep steady maintenance work. The proposed rehabilitation works of the drains are to remove sediment and to finish the canal section as designed. In these project areas, a main drain runs across the original areas, therefore a causeway will be provided for easy access to the respective fields and for transportation of agricultural products.

(1) Estimate of Drainage Requirements

Drainage requirements were estimated separately for paddy field and upland. The drainage requirement for paddy field was calculated at 1.0 lit./sec/ha for Ashaiman, 2.0 lit./sec/ha for Aveyime, and 3.0 lit./sec/ha for Okyereko, using 10-year probable 3-day continuous rainfall and on assumption that the allowable water depth in paddy fields is 150 mm. The drainage requirement for upland was estimated on the basis of 10-year probable daily rainfall and the MacMath equation which is similar to the rational equation. Study results are summarised below:

- Ashaiman : $Qd = 0.070\ A^{4/5}$

- Kpando-Torkor : $Qd = 0.181\ A^{4/5}$
- Mankessim : $Qd = 0.138\ A^{4/5}$

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

(2) Countermeasure for Soil Erosion

The Kpando-Torkor and Mankessim projects areas are subjected to soil erosion due to their sloped topography, if proper countermeasures are not applied. Although there are various countermeasures against soil erosion, it is proposed in this case to use a green belt together with a drainage system, which is simple and can be easily constructed. A green belt with an intercepting drain will be provided along a contour at about 200 m intervals, and the excess water caught by the intercepting drain will be drained by the collector drain. Because the flow velocity in the collector drain will become higher, it will be lined with concrete.

5.5 Plan for Farm Road and Buildings

(1) Proposed Farm Road Plan

All farm roads are generally poor and will require improvement for proper O&M of the project facilities as well as for conveyance of agricultural inputs and farm products. Taking into consideration such present condition and also the available local materials for pavement, it is proposed to apply the following farm road development plan: (i) existing roads should be incorporated into the new farm road network as much as possible; (ii) lateral farm roads should be provided so as to connect directly with the irrigation service unit (one acre) considering transportation of agricultural inputs and farm products; (iii) main farm roads should be so provided as to facilitate inspection of major canals and to link the project office and pumping station with public roads, at least.

There are two types of development of the main farm road. One is to improve the existing road, and the other is to construct a new one. The main road is 5m wide including 3 m gravel pavement. The surface of the existing road will be scarified, regraded and compacted prior to resurfacing. The gravel pavement will be provided for 10 cm thick. As for the new road, stripping, excavation, embankment and gravel pavement will be executed to the same dimension as that of the existing road to be rehabilitated. The total thickness of road will be 30 cm consisting of 20 cm of embankment and 10 cm of gravel pavement.

As for lateral farm roads, also two types of development are proposed improvement of the existing roads and construction of new roads. The lateral farm road is 3 m wide with 25 cm thick laterite pavement. The construction method for lateral farm roads will be the same as the

main farm road.

In order to approach the project area smoothly, it is essential to improve the public roads as access roads. These roads exist in the Kpando-Torkor and Mankessim project areas. The required works are scarifying, compaction and replacement of damaged cross drains with new ones. No pavement will be made and the original condition will be maintained.

(2) Buildings

The required buildings are largely divided into three categories: O & M office, post-harvesting facility, and training facility. The development plan for these buildings is as follows:

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

Post-harvesting facilities such as storehouse, sorter house, dry yard and garage are not sufficient at present in most of the project areas. They will be newly constructed. The required number of these facilities will be determined from the proposed cropping patterns.

Training of farmers is one of the important programmes for improvement and strengthening of the farmers' societies. Since IDC exists at in the Ashaiman project area, it is proposed that most of the training activities be provided at this centre. For this purpose, a lecture hall, a dormitory, guest house for visiting lecturers will be provided in Ashaiman. In addition, a lecture hall will be constructed also in the Okyereko project area.

5.6 Rehabilitation Plan of Project Facility

Based on the basic concept, a rehabilitation plan for facilities of the respective projects was prepared as shown in Figures-12 to -16 and Table-16, and summarised as follows:

5.6.1 Irrigation and Drainage Layout

(1) Ashaiman Project

Since the existing dam, reservoir and intake facilities are in good condition, no rehabilitation work will be required for them. The existing main irrigation canal is of earthen type and water leakage is observed at many points along the canal. Although the lateral canals are partly line with concrete, they are generally deteriorated, which results in low function. Therefore, the existing irrigation network will have to be rehabilitated totally. The main and lateral canals will

be of concrete flume type, in order to minimise canal seepage loss and to ensure the structural stability because these canals are constructed on backfilled foundation. Canal-related structures such as turnouts, checks, syphons, drops, culverts, dissipaters, etc. will be all rehabilitated to recover their functions. Measuring devices which are essential for realising proper water distribution, will be provided immediately downstream of turnouts. These devices are proposed to be of broad crested weir type for easy construction and observation. The measuring device .

Since the existing layout of the drains shows certain technical problems, the required rehabilitation works will include removal of sediment and grasses in the drains and construction of cross drains and causeways as additional structures.

(2) Aveyime Project

For the Aveyime project, two pumping stations will be constructed: one is to supply irrigation water for the total area of 95 ha, and the other is to further boost up water to irrigate Extension Area-3 of 15 ha. Because all pumping stations are planned to be electrified, a new transmission line of 2.6 km in long will be provided for this purpose.

The existing paddy field covering 63 ha net of land has an irrigation network, and the existing canal layout has no technical problem. Because the canal network including the main and laterals are severely deteriorated due to poor construction, however, all of them will be rehabilitated to recover their functions. Among three expansion blocks, two blocks could be irrigated by extending the existing canal network, but the remaining block will require a new sprinkler irrigation system in view of soil conditions and high elevation of land. Similarly to those for the Ashaiman project, all of the canal structures will be replaced by now ones. The required rehabilitation works for the drainage system will be the same as those for the Ashaiman project.

(3) Kpando-Torkor Project

As already discussed, the lower areas of Blocks -A and C were selected as the project area to be developed. The existing pumps and sprinkler system are deteriorated because of long time use over 10 years and can irrigate about 20 ha of land due to insufficient quantity. Because the proposed irrigation area will be expanded, Block A (70 ha) and Block C (85 ha) will have each a separate sprinkler system which consists of pumping station, pipeline and sprinkler sets. Similarly to the Aveyime project, the pumping stations are planed to be electrified, which will require construction of 8 km of transmission line in total. A drainage system consisting of intercepting drains and collector drains will also be constructed in connection with a green belt to prevent soil erosion.

(4) Mankessim Project

The Mankessim project also has a dam, reservoir and intake facilities, and they are maintained in good condition. Therefore, no rehabilitation will be required for them. Since the irrigation area is cultivated with upland crops, sprinkler irrigation is applied for this project. Because the existing sprinkler system such as pumps, pipeline, sprinkler equipment are all deteriorated and can serve only 17 ha of land because of insufficient quantity, a new sprinkler system will be provided for the two blocks on both the left and right banks. The required transmission line for pump electrification would be 3.5 km long. In order to prevent soil erosion, a green belt, intercepting drains and collector drains will be constructed similarly to other upland projects.

(5) Okyereko Project

The proposed rehabilitation plan includes a new pumping station and a new intake weir in order to cope with the present water shortage. These structure will be installed on the Ayensu river running adjacent to the project area. The proposed weir will have a crest of 13 m, a high of 1 m, and an intake capacity of 100 lit./sec/ha. The river water diverted by the weir will be conveyed to the pumping station through a headrace and lifted up in order to supply water to the reservoir. Since the discharge of the Ayensu fluctuates from season to season, operation of pumps will be restricted to 6 months from June to November every year. A 8 km long transmission line will be required.

The existing canal network covering 40 ha of paddy field consists of main, lateral and sub-lateral canals, and the main canal is lined with concrete blocks. They have many water leakage portions because of deterioration and poor construction. In addition, canal-related structures are also deteriorated and insufficient in required quantity as well as location. Therefore, they will be all constructed newly. The expansion block located downstream of the existing paddy field could be irrigated by extending the existing network. The new block on the left bank will require a new irrigation system. The proposed canals will be of concrete flume type, and the related structures will be designed and constructed in accordance with the design standard applied for the Ashaiman and Aveyime projects.

Since the existing drainage system including the main and lateral drains is deteriorated due to poor maintenance, they will be rehabilitated by removing sediment and grasses in the drains to recover their functions. It will be recommended that reforestation/green belt is provided around the reservoir by beneficiaries, in order to protect it from further siltation.

5.6.2 Farm Road

The required lengths of roads to be improved or constructed newly as designed based on the farm road plan mentioned previously, are as follows:

Estimated Road Length

(Unit: m)

Project	Main Farm road		Lateral Farm Road		Access Road
	Rehabilitated	Newly Constructed	Rehabilitated	Newly Constructed	Rehabilitated
Ashaiman	1,580	0	3,670	310	0
Aveyime	1,950	980	3,650	2,390	0
Kpando-Torkor	750	2,540	2,240	7,840	4,300
Mankessim	620	400	0	11,860	0
Okyereko	2,190	0	3,730	3,870	0

5.6.3 Buildings and Related Facilities

An O&M office will be provided for all projects, except the Ashaiman project. The proposed office consists of five rooms including one meeting room. Out of them, one room will be used for farmers' organisation. The required office space is 175 m^2.

The required numbers of these facilities, which were estimated from the proposed crops and crop production, are as follows:

Proposed Post-harvesting Facilities

Project	Storehouse	Sorterhouse	Dry Yard	Garage
Ashaiman	Not needed	1 no. (300m2)	Not needed	Not needed
Aveyime	1 no. (200m2)	1 no. (300m2)	1 no. (300m2)	1 no. (300m2)
Kpando-Torkor	2 nos. (400m2)	2 nos. (600m2)	2 nos. (600m2)	2 nos. (600m2)
Mankessim	1 no. (200m2)	1 no. (300m2)	1 no. (300m2)	1 no. (300m2)
Okyereko	1 no. (200m2)	1 no. (300m2)	1 no. (300m2)	1 no. (300m2)

For the Ashaiman project, the following training facilities will be provided:

- One lecture hall (32 m^2 in floor space)
- Two dormitories for officers (40 m^2 each in floor space)
- One dormitory (263 m^2 in floor space for about 20 trainees in one group)
- One dining room with kitchen (40 m^2 in floor space)

For the Okyereko project, one lecture hall only will be provided. These training facilities will be made of concrete block with asbestos roof.

5.7 Water Management and O&M of Project Facilities

5.7.1 General

At present, water management activities of all the projects do not reach the satisfactory level. The constraints to proper water management activities which have been found through field investigation, are (i) unclear responsibility between GIDA and farmers' organisation, (ii)

lack of experience of the staff, (iii) lack of basic data, (iv) no proper measuring devices, (v) poor conditions of project facilities, and (vi) insufficient activities of water users association. It is essential to eliminate these constraints for successful operation and management of the projects after rehabilitation of the project facilities. Since the basic institutional development plan for proper water management and O & M works including staffing required has been discussed previously, this matter is dealt with in this Section only from the technical point of view, as mentioned below:

Water management activities are largely divided into two portions; one is to prepare and determine a proper water delivery and application programme, and the other is to execute the water supply in line with this programme. In general, a water delivery and application programme is prepared based on the various data and information, because it should be well-fitted to the local and current conditions. However, no basic data and information are available for preparation of water delivery and application programme in the projects, except the Ashaiman project. Even for the Ashaiman project, these are still limited. Thus, water supply to each farm plot is presently made on the farmers' demand basis, and not on any logical basis. In order to improve this situation and to realise effective water use, such data and information as listed below should at first be prepared and/or collected.

- Detailed topographic maps, showing pipeline network, canal routes, field ridges, roads, etc.
- Detailed soil maps
- Cropping patterns and cropped areas
- Available water sources
- Physical conditions of soils such as water holding capacity, basic intake rate, etc..
- Meteorological data such as rainfall, temperature, related humidity, sunshine, wind speed, and evaporation.
- Canal conveyance loss
- H-Q curve for each measuring device

In order to collect data and information, it is proposed that IDC provide technical assistance for all the projects.

In water management, another important issue is to monitor, analyse and evaluate the actual activities, and to reflect the results on the water delivery and application programme in the next year. Hence, staffing and organisation should be ensured for effective execution of the monitoring activity.

5.7.2 O & M of Project Facilities

In parallel with proper operation, suitable and continuous maintenance of the project

facilities is indispensable to secure proper and stable function of the facilities as well as to ensure the realisation of their economic life. The following maintenance works will be required:

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

The maintenance work at the project level is briefly explained below:

1) Regular maintenance: Regular maintenance refers to the day-to-day maintenance of the project facilities. It includes routing repair of pumps, pipes, embankment, measuring devices, weeding , filling of holes on the inspection roads with earth and gravel, oiling of gates, etc. Satisfactory implementation requires an intensive daily inspection of the project facilities.

2) Periodic maintenance: Periodic maintenance is defined as repair of minor damage which does not cause immediate danger to or malfunction of the water supply system. However, the periodic maintenance work should be carried out by skilled workers and mechanics in order to protect the system from further damage. Minor improvements of the water supply system are also included in this periodic maintenance.

3) Emergency repair: Damage to the project facilities will hamper the normal practices of irrigation. Therefore, repair of damaged facilities should be carried out quickly and effectively under the category of the emergency repair. Since the damage is not predictable either with respect to the time of occurrence or to the scale of damage, the agency concerned should always be ready to confront the occurrence of damage. The damage to the project facilities may result from (a) flood, (b) heavy rainfall, (c) careless operation of the facility, (d) violation of rules, and (e) destruction by animals and vehicles.

4) Annual maintenance: Maintenance work which involves a large work quantity or requires special skills should be carried out under the category of annual maintenance. This maintenance work may be executed by contractor(s) to be selected through open tendering.

5.7.3 O&M Equipment

In order to operate and maintain the project facilities satisfactorily, the following O&M equipment will be required.

Proposed O&M Equipment

	Pick-up (4 x 4)	Backhoe (0.3m3)	Tractor (60hp)	Grass Cutter	Radio Communication	Bus
1. Ashaiman	1 no.	1 no.	1 no.	3 nos.	1 no.	1 no.
2. Aveyime	1 no.	-	1 no.	3 nos.	1 no.	-
3. Kpando-Torkor	1 no.	-	2 nos.	4 nos.	1 no.	-
4. Mankessim	1 no.	-	1 no.	3 nos.	1 no.	-
5. Okyereko	1 no.	-	1 no.	3 nos.	1 no.	-

5.8 Institutional Improvement Plan

5.8.1 Organisation of Project Executing Agencies

The implementation of the Project will be divided into three (3) stages; (i) rehabilitation works, (ii) handing-over of O&M, and (iii) O&M by the farmers. The organisation of executing agencies for the stages (i) and (ii) is proposed as follows, and that for the stage (iii) is described in Section 5.7.

(1) Executing Agency for Rehabilitation Works

GIDA under MOFA will be the executing agency for the rehabilitation of irrigation projects. GIDA will co-ordinate all activities of the relevant government agencies and regional administrative organisations having connection with the project implementation. The Department of Project Development under GIDA will have direct responsibility for the project implementation including both the engineering and the construction works. The Regional and PM Offices will manage and co-ordinate the construction of the Project at the district level on behalf of the Department of Project Development. The main tasks of these offices will be as follows:

1) Financial arrangements needed for the engineering and construction works of the Project;
2) Design and construction supervision of all the works;
3) Co-ordination between the government authorities concerned with the implementation of the Project;
4) Arrangements for staff required during the detailed design and construction stages; (The head office of GIDA should despatch at least one civil engineer to each PM Office for supervision of construction works.)
5) Progress and quality controls of the rehabilitation (construction) works; and

6) Preparation of O&M manuals.

(2) Executing Agency for Handing-over of O&M

After completion of the rehabilitation works, all project facilities will be transferred to the Department of Project Operations under GIDA, which will be responsible for the handing-over of O&M to the farmers' societies. The PM Offices will have direct responsibility for the handing-over at the project site under the management and instruction of the Department of Project Operations. The organisation of these two offices should be strengthened in order to ensure successful implementation of the handing-over. The proposed organisational structure and staffing of both offices with supporting agencies involved in O&M are presented in Figure-17, and briefly described below:

1) Department of Project Operations

The proposed organisation consists of three divisions; (i) O&M Division, (ii) Monitoring and Evaluation Division, and (iii) Extension Division. The O&M Division comprises five officers; an irrigation engineer, a civil engineer, a mechanical engineer and a mechanic under a deputy director. This Division undertakes the following activities:

- Overall engineering services for O&M through the PM offices;
- Training of the staffs of the PM Offices and societies on O&M;
- Improvement and dissemination of water management practices; and
- Movable services for pumps and equipment of the societies, etc.

The Monitoring and Evaluation Division monitors all project activities, and the Extension Division undertakes agricultural extension activities. These activities are described in Sub-section 5.8.4.

2) PM Offices

Two types of organisations and staffing are proposed in accordance with the development stages: (i) O&M during the transitional period until the handing-over, and (ii) O&M by the farmers' society after handing-over. Joint O&M of irrigation facilities by both the PM office and the farmers' society is made during the transitional period. Four officers (an O&M officer, a co-operative officer, an extension officer, and a monitor) are appointed to each PM Office during this transitional period. After the handing-over, an O&M officer, a extension officer and a monitor remain in each PM office, in order to support farmers' O&M.

In addition to the above strengthening and reorganisation programmes, it is proposed to establish the following task force and committee to ensure the successful implementation of rehabilitation works and handing-over of O&M.

1) Establishment of the Project Implementation Committee

It is recommended to establish a Project Implementation Committee in the GIDA's head office during the period of rehabilitation works and transition of O&M. The members of the Committee will consist of a Chief Executive, a Deputy Chief Executive, and Directors of Departments and IDC in GIDA. All activities relating to the rehabilitation works and handing-over of O&M will be monitored, and the problems and constraints identified through this monitoring will be settled immediately by the Committee.

2) Agricultural Co-ordinating Committee

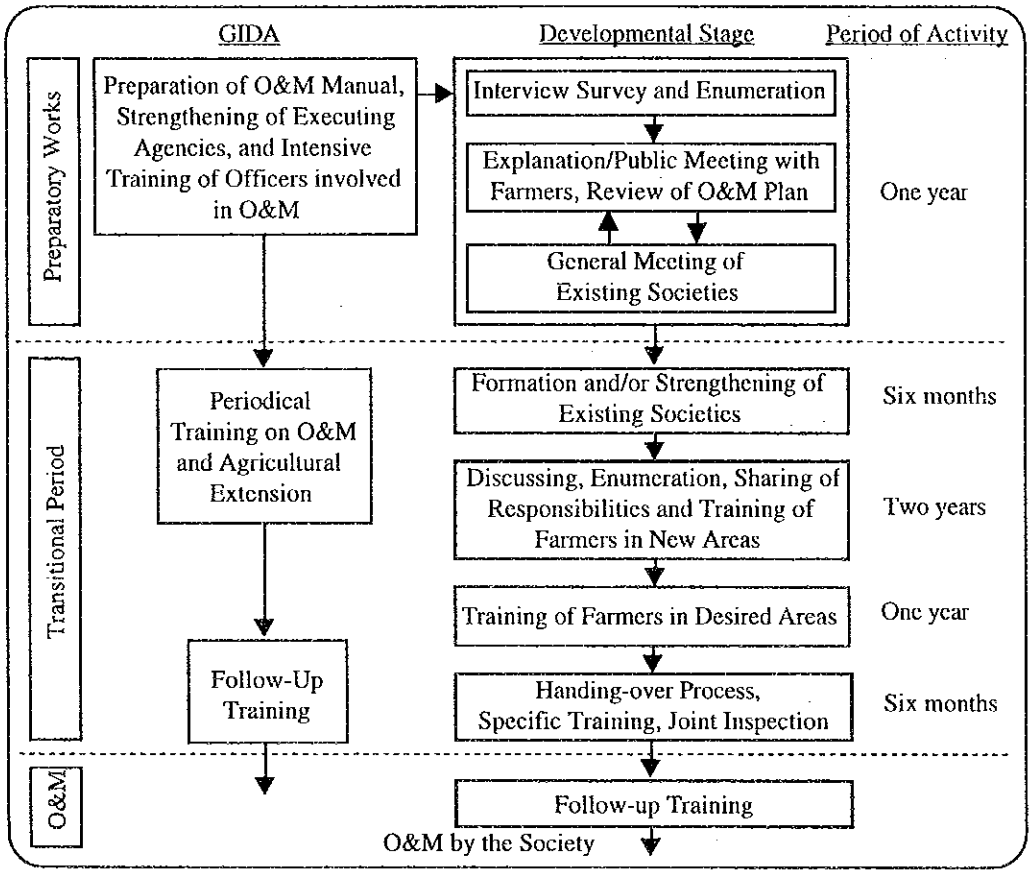
In order to keep a close co-ordination between the agencies related to the agricultural support services, it is proposed to establish an Agricultural Co-ordinating Committee in each project area. The membership of the Committee will consist of the representatives of the following agencies: (i) Regional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

5.8.2 Project Implementation and Management by GIDA

(1) Handing-over of O&M

At present, GIDA has a plan for the handing-over process. In this plan, the handing-over period has been set at 3 years. Although the contents of this plan can be adopted basically to the Project without problems, the period should be set up taking into account the actual situations of societies' activities, farmers' ability and the experience of GIDA's front line staff who directly implement the handing-over. As a reasonable period, it is proposed to set basically 5 years, based on the result of field investigation and referring to the progress of the Dawhenya Irrigation Project . It will be possible to hand over O&M to societies within 5 years, if those societies attain a good progress in the training programme. The proposed handing-over process is shown below.

Proposed Transfer of Project Management



In addition to the above handing-over process, the following matters are recommended from the standpoint of farmers' participation in the Project: interview survey on farmers' intention, explanation meeting (public meeting) with farmers, general meeting of farmers' society for project implementation, and joint inspection of the facilities.

(2) Management of Irrigation Facilities

Basically, all of the facilities rehabilitated under the Project will be handed over to the farmers societies, and managed and maintained by themselves. The proposed pumps for the Aveyime, Mankessim and Okyereko projects are of fixed type which is prevalent in the country, and the power source of these pumps is electric motor of which O&M is easier than diesel engine. The farmers can operate these pumps without problems. As for the Kpando-Torkor project, the floating type was proposed, taking into account the fluctuation of water level. The operation of this type is not so difficult, because the pump itself is of fixed type and the power source is electric motor, same as in other projects. However, farmers are not familiar with such type. Therefore, it is recommended that the pumps in the Kpando-Torkor project area be operated by the PM Office, and the farmers operate and maintain the sprinkler irrigation systems below the pumping stations. After the transitional period of 5 years, if the farmers could operate this floating type pump, GIDA will hand over the pump station to them.

(3) Land Allocation

All lands in the irrigation project areas are allocated to the farmers, in accordance with L.I. 1350 and traditional custom of land holding in the country. The land allocation procedure is as follows; (i) land acquisition by GIDA, (ii) establishment of the Land Allocation Committee, and (iii) land allocation to the farmers by the Committee.

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

(4) Training Programme for O&M and Strengthening of the Farmers' Societies

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

The O&M Division and the Extension Division will be responsible for conducting the training. The training contents will consist of O&M and strengthening of the society, but some other topics such as new agricultural extension system and promotion of the women in development will also be included in this training programme, because the officers and the people involved in the O&M and strengthening of the society should have the basic knowledge of these matters. The training programme is shown in Table-4.

(5) Establishment of a Monitoring System

To sustain O&M by the farmers' societies, and to make further improvement of O&M and agricultural production after handing-over, it is proposed to establish a monitoring system in GIDA. The monitoring items necessary for these purposes are (i) meteorological data including rainfall, temperature, evaporation, humidity, etc.; (ii) water management; (iii) operation and maintenance of the facilities; (iv) activities of the farmers' societies, and agricultural production and farmer's economy.

As for the monitoring of agricultural production and farmer's economy, it is recommended to carry out the "Bench Mark Survey (BMS)" method.

It is proposed to reorganise the existing Monitoring and Evaluation Division in the Office of Planning and Management or to establish a new Division in the Department of Project Operations to take charge of these monitoring works. The O&M of this monitoring system will be undertaken by this Division, and will be linked closely with IDC. The PM Offices will have a direct responsibility for field survey and observation of the above monitoring items. In each PM Office, a monitor will be appointed to manage monitoring works in the field. These PM Offices are now preparing the following four documents: (i) monthly report, (ii) quarterly report, (iii) mid-year report, and (iv) annual report. All data should be reported in these documents, and processed by the Monitoring and Evaluation Division and IDC by the use of computers. The data will be fed back to improve O&M and agricultural production in the project areas. The evaluation and assessment of the project effects and environmental protection will also be studied based on these data. The monitoring manual including forms necessary for recording data will be prepared along with the O&M manual at the detailed design stage.

5.8.3 Farmers' Societies

As the basic approach, the O&M should be handed over to the societies which have already been established in each project area, and it is not considered to establish any new societies, but only to reorganise the existing ones, if necessary. The strengthening of the existing societies should be undertaken by GIDA, in co-operation with the Department of Co-operatives. The proposed strengthening plan for the existing farmers' societies is described below:

(1) Objectives of Farmers' Societies

The main objective of a farmers' society is to operate and maintain the irrigation facilities. In addition, other objectives such as marketing and credit services are also included in order to meet the farmers' intention and to improve present agricultural support services. The result of interview survey indicates that many farmers have requested such agricultural support services by the farmers' society.

(2) Organisation and Activities

At present, a farmers' society has been established in each project area, but all these societies have no function of O&M of the irrigation facilities. These existing societies should therefore be reorganised to new societies which have the functions of O&M with the agricultural support services such as marketing and credits. The proposed organisation consists of Type-A and Type-B. Both types have almost the same structure, and the difference between the two types is as follows:

1) Type-A is for small projects having less than 100 farmers, and the farmers are

linked directly with the committee of management.

2) Type-B is for larger projects with over 100 farmers. In this type, the farmers are divided into several groups by each irrigation block, and each group is linked separately with the committee of management. Each farmers' group elects a representative who is the member of the committee.

The adoption of these types is entrusted to the society. But it is recommended that the size of a farmers' group should be less than 100 farmers, so that one of the prime requirements to activate the society is "face to face" communication between the committee of management and the farmers.

The proposed organisational structure of each project is presented in Figure H-6. A society consists of the following 4 components; (i) general meeting, (ii) committee of management, (iii) audit, and (iv) service sections (sub-committees) including O&M, agriculture, marketing and credit, and women's group. In addition, irrigation groups are formed under the committee of management. Their main functions and activities are as follows:

1) General Meeting

The general meeting is held at least annually.

2) Committee of Management

The committee of management is composed of the following members; chairman, vice chairman, general secretary, treasurer, and several members who are representatives of the service sections. In the case of Type-B, several representatives of the farmers' groups are included as committee members. In addition, one or several porters, who are volunteers, are appointed in the committee in order to maintain close communication among the members and between the committee and the farmers. The main tasks of the committee are (i) to prepare annual management plans and budget, (ii) to instruct and supervise activities which are implemented by the service sections, (iii) to manage complaints and grievances from the farmers, (iv) to arrange and appoint volunteers to work in the service sections, (v) to manage accounting and general affairs, (vi) to co-ordinate with other agencies and associations, and so on. The committee members take charge of parts or portions of these works. Regular meetings are held monthly for implementing these activities.

3) Service Sections

Under the instruction and supervision of the committee of management, the routing service works are implemented by the following four sections; (i) O&M, (ii) agriculture, (iii) marketing and credit, and (iv) women's group.

4) Audit Section

At present, the staff of an society consists of a chairman, a vice chairman, a secretary, a treasurer and several members of the committee as mentioned earlier, but generally no auditor is assigned. In other words, the society has no auditing system in its accounting operation, and this is one of the society's problems. To solve this problem, it is proposed to establish an auditing system.

5) Irrigation Groups

An irrigation group is formed by each lateral canal for gravity irrigation and each rotational block for sprinkler irrigation, in order to make smooth water management. Each group operates the facilities within the irrigation block divided by the lateral canals or one unit of sprinkler irrigation system. A group selects a leader, and links with the society through this leader.

(3) Number of Farmers' Societies

The number of farmers' societies to be established in the project areas is as follows:

Number of Farmers' Societies to be Established in the Project Areas

Projects	Irrigated Areas (ha)	Holding Size of Farmer (ha)	No. of Farmers (No.)	No. of Intake/Pump Station (No.)	No. of Society (No.)	No. of Farmers' Groups (No.)	Irrigation Groups (No.)
Ashaiman*	54	0.45	120	1	1	-	13
Aveyime	95	1.0	95	1	1	-	4
K-Torkor	70	0.4	175	1	1	2	29
	85	0.4	213	1	1	2	35
Mankessim	29	0.4	73	1	1	-	12
	57	0.4	143	1	1	2	24
Okyereko	81	0.6	135	1	1	-	17
Total	471	0.49	954	7	7		134

* Total irrigated area in the Ashaiman is 56 ha. Out of total area, 2 ha are occupied by IDC for experimental fields, and remaining 54 ha are provided to the farmers.

In the Kpando-Torkor and Mankessim projects, there are two pumping stations, and the water management is carried out separately. Therefore, a society is established for each pumping station. For the maintenance of access roads from the project area to the main roads, a coordination committee is established between them.

(4) Offices and Facilities

An office of the society shares the floor space in the PM Office. All necessary administrative works including typing, printing, photocopying, communication, etc. should be sup-

ported by the PM Office.

(5) Training of Farmers' Societies

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

The training is divided into two courses: intensive course and follow-up course. The former is implemented during the transitional period of O&M and includes all items mentioned above. The latter is conducted after the handing-over of O&M, and carried out for several specific items depending on their activities.

(6) Irrigation Service Fees

All O&M costs of irrigation facilities are covered by ISC collected from the farmers. The amount of ISC is estimated by each farmers' society, and includes basically the annual O&M costs and replacement costs of irrigation facilities. ISC is collected before each cropping season. All members of the committee collect ISC directly from the farmers, and the collected amount is deposited immediately in the society's bank account. The treasurer manages all these transactions.

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

1) Farmers who fail to pay ISC on time are imposed a fine equivalent to some percentage of the total ISC amount per month during the non-payment period.

2) Farmers who pay the ISC amount in full and on time are entitled to reimbursement of some percentage of the full ISC amount as an incentive.

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

(7) Articles and Bye-Laws

Standard articles and bye-laws on farmers' societies have been prepared by the Department of Co-operatives. But these are for the general co-operatives, and no articles required for the new societies which will be responsible for the O&M of the project are included. Although these standard articles and bye-laws are applied basically to the new societies, it is necessary to enact several new articles. These are listed below:

1) The society has the right to collect ISC from the beneficiaries who receive irrigation services from the society, and the beneficiaries have the duty to pay ISC to the society.
2) The society inflicts a punishment on the beneficiaries who use irrigation water and facilities illegally or who fail to pay ISC.
3) The beneficiaries have the duty to participate in the communal O&M works which are planned by the society.
4) The tenant beneficiaries have the right to join the society, and are bound to pay ISC and membership fees as proxy for the owner beneficiaries.

In addition to these articles, it also be necessary to enact some laws at the national level on the matters concerned.

(8) Irrigation Meeting

The crop production activities are linked with various agricultural support activities including machinery services, supply of farm inputs, credit services, etc., which are implemented by the public and private sectors, and all these should be co-ordinated closely with the farming. In this context, it is proposed to hold irrigation meetings under the presidency of the farmers' society.

The agricultural co-ordinating committee assists the society in holding such meetings. In the meeting, the following items are discussed by the attendants. Based on the result of these discussions, the society requests the related agencies for necessary support services.

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

5.8.4 Agricultural Support Services

(1) Extension Services

For the extension activities, there are two agencies at present; MOFA for staple foods and GIDA for irrigated farming. The agricultural extension services to be provided in the project areas are undertaken by the Project Management Division under the Department of Project Operations, GIDA. At present, two agronomists are attached to this division to deal with all subjects including paddy, vegetables, and plant protection. It is suggested to appoint two more officers.

As for the extension system, the "T&V" system adopted by MOFA is proposed to be introduced in the project areas. Under the farmers' society, the farmers form irrigation groups consisting of 6 - 24 members each. The extension services are provided through these groups, and the Agricultural Sections of the farmers' societies assist in communication between the extension officers and the irrigation groups. At present, all PM Offices have almost no extension equipment and facilities. The following equipment is therefore recommended to be provided in each PM Office, in order to ensure effective extension activities: (i) typewriter, (ii) printing machine (rotary mimeograph), (iii) photocopy machine, (iv) pick-up trucks, and so on.

(2) Research Activities on Irrigation Farming

In order to achieve the final target of the Project and allow further development of agricultural production in the project areas, it is proposed to strengthen agricultural research activities for irrigated farming. Main activities necessary for the Project are listed below. It is expected that these activities are undertaken by IDC in Ashaiman.

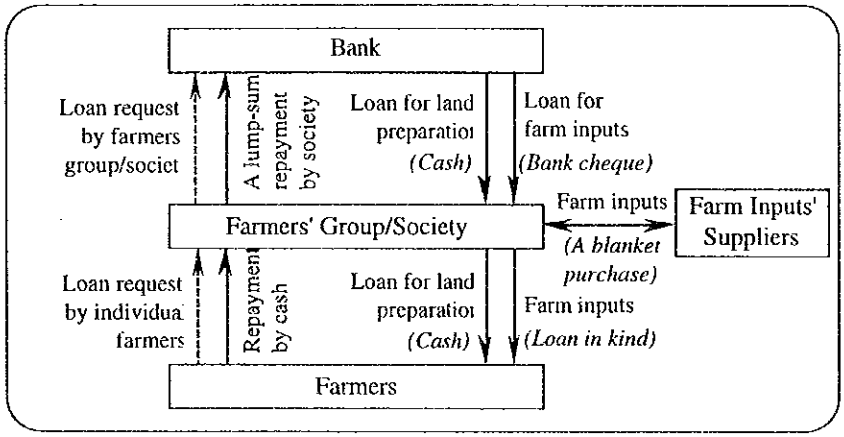
(3) Improvement of Agricultural Credits

At the initial stage of the Project, the farmers need a considerable amount of loan for purchasing farm inputs for crop cultivation, especially for vegetables. At present, several credits have been extended by the banks in and around the project areas. These credits have however serious problem on defaulting in payment of loans. To overcome this problem, it is proposed to introduce group loan or revolving loan systems. These are a comprehensive system including agricultural credit, marketing and technical guidance, and managed by the societies. The difference between them is financial sources, the former loan system obtains it from banks and the latter from public agencies. The details are described below:

1) Group Loan System

The group loan system is outlined below:

Outline of the Group Loan System



This loan system is managed by a farmers' group or society, and the loan procedures are as follows:

a) The loan is limited only to the purchase of farm inputs, and its ceiling amount is set depending on crops.
b) For borrowing loan, the farmers form a group and select a representative. The members of a group are jointly and severally responsible for repayment of loan for defaulters.
c) Farm input requirement is estimated by the group together with the required loan amount. At this time, the extension officer of the PM Office gives technical guidance such as recommended fertilisation and agro-chemicals to be used.
d) The bank provides a loan for the group on a lump sum basis or dividing it into two portions. The group purchases farm inputs in one lot.
e) The bank provides the loan amount only to the supplier of farm inputs, and the group receives farm inputs in kind from the supplier. In other words, the group and its representative do not touch cash money, except for the bank cheque to be issued to the supplier.
f) The representative collects the loan payment amount from each farmer, and repay it to the bank in a lump sum. The bank does not collect the loan payment amount from individual farmers.

The possibility of introduction of the proposed loan system was confirmed with the farmers in the irrigation projects and the head office of the Agricultural Development Bank (ADB), Accra. ADB said that it is possible to provide loans to the farmers' groups or the societies under such system and conditions. At the public meeting, the leaders of the societies and farmers said that the introduction of group loan system is possible and the societies could manage this system. At present, the societies in Tanoso and Akumadan have borrowed some loans from the banks under joint and several liability of the members, which is similar to the proposed loan system. It seems that all societies can manage such a new credit system without problems.

2) Revolving Loan System

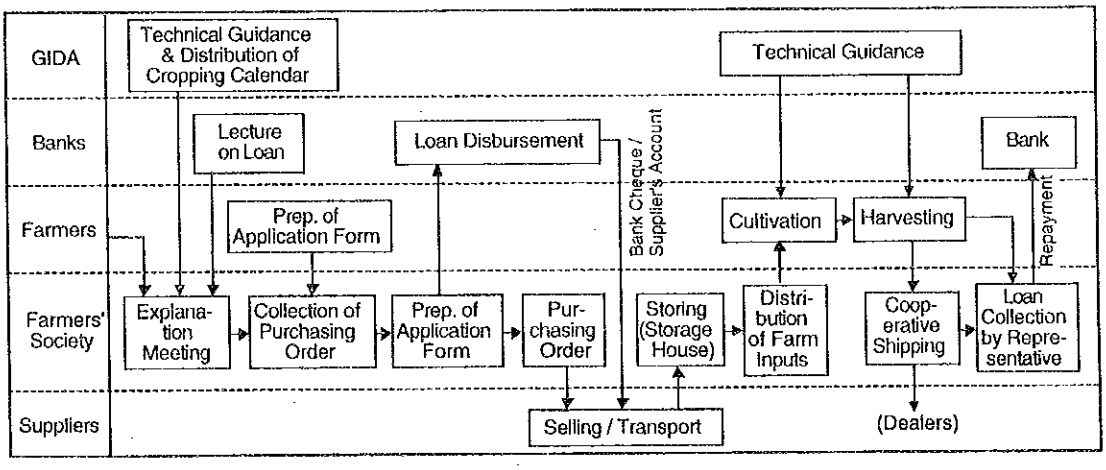
The implementing agency of the project (GIDA) arranges a considerable amount of funds, and provides it to the society under the condition of prevailing interest. The society lends its money to the farmers at an interest rate lower than the market rate. The repayment amounts from the farmers are deposited in the society's account, and the society finances the farmers again. Surplus from the revolving loan goes to payment to the investor. It is necessary that the bank provides supporting services to the society for management of the revolving loan system, because the society, which is the managing agency of the revolving loan system, has no knowledge and experience on such banking business. ADB is now providing management service for loans to irrigation projects. The Dawhenya irrigation project has a revolving loan system, and ADB has undertaken its management. ADB said that it is also possible to provide management service to other irrigation projects, if they so require.

The merit of the revolving loan system is a lower interest rate than the market rate. But, this loan system requires a considerable amount of funds to be acquired at a low interest rate. If no funds are available, it is proposed to introduce the group loan system.

(4) Improvement of Marketing

Timely farm inputs supply is one of the important factors for improving crop yields. To ensure smooth supply of farm inputs, a co-operative purchasing system is recommended to be introduced in the project areas. The overall flow of the co-operative purchasing system to be introduced to the societies is presented in the chart below. This system is closely connected with loan services, technical guidance and society's activities as mentioned earlier.

Co-operative Purchasing and Group Loan Systems



Farm inputs such as fertilisers and agro-chemicals would be supplied smoothly by the private suppliers through this system. As for the seed supply, the seeds of cereal crops have been supplied by MOFA and seeds of vegetables are by the private sector at present. The result of interview survey carried out by the Survey Team shows that most of the farmers in the project areas have no problems in purchasing these seeds. The seed supply is therefore entrusted to them so far. However, the supply of quality seeds will be necessary to increase crop yields in near future. It is expected that IDC or other accepted suppliers produce such certified seeds and provide them to the farmers through the GIDA's extension system.

At present, the dealers (market mummies) are handling a lot of farm products in the project areas. Their marketing activities cover all the country and are carried out from village to village and in urban areas. With the exception of the Mankessim project, no information on marketing problems is available from the project areas. In the case of Mankessim, the project area is under the buyer's market, and the farm gate prices of products have been wrongfully controlled by the dealers who come from the Mankessim market. To overcome such a problem, it is proposed to introduce a co-operative shipping system managed by the society. Such co-operative shipping may be possible to be introduced in the Mankessim project area. At present, some farmers in the Mankessim project area sell their products directly to another market near Accra.

5.9 Role of Women in Development

The Project will induce activation and strengthening of the crop production, marketing of farm inputs and products, post harvest, transportation, societies' services, etc. In parallel with such economic and social development in the rural areas, the women farmers will have much opportunity to join these activities. In order to encourage greater participation of women in public affairs, the following measures are recommended: (i) to appoint women's leaders in the farmers' societies; (ii) to include cultivation of groundnuts, tomatoes and soybeans in the cropping pattern; it is proposed to promote value-added processing of these crops by women's groups, in order to solve the problem of women unemployment in the project areas and improve their income source; and (iii) to promote homestead development and wide scale livestock raising of chicken, rabbit, etc. by the women's groups.

The farmers' societies should play an important role in promoting the above activities, and GIDA should provide necessary guidance to them. In this context, the establishment of women's groups in the societies is proposed. A representative of a women's group joins the committee of management as its member, and participates in all the society's management. To promote these activities mentioned above, it is also proposed that a subject matter specialist on the said activities be appointed by the Project Management Division in the head office of GIDA . At the field level, intensive promoting activities are undertaken by the co-operative officer stationed in the PM Office during the transitional period of handing-over, and after the handing-over of O&M, the extension officer conducts some follow-up services.

5.10 Staff and Facilities Required for O&M

The staff and facilities required for the implementation of O&M are summarised below. The staff is minimised as much as possible, taking into account the restructuring of GIDA and saving of O&M cost.

Staff and Facilities Required for O&M

Projects:		Ashaiman	Aveyime	Kpando	Mankessim	Okyereko	Total
Development Area*1	(ha)	54 *1	95	155	86	81	471
Staffing of PM Office	(Persons)						
(1) Transitional period of O&M		6	5	9	5	5	30
(2) After handing over of O&M		5	4	8	4	4	25
Office and Buildings							
a) PM Offices							
- Rehabilitation	(m2)	106	-	-	-	-	106
- Construction	(m2)	-	175	175	175	175	700
b) Store houses*2	(No.)	1	1	4	3	-	9
Training Facilities							
Lecture hall	(m2)	32	-	-	-	32	64
Dormitory for farmers	(m2)	263	-	-	-	-	263
Dormitory for officers	(m2)	80	-	-	-	-	80
Vehicles and Equipment							
(1) O&M Equipment	(Set)	1	1	1	1	1	5
(2) Equipment for Extension, Monitoring and Cooperative Activities	(Set)	1	1	1	1	1	5
(3) Office equipment	(Set)	1	1	1	1	1	5

*1 Excluding 2 ha of experimental farm (IDC). *2 For agriculture.

In parallel with the rehabilitation works, the existing PM Offices in the project areas should be reorganised and strengthened as the executing agencies for the handing-over of O&M. The total number of staffs to be stationed in the PM Offices is estimated to be 30 during the transitional period and 25 after the handing-over of O&M to the farmers (refer to Table-3).

6. ENVIRONMENTAL IMPACT ASSESSMENT STUDY

6.1 Possible Environmental Issues

Environmental screening and scooping were undertaken to identify and assess the potential adverse impacts of each project, taking the detailed features of the projects into account. It was assessed that the proposed projects will likely cause moderately to minor adverse impacts on the environment, unless mitigation measures are implemented. The environmental assessment of the projects is described in the next section, and its summary is shown in Table-5.

6.1.1 Deterioration of Downstream Water Quality

(1) Construction Phase: Kpando-Torkor

The construction of pumping stations in the Kpando-Torkor project area will generate a significant amount of surplus excavated materials to be disposed of at the construction stage, although some of them, of course, will be used for embankment and as road improvement materials. The efficient use (recycling) of those materials should be duly considered. According to proposed plan, about 12,000 m^3 of excavated materials will be produced and about 2,000 m^3 of them will be used while about 10,000 m^3 will be levelled near the pumping stations. It is considered that their impact could be mitigated by applying proper management measures such as re-vegetation, etc., during the levelling works.

(2) Operation Phase: Ashaiman, Aveyime, Okyereko

The use of farm inputs will increase under the future intensive agriculture to obtain higher yields. This might result in nutrient load in drainage water, and affect the downstream water quality. An examination of future impacts is presented in Annex-F, and estimated contamination of the runoff water from the fields by fertilisers is shown below.

(Unit : ppm)

	Ashaiman	Aveyime	Mankessim	Okyereko
Nitrogen	0.67	0.33	0.31	0.44
Phosphorous	0.04	0.03	0.03	0.04

Based on the above assumption, the nutrient load in the runoff water was estimated to be low. According to the Japanese water quality standard for lake water, the runoff waters (drainage waters) from the Aveyime, Mankessim and Okyereko project areas can be classified into Class III which can be drunk if treated at a high level in advance, and the rest from Ashaiman is in Class V, which is suitable for agricultural and industrial uses. The downstream of the project areas also have original discharge. Therefore, it is considered that the water

quality of in the project areas will be at a safe level for either purpose, and the impacts will be minor under proper management of farm input use. However, it is necessary to monitor the drain water quality and farming practice of the projects, periodically.

6.1.2 Health Hazard from Agro-chemicals: All Projects

The use of agro-chemicals would increase in the future due to intensification of vegetable cultivation, which is susceptible to cause pests and diseases. Although most of farmers have experience and knowledge in the use of agro-chemicals, it is possible that misuse or mishandling of agro-chemicals and improper disposal of used bottles cause health hazards. It is considered, however, that the problems could be minimised, because the improved farming practices will be introduced to the project areas through the proposed extension works at the operation stage.

Presently, IDC has carried out extension work to introduce the IPM (Integrated Pest Management) system into several irrigation schemes under the FAO programme. If this system is introduced and expanded in the project areas, this is still at initial stage, negative environmental impacts would be minimised.

6.1.3 Land Degradation

(1) Due to salt accumulation: Ashaiman, Okyereko

The salt balance under the proposed cropping pattern was preliminary estimated using the Bouman's quantitative calculation technique. The results of calculation are presented in Annex-C, and summarised as follows:

(Unit : mS/cm)

Project Area	EC of Irri. Water	Initial ECe of root zone	After irrigation 1 year	2 year	3 year
Ashaiman	0.13	13.2	4.0	1.5	0.9
		16.6	4.8	1.7	1.0
Okyereko	0.20	6.8	1.4	0.5	0.4
		23.0	3.8	0.9	0.5

According to result of a preliminary estimate, the salt will be completely leached out within 3 years under proper drainage. The results of calculation indicate that at least one year after the salinity level will be in a permissible range as shown below. Since the irrigation waters of both areas (the Ashaiman and Okyereko) would not be affected by salt contents of 0.13 and 0.20 mS/cm respectively, because a significant leaching effect could be expected under proper drainage.

Of course, these might be optimistic projections. The results of the calculation could change from suitable to undesirable ones in the case of lowest percolation rate even under

proper drainage condition. Consequently, some reclamation measures such as flushing, leaching and mulching are required to be applied before and during the farming operations. By this way, the yield loss due to salinity can be eliminated.

(2) Due to soil erosion: Kpando-Torkor

As mentioned in Annex C, soils in the Kpando-Torkor area are mainly shallow soils which have a skeletic phase. Since the effective depth of soils to the skeletic layer is about 20 to 50 cm, it is assumed that there will be a high potential of land degradation. Once the surface soil is removed, the lands will become useless for any purposes. The slope of the area is, however, gentle, 2 to 3 %, and the rain intensity is relatively high in the wet season.

If proper countermeasures are introduced and the profitable farming with significant sustainability is carried out in the project areas, it would be the best model for development of similar upland area extending in the whole country. However, it is difficult to predict the effects of soil conservation measures at present, because it is still at a trial stage. Consequently, careful monitoring should be undertaken at the operational phase to grasp the progress of soil erosion at susceptible area. Through the monitoring works, it will be possible not only to identify constraints of the countermeasures but also to find alternatives to match farming and farmers' conditions.

6.1.4 Incidence of Water-born Diseases: Aveyime, Okyereko

As it is reported that over 90 % of Ghanaian have contracted Malaria in general, the additional effect of this disease in the areas would not propagate significantly, but it may be rather minor. On the other hand, the expansion of paddy fields in the Aveyime and Okyereko project areas may increase chance to contract schistosomiasis, even though farmers have no sign to be infected with it at present. Especially, according to a doctor in Battor town near the Aveyime area, snails have propagated drastically and the number of patients has increased along the Volta river, since the Kpong dam has been constructed. The potential of increase in incidence of the disease might be high in the Aveyime area. As mentioned in the previous section, the main problem is unwareness of the villagers. They have no idea of how to be infected or how to prevent the disease. Hence it is considered that the impact could be minimised through sanitary education.

6.1.5 Destruction of Habit of Flora: Kpando-Torkor

At present, local people are using the potential area for shifting cultivation and fire wood collection. Therefore, when the agricultural land is expanded in the potential area, users of the land will be obliged to shift to other areas. This might cause a high pressure on the bush area or

even on secondary forest, and thus accelerate the degradation of forest ecosystem. Since the important species of fauna and developed forest do not exist in the areas, the environmental impacts from only following two aspects can be considered to rise up. Firstly, the intensified use of land and clearing of bush might result in land degradation due to soil erosion. Secondary, the wood collectors, which consist of gender groups, might be obliged to walk rather long distance to collect fire wood after the project completion. However, the related area is so small that the issue could be assessed as a minor impact.

6.1.6 Damage to Cultural Area: Mankessim, Okyereko

The small sacred glove areas are located in the rehabilitation area of the Mankessim and Okyereko projects. The size of the areas are 1.5 ha in Mankessim and 0.4 ha in Okyereko. Under the proposed development plan, the areas will be excluded from the rehabilitation area. Other construction works also will not disturb the area, because no physical works in these areas are included in the plan.

6.2 Environment Conservation and Monitoring Plan

6.2.1 Basic Approach

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

6.2.2 Institutional Aspect

Conservation measures and monitoring works will be implemented in the construction and operation phases. Therefore, not only government staff but also the beneficiary farmers in the areas play an important role for the success of the countermeasures. The monitoring works should be carried out by government staff in co-operation with the beneficiary farmers. In this connection, it is proposed that a research, monitoring and evaluation unit (M&E unit) be established in order to play the role of an engine for environmental management and also for effective transfer and dissemination of technologies to the farmers.

Concretely, this unit will have functions of research on land conservation, monitoring of

soil erosion and salinity progress, monitoring of water quality in drain, extension to farmers, and production and provision of tree seedlings to farmers. In addition to the natural environmental aspect, social matters such as health condition, expansion of diseases, etc. will also be monitored by this unit. It is one alternative that a sub-unit of IDC, called Agro-environment unit, shall be strengthened to fill the duties of the proposed unit.

6.2.3 Environmental Conservation Plan

(1) Reclamation Measures for Salinity Soils

The following land management approach is proposed for the reclamation of salinity soils.

1) Flushing

Most of salts in the saline soils are assumed to be concentrated on or near the surface, because of the low infiltration and poor drainage. Therefore, surface flushing (flooding, puddling, draining) prior to leaching may accelerate and improve the leaching process.

2) Leaching

This is by far the most effective procedure for removing salts from the root zone of soils. A useful rule of thumb is that a unit depth of water will remove nearly 80 % of salts from a unit soil depth. Salt concentration in surface soil will be decreased and that in subsurface soil will be increased after irrigation. Therefore, if the salty drainage water is removed from the project area under proper drainage, the salinity condition in the area will be improved.

3) Mulching

During periods of high evapotranspiration between two irrigation terms and during periods of fallow, the leached salt has a tendency to return to the soil surface. The practices that reduce evaporation from the soil surface and encourage downward flux of soil water will help to control root zone salinity. Therefore, mulching is assumed to be effective for improving the salinity condition, especially in fallow and upland cropping areas, in addition to establishment of the proper drainage system.

Concretely, it is recommended to carry out the flushing and leaching (irrigating) works in the salt affected fields immediately after the establishment of the drainage system and prior to the farming operations, if possible.

(2) Conservation Measures for Soil Erosion

Proper land management is required when the land in Kpando-Torkor is used for agricultural purpose, especially for intensive farming. In other words, countermeasures for land erosion such as contour hedgerow, contour ditches and drainage canals, mixed planting, contour plowing, etc., need to be introduced into the project areas at the time of implementation and also in the operation phase. Table-6 shows the recommendable measures and practices for control of soil erosion.

Under the proposed plan, green belt, composed of three countermeasures, i.e. vegetation row, contour bound and drainage canal, will be established at 200-meter intervals. In addition, a farm road will also be constructed between the green belts, and consequently, erosion protection bunds will be set up at every 100 m.

Farmers will operate one-acre of fields of 40 m vertically by 100 m horizontally. Therefore, it is recommended to construct a field bound on the edge of each field by farmers' own efforts. In other words, it can finally be said that the water movement to downward on fields will be obstructed by these bounds which will be placed at 40 m intervals. Of course, other measures such as mulching, contour planting, contour plowing should also be applied in the operation phase. By application of these measures, water erosion will be substantially minimised.

(3) Control of Water-born Diseases

The irrigation water resources in the project areas are already infested with schistosomes, especially in the Aveyime area. Therefore, countermeasures for reduction of the expansion schistosomiasis should be considered not only in the project areas but also along the upper reaches of the reservoirs. The adoption of chemical treatment is not recommended, since the contaminated area is so wide and the toxicity of chemicals may impact the environment. The following countermeasures should be considered in the extension programme to be taken in cooperation with the Ministry of Health in the aspect of sanitary education.

1) For malaria and schistosomiasis

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

2) For malaria

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

3) For schistosomiasis

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

6.2.4 Monitoring Plan

The following table shows the proposed monitoring items for each project area.

Project area	Items
Ashaiman	Water quality of downstream, Salinity condition, Farmers health
Aveyime	Water quality of downstream, Farmers health
Kpando-Torkor	Soil erosion, Farmers health
Mankessim	Water quality of downstream, Farmers health
Okyereko	Water quality of downstream, Salinity condition, Farmers health

Besides the above items, it is recommended to monitor the complaints of the beneficiary farmers and also other local people once a year at least, in order to check unexpected environmental changes caused by the projects.

(1) Progression of Salinity Condition: Ashaiman, Okyereko

In order to know the progression of the salinity condition in terms of area expansion and also degree of salinity, the surface and sub-surface soils in the susceptible area should be sampled and analysed. A general outline of works is given in the following table:

Monitoring items	Monitoring area	Frequency (times/year)	Phase
EC, pH , Exchangeable cations (Na, K, Ca, Mg, Al) and CEC in surface and sub-surface soil	Present and Potential salinity area (Soil map unit : P22s and P22)	2	Operation

(2) Farmers' Health Condition: All projects

Monitoring works will be done for two aspects: health hazard of agro-chemicals and water born-diseases. In the Ashaiman, Aveyime and Okyereko project areas, the monitoring works should cover both of the above aspects, and in other project areas, they should be concentrated on health hazard situation.

Monitoring items	Monitoring area	Frequency (times/year)	Phase
- Recent tendency of water-born diseases - Health hazard condition from Agro-chemical - Farmers intention and Health programme - Existence and occurrence of vector	- Beneficial villages and rehabilitation area - Health unit around the project areas	2	Construction Operation

(3) Deterioration of Water Quality: Ashaiman, Aveyime, Mankessim, Okyereko

A Ramsar site lagoon named Sakumo lagoon is located downstream of the Ashaiman project area. In the downstream areas of the Aveyime, Mankessim and Okyereko projects, water is being used for domestic purpose. Therefore, management of quality of the runoff water from the project areas is essential for attaining sustainability of the projects. In this connection, it is recommended that the following monitoring works be conducted:

Monitoring items	Monitoring area	Frequency (times/year)	Phase
- Physio-chemical property (pH, EC, SS, DO) - Organo-chemical property (COD, NH4-N, NO2-N, NO3-N, T-N, T-P) - Agro-chemical contamination - Farming practice	Downstream water Rehabilitation area (Interview to farmers)	6 - 12 (water quality) 2 (practice)	Construction Operation

(4) Effect of Erosion Conservation Measures: Kpando-Torkor

Even countermeasures will be applied to the susceptible fields, soil erosion might occur to a certain extent. Therefore, periodical monitoring should be carried out to know the effect and to avoid irreversible changes. For this purpose, the following items should be surveyed by field measurement, interview of farmers, and field observation.

1) Erodibility of levelled disposal soils near pumping stations

A significant amount of disposal soils will come out from the excavated works for installation of pumping stations as mentioned before. Although they will be dumped and levelled near the pumping stations with the optimum erosion protection such as revegetation, the condition of the disposal soils should be monitored in both construction and operation phases. The recommended process and frequency are shown below:

Monitoring procedures	Frequency (times/year)	Phase
- Field observation (eye confirmation) of condition of leveled soils and eroded soils in the lake	3 - 4	Construction Operation

2) Amount of Seasonally Eroded Soil

a) Procedures

It is proposed to construct experimental plots in the project areas, in order to measure the amount of eroded soils. The experimental plot is defined as a physically isolated piece of land of known size, slope steepness, slope length and soil type. It is desirable that two types of land surface "with mulching

condition" and "without mulching condition" will be measured in the area. The number of plots, therefore, is considered to be at least 4 in each rehabilitated block, taking into consideration two replicates. Each plot is surrounded by a tin plates, and at the lowest pont a soil trap with drain is constructed. Annex G shows an example of the experimental plot.

b) Monitoring period and frequency

The eroded soil amount precipitated in the drain should be measured every three or four months.

3) General Condition of the Area

Simultaneously with the above measurement works, an interview survey of farmers and a field reconnaissance survey should be carried out to grasp the following matters.

- Rainfall condition
- General erosion condition in the project areas
- Farmers intention on soil erosion
- Applied soil conservation measurements in the field

7. COST ESTIMATE

7.1 Implementation Schedule

7.1.1 Proposed Rehabilitation Works

The proposed rehabilitation works for each project will be as follows:

(1) Ashaiman project

1) Rehabilitation of main canal, lateral canals, and related structures.
2) Rehabilitation of main drain, lateral drains, and related structures.
3) Improvement of main farm road and rehabilitation of lateral roads.
4) Construction of buildings such as lecture hall, dormitories for officers and farmers, and sorter house.

(2) Aveyime project

1) Rehabilitation of pumping station including replacement of pumps and accessories.
2) Construction of booster pumping station including new pumps and accessories.
3) Rehabilitation of main canal, lateral canals, and related structures.
4) Rehabilitation of main drain, lateral drains, and related structures.
5) Installation of pipeline and sprinkler system for Extension Area-3.
6) Improvement of main farm road and rehabilitation of lateral roads.
7) Construction of buildings such as O&M office, storehouse, sorter house, dry yard and garage.

(3) Kpando-Torkor project

1) Construction of pumping station including replacement of pumps and accessories.
2) Installation of pipeline and sprinkler system.
3) Construction of collector drain and intercepting drain with green belt.
4) Improvement of main farm road and rehabilitation of lateral roads.
5) Construction of buildings such as O&M office, storehouse, sorter house, dry yard and garage.

(4) Mankessim project

1) Rehabilitation of pumping station including replacement of pumps and accessories,

for existing area and Extension Area-1

2) Construction of pumping station including installation of new pumps and accessories, for Extension Area-2.
3) Installation of pipeline and sprinkler system.
4) Construction of collector drain and intercepting drain with green belt.
5) Improvement of main farm road and rehabilitation of lateral roads.
6) Construction of buildings such as O&M office, storehouse, sorter house, dry yard and garage.

(5) Okyereko project

1) Construction of intake weir.
2) Construction of pumping station including replacement of pumps and accessories, for supplemental water source.
3) Rehabilitation of main canal, lateral canals, and related structures.
4) Rehabilitation of main drain, lateral drains, and related structures.
5) Installation of pipeline and set-up of sprinkler system.
6) Improvement of main farm road and rehabilitation of lateral roads.
7) Construction of buildings such as O&M office, lecture hall, storehouse, sorter house, dry yard, and garage.

7.1.2 Implementation Schedule

The five selected projects will be implemented on a project-by-project basis. The rehabilitation works required for the Project are scheduled to be completed in a period of about 3.5 years, including project appraisal, financial arrangement, survey, design, tendering and tender evaluation, taking into account the nature of the works, work quantities, and workable days. Out of 3.5 years, two years would be necessary for construction of all the five projects. Each project could be completed in one year judging from the project scale, and thus the five projects will be divided into two groups: the Ashaiman, Okyereko and Mankessim projects in one group, and the Aveyime and Kpando-Torkor projects in other group. This grouping is proposed taking into account the importance of early implementation of the Ashaiman project for early commencement of farmers' training for all the five projects and easy and effective construction supervision due to its location close to the Mankessim and Okyereko projects, and also referring to the result of economic evaluation. Table-7 shows the implementation schedule of the Project.

7.2 Organisation and Management

GIDA should be responsible for implementation of all the five projects. Construction of

project works will directly be controlled and supervised by the Project Office under the Department of Project Development of GIDA, and one civil engineer is required to be assigned for this purpose. Figure-19 shows the organisation chart of GIDA for construction supervision.

The Project Office will execute construction supervision in co-operation with the consultant. In order to keep close communication among the Project Office, the consultant and the contractor, it is proposed to hold a tripartite meeting once a week. In addition, it is proposed that a monthly tripartite meeting shall be held at the GIDA's head office with attendance of the Chief Executive and Deputy Chief Executive, to grasp the actual work progress and to settle the problems encountered on time.

7.3 Cost Estimate

7.3.1 Basic Conditions and Assumptions for Cost Estimate

The Project cost comprises direct construction cost, administration cost, engineering services cost, and physical and price contingencies. The following basic conditions and assumptions were applied for the Project cost estimate:

(a) The unit prices are based on the 1996 prices.
(b) The exchange rate is US$1.00 = Cedi 1,700 = ¥110 as of December 1996.
(c) Construction works will be executed on full contract basis through competitive bidding. The construction machinery and equipment required for construction will be provided by the contractor itself. Therefore, the depreciation cost of machinery and equipment is considered in the estimate of construction unit rates.
(d) Taxes on the construction machinery and equipment to be brought into Ghana by the contractor are excluded from the cost estimate.
(e) The construction cost comprises foreign and local currency portions. The local currency portion is estimated on the basis of the current prices as of December 1996 by referring to the prices applied in similar projects such as the Dawhenya Irrigation Project. The foreign currency portion is estimated based on the CIF prices in Accra.
(f) Engineering services cost is estimated at 15 % of the direct construction cost. Administration cost of the implementing agency is estimated at 5 % of the direct construction cost.
(g) Physical contingency estimated at 10 % of the direct construction cost and related cost is included both the foreign and local currency portions.
(h) Price contingency is calculated on the basis of an annual escalation rate of 2.5 % for the foreign currency portion and 25 % for the local currency portion, based on the

Quarterly Digest published by MOFA in March 1995 for the local currency portion and "G-5 MUV Index[1]" of the World Bank for the foreign currency portion. The estimated escalation rates in the respective years FY 1996 are as follows:

	Local Currency	Foreign Currency
FY1997	25.0%	2.5%
FY1998	56.3%	5.1%
FY1999	95.3%	7.7%
FY2000	144.1%	10.4%

7.3.2 Project Cost

(1) Project Cost

The costs for the respective projects were estimated on the basis of work quantities, and include the direct construction cost, cost for O&M equipment, administrative cost, cost for engineering services, and contingencies. The construction cost for respective projects is summarised as follows (for details, refer to Table-8):

Summary of Project Cost

(Unit: Cedis million)

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

*1 Cost of training facilities is included in the Ashaiman and Okyereko projects.
*2 Cost of bus and backhoe is included in the Ashaiman project only.
*3 15% of direct construction cost.
*4 5% of direct construction cost.
*5 10 % of direct construction cost.

(2) Annual Disbursement Schedule

The Project works are assumed to be implemented over 3-year period. The annual disbursement schedule for the Project implementation was prepared based on the implementation schedule (see Table-7). The following table shows in summary of the annual disbursement schedule for the respective projects (for details, refer to Table-9):

[1] The World Bank, Commodity Markets and the Developing Country- A World Bank Quarterly, August 1996.

Summary of Annual Disbursement Schedule

(Unit: Cedis million)

Fiscal Year	Ashaiman	Aveyime	K.-Torkor	Mankessim	Okyereko	Total
FY1997	41	85	203	109	81	519
FY1998	1,092	59	139	2,273	1,584	5,147
FY1999	829	2,332	4,366	1,495	1,531	10,553
FY2000	0	1,100	3,084	0	0	4,184
Total	1,962	3,576	7,792	3,877	3,196	20,403

(3) Replacement Costs

Some of the facilities, especially the mechanical works, have a shorter useful life than the Project life and will require replacement during the proposed 50-year life of the Project. The main replacement costs will therefore relate to pumps and accessories, pipes, sprinklers, canal gates, valves, and O&M equipment. The replacement costs and useful life of these facilities and equipment are given in Table-10.

(4) O&M Costs

The O&M costs for the Project facilities broadly consist of (1) administration cost such as salary of project staff concerned and operation cost of office, (2) cost of O&M of pumps and pumping stations, (3) cost of O&M of the command areas like cost for running, repair and maintenance of O&M equipment, labour cost for repair and maintenance works, material cost for repair and maintenance works, and contract cost for repair which could not be made by farmers' organisation. These costs were estimated for the respective projects as shown in Table-11 and summarised below:

O&M Cost

(Unit: Cedis 1,000)

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

7.4 Cost Comparison with Other Similar Projects

As mentioned in Annex-H, rehabilitation works have been conducted for the Dawhenya Irrigation Project commanding 200 ha. The executed works are construction of pumping station, main canals, lateral channels, access road, field drains, additional building, etc., which are similar to those of the Aveyime and Okyereko projects. The direct construction cost for the

Dawhenya Irrigation Project was Cedi 421.6 million equivalent to US$ 2.0 million at the 1988 price level. According to the inflation indices (G5 MUV index) prepared by the World Bank, the rate of 1988 to 1996 was about 1.36. The construction cost of US$ 2.0 million for the Dawhenya Irrigation Project at 1988 price was then updated to US$ 2.7 million equivalent to US$ 13,500/ha at the 1996 price level. On the other hand, the direct construction costs per ha for the Aveyime and Okyereko projects are US$ 11,500/ha and US$ 12,800/ha, respectively, which are about 5 % to 15 % lower than that of the Dawhenya Irrigation Project.

Most of the existing facilities will be replaced by new ones due their severe deterioration condition. All the five projects are therefore regarded as new projects from viewpoints of scale of required works and construction volume. The report entitled "Ghana Irrigation Subsector Review" prepared by the World Bank in 1986 presents the capital costs at the 1985 price level of small-scaled projects such as the Weija Irrigation Project, Dawhenya Irrigation Project, and Vea Irrigation Project, which are similar to the selected five projects. The results of comparison of costs between the selected five projects and these three projects are as follows:

Cost Comparison with Similar Projects

Item	Similar Projects			Selected Priority Projects				
	Weija	Dahhenya	Vea	Ashaiman	Aveyime	K-Torkor	Mankes.	Okyereko
(1) Irrigable area	220ha	200ha	850ha	56ha	95ha	155ha	86ha	81ha
(2) Irrigation system	P + S	P + G	G	G	P + G	P + S	P + S	P + G
(3) Required works								
Pump	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Canal system	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Others	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(4) Capital Cost/ha (US$ at 1985 price)	39,000	10,000	14,000	-	-	-	-	-
(5) Capital Cost/ha (US$ at 1996 price)	67,000	17,300	24,200	15,500	15,610	22,400	21,900	17,700

Note: (1) P= Pump, S=Sprinkler irrigation, G=Gravity irrigation.
(2) The cost is updated using the G5 MUV index prepared by the World Bank (1996/1985 = 118.52/68.61=1.73).
(3) The capitalcost for the selected priority projects includes purchase of O & M equipment, engineering service, administration cost and physical contingency.

As can be seen in this table, the costs for the selected priority projects would be on the lower side compared with those for the similar projects.