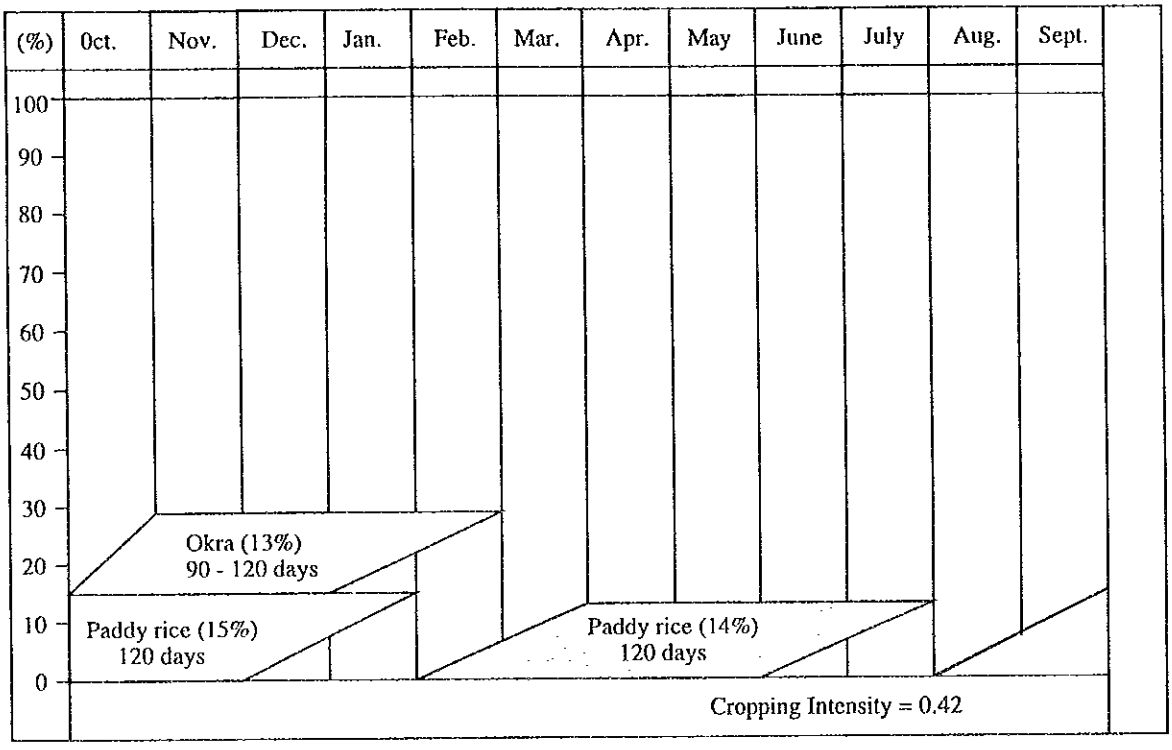
FIGURES



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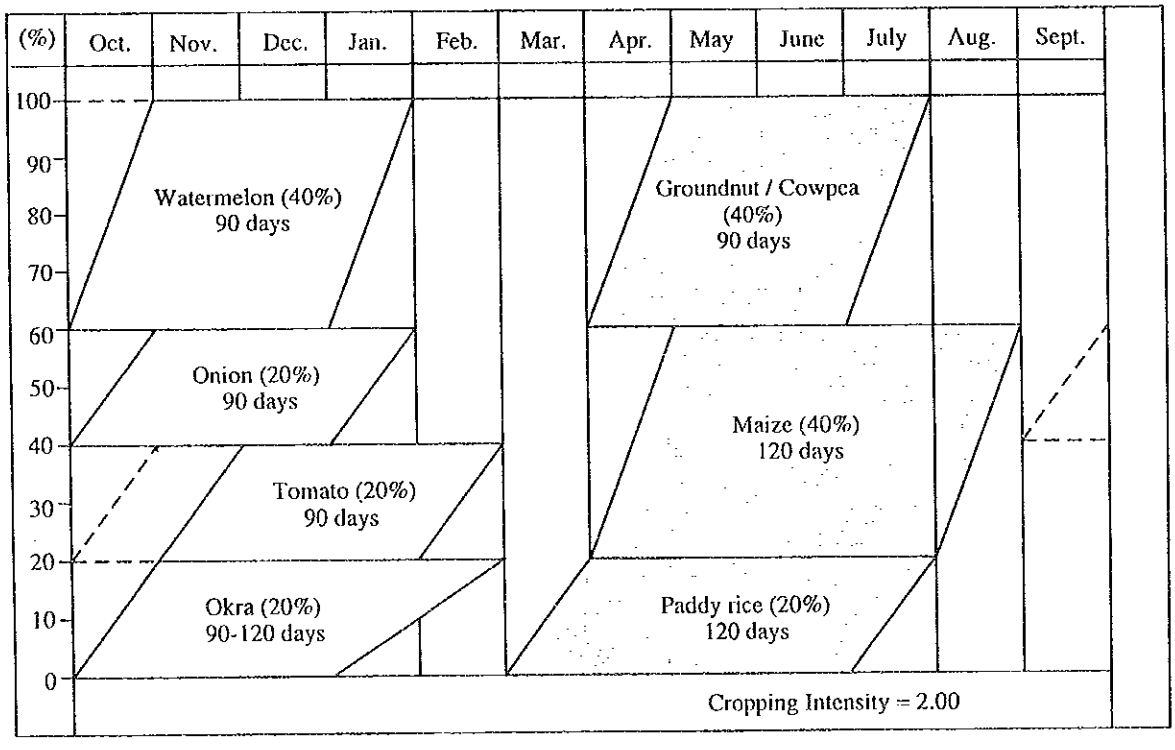


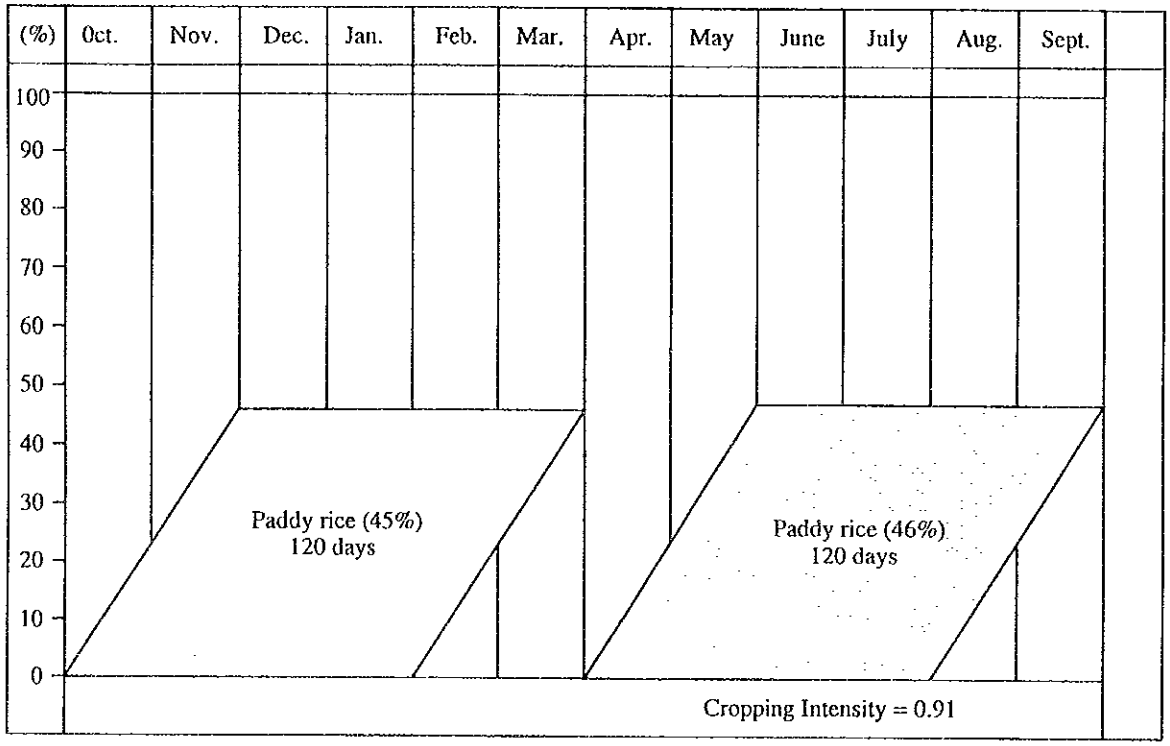
Proposed Cropping Pattern

Figure E-1

Present and Proposed Cropping Pattern at Ashaiman Project

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

Japan International Coopertion Agency



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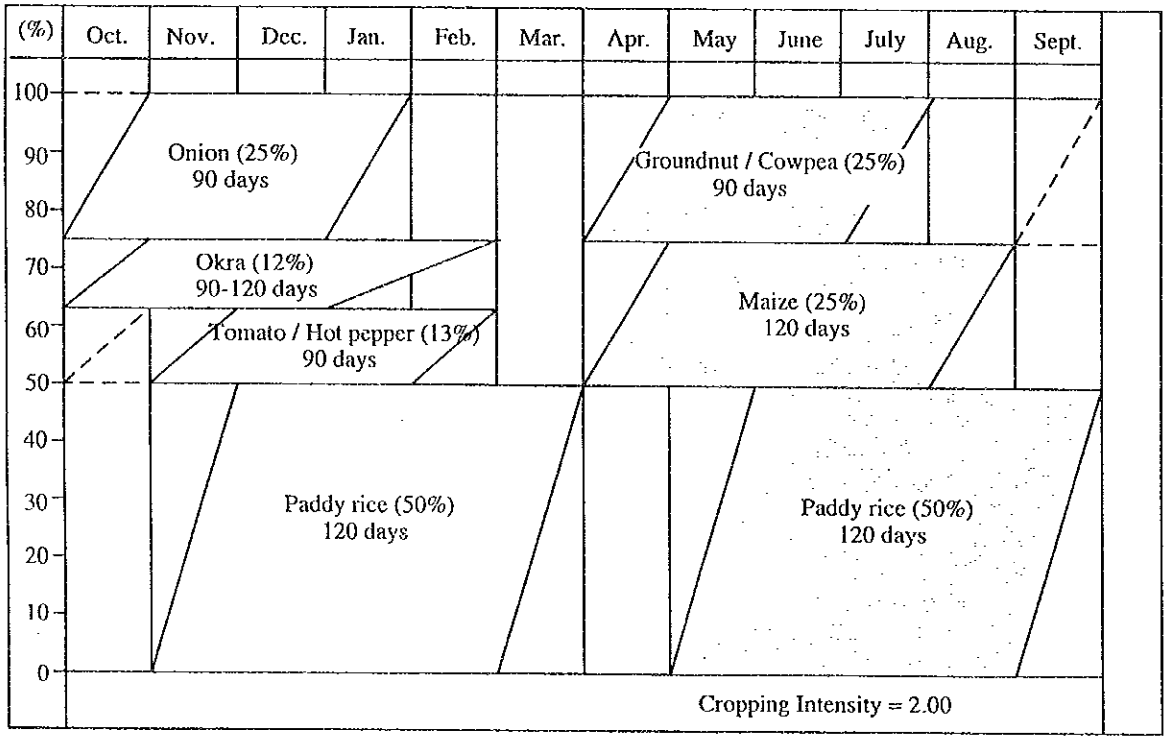


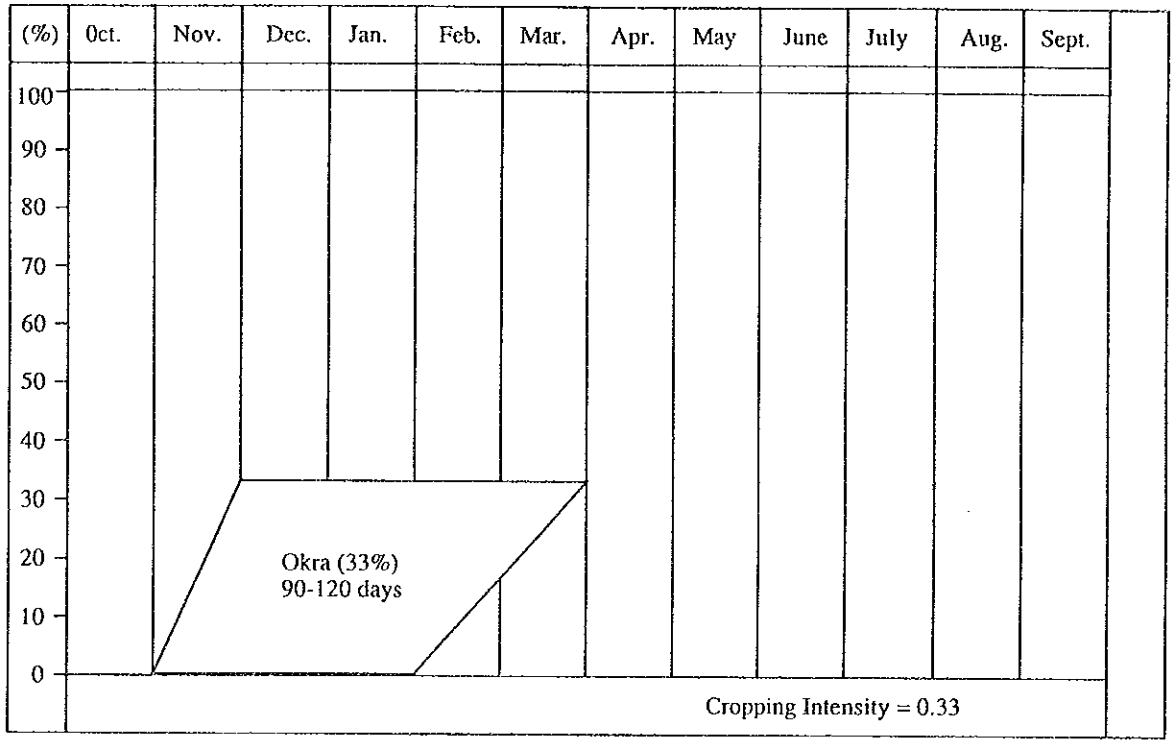
Proposed Cropping Pattern

Figure E-2

Present and Proposed Cropping Pattern at Aveyime Project

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

Japan International Coopertion Agency



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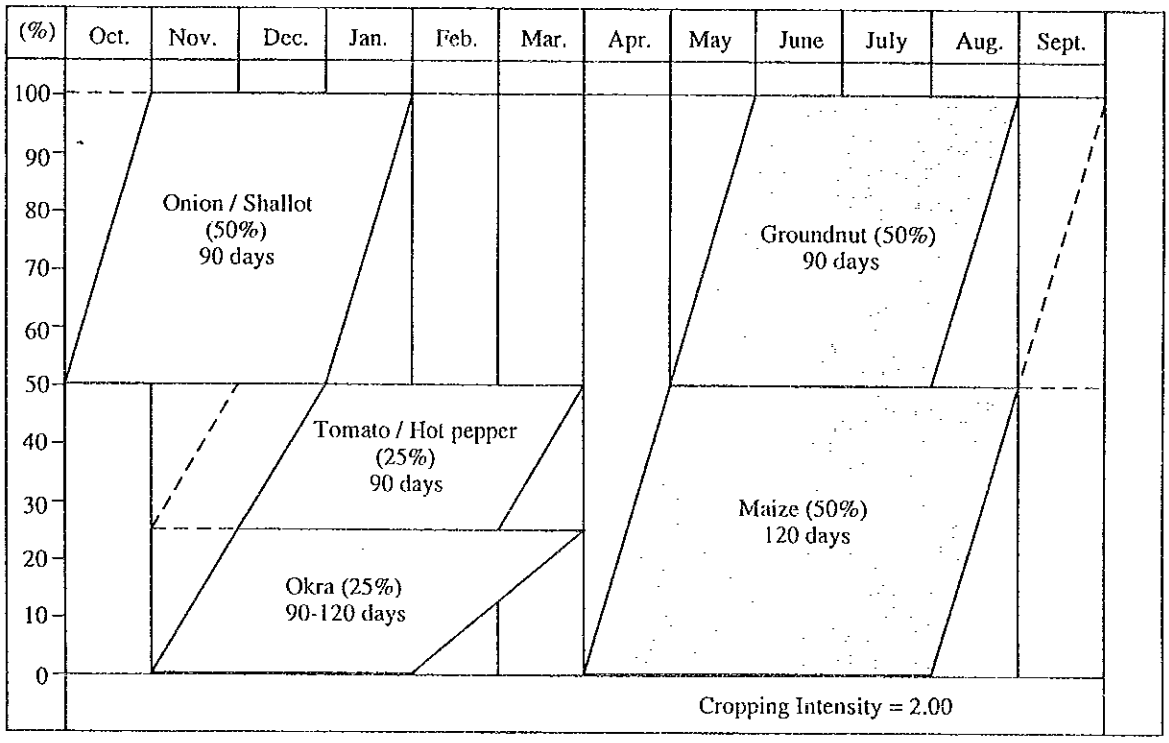


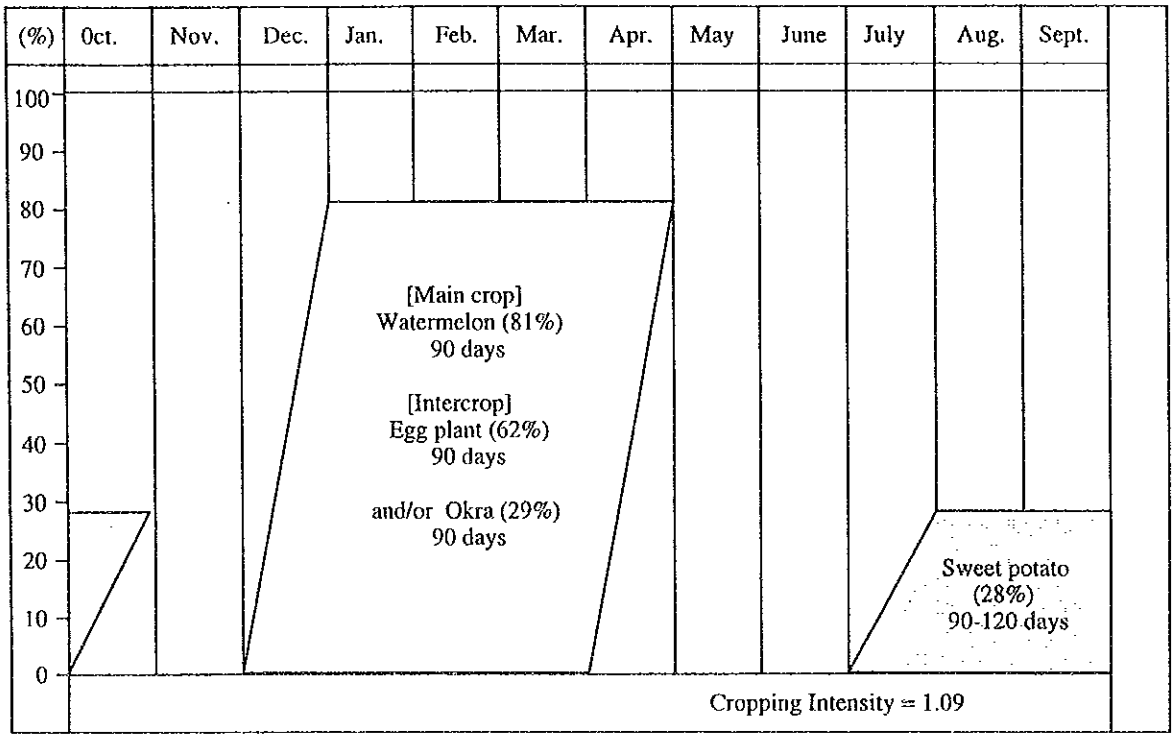
Proposed Cropping Pattern

Figure E-3

Present and Proposed Cropping Pattern at Kpando-Torkor Project

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

Japan International Coopertion Agency



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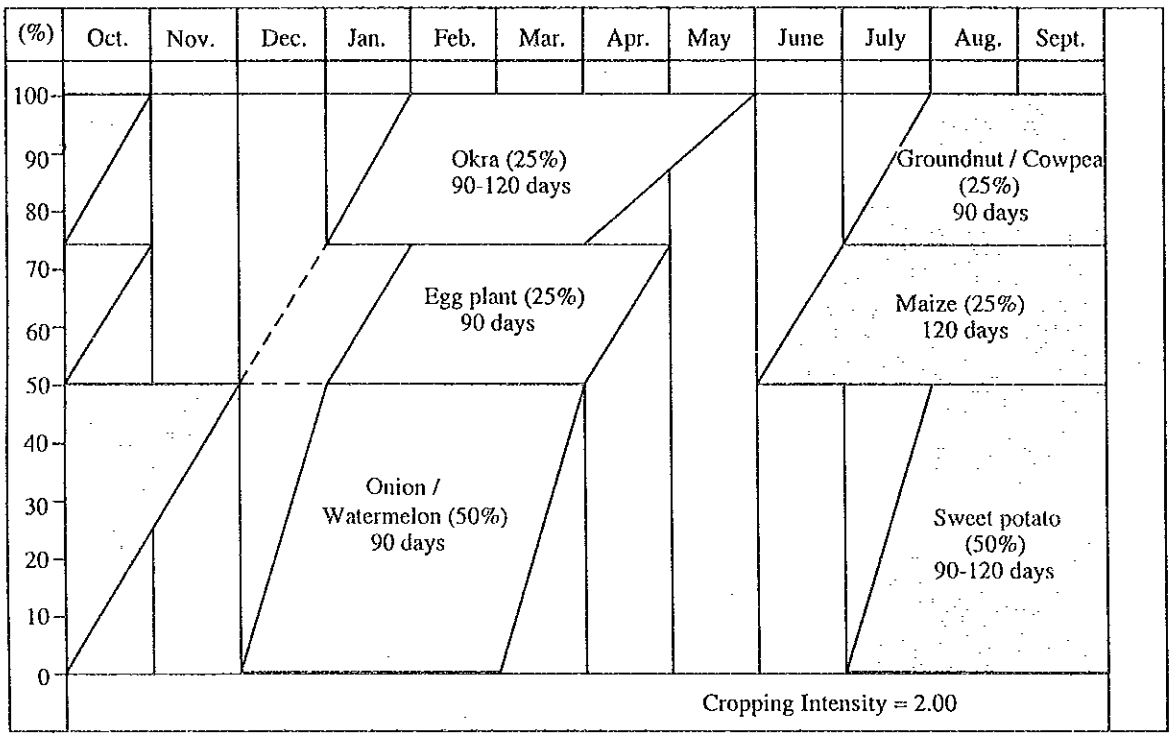


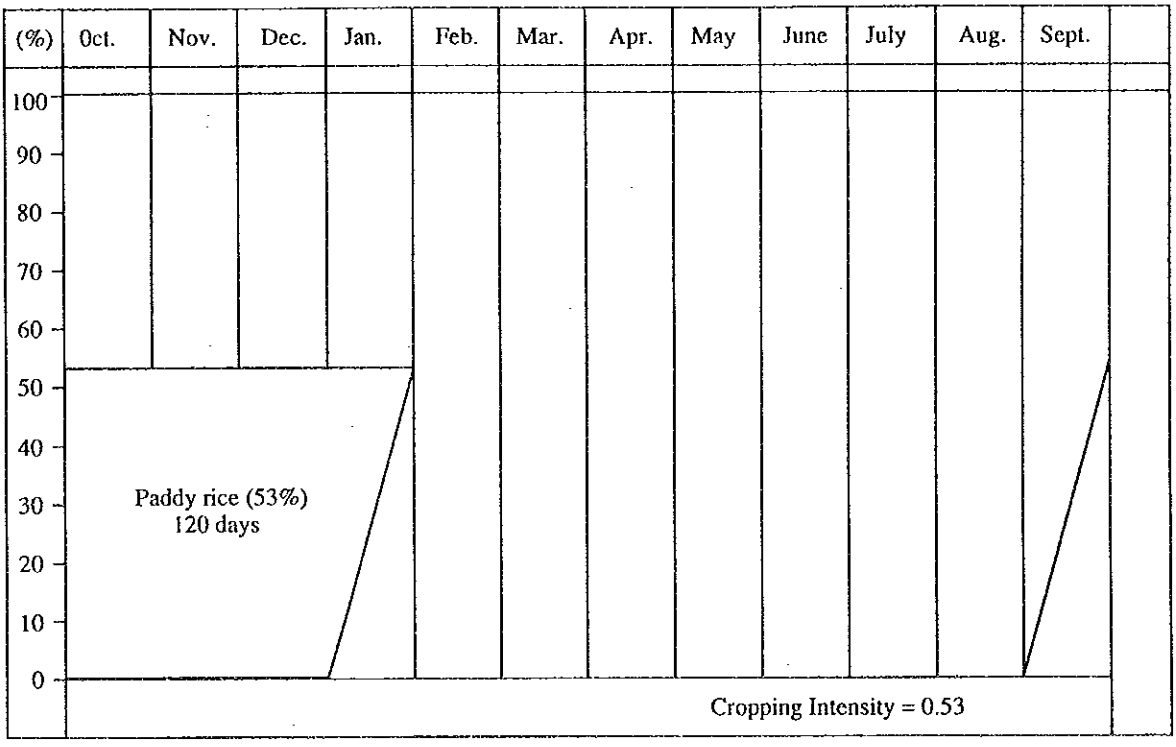
Proposed Cropping Pattern

Figure E-4

Present and Proposed Cropping Pattern at Mankessim Project

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

Japan International Coopertion Agency



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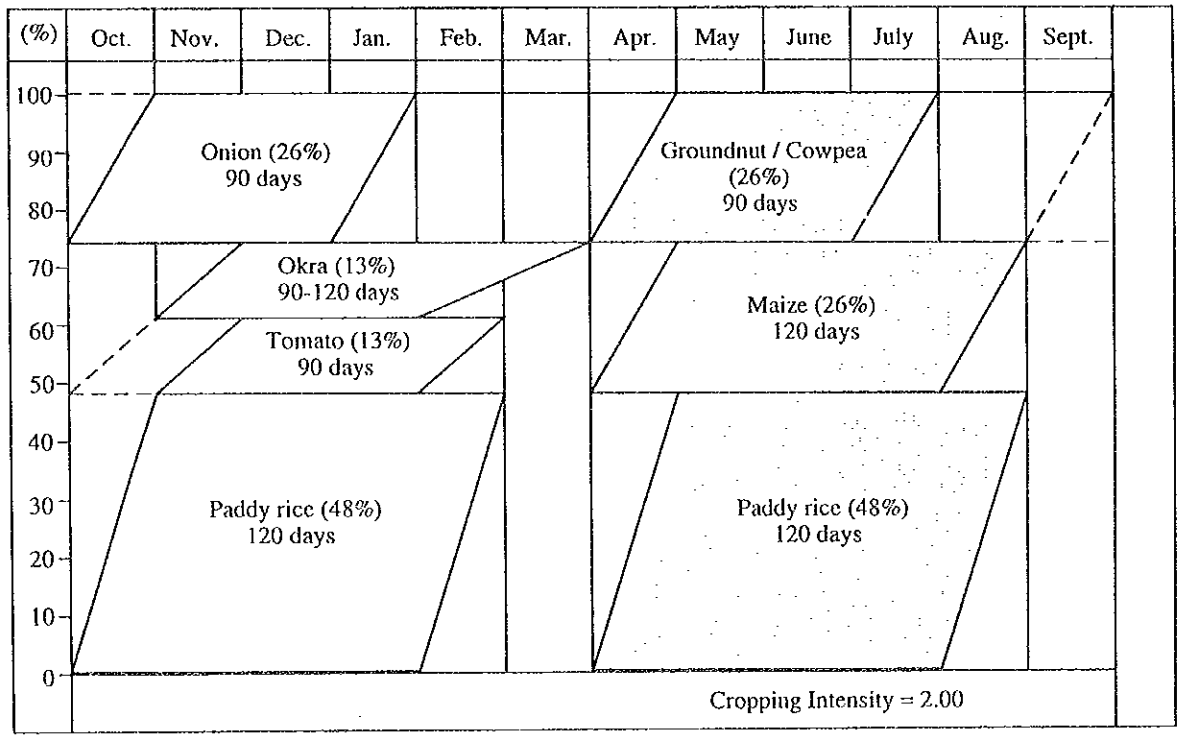

Proposed Cropping Pattern

Figure E-5

Present and Proposed Cropping Pattern at Okyereko Project

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

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Project	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sapt.	Oct.	Nov.	Dec.
	B M E	B M E	B M E	B M E	B M E	B M E	B M E	B M E	B M E	B M E	B M E	B M E
6 Kpando-Torkor	- - -	- - -	- - -	- - -	x x x	x x x	x x x	x x x	x x x	x x -	- - -	- - -
		(dry season)					(major season = rainy season)				(dry season)	
	# # #	# # #										# # #
	(harmatten)											(harmatten)
5 Aveyime	x x x	- - -	- - -	x x x	x x x	x x x	x x x	- - -	- - -	x x x	x x x	x x x
		(dry season)			(major rainy season)			(unclear short dry spell)			(minor rainy season)	
	# # #	# # #	# # #									# # #
	(harmatten)											(harmatten)
1 Ashaiman	- - -	- - -	x x x	x x x	x x x	x x x	- - -	- - -	x x x	x x x	- - -	- - -
	(dry season)			(major rainy season)			(short dry spell)		(minor rainy season)		(dry season)	
	# # #	# # #									# # #	# # #
	(harmatten)										(harmatten)	
12 Okyereko	- - -	x x x	x x x	x x x	x x x	x x x	x x x	- - -	- - -	x x x	x x x	- - -
	(dry season)			(major rainy season)				(short dry sell)		(minor rainy season)		(dry season)
	# # #	# # #									# # #	# # #
	(harmatten)										(harmatten)	
7 Mankessim	- - -	- - -	- - #	# # #	# # #	# # #	# # #	- - x	x x x	x x -	- - -	- - -
	(dry deason)			(major rainy season)					(minor rainy season)		(dry season)	
	# # #	# # #									# # #	# # #
	(harmatten)										(harmatten)	

Figure E-6

Rainfal Pattern and Harmattan Calender at the Projects

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

Japan International Cooperation Agency

ANNEX-F

ENVIRONMENTAL STUDY

ANNEX - F

ENVIRONMENTAL STUDY

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1. Introduction

1.1 General

This annex describes the environmental impact assessment system in the Ghana, the present environmental condition, results of the environmental assessment study, and environmental conservation plans of the priority project areas. Field reconnaissance was conducted to grasp the natural condition, particularly those of the proposed project sites. The assessment of the probable environmental impact was carried out considering the present condition of the project sites and the proposed features of each project. A detailed survey including a baseline survey, projection of impacts, etc., were undertaken on the four (4) project areas, Aveyime, Kpando-Torkor, Mankessim and Okyereko, as a entrusted works for local consultants .

It shall be noted that in this feasibility study, an emphasis has been placed on to minimize the probable adverse environmental impacts from the beginning of the plan formulation process.

1.2 Environmental Impact Assessment System

(1) EIA Procedure

Under the EPA Act 490, the project proponents are obligated to submit an Environmental Impact Statement (EIS : EIA report) , Preliminary Environmental Report (PER : IEE report) or Environmental Assessment Preliminary Registration Form on the planning of any projects. According to the "Environment Impact Assessment Procedure" issued by the Environment Protection Agency (EPA), the EIA procedures shall be taken the following paragraphs and Fig. F-1 shows the administrative flow chart of the EIA procedure in Ghana.

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

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

   a) Objection to the undertaking
   b) No objection to the undertaking
   c) Preliminary Environmental Assessment required

      If the Preliminary Environmental Report (PER) foresees significant adverse environmental impacts which may result from the undertaking of the project, the EIA is required and Environment Impact Statement will be prepared.

   d) Environmental Impact Assessment required

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

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

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

(2) EIA Requirement of Agricultural Project

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

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

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

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

2 Process for Environmental Study

In the phase I study, the Initial Environmental Examination (IEE) study was carried out for the 12 project areas. Based on the result of the IEE study and project outlines which had been delineated in the end of phase I study, the necessity of EIA study for the priority projects and TOR of the EIA study were discussed with EPA in phase II study. Based on the results, the EIA study was carried out on four (4) projects as Aveyime, Kpando-Torkor, Mankessim and Okyereko by the local consultants from August to November, 1996.

2.1 Initial Environmental Examination (IEE)

Initial Environmental Examination (IEE) study was carried out to identify the potential impacts of the proposed rehabilitation projects at short-term. For assessment of the impacts, the comparison with the present environmental issues and future issues to be caused by the implementing of the Projects was done. The field survey of IEE study consists of field reconnaissance and interview survey to the farmers, project staff, public health unit and so on.

2.2 Environmental Impact Assessment (EIA)

EIA study was carried out for the following objectives in the present study.

- to correct the baseline data of the project areas
- to clarify the future impacts will accrue from implementation of the projects
- to prepare and suggest the mitigation measurements and monitoring plans for the future impacts
- to prepare the basic and reference data for the submission of Environmental Impact Statement (EIS) to the EPA by GIDA.

Prior to the study, the discussion was held with EPA to make the assessment fit with EPA policy. The necessity of Environmental Impact Assessment (EIA) study for the priority 5 projects and the Terms of Reference (TOR) for the study were confirmed through this discussion. The outline of the EIA study was decided as following paragraphs. The TOR of the EIA study is shown in Attachment - I.

(a) Study area : The EIA study was required to be carried out in the following four (4) projects, except for Ashaiman.
- Aveyime
- Kpando-Torkor
- Mankessim
- Okyereko

Since the area of Ashaiman project would not be expanded through the implementation of the project, it was considered that the environmental impacts accrued in future will be minor. Consequently, the EIA study for Ashaiman project was not required. However, the Environmental Management Plan (EMP) shall be required to be submitted to EPA on the implementation of the Project.

(b) Items : The following items was surveyed in the EIA study.
- Water pollution (water quality)
- Land degradation
- Impact for the rural environment
- Impact form future land use plan
- Health hazard of farmers

3 Present Environmental Conditions of the Project Areas

3.1 Physical Environment

3.1.1 Climate

The project areas are classified into coastal savanna zone and transition zone. The coastal savanna zone has two (2) rainy seasons, i.e. March to July and September to November. In the main rainy season form March to July, about 70 % of annual rainfall is observed. While, the transition zone has a rainy season from April to October and a dry season from November to March. The dominant rainfall is recorded on May and June. Mean monthly rainfall and temperatures are shown below :

Project areas	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Rainfall (mm)													
Ashaiman	7	24	49	90	129	179	58	18	50	57	21	16	698
Aveyime	14	52	93	129	150	205	92	55	142	132	82	26	1170
Kpando-Torkor	24	65	118	127	181	202	137	96	142	164	52	35	1342
Mankessim	16	25	58	99	207	285	74	36	57	90	56	22	1025
Okyereko	17	27	53	50	171	165	55	59	64	82	39	22	803
Temperature (°C)													
Ashaiman	27.2	27.9	28.1	28.0	27.5	26.2	25.0	24.7	25.1	26.4	27.3	27.3	26.7
Aveyime	27.8	29.3	29.4	29.0	28.2	26.8	26.0	26.1	26.6	27.1	27.5	27.1	27.5
Kpando-Torkor	27.9	29.0	28.7	28.2	27.5	26.1	25.2	25.2	25.8	26.6	27.7	27.4	27.1
Mankessim	26.8	27.6	27.6	27.6	27.0	25.8	24.9	24.3	24.8	26.0	26.9	26.8	26.3
Okyereko	26.8	27.6	27.6	27.6	27.0	25.8	24.9	24.3	24.8	26.0	26.9	26.8	26.3

Remarks :Available period for data are basically for 30 years of 1960 to 1990.
Source : Annex B

3.1.2 Hydrology

The following table shows the water sources concerning with the priority projects.

Project	River Basin	Water Source	Catchment Area
Ashaiman	Coastal	Gyorwulu River	82.4 km^2
Aveyime	Volta	Volta River	-
Kpando-Torkor	Volta	Volta Lake	-
Mankessim	Coastal, Ochi-Amis	Aprapon River	57.3 km^2
Okyereko	Coastal, Ayensu	Okyereko River Ayensu River	17.6 km^2 1,659.0 km^2

The water quality of each water sources except the Gyorwulu river was analyzed on the EIA study. The results of water quality analysis are shown in Table F-1, and summarized as follows:

River name	TA (C)	TW (C)	pH	$CaCO_3$ ppm	EC S/cm	DO mg/l	BOD mg/l	NH_3-N ppm	NO_2-N ppm	NO_3-N ppm
Gyorwulu river	-	-	7.7	-	0.13	-	-	-	-	-
Volta river	26	28	8.0	144	0.01	3.4	1.2	1.25	<0.05	0.30
Volta lake	25	28	8.7	58	0.01	6.1	3.5	<0.2	<0.05	<0.25
Aprapon river	28	27	8.2	99	0.25	5.1	1.6	1.0	0.05	0.50
Okyereko river	27	24	7.0	105	0.20	2.4	0.7	0.6	<0.05	<0.25
Ayensu river	29	26	7.9	80	0.15	5.5	2.1	0.6	<0.05	0.25

Remarks : Data for the Gyorwulu river are taken from IDC report (1993)

3.1.3 Soils

The soils of the project areas consist of (15) soil series of FAO/UNESCO system. The soil units identified in the areas are shown below :

Project		FAO/UNESCO Classification
1	Ashaiman	Distric Planosols, Cambic Arenosols, Gleyic Cambisols, Dystric Vertisols
2	Aveyime <1	Ferralic Arenosols, Dystric Cambisols, Gleyic Cambisols, Dystric Vertisols
3	Kpando-T	Skeletic- Vertic Cambisols *1, Skeletic- Chromic Cambisols, Dystric Fluvisols / Cambic Arenosols, Skeletic-Distric Gleysols, Dystric Vertisols
4	Mankessim	Eutric Gleysols, Haplic Alisols, Ferric Alisols, Gleyic Cambisols, Skeletic-Haplic Alisols*1
5	Okyereko	Skeletic-Haplic Alisols, Cambic Arenosols, Haplic Alisols, Dystric Cambisols, Gleyic Cambisols

Remarks : *1 "Skeletic" indicates the occurrence of accumulated layer of oxidic concretions or ironstones, with a thickness of at least 25 cm.

Source : Annex C

3.2 Biological Environment

3.2.1 Vegetation and Land Use

Several land use types were recognize in the project areas. The hill area in Kpando-Torkor and Mankessim projects are generally covered by bush or grassland which are under shifting cultivation system. The plain area in Ashaiman, Aveyime, Okyereko are mostly used for paddy field or sometimes abandoned, due to poor irrigation system. The present land use conditions are summarized as follows :

(Unit : ha)

Land Use	Ashaiman	Aveyime	Kpando-T	Mankessim	Okyereko
1. Agricultiral Land	(66)	(84)	(43)	(47)	(51)
(1) Paddy fields	65	70	0	1	45
(2) Upland fields	1	14	43	42	6
(3) Orchard fields	0	0	0	4	0
2. Non-agricultural Land	(1)	(28)	(129)	(48)	(44)
(1) Grassland	1	11	47	40	44
(2) Glove, Bush, Shrub	0	16	82	8	0
(3) Others (swamp, Houses)	0	1	0	0	0
Total	67	112	172	96	95

Remarks : Area is identified by gross area.

Source : Annex C

3.2.2 Wild life

Wildlife are rarely observed in and around the project areas due to the depletion of the forest by the human activities such as forest clearing for agriculture, logging and timber extraction, construction of the reservoir, etc. In addition, hunting of animals as a source of protein ("bushmeat") is also a main reason for the decrease of the wildlife. At present, only small animals such as grass cutters, squirrels, and snakes can only be found commonly in and around the project areas.

3.2.3 National Park and Conservation Area

There is no national park and conservation forest in and around the priority project areas. Even secondary forest are hardly found in the areas. It can be said that the project areas have been already exploited by human activities. However, one lagoon namely Sakumo lagoon, under the Ramsar Site, is located on the downstream of Ashaiman project. The general features of the lagoon are shown below :

Location	Lagoon Area	Catchment Area	Fishery	Present conditions
Tema	300 ha	3,500 ha	High	Sedimentation and pollution have been occurred due to inflow of the wasted water from surrounding town.

3.3 Social Environment

3.3.1 Community and Ethnicity

The following communities exist in and around the project areas. The size and ethnic status are different between the projects.

Project	Community	Dominant Ethnic	Population *1 (estimation)
Ashaiman	Ashaiman, Zenu	Ga, Ada	10,000
Aveyime	Aveyime, Mangoase, Manya, Botikope, Kekpoe, Lasivenu-Kpodzi, Battor	Ewe	7,000
Kpando-Torkor	Kpando-Torkor, Dzigbe	Ewe	6,750
Mankessim	Beifikrom, Anyamain, Akotogwe, Kwaabedukrom, Gyedu, Nkwanta, Takorasi, Eduafo, Mankessim	Akan	16,200
Okyereko	Okyereko, Adawuukwa	Akan	1,700

Reparks : *1 Figures are estimated based on the interview survey results.

3.3.2 Religion and Education

The Christianity is a dominant religion for the people in the project areas, and followed by Muslim, and Animism. Educational level of villagers are generally low, as most of farmers in the project areas have had only primary school education. However, the literacy rate in the villagers is not always low because of the religious activities.

3.3.3 Health and Hazard

According to the interview survey to farmers, diarrhea, malaria, schistosomiasis, etc. were listed up as the commonly contracted diseases in the areas. The shortage of sanitary

facilities such as water pipe, tubewell , toilet, etc. is one of the main reason for diarrhea disease, especially in dry season. In other hand, Malaria and Schistosomiasis are assumed that lack of knowledge about the diseases is main reason for expansion of those. The number of patients who goes to hospital for treatment of schistosomiasis is less than those of malaria disease as shown in the following table. It may indicate that the farmers intention of the disease is lower than the malaria

(Unit : population)

	Ashaiman *1	Aveyime *2	Kpando-Torkor *2	Mankessim *2	Okyereko *2
Malaria	ND	6,177	235	3,274	2,478
Schistosomiasis	ND	181	59	20	1

Source: Data was collected at health unit, hospital.
Remarks : N.D. is "Not Available Data".
*2 Figures is the accumulation of the patients from Jan. to Jun. of 1996

3.3.4 Historical and Religious Sites

There is no archeological and / or historical sites in and around the priority project areas. However, the sacred forest groves were found in Mankessim and Okyereko project areas. The size of those in Mankessim and Okyereko project areas is 1.5 ha and 0.4 ha, respectively. Other religious sites such as cemetery, fetish shrine, etc. are not located in the project areas.

3.3.5 Economic Condition

According to the household survey, the average family income in the project areas is estimated at 1.7 million cedies to 2.4 million cedies per annum as follows:

(Unit : 1000 Cedies)

	Ashaiman	Aveyime	Kpando-Torkor	Mankessim	Okyereko
Gross Income	2,400	1,690	2,060	1,820	2,130
Gross Outgo	2,400	1,690	2,060	1,820	2,130
Production cost	330	80	260	220	310
Living cost	2,060	1,600	1,800	1,600	1,800
Loan repayment	10	10	0	0	20
Net Reserve	0	0	0	0	0

Source : Annex F

3.4 Present Environmental Issues

The present environmental issues are identified for each project, based on the information obtained from the baseline survey. Some of issues, i.e. sedimentation in reservoir, contracting with water-born diseases, soil erosion in hill area, etc. were commonly observed between the projects. The present issues are summarized below, and their causes, significance and countermeasures to be considered are shown in Table F-2. By the application of proper countermeasures through out the project stage, the issues could be minimized in terms of the magnitude and the extent.

Project	Present Environmental Issues
Ashaiman	1. Sedimentation in the reservoir due to the erosion from the surrounding area 2. High percentage of contracting Malaria and schistosomiasis 3. Expanding of salinity fields in the developed area due to the poor drainage condition 4. Downstream pollution due to flowing of domestic disposal water into the drain and Tema
Aveyime	1. Deforestation of forest around the project area due to the charcoal production 2. High percentage of contracting Malaria and Bilharzia 3. Water logging in farm land due to the poor drainage condition
Kpando-Torkor	1. High percentage of contracting Malaria and Bilharzia 2. Soil erosion of sloping fields in and around the project areas due to the farming without proper soil conservation measures
Mankessim	1. Sedimentation in the reservoir due to the erosion from the surrounding area 2. Seasonal stagnant water in the fields due to the flooded and/or backflow water from Ochi river 3. High percentage of contracting Malaria and Bilharzia 4. Soil erosion of sloping fields in and around the project areas due to the farming without proper soil conservation measures
Okyereko	1. Sedimentation in the reservoir due to the erosion from the surrounding area 2. High percentage of contracting Malaria and Bilharzia 3. Expanding of salinity fields in the developed area

The following paragraphs explain about the present environmental issues in the areas.

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

This is a major problem commonly observed in the irrigation reservoirs in Ghana. Due to the cultivation without applying soil conservation measures and deforestation caused by the shifting cultivation, bush fires, removal of vegetation for fuelwood, etc. along the reservoir and in the watershed area, the land degradation has been occurred, and it has resulted in silt deposition in the reservoir. In fact, the many cultivated land along the reservoir were observed in the field survey. Due to the silt deposition, the capacity of the reservoir has been substantially reduced, and this would result in the shortage of water. According to the fishermen around the reservoirs, the water of the reservoirs has become muddy, and the products by fishing have also decreased year by year.

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

(2) Deforestation : Aveyime

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

(3) Degradation of downstream lagoon ecology : Ashaiman

The Sakumo lagoon is used by artisanal fishmen who catch tilapia, crab and shrimp with cast nets and traps at present. This area has considerable value as urban "green space" for recreational activities of inhabitants of the metropolitan region. However, the Sakumo lagoon has extermlly polluted by the inflow of wasted water from surrounding towns due to increasing population density. In fact, the following issues were observed in the Sakumo

lagoon at present.

1) Siltation into the lagoon
According to study report surveyed by Department of Game and Wildlife at 1995, the heavy siltation in the lagoon had been found through examination of lagoon bed and riverine portion. In fact, it is reported that the lagoon has lost a great part of its storage capacity as a result of siltation which is due to the farming and construction activities within the middle and northern parts of the catchment.

2) Pollution of water quality
Inflow of the waste water from the densely populated areas, especially from Tema town, into the lagoon is a major reason for the pollution of water quality. In fact, the wasted water from Ashaiman town also joins with the Gyorwulu river (drainage of the project) in the project area and flows into the lagoon. Datas of water quality at the Gyorwulu river (downstream of the project area) and at the lagoon are summarized below :

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

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

As mentioned before, the Ashaiman project area is located in catchment area of the Sakumo lagoon. Even the project is not considered to affect the lagoon' environment and the main adverse impacts come from town, newly expansion of the irrigation area is not recommendable in order to minimize unexpected negative impacts to the lagoon.

(4) Water logging and Salinity Problems: Ashaiman, Aveyime, Okyereko, Mankessim

Due to the poor drainage works, water logging and also salinity problems result in lowering of crop yields and often in abandonment of lands. These problems are found in Ashaiman, Aveyime and Okyereko projects. In Mankessim project, the seasonal flood from the Ayensu river which flow at the edge of the project area result in the water logging at lower part. Therefore, the improvement of drainage facility and system is a necessary work in the former three (3) projects, and the construction of river dike is necessary in Mankessim project.

(5) Water born diseases : All projects

It is reported that about 90 % of total population of Ghana has been infected by malaria disease, and most of farmers in and around the Project areas, too. Schistosomiasis (Bilharzia) is also popular disease among the farmers in and around the Project areas. The farmers know the importance of medical treatment of these diseases, and they think a serious problem for them about malaria. However in case of schistosomiasis, the situation may be slightly different. They do not think seriously about it because they also know that the problem can be easily solved by taking medicines. The main problem is that they have no knowledge about the causes of the both diseases. Hence, health education and sanitary programme is required to prevent and control the problem. For instance, maintenance works of weeding in the canals and field bunds are also necessary for control of stagnant water and snails in paddy fields,.

4 Environmental Assessment of the Projects

4.1 Outlines of the Projects

The proposed project component are summarized in Table F-3, and general outlines of them are shown bellow.

	Ashaiman	Aveyime	Kpando-Torkor	Mankessim	Okyereko
Water source	Reservoir	Volta river	Volta lake	Reservoir	Reservoir
Irrigation system	Gravity	Gravity	Sprinkler	Sprinkler	Gravity
Existing area	56 ha	63 ha	40 ha	17 ha	40 ha
Rehabilitation area	56 ha	95 ha	155 ha	86 ha	81 ha
Main crop	Paddy-Vegetables	Paddy-Vegetables	Vegetables	Vegetables	Paddy-Vegetables

Remarks : *1 Existing area indicates the developed one in rehabilitation area

Since the main purpose of project is rehabilitation of the existing irrigation facilities, the project components of them are not complicated and the size of construction is also not large. The extension area is less than 40 ha on Ashaiman and Aveyime areas, while the others, especially Kpando-Torkor project, will be expanded over 40 ha from the existing condition.

Proposed cropping pattern also differs between the projects, as paddy and vegetables under gravity irrigation system and only vegetables under sprinkler system.

4.2 Possible Environmental Issues

Environmental screening and scooping were undertaken to identify and assess the potential adverse impacts of each project, taking the detail features of the projects into account. The results of the screening / scooping are summarized as follows :

Project area	Possible Environment Issues (Negative)
Ashaiman	i) Deterioration of water quality in downstream (at operation) ii) Health hazard due to improper usage of agro-chemical iii) Land degradation due to salt-accumulation
Aveyime	i) Deterioration of water quality in downstream (at operation) ii) Health hazard due to improper usage of agro-chemical iii) Increase of incidence of water born diseases
Kpando - Torkor	i) Destruction of habit of flora (deforestation) ii) Deterioration of water quality in downstream (at construction) iii) Health hazard due to improper usage of agro-chemical iv) Land degradation due to soil erosion
Mankessim	i) Damage to cultural area ii) Deterioration of water quality in downstream (at operation) iii) Health hazard due to improper usage of agro-chemical iii) Land degradation due to soil erosion
Okyereko	i) Damage to cultural area ii) Expansion of flood damage due to project works iii) Deterioration of water quality in downstream (at operation) iv) Health hazard due to improper usage of agro-chemical v) Land degradation due to salt-accumulation vi) Increase of incidence of water born diseases

It was assessed that, the proposed projects will likely cause moderately to minor adverse impact on the environment, unless mitigation measures will be pursued. The environmental assessment of the projects is described in next section, and its summary is

shown in Table F-4.

4.2.1 Deterioration of Downstream Water Quality

(1) Construction Phase : **Kpando-Torkor**

For installation of pumping station in Kpando-Torkor project, a significant amount of disposal material will be born from excavated materials at construction stage, although some of the excavated materials, of cause, will be used for embankment and as road improvement materials. The efficient using (recycling) of the materials should be considered as much as possible. In the proposed plan, about 12,000 m³ of excavated materials will be occurred, out of them about 2,000 m³ of material will be used and about 10,000 m³ will be leveled near pumping station. It is considered that the impacts for them could be mitigated by application of the proper management such as re-vegetation, etc., at the leveling works.

(2) Operation Phase : **Ashaiman, Aveyime, Okyereko**

1) Projection of increase of farm inputs
The level of fertilizer use will increase under the future intensive agriculture to obtain higher yields. This might result in nutrient load in drainage water, and affect the downstream. Especially in Ashaiman, Aveyime, and Okyereko projects, it could be expected that the nutrient load to downstream might be higher than the others because of significant surface runoff. While, the downstream waters of Aveyime, Mankessim and Okyereko are presently used for drinking water, respectively. Hence, a confused usage of the agro-input might cause a significant impact.

The possibility and the degree of the loading are examined on the basis of the calculated result of the mass balance of farm inputs between present condition and future with project condition. Total quantities of the farm inputs were estimated based on the present and proposed farm input application mentioned in Annex E, and summarized below.

(Unit : ton)

Project Area		Without Project Condition			With Project Condition			Balance		
		Rainy season	Dry season	Total	Rainy season	Dry season	Total	Rainy season	Dry season	Total
Ashaiman	N	0.6	1.1	1.7	3.9	6.0	9.9	3.3	4.9	8.2
	P	0.2	0.4	0.7	1.7	2.7	4.4	1.4	2.3	3.7
Aveyime	N	4.8	4.8	9.7	9.6	8.7	18.3	4.7	4.0	8.7
	P	2.0	1.9	3.9	3.9	3.6	7.5	1.9	1.7	3.6
Mankessim	N	0.0	6.3	6.3	2.7	9.1	11.9	2.7	2.8	5.5
	P	0.0	2.7	2.7	1.6	3.8	5.4	1.6	1.2	2.8
Okyereko	N	0.0	2.8	2.8	8.0	10.5	18.5	8.0	7.7	15.7
	P	0.0	1.6	1.6	3.3	4.4	7.7	3.3	2.7	6.0

2) Projection on the downstream water quality
The possibility of the deterioration of downstream water quality was examined based on the above calculated result and the following assumption.

a) Runoff of farm inputs
There is no available data concerning the runoff rate of chemical fertilizer in Ghana. In this assumption, however, the runoff rate of nitrogen is set to be 1 % and 0.2 % for phosphorous by applying the modified figures from the research results at USA and Japan. The estimated runoff quantity from the application are shown below.

(Unit : kg)

	Ashaiman	Aveyime	Mankessim	Okyereko
Nitrogen	100	183	119	185
Phosphorous	9	15	11	15

b) Runoff discharge
Runoff discharge is assumed to be 30 % of total irrigated discharge without consideration of original flow, rainfall, inflow of water from other cachtments. Therefore, it will be a minimum value of runoff discharge form irrigated fields.

(Unit : MCM)

	Ashaiman	Aveyime	Mankessim	Okyereko
Runoff	0.20	0.56	0.35	0.42

c) Runoff of farm inputs
On the basis of the above assumption, the pollution load in the runoff water is calculated as follows:

(Unit : ppm)

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

The nutrient load into the runoff water is estimated to be low. Under Japanese water quality standard for lake water, the runoff waters (drainage waters) of Aveyime, Mankessim and Okyereko can be classified into Class III which can be drunk under highly level treatment in advance, and the rest of Ashaiman is Class V, which is suitable for agriculture and industry. The downstream of the former three (3) projects have also original discharge, respectively. Therefore, it is considered that the water quality of them will be in safety level even for drinking water using, and the impacts will be minor under proper management of farm input use.

4.2.2 Health Hazard from Agro-chemical : <u>All projects</u>

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

Presently, IDC has carried out a extension work to introduce the IPM (Integrated Pest Management) system into several irrigation schemes under the FAO programme. Since this is still initial stage, the effect and expansion is also small. The operation cost is cheaper than the ordinal one but the labour requirement is more under the IPM system. If the extension work be continued and the benefit be appeared, this system might be expanded across the country of Ghana because of the lower operation cost. From the environmental aspect, negative environmental impacts must be minimized or sometime eliminated by the introduction of the IPM system in the project areas.

4.2.3 Land Degradation

(1) Due to salt accumulation : **Ashaiman, Okyereko**

As described in Annex C, total 12 ha in Ashaiman and 2 ha in Okyereko were assumed to be affected by salt as a salinity soils at present. The salinity soils were observed in poorly drained fields along the drain. The area of salinity soils was small part and just found at spot in the area, however both project areas have still potential lands to be effected under poor drainage system. Therefore, if the projects be implemented without establishment of the proper drainage system, the salinity area will expand and the significant damage will be resulted in. The present ECe values of surface in the saline soils are high and they are classified into saline to strongly saline soil (saline soil : 8-15 mS/cm, strongly saline soil : over 15 mS/cm), as shown below.

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

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

According to a preliminary estimate of the salt balance under proposed cropping pattern , the salt will be completely leached out within 3 year under proper drainage system. At least 1 year after, the results of calculation indicate the salinity level will be in permissible range as shown below. Since the irrigation waters of both areas are not effected by salt as 0.13 and 0.20 mS/cm respectively, the significant leaching effect could be expected under proper drainage system.

(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

Of course, these might be optimistic projections. The results of the calculation could change from suitable results to undesirable ones in case of lowest percolation rate even under proper drainage system. Consequently, some reclamation measures such as flushing, leaching and mulching are required to be applied before and on the farming operation periods. By this way, the yield loss due to the salinity can be eliminated.

(2) Due to soil erosion : **Kpando-Torkor**

As mentioned in Annex C, the soils in Kpando-Torkor is mainly shallow soils which has a "skeletic" phase. Since the effective depths of soils to the skeletic layer is about 20 to 50 cm, it is assumed to be a high potential for land degradation. Once the surface soil is removed out, the lands will be changed to useless land for any purposes. The slope of the area is, however, gentle as 2 to 3 % , the rain intensity is relatively high in rainy season. In fact, the depth of soils in present irrigated fields is shallower than the one under secondary forest. Therefore, it is apparent that the land use and farming practice is key factors for the sustainability.

If the proper countermeasures be introduced and the profitable farming which has also a significant sustainability be carried out in the projects, it would be the best model for

development of similar upland area extending in the whole of Ghana . However, it is difficult to predict the effects of soil conservation measures at present, because it is still at the trial stage. Consequently, the careful monitoring shall be undertaken at the operational phase to grasp the progress of soil erosion at susceptible area. Through the monitoring works, it will be possible for not only to identify constraints of the countermeasures but also to find alternatives to match with farming and farmers' conditions.

4.2.4 Incidence of Water-born Diseases : Aveyime, Okyereko

As it is reported that over 90 % of Ghanaian has been contracted with Malaria in general, the additional effect of the Malaria diseases in the areas will not be projected significantly, it may be minor. However, the malaria diseases will still remain as a big problem in Ghana.

In other hand, the expansion of paddy fields in Aveyime and Okyereko projects may increase chances to contract with the schistosomiasis, even farmers have no sign to be infected with it in fields at present. Especially, according to the doctor in Battor town near Aveyime area, the snails have been propagated drastically and the number of patient have increased along the Volta river, since the Kpong dam had been constructed. The potential for increase of incidence of the disease might be high at Aveyime area. As mentioned in before section, the main problem is the villagers ignorance. They have no idea for how to be infected or how to prevent the disease. Hence it is considered that the impact could be minimized through sanitary education.

4.2.5 Destruction of Habit of Flora (Deforestation) : Kpando-Torkor

At present, the local people are using the potential area for the field of shifting cultivation and fire wood collection. Therefore, when the agricultural land is expanded in the potential area, the user of the land will be obliged to sift to other areas. It might make a high pressure using in the bush area or even in secondary forest, and then 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 (2) aspects can be considered to rise up. Firstly, the intensified using of land and clearing bush might be resulted 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 woods after the project. However, the related area is so small that the issue could be assessed as a minor impact.

4.2.6 Damage to Cultural Area : Mankessim, Okyereko

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

4.2.7 Expansion of Flood Damage due to Project Facility : Okyereko

In Okyereko project, it is necessary to construct an intake weir on the Ayensu river, to supply supplemental water to the reservoir. The proposed intake weir will be set at about 350 m downstream from crossing point with Accra - Sekondi national road. In the sandwiched area between the national road and the proposed weir site, there is no farm land due to inundation during the rainy season. However, there is also some possibility that the construction of the intake weir might expand the inundated area and / or make the flood water overtop the national road at flooding time.

Presently, the influence by the intake weir can be considered to be small. A difference between with and without weir condition was calculated at about 20 cm in water level to 10 year flood, and it means the water level will became El. 8.72 m at the crossing point, which is still lower than top of the national road (El. 19.86 m). In addition, the existing spill way located just upstream of the proposed weir site is not taken into consideration in this assessment. Therefore, it is considered that the environmental effect from the intake weir will be minor under the proposed plan.

5 Environment Conservation and Monitoring Plan

5.1 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 of Ghana. Through the fields 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. The following paragraph explain the basic concepts of conservation and monitoring plans for the major future environmental issues.

5.2 Institutional Aspect

The conservation measurements and monitoring works will be applied on the construction and operation phases. Therefore, not only government staff but also the beneficial farmers of the areas have an important role for the success of the countermeasures. While, the monitoring works should be also carried out by government staff in cooperation with the beneficial farmers. In this connection, to establish a research, monitoring and evaluation unit (M&E unit) is proposed in order to effectively transfer and disseminate the technologies to the farmers. It is also recommended that this unit will have a functions of research of land conservation, monitoring of soil erosion and salinity progress, evaluation of protection measures, extension to farmers, and producing and providing of tree seedling to farmers. In addition to the natural environmental aspect, the social matters such as health condition, expanding of the diseases, etc. will be also monitored by this unit. It is one alternative that the sub-unit of IDC, called Agro-environmen, shall be strengthened to play a role for the proposed unit.

5.3 Environmental Conservation Plan

5.3.1 Reclamation Measures for Salinity Soils

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

1) Flushing
In the saline soils, most of salts 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 the leaching may accelerate and improve the leaching process.

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

iii) Mulching
During periods of high evapotranspiration between the two (2) irrigation terms and during periods of fallow, there is a tendency for the leached salt 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 on fallow and upland cropping, in addition to establishment of the proper drainage system.

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

5.3.2 Conservation Measures for Soil Erosion

The proper land management is required when the land be used for agricultural purpose, especially on intensive farming. In other word, the countermeasures for land erosion such as contour hedgerow, contour ditches & drainage canals, mixed planting, contour plowing, etc., need to be introduced into the project activities on the implementation and also operation phases. Table F-5 shows recommendable measures and practices for control of soil erosion, and the following shows its summary.

Measures	Descriptions	Phase
1. Contour hedgerow	Vegetative rows or strips established along the contour. Trees serve as live barrier to surface runoff and soil erosion. If the nitrogen fixing crops or trees such as leguminous crops are used, it can improve soil condition.	Construction and Operation
2. Contour bund	They are earth bunds, thrown across the slope to act as a barrier to runoff, and to break up a slope into segments shorter in length than is required to generate overland flow. They are frequently used with strip-cropping system.	Construction and Opertion
3. Contour ditches & drainage canal	They are digging structures established in the hillsides to check the erosive power of surface runoff by tapping soil particles. Drainage canal are used as the outlet for contour ditches. It runs and empty into other outlets.	Construction
4. Contour plowing	It is a plowing method to create furrows following the contour of the land.	Operation
5. Contour planting	It is a planting method following the contour of the land. The crops planted act as barriers to the force of surface runoff.	Operation
6. Mulching	The mulching is the covering of the soil with crop residues such as straw, maize stalks, palm fronds or standing stubbles. The effect of mulching is the reducing of raindrop impact and of the velocity of runoff.	Operation

Under the proposed plan, green belt, composed by three countermeasures as vegetation row, contour bund and drainage canal, will be established at the 200 meter spacing. In addition, a farm road will also be constructed between the green belts, consequently, the erosion protection bunds will be set up on each one hundred (100) meter distance.

Farmer will operate one acre of field sized 40 m in verticality and 100 m in holizontality. Therefore, it is also recommended to construct a field bund on the edge of each field by farmers own efforts. On the other word, it can finally be said that the water movement to downward on fields will be obstructed by these bund at the 40 m spacing. Of course, the other measures such as mulching, contour planting, contour plowing shall also be applied on operation phase. By the application of these measures, the water erosion will completely minimized.

5.3.3 Prevention of Destruction of Flora (Forest Conservation)

The main reasons for deforestation in and around the Project areas are bush fires, illegal cultivation, tree cutting of farmers for firewood, and shifting cultivation. The necessary

actions of the government for conservation of secondary forest and watershed vegetation are not only the land use restriction, but also the integrated government support services to improve the present living condition. Therefore, the installation of irrigation facilities will be one of the effective measures through the stabilization of farmer's life expected the effect to reduce the slash and burn cultivation, illegal cultivation, and charcoal production. In addition, the following approaches are proposed to be considered to reduce the deforestation.

1) Energy development
   As mentioned above, firewood cutting is one of the main reason for forest degradation, since the local people mainly use firewood and charcoal for their energy source. The improvement of cooking stove of local people is one of effective measures for sustainable energy development. The introduction of biogas system as an alternative energy source is also useful.

2) Reforestation or Establishment of community forest
   Plantation of tree and establishment of forest are also essential for the forest conservation. Therefore, the government should support the local people by providing tree nursery and training them. If the local people understand the importance of forest management and get the technology, they can produce their own energy source in the certain land permanently. At present, the IDC has been implementing the extension work of reforestation around Ashaiman reservoir from 1993 on trial. The Department of Forest, Ministry of Forest has also a programme to encourage the local people to establishment of community forest, however, due to the lack of staff and fund, the effect is limited. The corroboration works are expected to be undertaken for the smooth attainment.

5.3.4 Management of Water-born Diseases

The water resources of irrigation in the project areas is already infested by the schistosomiasis, especially in Aveyime area. Therefore, the countermeasures for reduction of the expansion should be considered not only in the project areas but also along the upper streams of the reservoirs. The adoption of chemical treatment is not recommendable, since the contaminated area is so widen and the toxicity of chemicals may impact the environment. The following countermeasures is considered as the recommendable measures to be taken in cooperation with Ministry of Health.

1) For malaria and schistosomiasis
   a) Concrete canal lining to prevent growth of weed and stagnant of water
   b) Maintenance works for cleaning and weeding canals
   c) Health education of local people

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

3) For schistosomiasis
   a) Putting on rubber boots when going into the water
   b) Prohibition to urinate to water source and providing sanitary facility

5.4 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 better to monitor the complaint of the beneficial farmers and also other local people once a year at least in order to check the unexpected environmental change to be caused by the projects. The summary of the environmental monitoring plan is presented in Table F-6.

5.4.1 Progression of Salinity Condition : Ashaiman, Okyereko

In order to know the progression of the salinity condition in terms of area expanding and also degree of salinity level, the surface and sub-surface soils in the susceptible area shall be sampled and analyzed, the general outline of works is as follows:

(1) Monitoring items

1) Sampling
Surface soil (0-20cm) and sub-surface soil (20-50cm)

2) Laboratory analysis
- Soil acidity (pH) and electric conductivity (EC)
- Exchangeable cations (Na, K, Ca, Mg, Al) and cation exchangeable capacity (CEC)

(2) Monitoring area

- Present Salinity area (soil map unit : P22s)
- Potential Salinity area (soil map unit : P22)

(3) Monitoring period and frequency

Periodic monitoring should be conducted as least twice a year, especially before cropping season (Feb. - Mar., Sept. - Oct.)

5.4.2 Farmers' Health Condition : All project

The monitoring works will be done for two (2) aspects, such as health hazard of agro-chemicals and water born diseases. In Ashaiman, Aveyime and Okyereko project areas, the monitoring works shall be carried out the above two aspects, and in the others the survey shall be concentrated on health hazard situation.

(1) Monitoring items

- Recent tendency of diseases (especially malaria and schistosomiasis)
- Health hazard condition
- Farmers intention for the diseases and agro-chemical hazad
- Existence and occurrence of vectors
- Condition of health programme

(2) Monitoring area

- Beneficial villages and rehabilitation area
- Health unit such as hospital, clinics, etc., near the project area

(3) Monitoring period and frequency

Periodic monitoring should be conducted as least twice a year

5.4.3 Deterioration of Water Quality : Ashaiman, Aveyime, Mankessim, Okyereko

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

(1) Monitoring items

1) Sampling
Surface flow of drain or downstream water

2) Survey items
- Physio-chemical substances (pH, EC, SS, DO)
- Organo-chemical substances (COD, NH4-N, NO2-N, NO3-N, T-N, T-P)
- Agro-chemicals
- Farming practice such as usage of farm inputs

(2) Monitoring area

For the surface water quality, the sampling is taken at the downstream just below the project areas. Farming practice is surveyed in the rehabilitated area through interview to the farmers.

(3) Monitoring period and frequency

1) During the construction stage, the surface water should be sampled by the M&E unit at least bimonthly. The physio- and organo-chemical substances should be analyzed by itself or other institutes such as the Institute of Aquatic Biology, etc.
2) During the operation stage, the surface water should be sampled by the M&E unit at least monthly on the cropping season. For the farming practice survey, field visitation should be carried out twice a year.

5.4.4 Effect of Erosion Conservation Measures : Kpando-Torkor

Even the countermeasures will be applied to the susceptible fields, the soil erosion might be occurred to certain extents. Therefore, the periodical monitoring is required to be carried out to know the effect and to avoid irreversible change. For this purpose, the following items should be surveyed by field measurement, interview to the farmers, and field observation.

- Erodibility of leveled desposal soils near pumping station
- Amount of seasonal eroded soil in the operation phase
- Rainfall condition
- General erosion condition in the project area

- Farmers intention of soil erosion
- Applied soil conservation measurements in the field

(1) Erodibility of leveled desposal soils near pumping station

A significant amount of disposal soils will be occurred at the implementation stage because of the excavated works for installation of pumping station as mentioned before. The materials will be used for the embankment materials and also road improvement materials, however, the rest of them is assumed to be still large amount of soils. Although they will be leveled near the pumping station with the optimum erosion protection, the condition of the disposal soils should be monitored in the both phases.

1) Procedures
The monitoring work is mainly conducted by the field observation. Through the observation, the rill erosion or gully erosion can be identified, and the effect of erosion to the Volta lake also can be checked by the eye confirmation. Based on the results, some countermeasures should be conducted to the area, if necessary.

2) Monitoring period and frequency
The surveillance work should be carried out every month in the construction phase, and at least twice a year in the operation phase.

(2) Amount of Seasonally Eroded Soil

1) Procedures
It is proposed to construct experimental plots in the project area, in order to measure the amount of eroded soils. The experimental plot is defined as a physically isolated piece of land of known size, slop steepness, slop length and soil type. It is desirable that two type of land surface such as "with mulching condition" and "without mulching condition" shall be measured in the area. The number of plots, therefore, is considered to be at least 4 plots in each rehabilitated block, taking into consideration two (2) replicates. Each plot is surrounded by tin plate, and at the lowest soil trap with drain is constructed. Fig. F-2 shows an example of the experimental plot, which was applied at previous study in Indonesia. The plots in the study was 4.5 m x 12 m (54 m2).

2) Monitoring period and frequency
Eroded soil amount precipitation in the drain should be measured every three or four months. Rainfall data during the experimental period should also be collected from the rainfall station of Kpando.

(2) General Condition of the Area

At the same time of the above measurement work, a interview survey to the farmers and field reconnaissance survey should be also carried out to grasp the status of erosion condition and conservation measurement applied by farmers.

TABLES

Table F-1 Water Quality of Irrigation and Drainage Water in the Project Areas

Sampling point	Temp (C)	TRAN (m)	PH	CacO3 (ppm)	EC (Sm/cm)	Ca (me/l)	Na (me/l)	Mg (me/l)
Ashaiman								
Reservoir	-	-	7.7	-	0.13	0.33	0.22	0.04
Main Canals	-	-	7.7	-	0.13	0.33	0.23	0.04
Lateral Canals	-	-	7.8	-	0.13	0.34	0.22	0.04

Source : IDC Annual Report (1993), GIDA

Project Area	Temp (C)	TRAN (m)	PH	CacO3 (ppm)	EC (Sm/cm)	DO (mg/l)	BOD (mg/l)	NH3-N (ppm)	NH2-N (ppm)	NO3-N (ppm)
Aveyime										
Volta river (intake point)	28	N.D.	8.0	144	0.06	3.40	1.17	1.25	<0.05	0.30
Drain	27	N.D.	6.7	130	0.08	0.80	0.60	4.00	<0.05	<0.25
Downstream	26	N.D.	6.8	12	0.06	1.10	0.78	8.00	<0.05	0.25
Kpando-Torkor										
Intake point (Block A)	28	1.4	8.8	80	57	6.2	3.48	<0.2	<0.05	<0.25
Intake point (Block B)	28	0.9	8.7	50	58.3	5.9	3.31	<0.2	<0.05	<0.25
Intake point (Block C)	28	1.3	8.6	44	57.4	6.1	3.74	<0.2	<0.05	<0.25
Mankessim										
Reservoir (opposite end of dam)	28	1.4	8.1	80	0.27	6.60	3.40	0.40	<0.05	<0.25
Reservoir (opposite end of dam)	27	1.3	8.2	99	0.25	5.10	1.62	1.00	0.05	0.05
Ochi river (before project site)	25	-	8.0	50	0.12	6.40	2.74	1.00	<0.05	<0.25
Ochi river (after project site)	26	-	8.0	50	0.13	5.90	2.27	1.50	<0.05	<0.25
Okyereko										
Reservoir (Opposite end of dam)	29	1.2	8.0	107	0.28	4.60	2.89	0.30	<0.05	<0.25
Reservoir (near dam)	26	1.5	7.0	105	0.20	2.40	0.68	0.60	<0.05	<0.25
Drain	24	N.D.	8.4	200	0.45	2.80	1.36	0.60	<0.05	0.25
Ayensu river (before project site)	26	N.D.	7.9	80	0.15	5.50	2.08	0.60	<0.05	<0.25
Ayensu river (after project site)	25	N.D.	8	80	0.27	5.90	1.88	0.40	<0.05	<0.25

Remarks :

TRAN means water transparency.

N.D. means "not determinable at time of sampling)

Table F-2 Present Environmental Issues and Its Mitigation Measures

Environmental Issues	Main Causes	Significance at present	Remedial Measures to be considered	Significance in future	Relating project
1. Silt deposition in the reservoir	Soil erosion from catchment area, due to unproper land use	moderate	Reforestation of the catchment area, Introduction of soil conservation measurement	minor - moderate	all project
2. Water logging and stagnant water in farm land	Poor work of drainage facility	minor - moderate	Improvement of drainage facility Construction of flood dike	none - minor	As, Av, Ok Ma
3. Low productivity due to salinity problem	Poor work of drainage facility Inclusion of brackish water (to farmland or grained water)	minor - moderate	Improvement of drainage facility, Leaching of salt	minor minor	As, Ok Af
4. Incidence of water-borne diseases	swimming and water taking in reservoir influenced by diseases	minor - moderate	Education of farmers through sanitation education program	minor	all project
5. Soil erosion of farm land	no application of soil erosion control unproper land use	minor - major	Introduction of soil conservation measurement, Introduction of orchard or perennial crops	minor	Kp, Ma
6. Decrease in Forest in and around the project areas	Increase demand for fire wood (increase population)	moderate	Recommending sustainable management of limited forest resources, including tree planting, Recommending the use of alternative energy sources such as biogas	minor	all project

Remarks :

As : Ashaiman, Av : Aveyime, Kp : Kpando-Torkor, Ma : Mankessim, Ok : Okyereko

Table F-3 Sumarry of Project Components under Rehabilitation Projects

Project Components	Ashaiman		Aveyime		Kpando-Torkor		Mankessim		Okyereko	
	Yes/No	Qty	Yes/No	Qty	Yes/No	Qty	Yes/No	Qty	Yes/No	Qty
General Concepts										
Water source	Reservoir		Reservoir		Reservoir		Reservoir		Reservoir	
Irrigation system	Gravity system		Gravity system		Sprinkler system		Sprinkler system		Gravity system	
Existing Developed area (net : ha) *1	56 ha		63 ha		40 ha		17 ha		40 ha	
Rehabilitation area (net : ha)	56 ha		95 ha		155 ha		86 ha		81 ha	
Physical Components (Approxi.)										
1. Irrigation and Drainage Facility										
1-1 Pumping station	No	-	Yes	1 nos	Yes	2 nos	Yes	2 nos	Yes	1 nos
(Number of pump)				(3)		(3)		(5)		(2)
1-2 Gravity irrigation system										
(1) Head race and Main	Yes	1.9 km	Yes	4.3 km	Yes	0.4 km	No	-	Yes	2.5 km
(2) Secondary and Lateral	Yes	4.6 km	Yes	9.1 km	No	-	No	-	Yes	7.0 km
1-3 Pipeline system										
(1) Main and Secondary	No	-	Yes	0.3 km	Yes	6.4 km	Yes	4.0 km	No	-
(2) Lateral and Movable	No	-	No	-	Yes	16.7 km	Yes	9.2 km	No	-
1-3 Drainage system										
(1) Main	Yes	3.5 km	Yes	1.3 km	No	-	No	-	Yes	3.7 km
(2) Scondary + Lateral	Yes	8.6 km	Yes	10.8 km	Yes	2.8 km	Yes	1.1 km	Yes	8.3 km
2. Rural Road Upgrading										
(1) Main	Yes	1.6 km	Yes	2.0 km	Yes	10.1 km	Yes	2.7 km	Yes	3.2 km
(2) Lateral	Yes	4.0 km	Yes	5.1 km	Yes	9.5 km	Yes	9.2 km	Yes	6.5 km
3. Others										
3-1 Project buildings	Yes	1 nos	Yes	1 nos	Yes	2 nos	Yes	1 nos	Yes	1 nos
3-2 Electric line	No	-	Yes	2.3 km	Yes	8.0 km	Yes	3.5 km	Yes	8.0 km
3-3 Green belts + Drain	No	-	No	-	Yes	5.7 km	Yes	2.5 km	No	-
Social and Institutional Components										
1. O&M organization										
1-1 Farmers' organization	Yes	1 group	Yes	1 group	Yes	2 group	Yes	1 group	Yes	1 group
1-2 Governmental support	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-

Remarks : *1 Area in rehabilitation area.

Table F-4 Assessment of Probable / Potential Impacts (1/5)

(1) Ashaiman Project

Probable / Potential Impacts	Stage				Comments / Recommended Mitigation Measures
	Construction		Operation		
	without	with *1	without	with *1	
1 Soil erosion in and around the construction sites	3N	-	-	-	• No fresh cut and embankment which can introduce the effect are not in the project works.
2 Alternation or destruction of the habit of flora and fauna	-	-	-	-	• Unlikely
3 Damage to historic, cultural or religious area	-	-	-	-	• No such site exists
4 Effects on farm land, existing facilities, houses, due to project works	3N	-	-	-	• Quality and quantity of water flowing into the fish pond near dam wall might be effected. • This effect will be eliminated by undertaking the proper management of waste water.
5 Deterioration of water quality in downstream	2N a-c-e	3N	2N a-c-e	3N	• Liquid waste from concrete preparation works might be effused. • Proper disposal of the liquid waste the shall be enforced thoroughly. • IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • Proper water management taking agro-chemical input into consideration will be undertaking.
6 Health hazard from agro-chemical	-	-	2N a-c-e	3N	• IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • The hazard will be minimized by proper handling way of chemical under proposed extension works.
1 Reduction of downstream flows that affect users of water	-	-	-	-	• Present flow from project site into drain is quite low.
2 Increase of downstream flows affecting downstream ecology and/or	-	-	2P a-d	2P a-d	• Water quality of downstream will be improved by diffusion effect of the polluted water.
3 Land degradation in the project area due to erosion hazard	-	-	-	-	• No such site exists
4 Land degradation in the project area due to salt-accumulation	-	-	2N a-d-e	2P a-d	• Present salt-effected area will be reclaimed by irrigation farming because of establishment of proper drainage system.
5 Increased incidence of water borne diseases	-	-	3N	-	• The infection from paddy field is hardly observed at present. Cropping intensity of paddy will not be increased with project. • O&M works such as weeding canal and bund, and pesticide application which make snail's habitat decrease will be undertaken by farmers.
6 Increase of constructed-related employment opportunity	2P a-c	2P a-c	-	-	• The construction works will provide temporary job opportunity to the villagers nearby.
7 Increase of crop production	-	-	1P a-d	1P a-d	• The biggest positive effect of the project. • This will be lead to higher living standard of the population.
8 Increase of agricultural-related employment opportunity	-	-	1P b-d	1P b-d	• Employment opportunity in marketing of inputs and outputs, processing, etc. will be increased substantially.

Remarks : *1 "with" indicates future condition with conservation measurements.

Significance of impact
1 : Significant
2 : Moderate
3 : Minor

Feature of impact
P : Positive
N : Negative

Characteristics of impact
a : Direct
b : Indirect
c : Short term
d : Long term
e : Reversible
f : Irreversible

The feature of impacts is indicated as follows:

1N a-c-e Negative impact would be significant, direct, short term, and reversivle.

1P a-c-e Positive impact would be significant, direct, short term, and reversivle.

The characteristics of insignificant impacts are not identified.

Table F-4 Assessment of Probable / Potential Impacts (2/5)

(2) Aveyime Project

Probable / Potential Impacts	Stage				Comments / Recommended Mitigation Measures
	Construction		Operation		
	without	with *1	without	with *1	
1 Soil erosion in and around the construction sites	3N	-	-	-	• No fresh cut and embankment which can introduce the effect are not in the project works.
2 Alternation or destruction of the habit of flora and fauna	-	-	-	-	• Unlikely
3 Damage to historic, cultural or religions area	-	-	-	-	• No such site exists
4 Deterioration of water quality in downstream	2N a-c-e	3N	2N a-c-e	3N	• Liquid waste from concrete preparation works might be effused. • Proper disposal of the liquid waste the shall be enforced thoroughly. • IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • Proper water management taking agro-chemical input into consideration will be undertaking.
5 Decrease of crop production on construction phase	-	-	-	-	• Irrigation facility completely does not work at present.
6 Health hazard from agro-chemicals	-	-	2N a-c-e	3N	• IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • The hazard will be minimized by proper handling way of chemical under proposed extension works.
7 Increase of downstream flows affecting downstream ecology and/or	-	-	-	-	• Unlikely
8 Land degradation in the project area due to erosion hazard	-	-	-	-	• No such site exists
9 Land degradation in the project area due to salt-accumulation	-	-	2N a-d-e	-	• Salt-effected area is not found in the project area at present. But it has a potential to progress the salt accumulation under un-proper drainage system.
10 Increased incidence of water borne diseases	-	-	2N a-d-e	2 - 3N a-d-e	• The infection from paddy field is hardly observed at present. However, since cropping intensity of paddy will be increased with project, the incident of diseases might be increased. • Health education of local people shall be • O&M works such as weeding canal and bund, and pesticide application which make snail's habitat decrease will be undertaken by farmers.
11 Increase of constructed-related employment opportunity	2P a-c	2P a-c	-	-	• The construction works will provide temporary job opportunity to the villagers nearby.
12 Increase of crop production	-	-	1P a-d	1P a-d	• The biggest positive effect of the project. • This will be lead to higher living standard of the population.
13 Increase of agricultural-related employment opportunity	-	-	1P b-d	1P b-d	• Employment opportunity in marketing of inputs and outputs, processing, etc. will be increased substantially.

Remarks : *1 "with" indicates future condition with conservation measurements.

Significance of impact
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Feature of impact
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N : Negative

Characteristics of impact
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b : Indirect
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d : Long term
e : Reversible
f : Irreversible

The feature of impacts is indicated as follows:

1N a-c-e Negative impact would be significant, direct, short term, and reversivle.

1P a-c-e Positive impact would be significant, direct, short term, and reversivle.

The characteristics of insignificant impacts are not identified.

Table F-4 Assessment of Probable / Potential Impacts (3/5)

(3) Kpando-Torkor Project

Probable / Potential Impacts	Stage				Comments / Recommended Mitigation Measures
	Construction		Operation		
	without	with *1	without	with *1	
1 Soil erosion in and around the construction sites	3N	-	-	-	• No fresh cut and embankment which can introduce the effect are not in the project works.
2 Alternation or destruction of the habit of flora and fauna	3N	-	2-3N b-d-e	3N	• The extension area of about 110 ha presently used for shifting cultivation and woods collection by villagers, even the area is not primary forest. Dependance on remaining bush will be increased and it might result in land degradation.
					• Extension works for reforestation and reduction of shifting cultivation shall be carried out. Through the works, the farmers could aware the importance of forest for their life and they could manage the area by themselves.
3 Damage to historic, cultural or religions area	-	-	-	-	• No such site exists
4 Deterioration of water quality in downstream	1 - 2N a-c-f	2 - 3N a-c-f	2N a-c-e	3N	• Efficient use (recycle) or leveling of disposal materials form excavation works shall be undertaken completely. • Liquid waste from concrete preparation works might be effused. • Proper disposal of the liquid waste the shall be enforced thoroughly. • IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • Fertilizer incorporating and mulching works could minimize the effect.
5 Health hazard from agro-chemicals	-	-	2N a-c-e	3N	• IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • The hazard will be minimized by proper handling way of chemical under proposed extension works.
6 Land degradation in the project area due to erosion hazard at operation stage	-	-	1 - 2N a-d-f	2 - 3N a-d-f	• Soil conservation measures such as contour bund with strip cropping and waterways will be included in the project components. • Mulching and contour plowing undertaken by farmers could minimize the effect.
7 Land degradation in the project area due to salt-accumulation	-	-	-	-	• No such site exists.
8 Increased incidence of water borne diseases	-	-	3N	-	• No additional effect can be expected.
9 Increase of constructed-related employment opportunity	2P a-c	2P a-c	-	-	• The construction works will provide temporary job opportunity to the villagers nearby.
10 Increase of crop production	-	-	1P a-d	1P a-d	• The biggest positive effect of the project. • This will be lead to higher living standard of the population.
11 Increase of agricultural-related employment opportunity	-	-	1P b-d	1P b-d	• Employment opportunity in marketing of inputs and outputs, processing, etc. will be increased substantially.

Remarks : *1 "with" indicates future condition with conservation measurements.

Significance of impact
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Characteristics of impact
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f : Irreversible

The feature of impacts is indicated as follows:

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1P a-c-e Positive impact would be significant, direct, short term, and reversivle.

The characteristics of insignificant impacts are not identified.

Table F-4 Assessment of Probable / Potential Impacts (4/5)

(4) Mankessim Project

Probable / Potential Impacts	Stage				Comments / Recommended Mitigation Measures
	Construction		Operation		
	without	with *1	without	with *1	
1 Soil erosion in and around the construction sites	3N	-	-	-	• No fresh cut and embankment which can introduce the effect are not in the project works.
2 Alternation or destruction of the habit of flora and fauna	3N	-	3N	-	• Almost rehabilitation area has been developed and existing forest is scarcely found in the area.
3 Damage to historic, cultural or religions area	2N a-c-f	3N	2N a-c-f	3N	• There is a sacred grove of 0.4 ha in rehabilitation area. However, the area is excluded from rehabilitation plan. • Careful attention for un-disturbing the area should be taken on both stages.
4 Deterioration of water quality in downstream	2N a-c-e	3N	2N a-c-e	3N	• Liquid waste from concrete preparation works might be effused. • Proper disposal of the liquid waste the shall be enforced thoroughly. • IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • Fertilizer incorporating and mulching works could minimize the effect.
5 Decrease of crop production on construction phase	3N	3N	-	-	• No irrigation water supply in construction phase, but just 1 year. • This effect is already accepted by farmers. In the year, farmer can get a work as construction labour.
6 Health hazard from agro-chemicals	-	-	2N a-c-e	3N	• IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • The hazard will be minimized by proper handling way of chemical under proposed extension works.
7 Land degradation in the project area due to salt-accumulation	-	-	-	-	• No such site exists.
8 Increased incidence of water borne diseases	-	-	3N	-	• No additional effect can be expected.
9 Increase of constructed-related employment opportunity	2P a-c	2P a-c	-	-	• The construction works will provide temporary job opportunity to the villagers nearby.
10 Increase of crop production	-	-	1P a-d	1P a-d	• The biggest positive effect of the project. • This will be lead to higher living standard of the population.
11 Increase of agricultural-related employment opportunity	-	-	1P b-d	1P b-d	• Employment opportunity in marketing of inputs and outputs, processing, etc. will be increased substantially.

Remarks : *1 "with" indicates future condition with conservation measurements.

Significance of impact
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3 : Minor

Feature of impact
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Characteristics of impact
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1P a-c-e Positive impact would be significant, direct, short term, and reversivle.

The characteristics of insignificant impacts are not identified.

Table F-4 Assessment of Probable / Potential Impacts (5/5)

(5) Okyereko Project

Probable / Potential Impacts	Stage				Comments / Recommended Mitigation Measures
	Construction		Operation		
	without	with *1	without	with *1	
1 Soil erosion in and around the construction sites	3N	-	-	-	• No fresh cut and embankment which can introduce the effect are not in the project works.
2 Alternation or destruction of the habit of flora and fauna	-	-	-	-	• Unlikely
3 Damage to historic, cultural or religions area	2N a-c-f	3N	3N	-	• There is a sacred grove of 0.4 ha in rehabilitation area. However, the area is excluded from rehabilitation plan. • The excavation works for drainage improvement is not included in project activities.
4 Effects on farm land, existing facilities, houses, due to project works	-	-	2N a-d-e	3N	• After construction of pumping station and intake facilities, seasonal flood damage will expand to roads and/or farm land. • Design and plan shall pay the attention carefully, and flood dike to protect to farm lands will be established.
5 Deterioration of water quality in downstream	2N a-c-e	3N	2N a-c-e	3N	• Liquid waste from concrete preparation works might be effused. • Proper disposal of the liquid waste the shall be enforced thoroughly. • IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • Proper water management taking agro-chemical input into consideration will be undertaking.
6 Health hazard from agro-chemicals	-	-	2N a-c-e	3N	• IPM or proper use of fertilizer and pesticide will be included in the improved farming practices. • The hazard will be minimized by proper handling way of chemical under proposed extension works.
7 Reduction of downstream flows that affect users of water	-	-	-	-	• Present flow from project site into drain is quite low.
8 Increase of downstream flows affecting downstream ecology and/or community	-	-	-	-	• Unlikely
9 Land degradation in the project area due to salt-accumulation	-	-	2N a-d-e	2P a-d	• Present salt-effected area will be reclaimed by irrigation farming because of establishment of proper drainage system.
10 Increased incidence of water borne diseases	-	-	2N a-d-c	3N	• The infection from paddy field is hardly observed at present. However, since cropping intensity of paddy will be increased with project, the incident of diseases might be increased. • Health education of local people shall be • O&M works such as weeding canal and bund, and pesticide application which make snail's habitat decrease will be undertaken by farmers.
1 Increase of constructed-related employment opportunity	2P a-c	2P a-c	-	-	• The construction works will provide temporary job opportunity to the villagers nearby.
2 Increase of crop production	-	-	1P a-d	1P a-d	• The biggest positive effect of the project. • This will be lead to higher living standard of the population.
3 Increase of agricultural-related employment opportunity	-	-	1P b-d	1P b-d	• Employment opportunity in marketing of inputs and outputs, processing, etc. will be increased substantially.

Remarks : *1 "with" indicates future condition with conservation measurements.

Significance of impact
1 : Significant
2 : Moderate
3 : Minor

Feature of impact
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Characteristics of impact
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1P a-c-e Positive impact would be significant, direct, short term, and reversivle.

The characteristics of insignificant impacts are not identified.

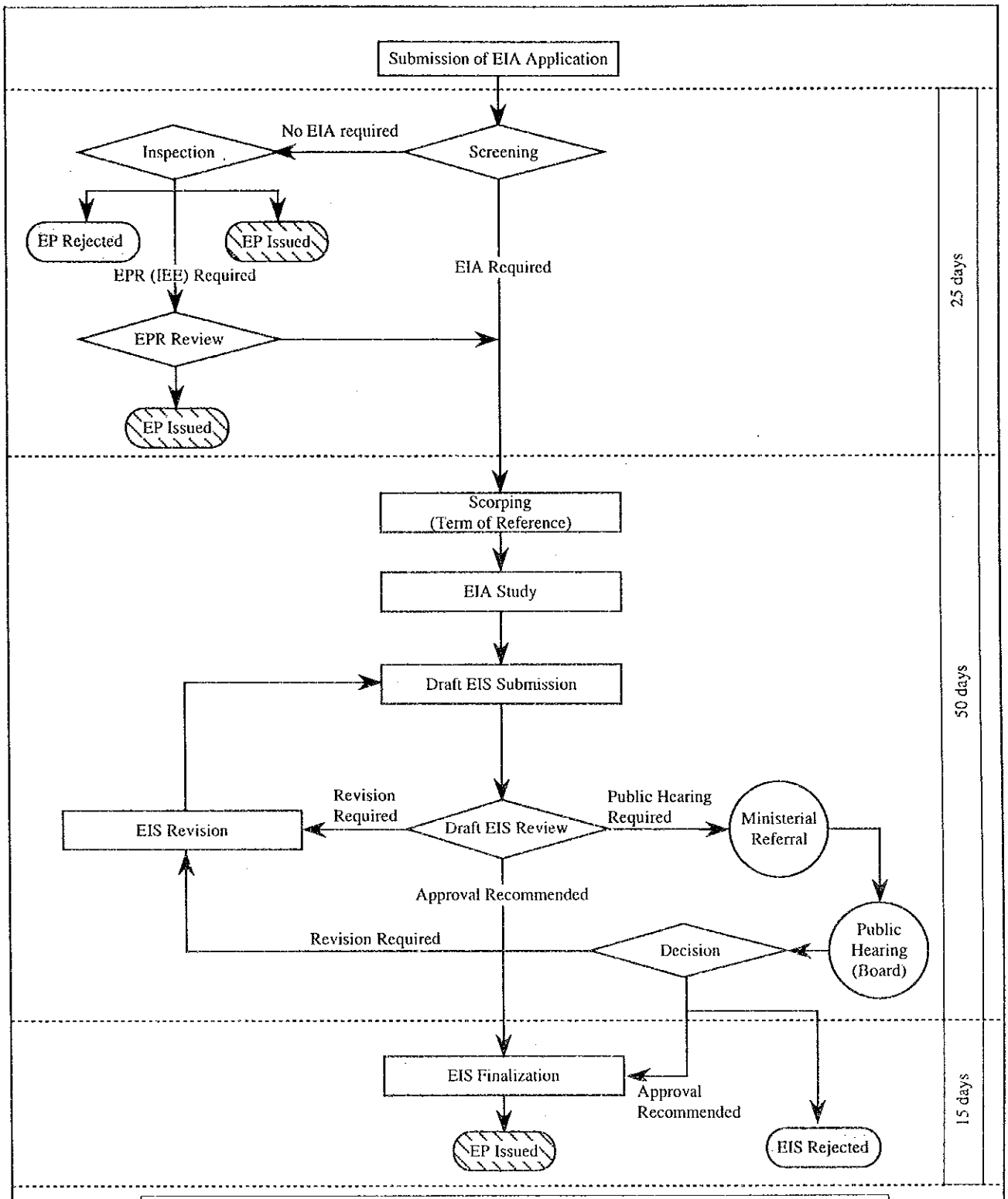
Table F-5 List of Recommendable Soil Erosion Control Measures

Descriptions	Merits	Demerits
Vegetative Measures		
1. Contour hedgerow (Strip cropping) Vegetative rows or strips established along the contour. Trees serve as live barrier to surface runoff and soil erosion. If the nitrogen fixing crops or trees such as leguminous crops are used, it can improve soil condition.	1. Economical 2. Adaptable to various conditions 3. Easier to establish and repair 4. Durable if maintained properly 5. Improve the soil condition, if nitrogen fixing crops are used	1. It takes some time to attain benefits 2. Less effective when slope is too steep 3. Hedgerows may pose competition with crops
2. Mulching The mulching is the covering of the soil with crop residues such as straw, maize stalks, palm fronds or standing stubbles. The effect of mulching is the reducing of raindrop impact and of the velocity of runoff.	1. Economical 2. Adaptable to various conditions 3. Easier to establish and repair 4. Keeping of soil moisture and temperature 5. Improve the soil condition	1. Application of mulch may be required on each cropping season in tropical area 2. It requires a large amount of grasses (materials) for mulching
3. Agroforestry It is a system to incorporate trees within a farming system by planting them on land.	1. Economically 2. Trees can provide fuels, fodder, fruits, etc. to the farmers.	1. It takes some time to attain benefits 2. Trees may pose competition with crops 3. Less effective when slope is too steep
Physical Measures		
4. Contour bunds They are earth bunds, 1.5 to 2 m wide, thrown across the slope to act as a barrier to runoff, to form a water storage area on their upslope side and to break up a slope into segments shorter in length than is required to generate overland flow. They are frequently used with strip-cropping system.	1. Relatively easier to construct and repair 2. They are suitable for slopes of 1 to 7 degree.	1. The effectiveness is limited when heavy rains continue long. 2. The effectiveness is limited when used in very steep slope.
5. Waterways (Contour Ditches and Drainage Canals) They are digging structures established in the hillsides to check the erosive power of surface runoff by tapping soil particles. Drainage canal (grass waterways) are used as the outlet for contour ditches. It runs downslope and empty into river system or other outlets.	1. Relatively easier to construct and repair 2. Ditches and canals can be good water impoundment structures that can hold water for plants.	1. The effectiveness is limited when heavy rains continue long. 2. The effectiveness is limited when used in very steep slope.
Cultural Measures		
6. Contour Plowing It is a plowing method to create furrows following the contour of the land.	1. It increases water absorption capacity of the soil. 2. It also reduces both the quantity and velocity of surface runoff.	1. A bit difficult to plow properly.
7. Contour Planting It is a planting method following the contour of the land. The crops planted act as barriers to the force of surface runoff.	1. Easy to adopt	1. The effect is not high, if only it is adopted .

Table F-6 Summary of Proposed Monitoring Plan

Monitoring plan	Monitoring items	Monitoring area	Frequency (times/year)	Project area	Implementing Agency	Phase
1. Salinity condition	Salinity (EC) condition and Na ion content in surface (0-20cm) and sub-surface (20-50cm) soil	Present salinity area (Soil map unit :P22s) Potential salinity area (Soil map unit : P22)	2	Ashaiman, Okyereko	M&E Unit	Operation
2. Health condition	- 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	All Projects	M&E Unit in cooperation with Ministry of Health	Construction & Operation
3. Water quality	- Physio-chemical property - Organo-chemical property - Agro-chemical contamination - Farming practice	Downstream water	6 - 12	Ashaiman, Aveyime, Mankessim, Okyereko	M&E Unit in cooperation with Aquatic Biological Institute	Construction & Operation
4. Erosion condition	- Erodibility of leveled soils near pumping station - Seasonal Erosion from farm land (by field measurement) - General erosion condition in the area - Farmers intention and applied measures	Near pumping station (Leveled desposal soils) Measurement Plots	3 - 4	Kpando-Torkor	M&E Unit	Construction & Operation

FIGURES



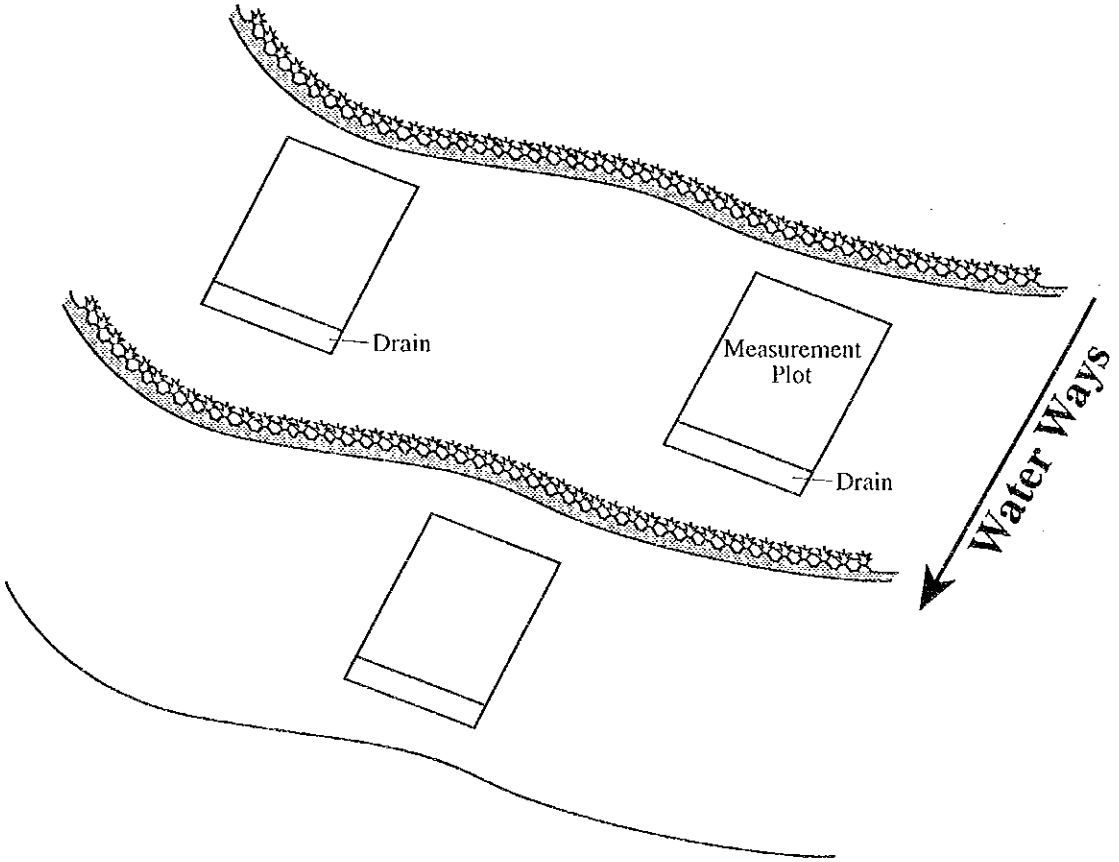
Legend	
EIA : Environmental Impact Assessment	EPA Action
EIS : Environmental Ompact Statement (Report of EIA)	Proponent's Action
EPR : Environmental Preview Report (Report of IEE)	Positive Decision (project to proceed)
EP : Environmental Permit	Negative Decision (provision for apeal)
	Public Consultation

Fig. F-1 EIA Procedure in Ghana

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

Japan International Cooperation Agency

(1) Example of Layout Plan



(2) General Layout of Measurement Plot

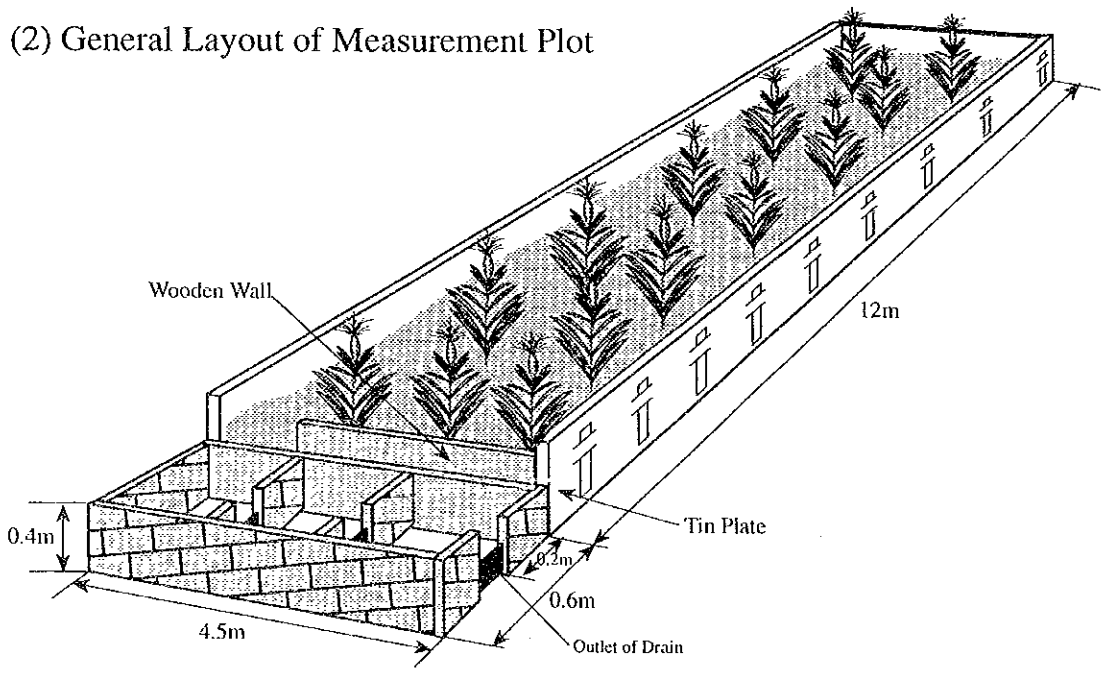


Fig. F-2
Example of Soil Erosion Measurment

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

Japan International Cooperation Agency

Attachment - I

Terms of Reference (TOR)
for
Environmental Impact Assessment (EIA)

TERMS OF REFERENCE
FOR
ENVIRONMENTAL IMPACT ASSESSMENT

1 INTRODUCTION

1.1 Project Background

The Rehabilitation Project of Existing Irrigation Projects (hereinafter as "the Project") is being studied in accordance with the Scope of Work agreed upon between Ghana Irrigation Development Authority (GIDA) and Japan International Cooperation Agency (JICA) dated 19 April 1995. The rehabilitation of the existing irrigation projects will contribute largely to the food security improvement by the increase of agricultural productivity with the extension of year-round irrigated agriculture through effective use of available water sources and existing facilities to be rehabilitated. It can be said that this is a realistic and practical approach to the achievement of the key policies set out in the 10-year Middle Term Agricultural Development Programme (MTADP : 1991-2000).

JICA conducted a field investigation and the master plan study of the 12 existing irrigation schemes, to make feasibility study of the selected priority projects in order to formulate the optimum rehabilitation plan, including proposed agricultural development in connection with the project rehabilitation. Based on the result of the Master Plan Study, JICA selected the five (5) priority schemes among 12 schemes.

The national environmental policy of Ghana aims at ensuring a sound management of resources and the environment and to avoid any exploitation of these resources in a manner that might cause irreparable damage to the environment. Therefore, the development which regarded to raise impacts is compulsory to be completed with EIA and its Environmental Management Plan and Environmental Monitoring Plan.

1.2 EIA Requirement for Agricultural Project

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

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

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

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

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

1.3 Objective of the Project

The objectives of the Project are to attain the governmental policies in the MTADP through the rehabilitation and improvement of existing small and medium size irrigation schemes, which are 5 schemes . The following benefits are expected through the implementation of the Project.

a) Food production increase
b) Accelerate of development equity
c) Creating new job opportunity
d) Increasing of the population living standard
e) Regional development and construction

2 OBJECTIVE OF THE STUDY

The purpose and objective of Environmental Impact Assessment of the Rehabilitation Projects for the selected four (4) existing schemes are as follows :

1) To identify the probable important impacts related to both social and natural environments, which the Project will cause and which must be addressed in detail in the further environmental study.
2) To identify the baseline data of each environmental issues as benchmark data.
3) To study in detail these identified significant effects both beneficial and adverse which the Project will have on the social and natural environment,
4) To identify and recommend the possible means for establishing environmental safeguards and minimizing detrimental impacts,
5) To evaluate the magnitudes / severity of the significant positive and negative impacts of both the proposed Project and the alternatives including mitigation measures by means of qualitative scaling system and / or monetary measurement methods ; and
6) To judge the acceptability of the proposed Project and the alternatives, from the environmental point of view, by ranking them or by an environmental cost-benefit analysis.

In order to achieve these objectives in the feasibility study, the environmental impact study is largely divided into two steps as in the flow chart of the study process in Attachment-1, i.e. environmental scoping stage and environmental impact assessment (EIA) stage.

3 SCOPE OF THE STUDY

3.1 Scope of Study Area

1) Study area
Among the five (5) priority project, totaled four (4) projects are selected as the study area of the EIA study, taking into consideration of the regulation of the EPA and future developed area.

2) Location and Administration
The administrative conditions of the selected four (4) projects are shown below,

Project		District	Region	Agro-ecological Zone
1	Aveyime	North Tongu	Volta	Coastal Savannah
2	Kpando-Torkor	Kpando	Volta	Transitional Zone
3	Mankessim	Mankessim	Central	Coastal Savannah
4	Okyereko	Goma	Central	Coastal Savannah

3) Project boundary
Possible irrigable area, developed area and potential area in each of the 4 projects are as follows :

Project	Potential area	Developed Area	Irrigable Area
1. Aveyime	150 ha	63 ha	150 ha
2. Kpando- Torkor	356 ha	17 ha	356 ha
3. Mankessim	256 ha	17 ha	176 ha
4. Okyereko	121 ha	40 ha	70 ha
Total	883 ha	137 ha	752 ha

4) Irrigation method and proposed cropping type
Proposed irrigation methods and introduced cropping type of the each priority project are shown below :

Project	Irrigation methods	Water source	Cropping Pattern
1. Aveyime	Pomp- gravity	Volta river	Paddy & Upland crops
2. Kpando- Torkor	Pomp - sprinkler	Volta lake	Upland crops
3. Mankessim	Pomp - sprinkler	Aprapon river	Upland crops
4. Okyereko	Pomp- gravity	Okyereko river	Paddy & Upland crops

5) Technical capacity limit
The technical capacity limit is the three above boundaries which consider to the limit of time, fund and expert availability.

Detail information of the 4 priority projects are shows in Attachment -2 as "Project Description".

3.2 Project Component Activities Affect to Environment

Main feature of the Project will implemented by stages. The project activities is the cause of the environmental impact which is to be identified. Project cycle study to be identified :

1) Construction phase
Activities carried out during construction stage estimated that may create potential impact are :
a. Structure and infrastructure development among others ;
- Base camp including all social facilities development.
- Personnel and equipment mobilization.
- Land preparation and land cleaning.
- Access road construction.
- Quarry and borrow area works.

b. Improvement of irrigation facilities ;
- Main canal and appurtenance facility improvement.

These activities may create impacts on the physical, chemical, biological, socio-economical and socio-cultural aspects of the environment.

2) Operational phase
There are activities that may create environmental impact, namely :
- Intensive farming, related into land degradation, water pollution of downstream, etc.
- Irrigation, related into occurring water borne diseases.
- Irrigation and its supporting facilities operation and maintenance.
- Watershed management similar to those in construction phase.

The impact created by the activities in this phase covers physical, chemical, biological, socio-economical and socio-cultural aspects of the environment.

3.3 Scope of Works for Environmental Impact Assessment

The environmental components needed to be analyzed and studied in the each priority project, especially in the EIA are as follows :

3.3.1 Physio-chemical Environment

(1) Climate

Climate type, monthly and annually temperature, rainfall (wet and dry season), relative air humidity, wind velocity and sun radiation intensity.

(2) Physiography and Geology

Topography, geomorphology, geological structure, and seismic information in the project site and surrounding.

(3) Soil
1) Soil type, characteristics of soil chemistry, physics and soil organism (flora and fauna).
2) Possibility of soil erosion and degradation present and after project implementation in the project areas.
3) Available measurements of soil loss in and around the Project area, and also from catchment are of the reservoirs.
4) Present extension and condition of the salinity soil and possibility of expansion after implementing of the project.

(4) Hydrology and Water Quality
1) Physical characteristics of rivers located in and around the project areas.
2) The average of annual discharge in rainy and dry seasons.
3) Physical condition of surface water infiltration area and ground water in the site and surrounding.
4) Supply and demand levels of water for other purposes, such as agriculture, fishery, industries, mining, domestic, etc. in the surrounding area.
5) To estimate and predict the influence to fish ponds and mangrove forest caused by change of river water quality and quantity after project implementation.
6) Physical, chemical, and biological characteristics of water quality.
7) Standard of water quality in domestic or international agency (WHO, FAO, etc.)

(5) Agriculture
1) Present agricultural condition (farming practice, yield, etc.)
2) Type and procedure of the applied fertilizer and agro-chemical for major crops, and the amount in and around the project areas.
3) Residual toxicity of agrochemical and fertilizer in soil and water, at present and in

future.

4) Future farming practice and future condition of farm input application

(6) Land

1) Present land use of, land status, especially forest area (inundated area).
2) Natural system in and around the Project areas (river, lake, forest, grassland, mangrove, lagoon, fish pond, coastal wetland, etc.)
3) Land use of watershed areas of reservoirs (forest, bush and shrub, grassland, paddy field, upland crop field, and fruit tree field, fish pond, mangrove forest, etc.).
4) Present governmental (provincial and district) land use plan of the in and around the Project areas.

(7) Health

1) Present health conditions and disease types effected by water borne diseases
2) Present and proposed method of contorl against the diseases.
3) To estimate and predict the influence the number of patience of it after project implementation.
4) Availability of public health facilities.
5) Peoples' knowledge for the diseases.

3.3.2 Biological Environment

(1) Flora

1) Kinds, structures and extents of vegetation communities in nature (primary forest) and man-made environment (production forest, grassland, shrub, farming field) in and around the Project areas, and also catchment of the reservoirs.
2) Use of vegetation community in economic and environmental development.
3) Protected forest in the upstream area.

(2) Fauna

1) Diversity of endangered, endemic, threatened or law protected species of wild animals in the site and surrounding.
2) Kind, distribution, density, and migration pattern of wild animal species (mammals, birds, fishes, amphibians, reptilians) which are economically, ecologically and aesthetically important.
3) Habitat and feeding area of important animals which might be impacted negatively by the project activities, so that the survival of the animal will be critical.
4) Predetors, beneficial species for integrated pest management (IPM) (e.g. frog, spiders, etc.)

3.3.3 Socio-economic and Socio-cultural Environment

(1) Socio-economic

1) Community structure covered number, age, sex, education, living profession, income, ethnic, density, distribution, diversity, and other demographic data.
2) The condition of economic centre, infrastructure, community income and its source, formal and informal tax (as local government income source).
3) Water right and fishing right in the water source (if any).
4) Relation of forest / fuel wood forest and human activities
6) Fuelwood availability, and amount of use of fuelwood
5) Land ownership pattern and land price.
6) Religion and beliefs.
7) Local tradition and norm characteristics.
8) Current social problem and its solution effort.

(2) Archaeology
1) Archacological site including cemetery which might be impacted by the project activities.
2) Historic remains and cultural assets, aesthetic sites, buried assets, and beauty sites of landscape in the project area and surrounding (if any).

3.3.4 Infrastructure and Facilities of the Public Utility

Inventory of all amount of the structure and facility exist in the project site, and analysis for those infrastructure such as place of these facilities, transportation etc., in the study area.

3.4 Relation to the Other Sector Activity

The activity of the dam and irrigation construction will have relation with other sector activity amongst other :

1) Land development for agriculture and land conservation.
2) Education and Health management programme.
3) Watershed management by the forestry.
4) The regional development by the Home Affair Development.
5) Downstream impact, especially impact to down stream fish cultures through possible change of river water quantity and quality.
6) Cultural and archaeological

3.5 Expected Impact by Project Activities

The preliminary IEE study was carried out by the JICA study team on November, 1995. The result of IEE, as shown below, will be help to scope of the surveys in the each priority project.

Environmental Issues	Aveyime	Kpando-Torkor.	Mankessim.	Okyereko
1 Health hazard from chemicals	+	+	+	+
2 Deterioration of downstream water quality	+-++	+-++	-	+-++
3 Ecological change on the downstream, i.e. lagoon area and volta lake	-	-	-	-
4 Beneficial impacts on farm and local economy	+++	+++	+++	+++
5 Land degradation (at area expansion)	-	++	+	-
6 Incidence of water-bone *1 diseases (at area expansion)	++	-	-	++
7 Decrease in forest in and around the project areas (at area expansion)	++	++	+	-

Marks indicate the significance of impact, - : none, + : minor, ++ : moderate, +++ : major
Remarks : *1 excluding malaria disease.

4 METHODOLOGY OF DATA COLLECTION

4.1 Methodology of Data Collection

(1) Primary data

The primary data on physio-chemical and biological environment will mainly be taken from the field. However, some of these data related to the irrigation and drainage development area will be provided by the JICA Study Team. These include:

1) Data on soil, land capability and land use,
2) Meteo-hydrologic data,
3) Data on agricultural and socio economic conditions
4) Results of preliminary evaluation of present and future environmental impacts

(2) Secondary data

The following secondary data will be collected from the government offices concerned.

1) Geophysics.
2) Biology.
3) Socio-economy.
4) Health and Socio-culture.

Recommended institutions to be visited are follows :

1) Project office of GIDA
2) Department of Meteorology, Forestry Health and their Station Office at the locality.
3) Local Government Office.
4) Library.
5) Resource person, etc.

4.2 Method of Sample Analysis, Data Analysis and Presentation

The water samples are analyzed at the appropriate laboratory by using right method. The result should be presented in tables, graphs, figures and maps.

4.3 Method of Impact Identification, Impact Prediction and Impact Evaluation

(1) Environmental Scoping
To use among others : checklist method, Leopold matrix method.

(2) Impact Prediction
To define the magnitude of the impact is used the formal and informal method. To use this method is to find the magnitude of the quantity and quality to the forecasting impacts. Method of formal are as follows :

1) Mathematical model.
2) Environmental standard quality.
3) Analogical use.

Informal method is judgement and valuation of the expert.

(3) Impact Evaluation

Based on the social and natural environmental baseline data/information collected in the surveys, the potential major impacts both negative and positive of the proposed Project will be analysed qualitatively or quantitatively. The evaluation will be carried out by taking consideration into the following items.

1) Amount of impacted human.
2) Area of impact distribution.
3) Period of impact lasting.
4) Impact intensity.
5) Other environment components affected by impact.
6) Impact cumulative characteristic.
7) Reversible and irreversible impact.
8) Economic or non-economic evaluation

4.4 Formation of Environmental Mitigation Measurements and Environmental Monitoring Plan

Environmental Mitigation Measurements and Environmental Monitoring Plan should refer to the EIA study and should select the good as possible alternative and contain inter alia :

1) Type of impact to be mitigated.
2) Magnitude / severity of impact measurement.
3) Environmental mitigation measures.
4) Recommendations of task and responsibility of the related institution in charge and how to control and Supervision.
5) Source of fund.

Environment Monitoring Plan should contain the main monitoring formulation of the result of Environmental Management Plan and refer to the EIA of report which select the best alternative inter aria :

1) Environmental component to be monitored.
2) Standard dimension of parameter to be monitored.
3) Method and period of monitoring covered location.
4) Frequency of monitoring.
5) Task and responsibility of the related institution in charge and to use the result of monitoring.
6) Source of fund.

4.5 Approach to the Economic Evaluation

(1) Economic Survey

This aims at collecting or estimating necessary economic data to value the significant environmental impacts in monetary unit. The data to be collected depend on the nature of the impacts and applicable valuation approaches, which range from change-in-productivity

approach to contingent valuation methods.

(2) Non-monetary and monetary evaluation

Using the data and information prepared in the surveys, both evaluation procedures will synthetically assess the environmental impacts for the Project and alternatives including mitigation measures as well as the with-out project case. These should cover both the construction and operation stages. While the non-monetary valuation will take a scaling system of the matrix methods, the monetary valuation will leas to the cost-benefit analysis or cost-effectiveness analysis. The selection of appropriate evaluation methods/techniques out of them is subject to the available data prepared in the surveys.

5 STUDY IMPLEMENTATION

5.1 EIA Team

1) To execute this environmental impact analysis, EIA team members need to have interdisciplinary expertise.
2) The Team Leader and socio-economist should poses a B certificate of EIA, and the member of team has to have experienced in EIA preparation and recommended to have the A certificate of EIA.

The Team to be composed in the each priority project are tentatively considered as follows :

Expert	Aveyime	Kpando-Torkor	Mankessim	Okyereko
Botanist/Ecologist	1	1	1	1
Soil scientist / Agronomist	1	1	1	1
Hydrologist	1	0	0	1
Chemist	1	1	1	1
Sociologist	1	1	1	1
Archaeologist	1	1	1	1

Field of study in the scope of works for the individual experts are as follows :

1) Botanist/Ecologist	Biological (Flora and fauna).
2) Soil Scientist/Agronomist	Physio-chemical (Soil, Land), Agriculture
3) Hydrologist	Physio-chemical (climate, hydrology).
4) Chemist	Chemical condition (quality of water and soil)
5) Sociologist	Socio-economic and Socio-cultural (Socio-economic), Health
6) Archaeologist	Archaeology

5.2 Study Schedule

Preparation of EIA, Environmental Management Plan and Environmental Monitoring Plan of the Project should be completed within two and a half (2.5) calendar months.

5.3 Report Schedule

Reports to be submitted by the team are :

1) Draft EIA
2) Draft Final Report
3) Final Report

All the report should be prepared in English. The time schedule for reporting is shown in the attached tentative schedule .

Table F-AI-1 Project Description (1/2)

	Items \ Project	Ashaiman	Aveyime	Kpando-Torkor	Mankessim	Okyereko	Remarks
1. Background	(1) Location & topography	Coastal Savannah Lowland	Coastal Savannah Lowland	Transitional Zone Sloping area	Coastal Savannah Undulating area	Coastal Savannah Lowland	See Location Map
	(2) Administration	Great Accra	Volta Region	Volta Region	Central Region	Central Region	
	(3) Project implementation	1966 - 1968	1962 - 1975	? - 1976	1974 - 1981	1976 - 1988	
	(4) Climate a) Agro-ecological zone b) Average annual rainfall	Coastal Savannah Zone 750 - 1,270 mm	Coastal Savannah Zone 750 - 1,270 mm	Transitional Zone 1,270 - 1,500 mm	Coastal Savannah Zone 750 - 1,270 mm	Coastal Savannah Zone 750 - 1,270 mm	
	(5) Project area a) Potential area (ha) b) Developed area (ha)	 148 130	 150 63	 356 40	 256 17	 111 40	Total 1,021 290
	(6) No. of farm family	120	62	118	89	68	457
2. Study Project	(1) Land suitability for irrigation	Not suitable for upland crops : 6 ha	Not suitable for paddy rice : 7 ha	Restricted suitable : 268 ha	Not suitable for paddy rice : 93 ha	All suitable	
	(2) Present agriculture a) Cropping season & main crops	Rainy Dry Rice Okra	Rainy Dry Rice Rice	Rainy Dry - Okra	Rainy Dry S.potato Vege-tables	Rainy Dry - Rice	
	b) Total irrigated area/year (ha)	59.0	-	13.0	26.4	21.6	
	c) Total irrigated area /family (ha)	0.49	-	0.11	0.30	0.32	
	d) Cropping intensity	45%	-	33%	155%	54%	
	(3) Present irrigation a) Water resource b) Water balance study	 Gyorwulu river/dam High water shortage	 Volta river/pumps No water problems	 Volta lake/pumps No water problems	 Reservoir & pumps Mostly no water problems	 Reservoir Need of suppl. water	
	c) Reservoir (catchment area)	82.4 km2	-	-	-	17.6 km2 (Ayensu river)	
	d) Irrigation method	Gravity irrigation	Gravity irrigation	Sprinkler irrigation	Sprinkler irrigation	Gravity irrigation	
	(4) Main project facility a) Irrigation & drainage system	Dam Mc. (4.8km) Lc. (11km) Md. (3km) Ld. (6km)	Pump (1) Mc. (0.4km) Lc. (3km) Md. (1km) Ld. (3km)	2-pump Pipeline - Mp. (600m) - Lp. (200m)	Dam 2-pump Pipeline - Mp. (900m) - Lp. (350m)	Dam Mc. (1.3km) Lc. (2.8km) Md. (2km) Ld. (2km)	Mc. : Main canal Lc. : Lateral canal Md : Main drainage canal Ld. : Lateral drainage canal Mp. : Main pipe Lp. : Lateral pipe
	b) Farm road & buildings	Road (16km) Office (6) Storage (1) Garage (1) Dry yard (1)	Road (5km) Office (2) Storage (1)	Road (2km) Office (1)	Road (3km) Office (1)	Road (7km) Office (1) Storage (1)	
	c) Deterioration of facility	Serious	No project activity	Serious	Dam: good Pump: serious	Dam: good Canals: serious	
	(5) Present O&M	Relatively good	No activity	Not enough	Not enough	Not enough	
	(6) O&M costs of GIDA	260,400/ha	279,020/ha	701,960/ha	366,940/ha	163,940/ha	
	(7) Irrigation service charge (Cedi) a) Amount b) Payment ratio	 50,400/ha/crop 12.3%	 - -	 260,400/ha/crop 100%	 99,400/ha/crop 100%	 50,400/ha/crop 50%	
	(8) Agricultural support services a) Farmers society b) Extension officer of GIDA	 Established (1983) 2 persons	 Established (1981) 2 persons	 Established (1974) 1 person	 Established (1987) 1 person	 Established (1994) 1 person	
	(9) Environment		Incidence of water-borne diseases	Land degradation			
	(10) Farmers' requests for support services a) Rehabilitation of irri. facility b) Supply of farm inputs c) Imp. of credits system	 70% 45% 70%	 100% 73% 60%	 93% 93% 87%	 80% 55% 50%	 100% 50% 70%	Farm interview survey by the Study Team.
	(11) Farmers' satisfaction of irrigation supply a) Amount of water supplied Satisfied Not satisfied b) Time of supply Satisfied Not satisfied	 20% 80% 25% 75%	 - 100% 7% 93%	 - 100% - 100%	 17% 83% 33% 67%	 10% 90% 60% 40%	
	(12) Farmers' intention of O&M transfer Yes No	 15% 85%	 67% 33%	 - 100% *	 88% 11%	 70% 30%	* If the facilities are rehabilitated by GIDA, farmers will agree to it.

Table G-AI-1 Project Description (2/2)

Items \ Project	Ashaiman	Aveyime	Kpando-Torkor	Mankessim	Okyereko	Remarks
3. Rehabilitation Plan						
(1) Agricultural development plan						
a) Proposed crops	Rice, okra	Rice, tomato, okra onion	Okra, tomato, onion	Watermelon, eggplant, okra	Rice, tomato, okra onion	
b) Cropping intensity	200%	200%	200%	200%	200%	
c) Land allocation	*All lands in the irrigation projects will be allocated to farmers in accordance with L.I. 1350 of GIDA.*					
(2) Rehabilitation plan of facility						
a) Irrigation plan	- Gravity irrigation - Continuous irrigation	- Intake by pumps - Gravity irrigation - Continuous irrigation	- 8-movable pump - Main pipeline : fixed - Movable sprinkler - Rotational irrigation	- Fixed pump station - Main pipeline : fixed - Movable sprinkler - Rotational irrigation	- Gravity irrigation - Fixed pump station - Continuous irrigation	
b) Irrigable area	44 ha	150 ha	356 ha	176 ha	111 ha	837 ha
c) Rehabilitation plan of facility	- Intake valve - Irrigation canal system - Drainage system - Farm road network	- Pump & pump station - Irrigation system - Drainage system - Farm pond - Farm road network	- Movable pumps & foundation works - Sprinkler system - Soil conservation works	- Intake facility - Pumps - Sprinkler system	- Pumps & pump station - Irrigation system - Drainage system - Related structures	
(3) Strengthening of GIDA	*Improvement and strengthening of the GIDA head office as well as the project offices, including training of the staff will be executed for successful transfer of O&M to the farmers' Societies.*					
(4) Strengthening of farmers' society	*The existing farmer's society will be improved and strengthened as an executing body of O&M of the project and for improvement of agricultural support services.*					
(5) Transition period of O&M transfer	5 years	5 years	5 years	5 years	5 years	
(6) Required staff of GIDA for O&M transfer						Total
a) Present staff (person)	4	6	3	5	2	20
b) Transition period (person)	11	11	14	11	12	59
c) After O&M transfer (person)	7	6	6	6	7	32
(7) Required equipment for O&M						
a) Pump station	-	1	4	2	1	
b) GIDA project office						
- Rehabilitation (m2)	106	-	-	-	-	
- New (m2)	-	175	175	175	175	
c) Storage (pipes, materials, etc.)	-	1	4	3	1	
d) Garage (nos.)	-	1	1	1	1	
e) Dry yard (nos.)	-	1	-	-	1	
f) Storage for farming (nos.)	1	1	4	3	-	
g) Equipment for O&M	L.S.	L.S.	L.S.	L.S.	L.S.	
h) Equipment for extension service	L.S.	L.S.	L.S.	L.S.	L.S.	
4. Cost for Project Rehabilitation						
(1) Project cost (million Cedis)	2,240	2,940	11,200	4,760	2,520	Not including price contingency.
(2) Cost for O&M per year (1,000 Cedis)	9,800	25,200	105,000	39,200	26,600	
5. Economic Evaluation EIRR =	4.2%	13.6%	20.2%	16.0%	13.0%	

Fig. F-AI-2 TENTATIVE SCHEDULLE FOR ENVIRONMENTAL IMPACT ASSESSMENT