Table VI-8.1 Financial Crop Budget under With-Project Condition (1/2)

Item	Unit	Paddy Price (/unit)	Paddy Q'ty (/ha)	Paddy Value (Ksh/ha)	Maize Price	Maize Q'ty (/ha)	Maize Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	kg	6.0	30	180	12.5	30	375
Fertilizer (ASN)	kg	4.1	350	1,435	4.1	350	1,435
Fertilizer (TSP)	kg	5.5	100	550	5.5	100	550
Insecticide	lit.	91	0	0	91	0	0
Fungicide	lit.	305	0	0	305	0	0
Labour*	manday	25	121	3,015	25	111	2,764
Oxen**	time	1,890	1.2	2,268	1,890	1.2	2,268
Miscellaneous		-	5%	370	-	5%	370
Total				7,820			7,760
(2) Production Value							
Products	ton	4,800	6.0	28,800	3,400	5.0	17,000
(3) Net Production Value				20,980			9,240

Note : *; Hired labours are required 67% of total requirement.
**; Hired animal power are required 60% of total requirement.

Item	Unit	Greengram/beans Price	Greengram/beans Q'ty (/ha)	Greengram/beans Value (Ksh/ha)	Cotton Price	Cotton Q'ty (/ha)	Cotton Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	kg	25.0	20	500	25.0	20	500
Fertilizer (ASN)	kg	4.1	115	472	4.1	390	1,599
Fertilizer (TSP)	kg	5.5	100	550	5.5	100	550
Insecticide	lit.	91	0	0	91	0	0
Fungicide	lit.	305	0	0	305	4	1,221
Labour*	manday	25	103	2,580	25	127	3,183
Oxen**	time	1,890	1.2	2,306	1,890	1.2	2,306
Miscellaneous		-	5%	320	-	5%	470
Total				6,730			9,830
(2) Production Value							
Products	ton	14,025	1.5	21,040	10,000	2.2	22,000
(3) Net Production Value				14,310			12,170

Note : *; Hired labours are required 67% of total requirement.
**; Hired animal power are required 60% of total requirement.

Table VI-8.1 Financial Crop Budget under With-Project Condition (2/2)

Item	Unit	Sugarcane*			Napier grass (dairy)**		
		Price	Q'ty (/ha)	Value (Ksh/ha)	Price	Q'ty (/ha)	Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	kg	0.3	3,000	900	0.5	3,000	1,500
Fertilizer (ASN)	kg	4.1	1,050	4,305	4.1	2,800	11,480
Fertilizer (TSP)	kg	5.5	200	1,100	5.5	200	1,100
Insecticide	lit.	91	0	0	91	0	0
Fungicide	lit.	305	0	0	305	0	0
Labour*	manday	25	440	11,000	25	660	16,499
Oxen**	time	1,890	1.2	2,268	1,890	1.2	2,268
Miscellaneous		-	5%	980	-	5%	1,640
Total			for 4 years	20,550		for 4 years	34,490
			for 1 year	5,140		for 1 year	8,620
(2) Production Value							
Products	ton	405	100.0	40,500	18,430		34,100
(3) Net Production Value				35,360			25,480

Note : *; Hired labours are required 67% of total requirement.
**; Hired animal power are required 60% of total requirement.

Item	Unit	Vegetables			Passion fruit*		
		Price	Q'ty (/ha)	Value (Ksh/ha)	Price	Q'ty (/ha)	Value (Ksh/ha)
(1) Production Cost							
Seed/nursery	/kg	1,007	1	1,007	0.50	1,000	500
Fertilizer (ASN)	/kg	4.1	580	2,378	4.1	290	1,189
Fertilizer (TSP)	/kg	5.5	100	550	5.5	60	330
Insecticide	lit. or kg	91	10	905	91	30	2,715
Fungicide	lit. or kg	305	10	3,053	305	4	1,221
Labour**	/md	25	364	9,100	25	297	7,420
Oxen***	/time	1,890	1.2	2,268	1,890	0	0
Miscellaneous		-	5%	960	-	**	3,230
Total				20,220			16,610
(2) Production Value							
Products	ton	3,400	20.0	68,000	5,000	10.0	50,000
(3) Net Production Value				47,780			33,390

Note : *; 5,000 seedlings are required every 5 years.
Planting materials such and wire are included in the miscellaneous cost.
**; Hired labours are required 80% of total requirement.
***; Hired animal power are required 60% of total requirement.

Source : Prepared by JICA Study Team

Table VI-8.2 Farm Budget under With-Project Condition

Long Rainy	Short Rainy	Unit value (Ks./ha)	I area (ha)	I value (Ks.)	II-1 area (ha)	II-1 value (Ks.)	II-2 area (ha)	II-2 value (Ks.)	III area (ha)	III value (Ks.)	IV area (ha)	IV value (Ks.)	V area (ha)	V value (Ks.)
(1) Farm Income														
Paddy	Beans	49,840	1.24	61,800	-	-	0.11	5,300	1.13	56,100	0.68	33,700	0.37	18,500
Maize	Paddy	45,800	-	-	-	-	-	-	0.08	3,600	0.74	33,700	0.60	27,600
Maize	Cotton/Beans	38,520	0.52	19,900	0.95	36,700	0.97	37,300	0.13	5,200	0.04	1,700	0.04	1,400
Sugarcane		40,500	-	-	-	-	-	-	1.37	55,500	1.36	55,100	1.83	74,300
Vegetables	Vegetables	136,000	0.52	70,300	0.91	123,200	1.06	143,600	0.16	21,200	0.01	2,000	0.02	2,400
Fruit tree		60,000	0.52	31,000	0.91	54,400	0.68	40,900	-	-	-	-	-	-
Pasture for dairy		33,390	0.21	6,900	0.19	6,400	0.17	5,800	0.14	4,800	0.16	5,200	0.14	4,700
Pasture for working cattle		0	0.10	0	0.14	0	0.12	0	0.09	0	0.11	0	0.10	0
Total			3.10	189,900	3.10	220,700	3.10	232,900	3.10	146,400	3.10	131,400	3.10	128,900
(2) Non-farm income				5,100		5,100		5,100		5,100		5,100		5,100
(3) Gross income				195,000		225,800		238,000		151,500		136,500		134,000
(4) Farm expenditure														
Paddy	Beans	14,550	1.24	18,000	-	-	0.11	1,500	1.13	16,400	0.68	9,800	0.37	5,400
Maize	Paddy	15,620	-	-	-	-	-	-	0.08	1,200	0.74	11,500	0.60	9,400
Maize	Cotton/Beans	16,040	0.52	8,300	0.95	15,300	0.97	15,500	0.13	2,100	0.04	700	0.04	600
Sugarcane		5,140	-	-	-	-	-	-	1.37	7,000	1.36	7,000	1.83	9,400
Vegetables	Vegetables	40,440	0.52	20,900	0.91	36,600	1.06	42,700	0.16	6,300	0.01	600	0.02	700
Fruit tree		14,680	0.52	7,600	0.91	13,300	0.68	10,000	-	-	-	-	-	-
Pasture for dairy		16,610	0.21	3,400	0.19	3,200	0.17	2,900	0.14	2,400	0.16	2,600	0.14	2,400
Pasture for working cattle		8,620	0.10	900	0.14	1,200	0.12	1,000	0.09	800	0.11	1,000	0.10	800
Total			3.10	59,100	3.10	69,600	3.10	73,600	3.10	36,200	3.10	33,200	3.10	28,700
(5) Living expence				34,800		34,800		34,800		34,800		34,800		34,800
(6) Gross outgo				93,900		104,400		108,400		71,000		68,000		63,500
(7) Net reserve				101,100		121,400		129,600		80,500		68,500		70,500

Source : Prepared by JICA Study Team

Annex VII

Irrigation and Drainage

Feasibility Study
on
Kano Plain Irrigation Project

Annex VII
Irrigation and Drainage

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1. INTRODUCTION

This report is prepared to deal with result of field investigation and study on irrigation and drainage of the Feasibility Study on Kano Irrigation Project. The field investigation and study has been conducted in three stages from August 1990 to October 1991. The following field investigation, study and planning work have been conducted:

- Field reconnaissance
- Field tests such as cylinder intake rate test and deep percolation test
- Collection of data and information
- Review of previous studies
- Preliminary development planning on irrigation and drainage which includes delineation of possible irrigable area, assessment of available water, water balance study, canal system planning.
- Definite planning of irrigation and drainage development which consists of layout of irrigation and drainage canals, field irrigation planning, etc.

2. CURRENT SITUATION OF IRRIGATION AND DRAINAGE

2.1 Main Previous Studies

2.1.1 Master Plan for the Drainage and Irrigation on Kano Plain Region (Lake Basin River Catchment Development River Profile Studies)

This master plan was conducted from 1982 to October 1985 by C.Lotti in association with WLPU Consultants under the contract between the United Nations Development Programme (UNDP) and the Government of Kenya for the river profile studies in the Lake Basin Development Authority (LBDA) for the purpose of River Catchment Development.

The Study Area covered by the Master Plan was bounded to the north by the line of the Kisumu-Nairobi railway; to the west by the semi-urbanized suburb of Kisumu and by the Lake Victoria; to the south and east by Asawo river, the 1,220 m above sea level contour line and Awasi-Chemelil road.

The Master Plan Study proposed the following measures for the agro-economic development of the Study Area:

(1) Construction of a network of main drainage canal, to collect the rainfall runoff of the drained area and also the flood waters of small tributaries thereby limiting the damages caused by the floods;

(2) Flood control measures consisting of embankments along the course of the Kibos, Nyando and Awach Kano rivers and vast embanked low-lying areas which will be used as flood plains (Lielango Reservoir, Oroba and Awach Kano Flood Plains),

(3) Irrigation system for 15,000 irrigated hectares; the water sources are the Nyando run-of-river (3,000 ha supplied), the Bunded Kano Swamp (1,200 ha), Sondu river (Miriu transbasin plant 8,000 ha), Yala river (Nandi forest transbasin plant 2,800 ha);

(4) New infrastructure such as roads, power transmission line, drinking water supplies, agricultural and livestock facilities.

The Master Plan recommended a time schedule for implementation of the proposed measures and the first phase of irrigation (3,000 ha) using the Nyando run-of-river. Irrigation water requirement in the Master Plan Study is shown as follows:

(l/sec/ha)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
0.42	0.27	0.34	0.39	0.61	0.78	0.31	0.26	0.58	0.63	0.56	0.53	0.47

The Master Plan study also says that 6,000 ha can be irrigated by the flow regulated by Koru dam considered on the Nyando river. Considered dimensions of the Koru dam is as follows:

Dam crest level	1334.5 m ASL
Full supply level	1330.5 m ASL
Live storage	25 million m^3
Dam embankment	0.87 million m^3

The JICA Study Team reviewed the Master Plan Study and found that:

(1) Extensive secondary and tertiary drains in the objective area are not proposed. It is questionable to drain excess rain and upstream water without provision of secondary and tertiary drains in flat area with low water permeability of soils.

(2) Creation of Oroba flood plain in conjunction with Lielango reservoir is proposed to be used for irrigation. About 900 ha can be irrigated by the proposed so called the Bunded Kano Swamp System. More than 1,000 ha will be submerged throughout a year. Although most of the area in the swamp is not utilized for production at present, construction of perennial reservoir will lose the area more than 1,000 ha which is larger than the irrigable area. Construction of the reservoir may be controversial.

2.1.2 Feasibility Study on the Sondu Hydropower Development Project and Pre-Feasibility Study on Kano Irrigation Project

These studies were conducted from January 1984 to December 1985 by Japan International Cooperation Agency (JICA) in accordance with the Scope of Work concluded between the Lake Basin Development Authority (LBDA) and the JICA. The objectives of this study consisted of the following:

(1) to undertake a feasibility study of the Sondu river hydroelectric power development, and

(2) to undertake a pre-feasibility study of the irrigation development in the area by using the Sondu river flow.

The study area for the pre-feasibility study is bordered by the Lake Victoria to the north, Nyando Escarpment to the south, Kendu Bay village to the west and Awach Kano river to the east.

The Feasibility Study and Pre-Feasibility Study proposed the following measures:

(1) Construction of Magwagwa reservoir with a waterway plus Sondu/Miriu run-of-river;

<u>Magwagwa reservoir plus waterway plan</u>

Firm discharge	:	24.1 m^3/sec
Plant discharge (8 hr peak operation)	:	72.3 m^3/sec
Full supply level	:	EL. 1,662.9 m ASL
Dam crest elevation	:	EL. 1,667.9 m ASL
Dam height	:	100.9 m
Active storage	:	590.7 mcm
Installed capacity	:	94.6 MW

<u>Sondu/Miriu run-of-river plan</u>

Firm discharge	:	24.1 m^3/sec
Plant discharge	:	39.9 m^3/sec
Installed capacity	:	48.6 MW

Irrigation area

In the left bank of the Nyando	:	15,610 ha
In the right bank of the Nyando	:	10,000 ha
Irrigation area subjected to the pre-feasibility study	:	8,540 ha

Detailed design work of Sondu/Miriu Hydropower Project is being undertaken by Nippon Koei Co.Ltd. in accordance with the contract between Kenya Power and Lightening Company Limited. Feasibility Study of the Magwagwa Hydroelectric Power Development Project has been started in February 1990. Their study result will be fully referred in the present study.

2.1.3 Integrated Regional Development Master Plan for the Lake Basin Development Area

This study was conducted from January 1986 to October 1987 by Japan International Cooperation Agency (JICA) in accordance with the scope of work concluded between the Lake Basin Development Authority (LBDA) and the JICA.

The study proposed Integrated Kano Plain development scheme to find out optimal use of water from multiple sources for irrigation in Kano Plain and surrounding area, while paying serious attention to flood control, protection of water quality in the Winam Gulf in the Lake Victoria and other environment aspects as well as existing land tenure system with many small holders. This development scheme consists of the following main projects.

(1) Irrigation complex project
(2) Sondu River multipurpose development project
(3) Nyando River and Kano Plain flood control project.

The irrigation complex consists of production of rice and other crops under irrigation primarily with water to be diverted from Sondu River, package of supporting services. The Sondu River multipurpose development project consists of implementation of Sondu/Miriu hydropower station, irrigation facilities in the Kano and Nyakach plains, and Magwagwa reservoir. The flood control project consists of drainage works in Kano plain associated with the irrigation development, flood control works on Nyando river to be followed by the establishment of flood forecast and warning system.

2.2 Existing Organization of Irrigation

2.2.1 Lake Basin Development Authority (LBDA)

The LBDA was established by an Act of Parliaments in August 1979. The Act empowers the Authority to undertake planning, coordinating and implementation of development projects in the Lake Victoria Catchment Area, to which the Kano and Nyakach Plains belong. LBDA is now one of the agencies in the Ministry of Regional Development. The following six departments and special projects are under the two Deputy Managing Directors i.e Technical Services and Financial & Administration.

Technical Services:

(1) Planning Dept.
(2) Development Dept.
(3) Engineering Services Dept.
(4) Special Projects
    - Rural Domestic Water Supply and Sanitation Programme (RDWSSP)
    - West Kenya Rainfed Rice Development Project (WKRRDP)
    - Small Scale Fish Farming Development Project (SSFFDP)
    - Public Health Programme (PHP)

Financial & Administration:

(1) Finance Dept.
(2) Personal & Administration Dept.
(3) Legal & Secretarial Dept.

There are two irrigation engineers and two assistant irrigation engineers in the Engineering Service Department. LBDA has more than ten farms and honey refineries as follows.

(1) Yala Swamp
(2,300 ha in gross, cropping area 1,200 ha, Irrigation area 500 ha)
(2) Lugari
(3) Lichota
(4) Muhoroni
(5) Kodera
(6) Solomgo
(7) Alude
(8) Lambwe
(9) Samgalo
(10) Kokwanyo
(11) Ndhiwa honey refinery
(12) Bondo honey refinery

Irrigation systems are developed in the Yala Swamp and Lugari. Current organization of the LBDA is summarized in the Fig. VII-1.

2.2.2 National Irrigation Board (NIB)

The NIB was established by an Act of Parliament (The Irrigation Act, June 1966) to provide for development, control and improvement of irrigation schemes in Kenya. It is now in the Ministry of Regional Development. NIB presently operates six national irrigation schemes. Total area of these schemes is about 8,710 ha so far. Organization of NIB is shown in Fig. VII-2. In the study area, two irrigation schemes i.e. Ahero Pilot Scheme and West Kano Pilot Scheme are managed by NIB.

2.2.3 Provincial Irrigation Unit (PIU)

Another institution dealing with irrigation is the Small-Scale Irrigation Unit (SSIU), which is a part of the Ministry of Agriculture. The development of small-scale projects was not covered by NIB. Therefore the SSIU was created in 1978 to support small-scale irrigation development. After the establishment of SSIU six PIU have been set up to coordinate the activities at provincial level. PIU for the Western and Nyanza Provinces has its office in Kisumu. Its organization is summarized in Fig.VII-3.

2.3 Existing Irrigation Schemes

2.3.1 Existing irrigation area

There exists about 27 irrigation schemes in the study area. The total of currently irrigated area is about 4,300 ha. Of the 27 schemes two schemes have been developed by NIB. The irrigation area of NIB schemes is about 1,770 ha. Most of the other schemes have been developed by PIU or LBDA The existing irrigation schemes are listed in Tables VII-1 and VII-2 and is shown in Fig VII-4.

2.3.2 NIB schemes

Two schemes i.e. Ahero Pilot scheme and West Kano Pilot scheme were developed by NIB in the 1960s.

(1) Ahero Pilot scheme

Total area set aside was approximately 1,520 ha. Irrigation area of the Ahero scheme is about 870 ha. One household has 1.6 ha and about 519 households exist in the scheme. Other area is provided for research station. Irrigation water is taken from the Nyando river by 4 sets of Ornel Axial Pumps driven by 100 hp electric motor. The maximum diversion water requirement is estimated at about 1.2 m^3/sec. Drainage is made by open ditches back to the Nyando river.

The original inhabitant were moved from the area during the construction stage. After the completion of facilities they were re-transmigrated to the area being given 1.6 ha per one household. All construction cost was borne by the Government of Kenya.

Initial land preparation in the paddy field is made by tractors owned by NIB. Irrigation water supply is also controlled by NIB. Farmers get all agricultural inputs such as seeds, fund, others from NIB. They sell rice harvested to NIB and thus NIB returns the balance between rice and all costs such as tractor, inputs, and water incurred by them.

(2) West Kano Pilot Scheme

Irrigation area of West Kano Pilot Scheme is estimated at about 900 ha. One household has 1.6 ha and thus about 700 households exist. Irrigation water is taken from the Lake by four sets of pumps. Drainage water is also pumped back to the Lake. The scheme was developed and is operated by the same procedures as Ahero.

2.3.3 PIU schemes and LBDA schemes

Twenty five of the twenty seven schemes are the so called PIU schemes. Total irrigation area is about 2,500 ha. The sizes of these schemes range from less than 1 ha to some hundred ha. One scheme with irrigation area of 6 ha is irrigated by pumped water from the Lake and the other schemes use river water for irrigation. Some of them were developed before PIU was established in the 1970s and transferred to PIU.

PIU gives technical advice and some limited material assistance, through budgetary allocations from the Ministry of Agriculture. In the PIU scheme participation of the farmers is strongly emphasized not only for operation works but also for construction works. The PIU scheme is generally built by the following procedures:

(1) Request to PIU from farmers' group(s) to develop irrigation scheme,

(2) PIU conducts field investigations to identify the services required and to estimate costs,

(3) The scheme planned is put on the list of all irrigation schemes conceived and wait for allocation of budget

(4) After getting the necessary budget the construction work is commenced. Technical services are also provided.

South West Kano Irrigation Project which is one of the PIU project has been implemented since 1990 under the finance of European Development Fund. This project will command about 1,130 ha. Water resources of the project is run-of-Nyando river. River diversion weir and intake structure is constructed at about 400 m downstream from the bridge in Ahero.

2.4 Existing Flood Control and Drainage Works

Many studies and report have been prepared to solve the flood problem in the Kano Plain. The following information has been adapted mainly from The Study of Integrated Regional Development Master Plan for the Lake Basin Development Area, October, 1987.

The Kano Plain of about 70,000 ha has large swamps in the central part of the plain (Central Kano Swamp), at the mouth of the Nyando river (Nyando Swamp), and along the coast of the Lake Victoria (Coastal Swamp). The total area of the swamps is about 10,000 ha. Rivers entering into the Central Kano Swamp are Lielango, Nyangeta, and Oroba which flow down from the Nandi Escarpment between Kibos and Ainomotua rivers. Rivers between the Nyando river and Nyakach Escarpment are the Nyaidho, Awach Kano, and Asawo. Those rivers in the Kano Plain are characterized by very small longitudinal gradients of the river bed and small cross section areas, both of which lead to very low flow capacity, resulting in the stagnation of its flow. The areas along the Kisumu-Ahero-Sondu road is liable to flooding; the flood starts several kilometres upstream of the main road and extends downstream of the road as far as to the Lake shore.

High intensity rainfall, low water permeability of soils in the Plain, soil erosion causing siltation in a river channel, and an incidental rise in the water level of the Lake are other major factors causing frequent flooding.

Government efforts on Nyando river flood protection started in 1960s. Many parts of the dike were washed away or destroyed by pedestrians and animals. The Government efforts has been continued on not only Nyando river but also other rivers such as Miriu and Awach Kano.

The Ministry of Water Resources Development (MOWD) started a construction project in 1985. The project consists of three phases. The first phase is to construct a dike of 12 km from Ahero bridge downstream up to the 1,136 m contour line, the second phase is to construct a dike of 8 to 10 km to upstream of Ahero bridge and the third phase is to strengthen the dikes of the first and second phase for a 750 m3/sec flood flow which is one in 50 years return period estimated by Ialconsul. Such a phasing is in line with the idea of LBDA (Nyando Flood Protection Project, November,1986). The dikes designed by the MOWD are 2.7 to 3.0 m high and 4 m wide at the top of dikes, and the distance between left and right side banks is approximately 200 m at Ahero and 500 m at swamp areas. The construction in 1985 completed 150 m but none in 1986 due to failure in machinery.

The Ministry has a plan to extend the flood protection to Kibos and Lielango rivers, and also to construct drainage canals in swampy area, expected after the completion of the Nyando flood protection dikes for a period of another 10 years. The completion of the whole project is said depend on the fund availability and smooth running of machinery.

2.5 Current Problem of Irrigation and Drainage

The water resources of the NIB schemes seem to be enough. Some irrigation pumps seem to be out of order but it does not seriously affect the irrigation and drainage in the schemes. These schemes have separate irrigation canal system and drainage canal system. Thus there exists no drainage problem. The main problem in the two schemes is shortage of tractors to conduct timely land preparation. It causes longer period for land preparation than required.

In the PIU schemes, farmers take water from small rivers which have no perennial flow. Farmers usually wait for long rains thus take water from the river or in most cases, let water flood from the river to the paddy field. After recession of the flood, they keep the water by constructing bunds in the paddy fields. The present agriculture is fully affected by the amount and seasonal distribution of rainfall. Irrigation in the PIU schemes are not year-round but seasonal. The irrigation canals are silted resulting in decreasing its flow capacity.

In the study area more than about 25,000 ha of land seems to have a potential for irrigated agriculture. Only 4,300 ha of paddy field, however, has irrigation system. Irrigation is operated in a limitted period. No upland irrigation has been practiced in the study area. The Nyando river the second largest river in the study area has not enough water to irrigate all of the potential area in the rainy season, much less in the dry season.

Many field is in the habit of being inundated every year due to the shortage of flood and drainage control facilities. It limits cultivation area in the rainy season. Transportation facilities such as road and bridges are not enough. the existing road is habitually damaged by the flood.

Current problems of irrigation and drainage can be summarized as follows:

(1) Annual shortage and uneven seasonal distribution of rainfall,
(2) Serious shortage of irrigation water resources endowed in the study area,
(3) Lack of perennial irrigation system for upland cultivation,
(4) Poor farm road networks and crossing structures, etc.

2.6 Result of Field Test

2.6.1 Cylinder intake rate test

Infiltration of soils in the study area was observed by Cylinder intake rate test. The test sites are selected by making reference to the soil map prepared as shown in Fig.VII-5. Based on the field observation, intake rate is obtained by the following formula:

$$D_t = C*T^n \quad \text{(1)}$$
$$I_t = 60*C*n*T^{n-1} \quad \text{(2)}$$

where;
D_t accumulated water infiltrated at T (mm)
C = constant
T = elapsed time (min)
n = constant
I_t = cylinder intake rate at T (mm/hr)

Intake rate generally decreases as time passes and eventually reaches almost constant in the actual field. No constant value, however, exist in the above equation (2) since as T becomes larger I_t becomes smaller. To solve this problem, Basic Intake Rate is practically used in the planning. The Basic Intake Rate is defined as that the intake rate when its reduction rate reaches 10% of the immediate intake rate.

$$I_t = 60*C*n*T^{n-1} \quad \text{(2)}$$

The reduction rate at T is

$-dI_t/dT = -60*(n-1)*C*n*T^{n-2}$ (- means reduction)
$-60*(n-1)*C*n*T^{n-2} = 60C*n*T^{n-1}*1/10$
$T = 10*(1-n)$ (hr)
$T = 600(1-n)$ (min)

$$I_B = 60*C*n*\{600*(1-n)\}^{n-1} \quad \text{(3)}$$

where;
dI_t, dT = differential calculus
I_B = Basic Intake Rate (mm/hr)

The test results are summarized in Table VII-3. Infiltration rate in the clayey soils are very high compared with general information. This is caused by the fact that clayey soils, so called black cotton soil develop so many deep cracks when it is dry. Water can infiltrate quickly through these cracks. When it is saturated by water, the infiltration must be decreased as small as percolation rate of 3 to 7 mm per day. Infiltration rate clarified through the field test shows that soils in the study area are widely classified from the optimum to the marginal suitable for surface irrigation.

2.6.2 Soil-water relations

Since irrigation for upland crops are considered in the project, soil-water relations of the soils in the study area was investigated. The result is summarized in Table VII-3.

2.6.3 Measurement of deep percolation rate

Flooding irrigation method is applied in the paddy field. The water is always kept in the paddy field with certain height about 5 to 10 cm. So the water in the field is lost by both evapotranspiration and percolation. The percolation rate which consists of vertical direction and horizontal direction depends on the soils, underground water table, topography, etc. Horizontal percolation is generally small and appears in the adjacent field. Field measurement has been undertaken by the Study Team in cooperation with Ahero Pilot Scheme.

The Ahero Pilot Scheme has own lysimeter and has observed evapotranspiration and percolation. Their latest observation from May 1985 to January 1990 percolation rate ranges from 0.2 mm/day to 6.7 mm/day as summarized below.

Observation period	May 1989 to January 1990
Minimum	0.2 mm/day
Maximum	6.7 mm/day
Arithmetic mean	3.02 mm/day
Most frequent value	3.0 mm/day

3. BASIC STUDY OF IRRIGATION AND DRAINAGE

3.1 Basic Concepts of the Planning

The following basic concept for irrigation and drainage development is envisaged:

(1) Water resources

Water in the Sondu river is a main water resources of the project. The flow in the Sondu will be regulated after Magwagwa dam constructed. The water will be released from Sondu/Miriu hydropower station and transferred to the Nyakach and Kano Plains to the maximum extent. The non-regulated flow of the Nyando river would be used to supplement the water resources transferred from the Sondu river system.

(2) Land suitability

Suitability of land classified in Annex III Soil and Land Classification is one of the major factors for delineation. In this connection paddy field would be made in lowlying alluvial lands in the vicinity of the existing paddy irrigation schemes.

(3) Swamps

The existing swamps i.e. Central Kano Swamp, Nyando Swamp, Coastal Swamp are excluded from the development from the view point of environmental conservation and high cost required for development. In this connection, the water level in the Lake is assumed at 1136 m ASL which was the highest water level.

(4) Flood control and drainage improvement

The flood protection works on the Nyando and other rivers which requires quite large investment could not be involved in this irrigation project. The flood protection work, however, will be performed against certain level of design flood as proposed in the Integrated Master Plan. After flood protection, followed by naturally induced land enhancement will bring interest in more agricultural production by irrigation practice. Therefore, future or eventual land use pattern should be considered. In this regard, the Lotti's plan for flood protection is referred.

The flood control and drainage improvement have to be considered for small tributaries such as the Asawo, Awach Kano and Nyaidho rivers and other creeks and wadis in the project area.

(5) Project economy

Extensive development plans on the vast land resources in the Kano and Nyakach Plains have been considered in the previous studies mentioned in the previous section. Project economy, however, has to be deeply taken into consideration in this feasibility study. Besides, scale of the project has to be formulated from the view point of financial bankability, capability of the organization and farmers,etc. The project scale would be optimized based on the results of further in-depth study.

3.2 Irrigable Area

3.2.1 Potential irrigable area

The delineation of the irrigable area was made on the existing topographic map with a scale of 1 to 50,000 and new maps prepared by JICA for this study with a scale of 1 to 5,000 taking into account water level in the main canal at EL.1,205 ASL by detailed design work of the Sondu/Miriu Hydropower Project, and hydraulic condition for conveyance of irrigation water.

Accordingly to the above, potential irrigable area of about 25,640 ha is delineated; the area is physiographically divided into several sub-areas as follows:

from Kendu Bay to left bank of Awach Kano	Sub area-I	600
	Sub area-II	3,880
	Sub area-III	2,780
from Awach Kano to left bank of Nyando	Sub area-IV	4,170
	Sub area-V	3,500
from Right bank of Nyando to Kibos	Sub area-VI	3,310
	Sub area-VII	1,790
	Sub area-VIII	5,610
	Total	25,640

3.3 Water Balance Study

As mentioned in the previous section in 3.1 (5), the project scale is to be optimized by a comparative study. The optimum scale of the Kano Irrigation Project is examined by using the data and information in the various field such as water resources, agriculture, agro-economy, cost estimate, deterioration of water quality, etc. In this section, detailed discussion is made only about water balance study, facilities required, cost estimate and result. The other aspects are discussed in other Annexes and summarized in this section.

3.3.1 Available water resources

(1) Sondu River

The Sondu River Multi Purpose Project proposes Magwagwa dam to regulate the flow of the Sondu river in the upstream of the Sondu/Miriu Hydropower station The water resources planning of the Kano Irrigation Project would be established based on the regulated flow of the Sondu river after construction of Magwagwa dam.

Table VII-4 shows the mean monthly release form the Magwagwa dam. This flow gradually increases with the runoff from the residual catchment of about 200 km^2 located between the Magwagwa dam site and the intake site of the Sondu/Miriu Hydropower Station. The mean monthly flow from the residual catchment is shown in Table VII-5. The Hydropower station intakes required discharge according to the flow released from the Magwagwa dam and sends it to its turbine through penstocks. The water is discharged after turbine to the tail race of the power station for irrigation water resources.

Five-year non-exceedance probable flows are analyzed to be 21.0 m^3/sec from the dam and 1.5 m^3/sec from the residual basin respectively based on the mean annual flow data. The probable flow, and then, is propotionally distributed to each month accordingly to the the averaged mean monthly flow rate. After deducting release to the downstream (3 m^3/sec) for fisheries, river maintenance flow etc., the available mean monthly irrigation water resources with five-year non-exceedance are estimated as follows:

Available Water From the Sondu/
Miriu Hydroelectric Power Station after Magwagwa dam Constructed

(m^3/sec)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
18.5	18.4	18.5	19.8	21.2	20.3	19.5	19.8	20.5	19.2	19.1	19.1

(2) Nyando River

Mean half-monthly river flow in the Nyando river are estimated from 1960 to 1978 as shown in Table VII-6. Since any reservoir is not planned in the Nyando river and only run-of-river type diversion works is considered in the project, mean daily flow will fluctuate day by day. It is larger than the actual intake capacity on some day and be lower on another day. The mean value of actual divertable flow in a certain period is generally smaller than the mean value of river flow in the same period. Variability of river flows significantly affect actual divertable flow.

To find out the relationship between actual mean divertable flow and mean flow in a half month, a qualitative analysis is made based on the daily discharge data of the Nyando. The divertable flow is a function of intake capacity and daily mean discharge. For the purpose of the present study mean daily flow data in 1956, 1957, 1958 and 1976 were subjected to the analysis because so many interruptions of data are found in other years. The intake capacity (Qm) is tentatively set up at 10 m3/sec. Actual divertable flow are calculated every day in the above four years. In this calculation mandatory release and river maintenance flow to the downstream are assumed at 0.7 m^3/sec referring to the Lotti's study and the flow record. The daily divertable flow calculated are summarized to mean half-mothly divertable flow (Qdiv). Ratio of Qdiv to Qm (Qdiv/Qm) and that of mean half-monthly flow (Qa) to Qm (Qa/Qm) are calculated. Mean half-monthly flow from late April to September is quite larger than those from October to early April. This is caused by rainfall distribution pattern in the catchment. Long rainy season generally starts from March and lasts to June. Runoff is generally delay from the rainfall. The daily fluctuation of river flow is larger in the rainy season than in the dry season. So analysis has to be made for two periods from late April to October and the others. The Qdiv/Qm and Qa/Qm in each season are plotted as shown in Fig.VII-6. The following relationships are developed for each season by applying least square method.

$Y = 0.55X+0.22X^2-0.13X^3$ (From October to early April)
$Y = 1.37X-0.59X^2+0.08X^3$ (from late April to September)

where,
- Y ; Qdiv/Qm ($Y<=1.0$)
- X ; Qa/Qm
- Qdiv ; Divertable flow
- Qm ; Intake capacity
- Qa ; Mean half-monthly flow

Thus Qdiv = Qm * Y

Actual divertable flows in half-month from 1960 to 1978 are estimated from mean half-monthly river flows by using the above equations. The mean divertable flow calculated are shown on Table VII-7.

Other rivulets which have quite limited flow in the dry season are not suitable for irrigation water resources.

3.3.2 Irrigation water demand and water balance

(1) Irrigation area

The following three alternative irrigation area are considered for the comparative study taking into account the topographic and other conditions.

Case 1 about 24,000 ha
Case 2 about 20,000 ha
Case 3 about 15,000 ha

Case 1 requires extensive use of water resources in the maximum extent of irrigable area. Benefit per hectare will be smallest. In Case 3 water is used intensively to produce the maximum benefit per hectare. Case 2 is medium size between Case 2 and Case 3. Fig. VII-7 shows location of alternative plans. Fig. VII-8 illustrates general alignment of irrigation canals for alternatives.

(2) Irrigation water demand and water balance

Unit irrigation water requirement by cropping pattern is estimated by half-month as described in the following Chapter 4 in this Annex. Rainfall data at Nyakwere and Ahero are employed in the present study. Rainfall data at Nyakwere is only available from 1955 to 1978 and at Ahero from 1960 to 1988. In order to keep uniformity of the study, calculation period was confined to the period from to 1960 to 1978.

Diversion water requirement in each alternative case are estimated by multiplying irrigation water requirement and cropping pattern considered.

Balance between the available water and diversion water requirement is calculated by half-month from 1960 to 1978 for each alternative. In the calculation, deficit of water which exceeds more than 15% of the diversion water requirement is considered as a drought which affects crop production proposed. Occurrence of drought is allowed only 6 or 8 times in 38 cropping seasons (19 years). If drought is observed more than 8 times then cropping area of paddy which requires the largest quantity of water and produces high benefit is changed to other crops such as maize and greengram (beans) until the diversion water requirement meets the available water. While the total irrigable area is fixed for each case as mentioned above. Cropping area which best fit to the available water is found for each alternative after trial and error. Tables VII-15 to VII-17 show the cropping area and the diversion water requirement determined after the trial and error. Figs. VII-9 to 11 show result of water balance in each case.

3.3.3 Cropping pattern

Based on the result of water balance study, proposed cropping pattern are determined as follows:

Long Rainy Season	Short Rainy Season	Case 1 (ha)	Case 2 (ha)	Case 3 (ha)
Paddy	Beans*	1,710	4,400	2,290
Maize	Paddy	950	1,560	0
Maize	Groundnuts	1,910	1,910	1,910
Maize	Beans*	7,680	5,520	4,720
Vegetable	Vegetable	960	880	830
Maize	Cotton/Beans*	5,530	1,240	570
Sugar cane		3,870	3,660	3,670
Napier Grass		470	350	340
Pasture		1,140	720	600
Total		24,220	20,240	14,930

*: Beans;beans, cowpeas and greengrams

3.4 Structure Plan and Cost Estimate

3.4.1 Structure plan

One regulating pond, one diversion intake and four main canals are proposed for 24,220 ha of the project area. All canals would be unlined open channel with trapezoidal section. Table VII-8 shows main facilities planned in the alternatives.

(1) Regulating pond

Water resources for irrigation would be released through Sondu/Miriu Hydropower Station after regulated by the Magwagwa dam which has been feasibility studied by JICA. The discharge released from the power station fluctuates night and day according to the power demand; the irrigation intake discharge is constant all day long. The discharge released to the tail race from the power station has to be regulated by proper size of detention storage. Topographically, there is no suitable site for the construction of such a considerable large capacity of regulating pond in the proximity of the Power Station. So the pond is constructed by widening the upstream reach of main canal to retain water level as high as possible after the Power Station.

(2) Nyando Head works

To achieve the development of irrigable area as proposed in the Case 1 and Case 2, the endowed Nyando river flow is utilized in addition to the water from the Sondu/Miriu Power Station. A headworks are proposed to take water in the Nyando river.

Site of the headworks is selected at just downstream of conjunction of Kundo and Nyando rivers, since available water for irrigation can be most expected and water level is high enough to irrigate the low elevated area of the Nyando right side area.

Headworks mainly consist of the diversion weir, sand sluice way, intake structure and settling basin, etc. A fixed overflow crest weir is proposed on the flood sluice of the headworks. The geological investigation reveals that base foundation of the weir body has enough bearing capacity. Embankment work is also necessary along the both sides of the river upstream from the weir to retain the back water flow caused by the weir.

(3) South Nyanza main Canal

The canal extends about 22 km long from the Sondu/Miriu Hydropower Station for Kendu bay. After branching out of the regulating pond near the Power Station, the canal traverses the Sondu river by disposition of a crossing structure, and then, follows its trace almost westwards along or in parallel with the Road Route C19. About seven secondary and tertiary canals branch off. The design discharge of the canal ranges from 1.4 m^3/sec to 0.9 m^3/sec respectively. This canal would command the upland of 1,250 ha.

(4) Nyakach-Kano main Canal

This main canal of about 46 km long originates from the regulating pond and follows its trace firstly nearly eastwards along the skirts of the hilly ranges until the vicinity of the Asawo river. After crossing the Awach Kano river, the canal takes its trace nearly northwards until traverse of the Nyando river, and finally is connected to the North Nyando main canal. The Nyakach-Kano main canal commands 18,990 ha in total, comprising 13,680 ha of its own irrigation area and 5,400 ha of the irrigation area under the North Nyando main canal. About thirty three secondary and tertiary canals would be aligned for the distribution of irrigation water to its own command area of 13,680 ha. The design discharge of the canal ranges from 19.0 m^3/sec to 7.0 m^3/sec at the head and tail races respectively.

(5) North Nyando main canal

This main canal of about 31 km long, originating at the outlet of the crossing structure of the Nyakach-Kano main canal and the Nyando river, extends almost east to westwards along or in parallel with the Nairobi-Kisumu railway, and finally reaches Kibos. The command area of about 5,400 ha is bounded by the vast Kano Swamp and the railway. This area is topographically elevated and flat, and almost free from flooding of the Nyando river. The design discharge of the canal ranges from 5.3 m^3/sec to 1.5 m^3/sec at the head and tail races respectively.

(6) South Nyando main canal

This canal of about 30 km long is not incorporated into the Nyakach-Kano irrigation canal system, and its irrigation water resources depends on the non-regulated water resources of the Nyando river. The main canal originates from the intake and extends south westwards in parallel with the right bank of the Nyando river to irrigate almost lowlying and flood-prone land of about 3,850 ha. The design discharge of the canal ranges from 3.7 m^3/sec to 0.9 m^3/sec at the head and tail races respectively.

3.4.2 Provisional cost estimate

Capital investment cost is estimated on the basis of the prices in March 1991. An exchange rate used in the estimate is as follows:

US$1.0 = Ksh.28.0 = J.yen 140.0

The provisional cost is summarized as shown in Table VII-9.

3.5 Selection of the Optimum Development Scale

Based on the above provisional cost and project benefit estimated economic analysis was made for each alternative. In addition provisional assessment of water quality pollution in the Lake was also made. The following is a summary of the economic analysis and environmental assessment.

(1) Economic analysis

	Capital Investment Cost (million Ksh.)	Net Incremental Benefit (million Ksh.)	B-C (million Ksh.)	B/C (million Ksh.)	EIRR (%)
Case 1	8,618	757	-557	0.75	7.3
Case 2	7,455	697	-446	0.79	7.8
Case 3	3,501	518	297	1.24	12.2

(2) Provisional assessment of water quality tentatively shows that Case 3 may cause the least water pollution in the Nyakach Bay. The irrigation development in any case may not cause serious water pollution in the Winam Gulf as a whole.

Taking into consideration the above results, the Case 3, irrigation development in the area of about 15,000ha, is selected.

Based on the above result a further study of the Feasibility Study on Kano Irrigation Project is concentrated into the area from Kendu Bay to the left bank side of the Nyando river. The land which is suitable for paddy is carefully investigated to increase project benefit. As a result of the further investigation, paddy field is increased from the original area considered in Case 3. Accordingly the proposed cropping patten is slightly modified to meet the available land and water resources. The water balance of the project is shown in Fig. VII-12. The modified cropping pattern is summarized as follows:

Long Rainy Season	Short Rainy Season	(ha)
Paddy	Beans*	2,690
Maize	Paddy	1,740
Vegetable	Vegetable	1,570
Maize	Cotton/Beans*	1,530
Sugar cane		5,130
Fruit tree		1,000
Napier Grass		1,270
Total		14,930

*: Beans;beans, cowpeas and greengrams

4. IRRIGATION WATER REQUIREMENT

4.1 General

Unit irrigation requirement by growing stage of each crop on half monthly basis is estimated based on i) consumptive use, ii) effective rainfall, iii) other water requirements and iv) irrigation efficiency. The following are the calculation formulas for the various requirements:

a) Consumptive use = (Average crop coefficient) x (Reference crop evapotranspiration)

b) Other water requirements = (Land preparation + Topping up + Re-flooding) - (Effective rainfall)

c) Water requirement = (Consumptive use) + (Percolation rate) - (Effective rainfall)

d) Net water requirement = (Water requirement) x (Rate of cropping area)

e) Total water requirement = (Net water requirement) + (Other water requirements)

f) Unit water requirement = (Total water requirement) / (Overall irrigation efficiency)

4.2 Consumptive Use of Water

(1) Reference crop evapotranspiration (ETo)

Reference crop evapotranspiration is defined as the rate of evapo-transpiration from an extensive water surface covered by green grass of uniform height, completely shading the ground (Ref.8). Among the various prediction methods developed so far, the modified Penman method is selected as the best applicable method in consideration of the availability of climatic data and wider acceptance in similar projects.

The ETo has been calculated from 1970 to 1988 on monthly basis as shown in Table VII-10. Meteorological data used in the calculation are tabulated in Annex I Hydrology.

(2) Crop coefficient (Kc)

Crop coefficient are employed to relate the reference crop evapo-transpiration to the consumptive use of water. Values of crop coefficients vary with the crop characteristics, time of planting and/or sowing and climatic conditions. Crop coefficients applied are as shown in Table VII-11.

4.3 Effective Rainfall

Rainfall data at Nyakwere (9034067,Sangoro Primary School) and Ahero are employed in the present study. Nyakwere is employed to the area from Kendu Bay to Nyando river (Sub area I to V) and Ahero to the right bank of Nyando (Sub area VI to VIII). Monthly rainfall data of both stations are summarized in Table VII-12. The data at Nyakwere is only available from 1955 to 1978 and at Ahero from 1960 to 1988. In order to keep uniformity of the study, calculation period was confined to the period from to 1960 to 1978. Missing data in several months are interpolated from other stations.

The effective rainfall for paddy is assumed to be 70 % of the rainfall. On the other hand, to estimate the effective rainfall for upland crops, the procedure of the U.S. Department of Agriculture's Soil Conservation Service is adopted (Ref.8). In this method, the effective rainfall values are computed from mean monthly rainfall and mean monthly consumptive use.

4.4 Other Water Requirement

(1) Land preparation, etc.

The other water requirements such as land preparation, topping up and re-flooding are assumed based on the figures from the AIRS General Report (Ref.7). The values are as shown below:

(mm)

Crop	Land preparation	Topping up	Re-flooding
Paddy	250	90	150
Maize	150	-	-
Cotton	150	-	-
Green Gram	150	-	-
Groundnut	150	-	-

(2) Deep percolation rate

The data provided from Ahero Pilot Scheme is used for determination of deep percolation rate. The data in Ahero ranges from 3 to 5 mm/day and value which occurred most frequently is about 3 mm/day. The deep percolation rate is assumed at 4.0 mm/day in the paddy field.

4.5 Irrigation Efficiency

The overall irrigation efficiency combined with canal conveyance efficiency, operation efficiency and application efficiency is estimated to be 50%.

4.6 Diversion Water Requirement

(1) Diversion water requirement of alternative plans

Table VII-13 and VII-14 give the calculation sheets of the half monthly unit water requirement by crops and by cropping patterns respectively. In the calculation, water requirement of napiar grass is assumed as same as of that of sugar cane.

The diversion water requirement in the alternative plans is calculated in accordance with the spatial distribution of irrigable area described before and proposed assignment of cropping patterns. The calculation was conducted for a period of 19 years from 1960 to 1978 in which rainfall data is available. Result of the calculation is shown in Tables VII-15 to VII-17.

(2) Diversion water requirement for the project planning

The diversion water requirement of the project with the proposed cropping pattern is calculated as shown in Table VII-18. Taking into account of recurrence of available discharge from the Sondu river and rainfall in the project area and making reference to the diversion requirement for the past 19 years, the 5th maximum diversion water requirement of 18.5 m^3/sec which occurs in March 1966 is applied for project planning.

5. IRRIGATION DEVELOPMENT PLAN

5.1 Irrigation Area

Following the optimum scale of 14,930 ha, the irrigation area is finally delineated on the topographic map of 1/5,000. The irrigation area extends southeast of Kisumu Municipality and is approximately bounded by Nyabondo Escarpment in the south, contour line of 1,200 m ASL in the east, left bank of the Nyando river in the north and the Nyakach swamp in the west.

The delineated area of 14,930 ha is physiographically divided into six sub-areas by four large rivers such as the Sondu, Asawo, Awach Kano and Nyaidho rivers and the location of the Sondu/Miriu Hydropower Station, as given below:

Sub-area	Hectareage	Boundary
I	600 ha	Kendu Bay to left bank of Sondu river.
II - 1	650 ha	Right bank of Sondu river to Sondu/Miriu P/S
II - 2	3,230 ha	Sondu/Miriu P/S to left bank of Asawo river
III	2,780 ha	right bank of Asawo river to left bank of Awach Kano river
IV	4,170 ha	right bank of Awach Kano river to left bank of Nyaidho river
V	3,500 ha	right bank of Nyaidho river to left bank of Nyando river
Total	14,930 ha	

As mentioned in the previous sections, proposed land use in the project area is comprised of upland and paddy field. Fig. VII-13 shows the proposed irrigation area with proposed land use.

The land use and cropping pattern are different from sub-area to sub-area. Table VII-19 shows the diversion water requirement in each sub-area. Unit diversion water requirement in the paddy and upland fields are determined by taking into account of the area of each cropping pattern in each sub-area.

5.2 Main and Secondary Irrigation System

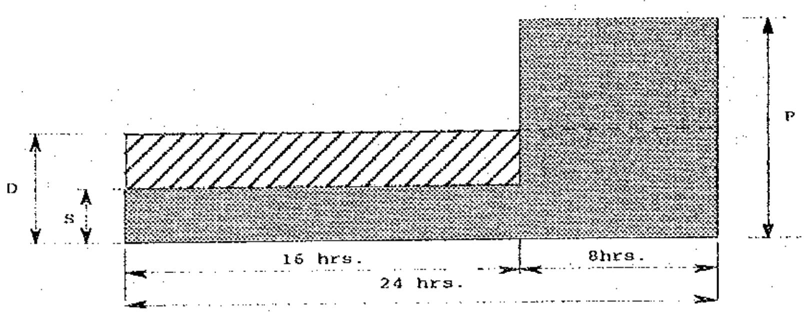
The main facilities of irrigation system is comprised of i) regulating pond, ii) main irrigation canals, and its related structures, iii) secondary canals and its related structures, iv) main and secondary drainage canals ,vi) farm road.

5.2.1 Regulating pond

The discharge released from the power station fluctuates night and day according to the power demand; the irrigation intake discharge is constant all day long. The discharge has to be regulated by proper size of detention storage.

(1) Pond Volume

The pond volume required is assumed as follows on the basis of power generation pattern and irrigation water demand:



P: Peak discharge from p/s 39.9 (m^3/sec)
S: Secondary discharge from p/s (m^3/sec)

$$S(m^3/sec) \times 16(hr) = I(m^3/sec) \times 24(hr) - P(m^3/sec) \times 8(hr)$$

I: Mean daily discharge in Sondu/Miriu river after Magwagwa Dam (m^3/sec)
D: Irrigation water demand (m^3/sec)

The pond capacity for storage is calculated as follows:

$V = (D\text{-}s) \times 16 \times 3{,}600$ (m^3)

Maximum regulating capacity is calculated to be about 634,000 m^3 during early March based on the result of water balance study in past 19 years.

(2) Pond Location

Topographically, there is no suitable site for the construction of such a large capacity of pond in the proximity of the power station. The pond is planned to be located between tail race of the Power Station and road D18 with a length of 1.1 km by widening Nyakach-Kano main canal to retain water level as high as possible after the Power Station.

(3) Pond Shape

The pond which will store 634,000 m^3 is composed of two ponds separated by power transmission line from the power station. Two ponds are connected by open channel at its end. A trapezoidal section having 1:2.0 canal side slope with 165.0 meters bottom width, 3.0 meters water depth (WL 1,205.00 - WL 1,202.00).

Each pond have width of 130 m and 120 m respectively with a trapezoidal section with a side slope of 1 to 2.0. Effective depth of the pond is to be 2.5 m (1,202 m to 1,204.5 m ASL) and total height of the pond is 4.5 m including a freeboard. A ditch with 10 m width and 1.8 m height are planned at the centre of each pond to convey water smoothly to control gate. The pond is constructed by excavating and embankment. Soil portion of inside slope is to be lined by stone to protect erosion.

(4) Related structures in the pond

An overflow weir is installed for easy distribution of water from the tail race to the pond. A spiilway is installed at the end of the pond to release excess water. Two outlet structures are proposed to release water from the pond to the Nyakach-Kano and South Nyanza main canals. One outlet structure has two type gate structures which have different funtion.

i) Constant Downstream Level Gate
This gate is installed to keep downstream water level constant against fluctuating water level in the regulating pond of 2.5 m.

ii) Discharge Control Gate
This gate is located downstream of the Constant Downstream Level Gate and has a function of controlling water discharge to the main canals.

Detail of the regulating pond is shown in the Drawing attached to this report.

5.2.2 Main irrigation canals and its related structures

(1) Canals

Two main canals originate from the regulating pond. Layout of the main canals are made taking into the following conditions:

i) To keep water level in the canal as high as possible to sustain irrigable area envisaged,

ii) To avoid serious disturbance of private property e.g., important facilities, houses, etc,

Nyakach-Kano Main Canal of about 46 km long originates from the regulating pond and follows its trace firstly nearly eastwards along the skirts of the hilly ranges until the vicinity of the Asawo river. After crossing the Awach Kano river, the canal takes its trace nearly northwards and finally debouches into the Nyando river. This main canal commands totally 13,680 ha under the Nyakach and Kano Plains. Twenty-six numbers of secondary canals and seven tertiary canals directly branch off from the main canal. Twenty-four sub-secondary canals branch off from the secondary canals.

The South Nyanza Main Canal extends about 6.0 km from the the regulaing pond. It extends almost westwards until the right bank of the Sondu river. After crossing the Sondu river by inverted siphon, the canal follows its trace further westwards along or in parallel with the Road Route C19, and finally debouches into the Aoch Nyandega river. Five secondary and two tertiary canals branch off from this main canal.

The Nyakach-Kano Main Canal commands 13,680 ha under Sub-area II-2, III, IV, and V, while the South Nyanza Main Canal which commands 1,250 ha under Sub-Area I and II-1. A proposed layout of main and secondary irrigation canals is shown in Fig. VII-14.

The design discharge of the Nyakach-Kano Main Canal ranges from 17.1 m^3/sec to 4.3 m^3/sec and that of the South Nyanza Main Canal ranges from 1.4 m^3/sec 0.9 m^3/sec. The entire reach of both main canals have earthen trapezoidal section with an inside slope of 1 to 1.5 (vertical to horizontal); longitudinal gradient of the Nyakach-Kano Main Canal ranges from 1/7,000 to 1/3,000, while that of the South Nyanza Main Canal, 1/5,000 to 1/3,000. Irrigation area and design discharge of each secondary canal is shown in Fig. VII-15.

Canal Sections are designed by application of Manning's formula based on the following criteria:

Roughness coefficient

Earth canal	0.03
Concrete lined canal	0.015
Masonry lined canal	0.025

Allowable velocity

Earth Canal	0.3 m/sec - 0.7m/sec
Concrete lined canal	0.3 m/sec - 2.0m/sec
Wet masonry lined canal	0.3 m/sec - 3.0m/sec

Free board

Design discharge (m^3/sec)	F_{min} (m)
$Q < 3.0$	0.3
$3.0 < Q < 6.0$	0.4
$6.0 < Q$	0.5

Standard design is made for each main canal as follows:

Nayakach-Kano Main Canal (earth canal)

Trapezoidal section with	1:1.5 side slope
canal slope	1/6,000 - 1/5,000
base width	10.0m - 3.5 m
water depth	2.3 - 2.2 m

South Nyanza Branch Canal (earth canal)

Trapezoidal section with	1:1.5 side slope
Canal slope	1/3000 -
base width	2.0m -
water depth	1.2 m -

Preliminary design of main canals are shown in the Drawing attached to this report.

(2) Related Structures

Nine kinds of related structures of main canal are proposed for the full function of conveyance, regulation, and protection of the canal system. The proposed related structures are functionally classified as follows:

	Function	Name of related structures
(1)	Conveyance	i) Inverted Siphon, ii) Culvert & Bridge,
(2)	Regulation	i) Turnout , ii) Check
(3)	Protection	i) Spillway, ii) Drop, iii) Cross Drain,
(4)	Others	i) Washing Step, ii) Inspection Road

The following is a brief description on function of the proposed structures:

i) Turnout
Turnout is provided to divert required water from main canal to secondary or tertiary canals. Turnout have an measuring device (broad crested weir, or Cipolleti weir) at its rear end for equitable water distribution and effective water management.

ii) Check
Check structure is planned in the vicinity of turnout in order to maintain required intake water level in front of turnout throughout the irrigation period.

iii) Inverted Siphon
Inverted siphon would be provided as a part of canal in order to underpass a river in consideration of easy flood-pass in the river. No aqueduct would be proposed for crossing of such a river in view of safety of canal.

iv) Culvert and Bridge
Culvert as a part of canal or bridge would be provided at crossing site of existing road and proposed canal route.

v) Spillway
Spillway with control gate would be provided close to inlet of inverted siphon to drain excess water into river or to evacuate water in the siphon barrel for its maintenance works

vi) Drop
Drop structure would be provided to dissipate excess hydraulic energy for protection of channel body. Vertical drop would be proposed in consideration of design discharge and height of drop.

vii) Washing Step
Washing step would be provided for convenience of inhabitants thereby, where canal traverses near the village.

viii) Inspection Road
Inspection road would be provided along one side of canal banks for easy access and convenience of operation and maintenance of canal. The road is proposed to be 5 m wide, and is laterite-paved with 4 m wide and 10 cm in thickness.

iv) Cross Drain and Side Drain
To safely release runoff from hillside along the main canal, cross drain would be provided under the canal. Runoff from small rivulet would be collected by side drain and drained into

the nearest natural river. Cross drain would be structured with pipe or box culvert depending on design discharge ; side drain would be structured with unlined open ditch.

Numbers of related structures on the main and secondary canals are summarized in Table VII-20. Typical design of the related structures are shown in the Drawing attached to this report.

5.2.3 Secondary canals and its related structures

57 numbers of secondary canals of about 213 km in total length branch off from two main canals proposed. All the secondary canals are unlined and trapezoidal section as well as main canal; the side slope of channel is 1 to 1.5.

Functionally and structurally, the structures related to the secondary canals would be almost similar to those to the main canal. A turnout.has a measuring device (Cipolleti weir) at its rear end for equitable water distribution and effective water management. Inspection road would be provided along one side of canal banks. The road is proposed to be 5 m wide, and is laterite-paved with 3 m wide and 10 cm in thickness.

6. DRAINAGE IMPROVEMENT PLAN

6.1 Basic Idea of Drainage Improvement

Flood control and protection work in the Nyando river is being undertaken by the Ministry of Water Development in the Kano Plain. Therefore the flood control work in this project is concentrated into the Nyakach Plain as a part of drainage improvement work.

The flood control and river training along rivulets and torrents developed across the project area from the east to westwards are essential from the maintenance of the proposed irrigation canal facilities. In addition, the flood control of such torrents is essential from soil conservation viewpoint as well, because farm lands around the torrents have been seriously eroded by habitual rush of floods.

Thirty one rivers and rivulets were identified in the project area. Based on this identification, and in due consideration of recommendation by water quality conservation study, drainage improvement plan is envisaged so as to drain excess water from the project area into the Nyando and Coastal swamps as far as possible for purification of polluted water by irrigated agriculture.

6.2 Layout of Main and Secondary Drains

Sixty-nine main and secondary drains are proposed; of them fourteen drains are aligned westwards from the Power Station, while fifty-five main and secondary drains, northeastwards from the Power Station. Total catchment area is estimated about 850 km^2 including 567 km^2 of outside project area. Excess water from this catchment finally drained into the Lake. However, only eighteen drains which cover about 110 km^2 flow directly into the the Lake. The others firstly flow into the Nyando swamp or Nyando river. Total length of the drains are about 266 km. Proposed layout of drains is shown in Fig. VII-16.

6.3 Flood Discharge and Drainage Water Requirement

6.3.1 Flood discharge in the rivers

Forty-three drains of which catchment area is estimated about 567 km^2 originate from the outside project area and traverse proposed main irrigation canals. The flood discharge in these rivers have to pass smoothly at the crossing point for the security of the irrigation canals. The flood discharge at the crossing point are estimated by Rational formula as follows:

$$Q = 1/3.6*f*r*A$$

where,
- Q : flood discharge in m^3/sec
- r : rainfall intensity in mm/hr for a duration equal to the time of flood concentration
- f : runoff coefficient
- A : catchment area (km^2)

The rainfall Intensity-Duration-Frequency Relationships in Kenya has been developed by the Director Water Development in the Ministry of Water Development in Kenya. The said relationships for Kisumu is extracted and shown in Annex I Hydrology in this report. For the planning of crossing structures between rivers and main irrigation canals, flood discharge with 50-year exceedance is applied. The runoff coefficient is assumed to be 0.6 considering the physical characteristic in the catchment area. Many equations have been developed to estimate the time of flood concentration. Some of them give quite large result of discharge. The following Kadoya's equation which seems to give reasonable value is used in this study.

$$T_p = C^* A^{0.22} / r_e^{0.35}$$

where,
- C : constant, 290 for hilly forest, 210 for pasture, In this study 240 is adapted
- T_p : time of flood concentration (min.)
- A : drainage area (km^2)
- r_e : effective rainfall intensity for duration equal to the time of flood concentration (mm/hr)

The said rainfall Intensity-Duration-Frequency Relationships is converted to the effective rainfall intensity-duration-frequency by multiplying original relationships and runoff coefficient (0.6). To calculate T_p, relationships between A and r_e are developed as shown in Fig. VII-17. The flood discharge of the rivers are estimated by using this relationships and catchment area.

6.3.2 Drainage water requirement in the project area

(1) Upland field

The drainage water requirement in the upland field is estimated by the same Rational formula as described in the preceding section. A five-year exceedence is applied in the study.

(2) Paddy field

From the past experiments and observations in Japan on the relation between the yield and reduction rates of paddy and depth and duration of submergence at different growing stages of paddy, the following considerations could be made:

i) The submergence at the growing stage of young panicle formation gives the serious damage to paddy. The damage due to submergence at the stage of maturing is insignificant.

ii) the duration of submergence within 1 to 3 days is not significant, but damage of paddy remarkable increases, if the submergence lasts for more than 3 days.

iii) When a part of leaves still remains above water surface, the damage to paddy is not serious as compared with the case that the leaves are completely submerged. (Ref. 9)

Since paddy plant has tolerance to flood as mentioned above and paddy field has a large storage function, the drainage water requirement in the paddy field is simply calculated by the following equation.

$$Q = R3 * A / (0.36 * 72)$$

where,
- Q : drainage water requirement (lit/sec)
- R3 : rainfall in 3 continuous days (mm)
- A : drainage area (ha)

The three day's continuous rainfall in Ahero and Nyakwere are picked up and analyzed as shown in Fig. VII-18. A probable rainfall of 110 mm with 5-year exceedance is adapted for the drainage planning. Thus the unit drainage water requirement is estimated at 4.24 lit/sec per one hectare.

The drainage water requirement and flood discharge estimated are shown in Fig.VII-19.

6.4 Drainage Facilities

6.4.1 Drainage canals

Total length of the main and secondary drainage canals are about 266 km.

(km)

Sub-area						
I	II-1	II-2	III	IV	V	Total
11	14	63	35	99	44	266

Drainage canal has a trapezoidal earthen section with an inside slope of 1 to 1.5. Canal section is designed by using Manning's formula with roughness coefficient of 0.035. Sample design of drainage canals are shown in the Drawing.

The drainage canal improvement is classified into two types, i.e. training of existing natural creek and new excavation of canal. The improvement works is planned to carry out cut-and-embankment for seasonal channel and to make embankment for perennial river channel.

6.5 Related Structures

The following structures are planned:

(1) Canal revetment

Since some drainage canals are quite meandering, canal revetment works is proposed to protect the canal section. Revetment works consist of gabion protection with 0.5 m thickness. The revetment works are made at the meandering reach of the drainage canal.

(2) Drop

In drainage canal drop works are proposed to dissipate excess hydraulic energy. Height of a drop vary from 0.5 m to 1.5 m. It is constructed in combination of concrete works and gabion protection with a length of 25 m.

(3) Culvert

A passage facility is necessary where a drain intercepts the existing road. A culvert which has rectangular section for water pass is planned. The road will cross over the rectangular portion. Size of rectangular portion is depend on the design discharge of the drainage canal. The culverts are classified into 6 types by size. The smallest is 5 m width and 2 m height for the design discharge of 5 to 20 m^3/sec. The largest one has five rectangular portions for design discharge from 200 to 250 m^3/sec.

(4) Inspection road

Inspection road is planned at both sides of drainage canal. The material of the road is mainly comprised with excavated material from the drainage canals. The width of the road is at about 5 m.

Typical design of related structures are shown in the Drawing. The numbers of related structures are summarized in Table VII-21.

7. TERTIARY AND ON-FARM DEVELOPMENT PLAN

7.1 Field Irrigation Plan

7.1.1 Field irrigation schedule

Field irrigation schedule were studied based on the field water balance.

(1) Depth of irrigation application

Depth of irrigation application is defined as the water depth that can be stored in the root zone for growing of crop. The total available amount of water stored in the soil is generally given by soil moisture content at field capacity (FC, pF1.5 to 1.7) to temporary wilting point to wilting point (TWP, WP, pF3.9 to 4.2). Water holding capacity of soils in the study area is not well known so far though laboratory test is undertaken. So general information are used for this study. Available water in the soil is assumed as follows:

Available Soil Water*1	Soil Texture
60	sandy
140	loamy
180	clayey

*1 Ref.8

Not all soil water in the root zone held between FC to TWP is readily available. The depth of water readily available is generally defined as RAM (Readily Available Moisture). The RAM is dependent on the crops. Soil Moisture Extraction Pattern (SMEP) in the root zone of crops is different from crop to crop. Since there is no data available about SMEP of the crops proposed in the project the reference data in the FAO publication are applied in this study as follows:

Crop	Rooting Depth*1 (m)	Fraction of Available Water*1	TRAM (mm) Sandy	TRAM (mm) Loamy	TRAM (mm) Clayey
Cotton	1.4	0.65	55	127	164
Groundnuts	0.8	0.4	19	45	58
Maize	1.4	0.6	50	176	151
Onions	0.4	0.25	6	14	18
Beans	0.6	0.45	8	18	24
Sugar cane	1.6	0.65	62	146	187
Vegetables	0.5	0.2	6	14	18
Tomato	1.1	0.4	11	26	79
Cabbage	0.5	0.45	7	15	20

*1: Ref.8

(2) Irrigation application interval and field irrigation requirement

Irrigation application interval is theoretically calculated by dividing TRAM by evapotranspiration of crops. Evapotranspiration of crops, ETcrop varies from 2 to 5 mm per day as mentioned in the previous section 4.6. The TRAM of crop shows quite different value from sandy soils to loamy and clayey soils in the above table. So,irrigation interval is calculated by crops in sandy soils, and loamy to clayey soils. Net field irrigation water requirement is calculated by multiplying the irrigation interval with ETcrop. Assuming that the field irrigation efficiency is about 70%, gross field irrigation requirement is also estimated in the Table. VII-22.

As a result of calculation, average irrigation interval is classified into two groups as follows:

	Irrigation Interval (day)	Gross Field Irrigation Req. (mm)
i) Sandy soils		
- Cotton, maize, sugarcane	11	81
- Groundnuts, onion, peas, vegetable, tomato, cabbage	2.3	16
ii) Loamy to clayey		
- Cotton, maize, groundnuts, peas, sugarcane	23	163
- Onions, vegetable, tomato, cabbage	4.5	29

7.1.2 Field irrigation supply schedule

(1) Field irrigation method

Field supply is primarily determined by those of depth and interval of irrigation and by the irrigation method on the fields. The method of irrigation is determined by factors such as type of crop, soil type, topography, and cost. According to the infiltration test, soil in the study area is classified into the optimum to the marginal suitable to surface irrigation. Considering topographic condition and cost required, furrow irrigation is proposed in the project.

All crops proposed in the project other than fruit tree are suitable for furrow irrigation. In some areas in which land slope is rather steep, furrow should be made diagonally or parallel to the slope.

No direct irrigation from the main, secondary and tertiary canals to the field is considered for adequate water management practice. Irrigation to the field is made from a water course which branches from the tertiary. Farm ditches will be constructed by farmers in their field if necessary.

(2) Stream size and irrigation time

Stream size depends mainly on type of soils or infiltration rate and slope of filed. Flow of water per furrow should be large enough to reach end of run, and small enough not to cause erosion, flooding and tail losses. Relation between soil type, furrow slope, furrow length are tentatively determined based on the general information (Ref.10). Accordingly the furrow length is estimated from 30 m to 150 m. Maximum allowable non-erosive furrow stream is to be 0.6 lit/sec on the slope of 1 % and 0.3 lit/sec on 2 %. Based on these information stream size and irrigation time are calculated. In the calculation irrigation interval is assumed to be seven days at the maximum. Eventually it takes about 6 to 12 hours to irrigate 1.0 ha on condition that about 20 to 30 furrows can be operated simultaneously. The calculation is shown in Table VII-23.

7.2 Tertiary Canal System

7.2.1 Component of a tertiary block

As estimated in the preceding section a flow rate of 6 to 12 lit/sec is to be used in one hectare. On the other hand a flow rate of about 30 to 40 lit/sec is generally considered minimum flow rate in the small canal from the view point of construction technique and water management practice by farmers.

Based on the above considerations, a tertiary system in the project is tentatively planned as follows:

i) One rotation block of which fields are irrigated in the same day is to be about four to five hectares.
ii) About six rotation blocks are irrigated by turns in a week.
iii) So an irrigation block is composed of about six rotation blocks and commands about 25 to 30 ha.
iv) One tertiary block consists of one or more irrigation blocks.

7.2.2 Layout of a tertiary system

(1) Basic conditions of canals

A tertiary canal system has the following canals and drains:

i) one tertiary canal and sub-tertiary canals, if necessary,
ii) About six water courses branch from one tertiary canal, one water course commands one rotation block
iii) tertiary and field drains
iv) If necessary, farm ditches in the farm, which branch off from the water course

All canals are constructed by embanking and cutting of earth material. So normal length of a tertiary canal is about 1,000 to 1,500 m. Maximum length is to be about 2,000 m. Length of a water course is limited to about 1,500 m in maximum. Farm road having a 4 m width is provided along the tertiary canals and water courses. Farm ditches are constructed by farmers in their own land if necessary. A typical configuration of the tertiary system is shown in Fig. VII-20.

(2) Canal dimension

Design discharge of the tertiary and water course is to be 30 to 70 lit/sec. Inside and outside slope of the canal is to be 1 to 1.0. Its dimensions is as follows:

	Bottom Width	Canal Depth	Canal Height	Bank Width	Road Width
Tertiary Canal					
Upland Area:	0.2 m	0.5 m	0.6 m	0.8 m	4.0 m
Paddy Area:	0.3 m	0.5 m	0.6 m	0.8 m	4.0 m
Water Course					
Upland Area:	0.2 m	0.4 m	0.5 m	0.8 m	4.0 m
Paddy Area:	0.3 m	0.4 m	0.5 m	0.8 m	4.0 m

A tertiary drain has a drainage area of about 40 ha on average and a field drain has about 5 ha. The design discharge of the drains are at 0.12 m^3/sec/ha in the upland area and 4.24 lit/sec/ha in the paddy area. These drains are designed to flow excess water from the drainage area and also is designed to take enough quantity of embankment material for tertiary canal and water course. Dimensions of the tertiary and fields drains are determined as follows:

	Bottom Width	Canal Depth	Design Discharge
Tertiary drain			
Upland Area	0.5-1.2 m	0.7-1.4 m	0.8-4.9 m^3/sec
Paddy Area	0.5-1.2 m	0.7-1.4 m	0.03-0.22 m^3/sec
Field drain			
Upland Area	1.2 m	1.3 m	0.2-0.8 m^3/sec
Paddy Area	0.2 m	0.2 m	0.03 m^3/sec

Division boxes, drops and pipe culverts are constructed on the tertiary canal. Farm outlets, and field access are constructed on the water course. Drops ,cross drains and drainages culverts are required on the tertiary drains.

(3) Sample layout of tertiary system

Based on the above conditions layout of tertiary system is made in the command area of S5 and S20. The S5 area is a sample of upland area and S20 is combined area of upland and paddy area. Total area of S5 and S20 is about 2,071 ha. The results are shown in the Drawing and list of structures are summarized in Table VII-24.

7.3 On-farm Works

On-farm works consists of construction of water courses, field drains, field roads and their related structures, and land levelling and land adjustment works in the paddy fields.

(1) Paddy field

About 4,430 ha of paddy fields is proposed in the project. Of them only 780 ha is of existing paddy fields. The other 3,650 ha is to to be newly developed in the project.

In the Ahero Pilot Scheme paddy field is developed in a rectangular shape with an area of 0.4 hectare. In the project area size of existing paddy fields varies from 0.1 to 0.5 hectare and its shapes are polygons nearly to a regular square. Taking into consideration of these facts, a farm lot is proposed to be a rectangular shape having a net cultivation area of 0.3 ha with a 30 m length and 100m width. Existing boundary of farm lot is to be adjusted in the on-farm works. Sample design is made in the S20 area as shown in the Drawing. List of structures are summarized in Table VII-24.

(2) Upland fields

About 10,500 ha of upland fields is proposed in the project. Of them only about 830 ha is classified present scrub. The other area is presently cultivated for upland crops or pasture. Water courses and other facilities are to be provided to achieve the agricultural development plan envisaged. Sample design is made in the S5 and S20 areas as shown in the Drawing. List of structures are summarized in Table VII-24.

8. IMPROVEMENT OF EXISTING ROAD

Existing roads in the projecr area are rather deteriorated by habitual floods and inundation due to its low embankment. Road improvement works which is comprised of heightening and laterite pavement is proposed. Thichness of the pavement is of 10 cm.

The existing roads are not fully networked due to lack of crossing structures on the rivers. This is the one of the crucial constraints for daily traffics and transportation of farm inputs and products. Proper number of bridges and causeways would be proposed to cross main perennial rivers and seasonal streams.

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Tables

Table VII-1 List of Exsisting Irigation Schemes

	Name of Scheme	Location/ Sub-Location	Area (ha)	Potential area (ha)	Water Source	Year of Implementation	Agency	Cropping Calender
1.	Alungo A	Ombeyi / Ramula	40	170	Oroba River	1987	PIU	Jan.-June x 2
2.	Awach Kano	N. Nyakach / Wawidhi 'A'	80	300	Awach Kano River	1983	PIU	May-October
3.	Kore	L.N.E. Kano / Kamagaga	90	150	Oroba and Ombeyi	1983	PIU	April-October
4.	Nyachoda	N. Nyakach / Wawidhi 'B'	50	50	Awach Kano	1985	PIU	July-December
5.	Nyakach	N. Nyakach / Gem Rae	90	110	Awach Kano	1983	PIU	July-December
6.	Obange	S.E. Kano	80	200	Miriu	1987	PIU	June-November
7.	Wasare	N. Nyakach / Jimo Middle	110	125	Asawo River	1984	PIU	July-December
8.	Nyatini	N.W. & S.E. Kano / Kobura & Kakola	150	250	A.P.S. Drainage Water	1987	PIU	July-December
9.	Ombaka	S.W. Kano / Kakola	20		Nyndo	1983	PIU	N / A
10.	Masune	N. Nyakac/Wawidhi 'A'	250	250	Nyaidho	1986	PIU	May-December
11.	Ahero Pilot Scheme	L.N.E. Kano/Irr.	870	870	Nyando River	1966	NIB	
12.	West Kano	S.W. Kano	900	900	L. Victoria	1969	NIB	
13.	S.W. Kano	S.W. Kano / All Loc.	200	1130	Nyando River	1990	PIU	N / A
14.	Chiga	E. Kolwa / Chiga	50	400	Lielango	1986	PIU	June-December
15.	Asunda	Ombeyi / Ramula	20	40	Oroba	1989	PIU	Jan.-June x 2
16.	Abwao	Ombeyi / Ramula Kore	43	70	Oroba	1987	PIU	March-August
17.	Kopudo	L. Nyakach / Gem Rae	30	50	Awach Kano	1989	PIU	July-December
18.	Odhong	Obumba / Wanjare	30	-	Nyangeta	1987	PIU	June-December
19.	Oyani	N. Nyakach / Gem Rae	30	30	Awach	1985	PIU	July-December
20.	Siany	-	6.4	10	Ahol	N / A	PIU	July-December
21.	Gem Rae	N. Nyakach / Gem Rae	70	70	Awach	1983	PIU	July-December
22.	Obino	East Kolwa / Chiga	10	200	Riwa	1987	PIU	May-October
23.	Malele	East Kolwa / Chiga	40	100	Riwa	1987	PIU	May-October
24.	Ahol	East Kolwa / Chiga	20	100	Nyangeta	1987	PIU	May-October
25.	Alungo B	Ombeyi / Ramula						
26.		Wang' chieng / Kamser	4	5	Lake Victoria	1980	PIU	May-November
27.	Seka Bondo							

SR: Short rainy season rice LR: Long rainy season rice
Source: LBDA

Table VII-2 List of Exsisting Irrigation Facilities

Name of Scheme	Water resouce	Diversion work	Irrigation canal (km) Main	Secondary	Tertiary	Related structure
1. Alungo A	Oroba River	Gabion not constructed	0.828	1.5	1.5	5 division/drop boxes
2. Awach Kano	Awach River	Gabion weir	1.6	3.4	1.9	2 intakes, several division boxes
3. Kore	Oroba & Ombey	Culverts	-	5.0	3.2	7 km dyke
4. Nyachoda	Awach River	Gabion Weir	0.86	2.1	3.7	1 intake, bridge, 1 drop box
5. Nyakach	Awach River	Gabion weir	1.76	2.21	4.8	5 division/drop structures
6. Obange	Miriu	Temporary weir	-	-	-	-
7. Wasare	Asawo River	Concrete weir	0.6	1.95	2.8	Drain outfall structures
8. Nyatini	APS drainage	Duekbill weir (not yet constructed)	0	2.6	2.1	Several division boxes
9. Aguko	-	NA	-	-	-	-
10. Ombaka	Nyando	NA	-	-	-	-
11. Nyamasaria	Kibos River	Pumping	-	-	-	-
12. Masune	Nyaidho	Temporary weir	-	-	-	-
13. Ahero Pilot Scheme	Nyando	Pumping	-			
14. West Kano	Lake Victoria					
15. South West Kano	-	-	4.7	Over 5.0	-	(not constructed yet) siphon and outfalls
16. Chiga	-	-	2.7	-	-	(cut off drain) - NA
17. Asunda	-	-	0.3	0.8	1.1	Drain outfall structures
18. Abwao	-	-	1.9	2.7	NA	(not constructed) - NA
19. Kopudo	-	-	2.9	1.2	1.8	5 flumes
20. Odhong	-	-	0.5	3.0	1.9	NA
21. Oyani	-	-	-	-	-	-
22. Siany	-	-	-	-	-	
23. Gem Rae	-	-	0	0	4.8	NA
24. Obino						
25. Malele						
26. Aholo						

Source: LBDA

Table VII-3 Results of Cylinder Intake Rate Test and Soil-water Invesigation

Cylinder Intake Rate Test

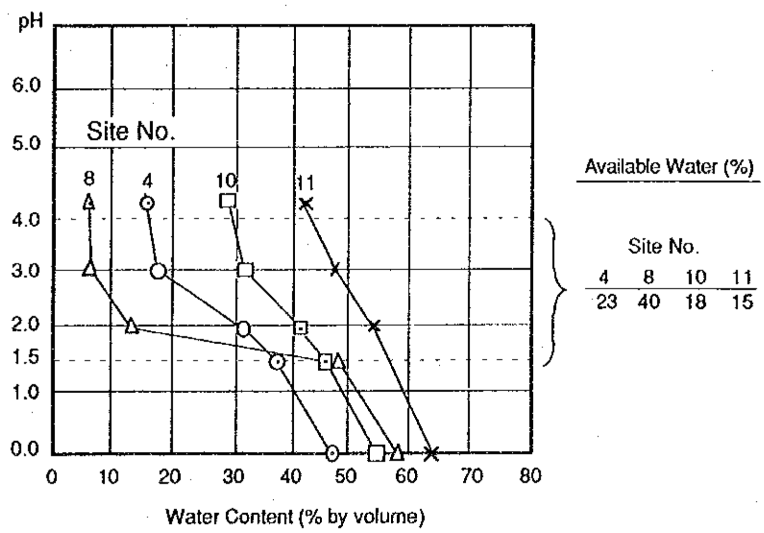
Site	Time	C	n	IB(mm/hr)	Soil texture
1	Oct.'91	5.7	0.59	21	Clayey to loamy
2	Oct.'91	22.0	0.86	581	Clayey*1
3	Oct.'91	16.0	0.79	275	Clayey*1
4	Oct.'91	12.3	0.48	106	Clayey to loamy
	July'91	4.7	0.41	2	
5	Oct.'91	11.6	0.75	149	Loamy to sandy
6	Oct.'91	23.7	0.62	112	Clayey*1
7	Oct.'91	78.4	0.56	227	Clayey*1
8	July'91	20.9	0.80	38	Sandy
9	July'91	4.9	0.61	21	Clayey to loamy
10	July'91	6.0	0.34	2	Clayey
11	July'91	9.1	0.67	64	Clayey*1

*1 Black cotton soil

Result of Soil-water Investigation

	Site No.			
	4	8	10	11
Moisture retained (% w/w)				
pF = 0	36.5	40.1	42.4	57.5
pF = 1.5	29.6	33.8	35.8	50.8
pF = 2.0	24.5	10.3	32.7	48.5
pF = 3.5	13.6	4.3	24.3	42.3
pF = 4.2	11.9	4.1	22.1	37.1
Bulk dendity (gr/cm^3)	1.27	1.44	1.28	1.12
Porosity (v/v)	46.5	43.3	54.4	64.5
Particle size distribution (%)				
Sand	57.5	85.0	32.5	12.5
Silt	15.0	7.5	20.0	17.5
Clay	27.5	7.5	47.5	70.0
Texture	Sandy clay loam	Loamy sand	Clay	Clay

Soil-water Retention Curve



Source : Prepared by JICA Study Team

Table VII-4 Mean Monthly Release From the Magwagwa Dam

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1947	20.4	20.5	20.6	45.9	60.8	60.8	47.6	51.5	54.9	46.2	20.3	20.4	39.2
1948	20.5	20.7	20.9	21.1	21.2	21.3	21.3	21.1	20.8	20.7	20.7	20.9	20.9
1949	21.1	21.3	21.6	21.4	21.1	21.0	20.8	20.9	21.2	21.3	21.3	21.1	21.2
1950	20.9	20.7	20.4	20.1	20.0	20.0	20.1	20.5	20.9	21.2	21.1	20.9	20.6
1951	20.6	20.3	19.9	20.5	21.7	20.9	20.6	20.4	20.3	20.3	41.1	60.8	25.6
1952	55.1	20.3	20.4	20.3	60.8	60.8	26.0	48.4	42.3	22.7	20.3	20.4	34.8
1953	20.5	20.6	20.8	21.0	21.2	21.3	21.5	21.7	21.4	21.2	21.0	20.8	21.1
1954	20.5	20.1	19.7	19.2	19.3	20.2	20.8	21.0	21.3	21.8	21.4	21.3	20.6
1955	21.1	20.8	20.6	20.3	20.0	19.8	19.6	19.8	20.6	21.3	21.7	21.7	20.6
1956	21.6	21.4	21.4	21.4	21.0	30.3	44.0	49.4	60.8	36.7	24.7	20.3	31.1
1957	20.4	20.5	20.6	20.6	61.1	60.8	55.9	48.7	41.3	20.3	20.4	20.5	34.3
1958	20.6	20.7	20.9	21.0	20.8	20.6	20.5	20.4	25.6	24.6	20.3	20.4	21.4
1959	20.5	20.6	20.7	20.7	20.5	25.8	20.3	20.3	20.3	20.3	20.3	20.3	20.9
1960	20.4	20.6	20.6	20.5	51.3	50.7	33.0	36.3	60.8	39.4	20.4	20.3	32.9
1961	20.4	20.5	20.7	20.8	20.9	21.0	21.1	21.1	20.9	20.6	61.1	60.8	27.5
1962	60.8	23.4	20.3	20.3	60.8	60.8	60.8	41.6	60.8	60.8	27.9	20.3	43.2
1963	23.7	21.1	20.3	60.8	60.8	60.8	31.5	46.8	33.9	20.3	20.4	60.3	38.4
1964	30.2	20.3	20.3	60.8	60.8	44.7	58.6	60.8	55.6	60.8	20.3	20.3	42.8
1965	20.4	20.5	20.7	20.7	20.5	20.3	20.3	20.4	20.4	20.5	20.5	20.5	20.5
1966	20.6	20.7	20.7	36.2	60.8	29.9	23.5	21.7	60.8	20.3	20.3	20.3	29.7
1967	20.4	20.4	22.5	60.8	60.8	60.8	50.4	60.8	42.6	20.3	20.3	60.8	41.7
1968	20.3	20.3	33.3	60.8	60.8	60.8	50.4	60.8	42.6	20.3	20.3	60.8	42.6
1969	20.3	43.4	35.6	26.6	33.8	20.9	20.3	20.3	20.3	20.3	20.4	20.5	25.2
1970	20.6	20.7	20.5	60.9	60.8	60.8	38.6	60.8	60.8	54.1	24.1	20.3	41.9
1971	20.4	20.5	20.6	20.8	20.8	20.5	49.5	60.8	60.8	42.0	20.3	20.3	31.4
1972	20.4	20.6	20.7	20.8	20.9	20.7	20.6	20.4	20.3	20.3	60.8	42.9	25.8
1973	39.4	29.0	20.3	20.3	20.3	60.8	28.3	44.4	57.7	32.9	26.8	20.3	33.4
1974	20.4	20.5	20.7	20.6	34.0	51.8	60.8	60.8	50.2	38.8	21.4	20.3	35.0
1975	20.4	20.6	20.7	20.8	20.7	20.6	20.4	60.8	60.8	60.8	33.2	20.3	31.7
1976	20.4	20.5	20.6	20.8	20.9	20.8	20.6	24.3	60.8	20.3	20.3	20.4	24.2
1977	20.5	20.6	20.6	36.3	60.8	60.8	60.8	60.8	50.6	23.0	60.8	60.8	44.7
1978	27.8	22.7	60.8	60.8	60.8	42.3	51.4	51.2	60.8	60.8	36.9	25.4	46.8
1979	20.3	58.8	43.6	60.8	60.8	60.8	51.6	58.2	31.8	20.3	20.4	20.5	42.3
1980	20.6	20.8	20.9	21.1	21.0	20.8	20.5	23.6	28.9	20.3	20.4	20.5	21.6
1981	20.6	20.7	20.9	57.2	60.8	20.8	36.6	60.8	57.1	51.7	20.3	20.3	37.3
1982	20.4	20.5	20.7	20.9	20.9	20.6	20.3	53.9	45.7	32.2	60.6	60.8	33.1
1983	23.6	20.3	20.4	20.5	20.4	39.3	38.9	50.5	60.8	60.8	47.2	21.6	35.4
1984	20.3	20.4	20.5	20.6	20.7	20.8	20.9	21.0	20.9	20.9	20.9	20.9	20.7
1985	21.0	21.1	21.3	21.5	21.4	21.3	21.2	21.1	21.0	21.0	21.1	21.2	21.2
1986	21.3	21.5	21.8	21.3	21.4	21.7	21.6	21.5	21.4	21.4	21.5	21.6	21.5
1987	21.8	21.3	21.2	21.2	21.8	20.9	22.6	21.6	20.3	20.3	23.9	22.7	21.6
1988	20.3	20.3	20.4	53.9	60.8	55.6	48.1	60.8	60.8	60.8	35.0	20.3	43.1
Mean	23.4	22.4	22.9	30.5	36.4	35.8	32.9	38.4	39.6	31.1	27.2	28.0	30.7

Source: Feasibility Study on Magwagwa Hydroelectric Power Development Project

Table VII-5 Mean Monthly Flow From the Residual Catchment

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1947	0.8	0.7	1.0	6.3	16.8	5.0	3.3	3.6	3.8	3.4	0.8	0.5	3.8
1948	0.3	0.2	0.2	0.3	0.6	1.6	1.7	3.6	4.1	1.2	0.7	0.2	1.2
1949	0.2	0.2	0.1	0.3	0.4	0.9	1.0	2.3	3.6	1.5	0.7	0.6	1.0
1950	0.4	0.2	0.4	0.9	1.3	1.4	2.2	2.8	3.7	1.5	0.7	0.4	1.3
1951	0.3	0.3	0.3	7.0	5.8	5.5	2.2	2.9	1.8	2.0	2.9	7.8	3.2
1952	3.8	0.9	0.6	2.8	12.8	4.2	1.8	3.3	2.9	1.6	1.0	0.7	3.0
1953	0.4	0.2	0.1	0.4	0.6	0.7	0.6	0.8	0.6	0.4	0.4	0.4	0.5
1954	0.2	0.1	0.1	0.4	2.9	4.8	2.5	2.2	3.5	1.6	0.8	0.7	1.7
1955	0.4	0.4	0.2	0.4	1.0	0.6	1.0	2.9	5.4	4.0	1.6	1.2	1.6
1956	2.6	2.0	0.9	2.3	6.6	4.8	3.0	3.4	5.5	2.6	1.8	1.1	3.0
1957	0.5	0.4	0.4	3.0	7.2	9.5	4.0	3.4	2.9	1.0	0.7	0.6	2.8
1958	0.4	0.6	0.6	0.6	4.2	2.1	2.2	2.1	2.9	1.8	0.9	0.7	1.6
1959	0.5	0.4	0.7	2.3	4.4	2.2	1.0	1.2	1.8	1.4	1.5	0.9	1.5
1960	0.6	0.4	1.1	4.4	4.0	3.5	2.3	2.5	5.0	2.8	1.5	0.8	2.4
1961	0.4	0.3	0.3	0.6	1.5	1.0	0.8	2.1	2.9	3.6	16.4	14.4	3.7
1962	5.4	1.7	0.8	2.1	11.6	7.1	5.6	2.9	5.5	4.6	2.0	1.1	4.2
1963	2.0	1.6	1.3	4.7	16.8	7.5	2.2	3.2	2.4	0.7	0.8	5.6	4.1
1964	2.1	0.8	1.6	11.8	6.9	3.1	4.4	4.5	3.8	4.8	1.4	0.7	3.8
1965	0.6	0.4	0.3	2.1	4.6	1.5	1.0	1.0	1.1	0.7	2.0	1.4	1.4
1966	0.7	0.7	2.0	5.7	5.1	2.1	1.7	1.6	4.5	1.5	1.4	0.8	2.3
1967	0.4	0.3	0.2	1.3	6.3	4.1	4.8	2.5	2.0	1.1	1.3	3.6	2.3
1968	1.0	1.1	3.2	7.6	10.2	5.9	3.6	5.9	3.0	1.1	1.9	5.9	4.2
1969	1.4	3.1	2.5	1.9	2.4	1.5	0.9	1.1	2.2	0.9	0.6	0.4	1.6
1970	0.9	1.4	4.2	8.0	7.3	5.2	2.7	5.1	5.0	3.7	1.7	0.8	3.8
1971	0.7	0.4	0.3	0.7	2.6	4.2	4.1	6.4	5.9	2.9	1.1	0.7	2.5
1972	0.6	0.6	0.5	0.5	2.0	2.6	2.9	2.8	1.7	1.3	4.7	3.0	1.9
1973	2.8	2.1	1.3	0.8	2.1	5.1	2.0	3.1	4.0	2.3	1.9	0.8	2.4
1974	0.4	0.3	0.4	4.6	3.2	3.6	8.3	4.2	3.5	2.7	1.5	0.7	2.8
1975	0.4	0.3	0.3	1.8	2.1	3.2	2.7	6.0	8.6	5.2	2.3	0.9	2.8
1976	0.6	0.4	0.3	0.5	1.4	2.6	3.7	3.2	4.6	1.4	0.7	0.6	1.7
1977	0.7	1.5	0.9	5.7	10.4	5.1	7.0	5.0	3.5	1.7	7.0	5.0	4.5
1978	2.0	1.8	10.6	12.5	9.7	2.9	3.7	3.5	4.5	4.7	2.6	1.8	5.0
1979	1.3	4.4	3.0	4.4	5.9	4.8	3.6	4.0	2.2	1.0	0.6	0.5	3.0
1980	0.4	0.3	0.5	0.9	2.5	3.5	4.1	2.1	2.0	0.9	0.8	0.7	1.6
1981	0.4	0.4	0.8	9.0	5.9	2.1	2.6	5.0	3.9	3.6	1.4	0.8	3.0
1982	0.5	0.3	0.2	0.3	2.8	4.6	2.3	4.1	3.2	2.3	7.7	10.4	3.2
1983	1.7	0.7	0.5	1.1	3.1	3.2	2.7	3.5	6.8	5.1	3.3	1.6	2.8
1984	1.0	0.6	0.4	0.7	0.9	0.6	0.7	1.8	2.0	1.2	1.0	1.9	1.1
1985	0.6	0.6	0.6	6.6	6.8	4.9	3.0	4.9	4.0	1.4	1.5	1.0	3.0
1986	0.5	0.5	0.5	0.9	2.4	2.3	1.6	2.1	2.1	1.2	0.8	1.0	1.3
1987	0.6	0.5	1.3	1.7	4.3	8.3	3.1	1.5	1.3	1.1	2.3	1.6	2.3
1988	1.0	0.9	1.1	5.2	10.8	3.8	3.3	6.3	5.7	5.2	2.5	1.3	3.9
1989	0.8	0.9	0.9	4.2	7.6	3.5	2.0	3.1	5.1				3.1
Mean	1.0	0.8	1.1	3.2	5.2	3.6	2.8	3.3	3.6	2.2	2.1	2.0	30.9

Source: Feasibility Study on Magwagwa Hydorelectric Power Development Project

Table VII-6 Mean Half-monthly Flow in the Nyando River (1DG04)

(m3/sec)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	
1960	1.4	1.7	1.1	1.0	3.5	14.9	25.6	19.4	18.3	22.0	9.3	6.2	6.2	5.1	6.0	13.1	18.6	12.7	7.8	4.3	6.0	5.8	1.8	1.9	8.9
1961	0.8	0.5	0.9	0.5	1.0	2.3	5.9	3.1	7.3	4.6	2.8	2.4	2.3	2.8	18.3	30.3	26.7	16.3	14.3	9.3	35.4	65.9	53.9	61.6	15.4
1962	51.9	31.0	11.7	9.1	12.3	19.7	27.6	48.9	79.0	60.7	32.0	47.1	29.4	33.1	39.1	36.8	38.7	36.6	21.5	25.9	14.4	12.2	13.1	12.5	31.0
1963	11.4	12.5	11.8	11.1	11.3	13.1	11.9	49.6	91.8	59.5	60.3	20.6	17.9	15.6	22.6	36.6	24.1	12.2	9.3	8.5	7.5	21.2	49.5	21.6	25.5
1964	11.3	8.7	8.1	7.9	10.0	10.6	15.2	55.5	24.9	22.0	16.4	14.9	29.9	26.9	44.9	30.7	35.0	31.7	31.0	20.3	10.8	9.1	7.5	8.2	20.5
1965	7.7	5.5	5.1	4.1	4.3	4.5	4.5	9.1	7.4	6.0	3.9	3.6	3.7	3.9	4.4	4.8	3.6	3.7	3.2	5.7	7.0	5.4	4.8	4.8	5.0
1966	4.3	3.6	5.8	6.0	8.7	12.7	9.4	37.9	14.5	8.4	9.1	9.5	8.6	11.6	9.0	14.9	23.2	13.6	6.9	6.2	7.3	5.7	4.1	3.7	10.2
1967	2.7	2.6	3.5	2.4	2.8	2.6	8.9	9.9	22.2	30.6	12.3	14.6	27.4	34.0	19.4	22.5	15.6	11.5	7.5	8.6	7.3	24.2	28.1	14.4	14.0
1968	6.1	5.2	6.3	19.5	14.1	15.8	21.5	50.9	32.6	26.5	21.8	21.6	15.7	20.7	27.4	30.5	14.3	10.1	7.7	8.2	7.2	7.3	15.1	5.6	17.2
1969	4.0	7.7	9.5	13.3	6.0	12.5	4.4	4.1	8.1	8.5	5.0	5.7	4.8	5.3	7.4	8.0	8.8	7.6	4.5	4.5	4.0	3.5	3.1	2.2	6.4
1970	4.9	10.4	7.9	5.0	9.2	10.4	13.0	21.8	22.5	16.7	14.8	14.4	14.8	11.3	18.5	31.9	22.0	18.6	12.7	10.0	7.0	5.4	4.5	4.3	13.0
1971	3.4	3.7	2.5	2.1	2.3	2.5	6.3	13.9	17.2	17.0	13.2	16.0	17.5	22.5	19.7	29.1	27.7	17.0	16.0	10.8	7.5	6.2	4.7	6.9	11.9
1972	5.2	4.1	7.3	5.5	3.5	3.3	2.8	3.5	14.1	11.1	10.1	10.8	14.4	12.0	10.5	13.5	8.2	7.4	5.9	14.3	27.8	20.4	11.1	8.8	9.8
1973	8.2	8.9	6.4	11.6	6.0	3.9	4.0	5.0	9.6	11.2	12.9	9.7	7.5	6.8	14.6	18.7	16.4	18.7	11.3	7.6	7.6	6.7	4.1	3.6	9.2
1974	3.8	2.7	2.2	2.1	3.1	3.8	17.9	14.3	9.3	9.9	12.4	8.5	23.7	25.0	13.1	11.5	13.3	11.7	9.0	7.4	5.5	4.6	3.6	3.3	9.2
1975	2.6	2.2	2.6	3.0	3.1	4.7	7.4	11.4	4.4	9.3	13.2	11.7	8.4	20.5	25.2	31.5	47.1	24.3	23.9	17.4	9.6	7.3	8.9	4.7	12.7
1976	4.1	3.1	3.0	3.1	2.4	2.7	4.0	4.5	5.0	10.2	9.0	8.5	11.2	13.2	12.1	12.4	15.5	9.3	5.7	4.2	3.5	4.9	4.1	2.8	6.6
1977	3.9	3.5	6.3	5.0	3.9	3.4	15.6	10.7	31.5	29.0	23.1	20.6	22.9	19.3	23.3	19.5	15.8	16.9	9.7	11.2	19.8	40.7	19.5	13.6	16.2
1978	10.5	13.5	8.5	11.7	15.6	22.4	23.7	21.9	27.8	19.6	11.4	12.3	18.1	16.1	18.4	19.2	21.7	17.5	18.1	13.5	10.9	8.8	8.1	12.3	15.9
Mean	7.8	6.9	5.8	6.5	6.5	8.7	12.1	20.8	23.6	20.1	15.4	13.6	15.0	16.1	18.6	21.9	20.9	15.7	11.9	10.4	10.8	14.0	13.1	10.4	13.6

Table VII-7 Mean Half-monthly Divertable Flow in the Nyando River

(m3/sec)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	
1960	0.4	0.6	0.2	0.2	1.7	8.5	7.3	10.0	10.0	10.0	7.9	5.5	5.5	4.4	5.3	9.4	10.0	9.3	4.5	2.2	3.3	3.2	0.6	0.7	5.0
1961	0.0	0.0	0.1	0.0	0.2	0.9	3.2	2.4	6.6	3.9	2.1	1.7	1.6	2.1	10.0	9.6	9.8	10.0	8.3	5.5	10.0	10.0	10.0	10.0	4.9
1962	10.0	10.0	7.0	5.4	7.3	9.5	5.4	10.0	10.0	10.0	10.0	10.0	9.6	10.0	10.0	10.0	10.0	10.0	9.3	7.0	8.3	7.3	7.7	7.4	8.8
1963	6.8	7.4	7.0	6.6	6.8	7.7	7.1	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.2	5.6	5.0	4.3	9.3	10.0	9.2	8.4
1964	6.8	5.2	4.8	4.6	5.9	6.3	8.7	10.0	9.9	10.0	10.0	9.8	9.6	9.8	10.0	9.6	10.0	10.0	10.0	9.4	6.5	5.4	4.3	4.8	8.0
1965	4.5	3.0	2.7	2.1	2.2	2.3	2.3	7.8	6.7	5.3	3.2	2.9	3.0	3.2	3.6	4.1	2.9	3.0	1.5	3.1	4.0	2.9	2.6	2.6	3.4
1966	2.2	1.8	3.2	3.4	5.1	7.5	5.6	10.0	9.8	7.4	7.8	8.0	7.5	8.9	7.7	9.8	10.0	9.6	3.9	3.5	4.2	3.1	2.1	1.8	6.0
1967	1.2	1.1	1.7	1.0	1.2	1.1	5.3	8.2	10.0	9.6	9.2	9.8	9.7	10.0	10.0	10.0	10.0	8.9	4.4	5.0	4.2	8.2	4.8	8.3	6.4
1968	4.3	9.3	10.0	9.2	6.8	5.2	4.8	4.6	5.9	6.3	8.7	10.0	9.9	10.0	10.0	9.8	9.6	9.8	10.0	9.6	10.0	10.0	10.0	9.4	8.5
1969	2.0	4.5	5.7	7.8	3.3	7.4	2.3	3.4	7.2	7.4	4.3	5.0	4.1	4.6	6.7	7.2	7.7	6.9	2.4	2.4	2.0	1.7	1.4	0.8	4.5
1970	2.6	6.2	4.6	2.6	5.4	6.2	7.7	10.0	10.0	10.0	9.8	9.8	9.8	8.9	10.0	10.0	10.0	10.0	7.5	6.0	4.0	2.9	2.3	2.2	7.0
1971	1.6	1.8	1.0	0.8	1.0	1.0	3.5	9.6	10.0	10.0	9.5	10.0	10.0	10.0	10.0	9.6	9.7	10.0	8.9	6.5	4.4	3.5	2.5	4.0	6.2
1972	2.8	2.1	4.2	3.0	1.7	1.5	1.3	2.8	9.7	8.8	8.3	8.6	9.8	9.1	8.5	9.5	7.3	6.7	3.3	8.3	5.2	9.4	6.6	5.2	6.0
1973	4.8	5.3	3.6	6.9	3.3	2.0	2.0	4.3	8.1	8.8	9.4	8.2	6.8	6.1	9.8	10.0	10.0	10.0	6.8	4.4	4.4	3.8	2.1	1.7	5.9
1974	1.9	1.2	0.8	0.8	1.4	1.9	9.4	9.7	7.9	8.2	9.2	7.5	10.0	9.9	9.5	8.9	9.5	9.0	5.4	4.3	3.0	2.4	1.8	1.6	5.6
1975	1.1	0.9	1.1	1.4	1.4	2.5	4.3	8.9	3.7	8.0	9.5	9.0	7.4	10.0	9.9	10.0	10.0	10.0	8.4	9.3	5.7	4.2	5.3	2.5	6.0
1976	2.1	1.4	1.4	1.4	1.0	1.2	2.0	3.8	4.3	8.4	7.8	7.4	8.8	9.5	9.1	9.2	9.9	7.9	3.1	2.1	1.7	2.6	2.1	1.3	4.6
1977	2.0	1.7	3.5	2.7	1.9	1.6	8.8	8.6	10.0	9.7	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	5.8	6.7	9.5	10.0	9.5	8.0	7.5
1978	6.3	7.9	5.0	7.0	8.8	9.0	8.5	10.0	9.7	10.0	8.9	9.2	10.0	10.0	10.0	10.0	10.0	10.0	9.4	7.9	6.5	5.2	4.7	7.3	8.4
Mean	3.3	3.7	3.6	3.5	3.5	4.4	5.2	7.6	8.4	8.5	8.2	8.0	8.1	8.2	9.0	9.3	9.3	9.0	6.2	5.7	5.3	5.5	4.8	4.7	6.4

Table VII-8 Main Facilities of Alternatives

	Case 1	Case 2	Case 3
Regulating pond	510,000 m^3	510,000 m^3	340,000 m^3
Main irrigation canals			
Nyakach Kano main canal	46 km	46 km	46 km
South Nyanza main canal	22 km	22 km	22 km
South Nyando main canal	30 km	30 km	-
North Nyando main canal	31 km	-	-
Secondary canals	283 km	255 km	220 km
Sondu syphon	1,000 m	1000 m	1000 m
Nyando syphon	120 m	-	-
Nyando diversion works	1	1	-
Drainage and flood control	184 km	158 km	103 km

Source : Prepared by JICA Study Team

Table VII-9 Capital Investment Cost of Alternatives

(million Ksh.)

Description	Case 1	Case 2	Case 3
A. Construction cost	7,578	6,568	3,072
(1) Preparatory works	530	459	215
(2) Direct construction cost	5,299	4,588	2,149
- Regulating pond			
- Nyando diversion works			
- Main irrigation canals			
- Secondary, tertiary & on-farm			
- Drainage and flood control			
(3) Contractor's expense	1,060	917	430
(4) Physical contingency	689	596	278
B. O & M equipment	49	37	26
C. Administration cost	229	198	93
D. Engineering cost	762	660	310
Total	8,618	7,455	3,501

Source : Prepared by JICA Study Team

Table VII-10 Mean Monthly Reference Crop Evapotranspiration

(mm/day)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1970	4.98	5.89	5.18	5.04	4.72	4.59	4.47	4.26	5.21	5.79	5.41	5.43	5.08
1971	5.09	6.48	6.25	5.10	4.35	4.15	4.29	4.64	5.35	6.01	5.72	5.18	5.22
1972	6.07	5.08	5.91	5.91	5.18	4.17	4.31	4.61	5.47	5.24	4.98	5.51	5.20
1973	5.55	5.67	6.26	5.76	4.71	4.43	4.40	4.93	5.63	6.01	5.66	6.00	5.42
1974	6.10	6.65	5.04	4.97	4.63	4.54	3.84	4.89	4.81	5.59	5.24	5.75	5.17
1975	6.57	6.63	6.01	5.09	4.81	4.29	4.26	3.90	4.56	4.95	5.54	5.59	5.18
1976	6.16	5.88	6.36	5.28	4.28	4.25	3.86	4.67	5.32	5.76	5.76	5.40	5.25
1977	4.93	5.43	5.86	4.49	4.78	4.38	4.55	4.92	5.74	6.08	4.51	5.26	5.08
1978	5.73	5.73	4.75	4.84	4.82	4.18	4.34	4.75	5.24	5.45	5.33	5.15	5.03
1979	5.39	5.26	6.17	5.19	4.85	4.28	4.70	5.15	5.73	5.96	5.29	5.70	5.31
1980	6.23	6.48	6.28	5.73	4.30	4.38	4.55	4.80	5.58	5.92	4.98	5.69	5.41
1981	6.35	6.79	5.23	5.06	4.92	4.65	3.85	4.50	4.74	5.48	5.15	5.36	5.17
1982	5.55	5.67	6.01	4.43	4.14	4.54	4.46	4.53	5.28	5.03	4.81	5.12	4.96
1983	6.16	6.29	6.46	5.51	5.14	4.66	4.43	4.60	5.14	4.94	5.32	4.97	5.30
1984	5.80	6.82	6.66	5.77	5.26	4.77	4.74	5.20	5.92	5.59	5.10	5.53	5.60
1985	6.04	5.77	6.03	4.71	4.71	4.60	4.49	4.99	5.79	5.98	5.50	6.01	5.39
1986	6.10	6.62	6.05	4.89	4.87	3.99	4.61	5.40	5.39	5.70	5.08	5.22	5.33
1987	5.55	6.21	6.07	5.60	4.43	4.15	5.04	5.12	5.91	6.23	4.87	6.13	5.44
1988	5.46	6.15	5.66	4.63	5.22	4.75	4.36	4.84	4.77	5.39	5.28	5.47	5.17
Mean	5.78	6.08	5.91	5.16	4.74	4.41	4.40	4.77	5.35	5.64	5.24	5.50	5.25

Table VII-11 Crop Coefficient

Crop	Month				
	1st	2nd	3rd	4th	5th
Paddy	1.00	1.05	0.95	-	
Maize	0.04	0.80	1.00	1.00	0.40
Cotton	0.35	0.70	0.90	0.95	-
Groundnut	0.50	0.95	0.90	0.50	-
Green gram	0.50	0.95	0.90	0.25	-
Fruit tree	0.6 throughout the year				
Vegetable	0.50	0.95	0.90	0.25	-
Sugar cane					

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
0.54	0.67	0.72	0.68	0.98	1.00	1.00	1.00	1.00	1.00	0.95	0.83

Note: Crop coefficient of sugar cane is quoted from Multipurpose Yala Reservoir Project, Draft Proposals, United Nations, March, 1986.

Source : Prepared by JICA Study Team

Table VII-12 Monthly Rainfall at Nyakwere and Ahero

Station : Nyakwere (9034067) (mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1955	63	51	93	121	141	12	127	80	131	46	98	163	1,126
1956	93	65	89	173	212	98	44	112	88	64	24	56	1,118
1957	22	100	71	191	162	243	7	214	34	58	58	189	1,349
1958	2	52	167	133	243	54	87	127	17	69	1	56	1,008
1959	13	46	250	115	117	2	48	22	44	52	41	38	788
1960	24	88	150	163	180	15	30	43	60	91	92	14	950
1961	16	37	132	132	213	26	53	176	114	88	518	380	1,885
1962	117	41	171	107	361	134	101	39	83	77	91	94	1,416
1963	129	68	159	210	238	24	83	40	7	15	136	202	1,311
1964	43	85	53	239	59	94	143	71	149	71	2	78	1,087
1965	10	9	45	192	96	32	53	20	26	86	73	38	680
1966	22	115	192	157	56	32	67	121	90	42	36	26	956
1967	20	53	91	221	137	176	116	53	36	54	119	130	1,206
1968	9	156	107	280	157	38	108	189	28	61	92	62	1,287
1969	133	119	214	63	239	56	67	41	59	132	83	38	1,244
1970	59	88	173	185	70	59	75	89	39	29	32	119	1,017
1971	25	6	22	123	122	81	61	49	34	69	55	29	676
1972	51	50	58	37	78	49	42	118	81	74	125	74	837
1973	88	35	17	172	227	123	5	149	15	28	62	75	996
1974	41	11	103	137	138	104	103	126	147	44	25	52	1,031
1975	25	61	156	101	197	81	51	188	171	88	21	50	1,190
1976	10	57	12	87	119	29	121	120	65	30	96	219	965
1977	323	78	120	444	250	107	48	91	39	177	249	47	1,973
1978	138	103	264	199	99	8	123	97	39	32	100	18	1,220
Mean	62	66	121	166	163	70	73	99	67	66	93	94	1,138

Station: Ahero (mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1960	42	38	224	156	150	34	80	48	138	50	126	15	1,101
1961	5	50	99	163	159	29	28	95	110	148	568	324	1,778
1962	121	20	191	193	227	137	113	48	83	139	167	58	1,497
1963	108	182	201	210	190	64	38	57	38	44	212	159	1,503
1964	57	159	105	254	99	69	156	48	53	57	29	93	1,179
1965	83	23	198	199	76	13	42	38	86	156	50	111	1,075
1966	48	155	271	198	21	46	94	79	102	145	78	16	1,253
1967	25	41	90	222	161	67	31	34	91	68	145	116	1,091
1968	6	203	108	249	107	102	40	71	33	78	102	126	1,225
1969	135	119	128	175	136	87	58	43	39	37	111	75	1,143
1970	225	101	146	198	85	96	72	116	38	32	86	56	1,251
1971	60	7	31	220	171	149	56	71	50	47	134	68	1,064
1972	34	96	67	203	128	62	52	51	139	102	152	72	1,158
1973	154	133	4	76	251	49	71	138	70	57	113	28	1,144
1974	43	19	218	283	127	72	79	84	58	36	109	76	1,204
1975	10	78	178	98	117	60	102	233	65	61	43	79	1,124
1976	112	60	43	144	98	82	122	104	79	22	82	84	1,032
1977	86	124	117	231	121	104	59	68	49	127	157	22	1,265
1978	126	135	202	234	62	52	151	76	89	125	47	138	1,437
1979	79	203	225	101	154	65	54	42	134	57	103	105	1,322
1980	63	31	97	179	103	92	50	46	92	25	68	119	965
1981	8	30	222	167	155	51	128	98	115	28	76	8	1,086
1982	55	175	51	131	199	162	47	167	57	73	178	34	1,329
1983	32	66	69	217	97	58	70	132	39	153	37	61	1,031
1984	60	34	54	170	80	121	73	66	74	124	72	131	1,059
1985	37	46	177	252	165	34	65	138	60	60	84	31	1,149
1986	48	72	151	256	139	74	84	27	99	118	105	137	1,310
1987	58	64	144	204	144	159	34	76	42	68	151	38	1,182
1988	234	18	151	335	136	36	42	107	91	68	82	11	1,311
Mean	74	86	137	197	133	77	72	83	76	79	120	82	1,216

[ ] Interpolated Source: LBDA

Table VII-13 (a) Unit Water Requirement of Crop

Long Rains Paddy

Description	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First
Cropping pattern												
a) Land preparation	4.17	4.17	4.17	4.17								
b) Topping up		1.50	1.50	1.50	1.50							
c) Re-flooding			2.50	2.50	2.50	2.50						
d) Sub-total	4.17	5.67	8.17	8.17	4.00	2.50						
e) Half-monthly rainfall 1978	72.0	57.3	45.7	65.5	199	87.2	112	57.5	41.5	3.9	4.1	79.3
f) Converted to daily rainfall	4.50	3.82	5.72	4.36	12	5.81	7.46	3.83	2.59	0.26	0.27	5.29
g) Effective rainfall	3.15	2.67	4.00	3.06	8.69	4.07	5.22	2.68	1.81	0.18	0.19	3.70
h) Water requirement d)-g)	1.02	3.00	4.17	5.11	0.00	0.00						
i) Crop coefficient, Kc				1.00	1.00	1.05	1.05	0.95	0.95			
					1.00	1.00	1.05	1.05	0.95	0.95		
						1.00	1.00	1.05	1.05	0.95	0.95	
							1.00	1.00	1.05	1.05	0.95	0.95
j) Average Kc				1.00	1.00	1.02	1.03	1.01	1.00	0.98	0.95	0.95
k) ETo				5.91	5.91	5.16	5.16	4.74	4.74	4.41	4.41	4.40
l) Consumptive use j)x k)				5.91	5.91	5.25	5.29	4.80	4.74	4.34	4.19	4.18
m) Percolation rate				4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
n) Water requirement l)+m)-g)				6.85	1.22	5.18	4.07	6.12	6.93	8.15	8.00	4.48
o) Cropping area				0.25	0.50	0.75	1.00	1.00	1.00	0.75	0.50	0.25
p) Net water req. n)x o)				1.71	0.61	3.88	4.07	6.12	6.93	6.11	4.00	1.12
q) Total water req. h)+p)	1.02	3.00	4.17	6.83	0.61	3.88	4.07	6.12	6.93	6.11	4.00	1.12
r) Gross water req. q)/oief	2.0	6.0	8.3	13.7	1.2	7.8	8.1	12.2	13.9	12.2	8.0	2.2
s) -ditto- (l/sec/ha)	0.24	0.69	0.96	1.58	0.14	0.90	0.94	1.41	1.60	1.41	0.92	0.26

Average: 0.92 Anuual: 10.8 (1000 m3 in 1 ha) Max.: 1.60

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), i), g) and o)

Unit Water Requirement of Long rains paddy

Year	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First
1960	0.84	0.78	1.10	1.96	0.58	1.03	1.16	0.91	1.26	1.39	0.91	0.42
1961	0.88	1.09	1.56	2.02	0.64	1.14	1.35	0.70	1.12	1.34	0.88	0.38
1962	0.28	1.26	1.16	2.09	0.37	0.98	1.82	0.00	0.49	1.26	0.35	0.30
1963	0.44	0.69	1.67	1.64	0.65	1.35	0.41	0.75	0.66	1.26	0.94	0.31
1964	0.94	0.82	1.09	2.03	1.74	1.11	0.23	1.64	1.79	1.24	0.58	0.19
1965	0.89	1.22	1.89	2.41	1.44	0.98	0.90	1.26	1.81	1.23	0.92	0.36
1966	0.76	1.12	0.00	2.34	0.22	1.38	1.19	1.81	1.67	1.19	0.95	0.38
1967	0.86	0.74	1.89	2.29	0.89	0.19	1.36	1.27	1.35	1.31	0.09	0.27
1968	0.87	0.65	0.40	1.57	1.43	0.96	0.00	1.05	1.36	1.21	0.90	0.25
1969	0.00	0.43	1.20	2.28	0.02	1.59	1.80	0.94	0.47	1.02	0.93	0.39
1970	0.50	0.78	1.10	1.40	0.59	1.16	1.26	1.34	1.90	1.17	0.81	0.34
1971	0.74	1.28	1.83	2.46	1.74	1.45	1.24	0.92	1.83	1.04	0.78	0.34
1972	0.76	0.91	1.63	1.87	1.86	2.14	1.77	1.79	1.57	1.13	0.89	0.46
1973	0.78	1.09	1.60	2.46	1.81	0.81	1.38	0.07	1.57	0.68	0.79	0.47
1974	0.96	1.19	1.89	2.31	0.68	0.52	1.89	1.10	0.59	1.24	0.78	0.43
1975	0.78	0.70	1.79	1.50	0.59	0.93	1.70	0.78	1.24	1.05	0.78	0.43
1976	0.91	0.97	1.38	2.42	1.93	1.46	1.62	1.29	1.52	1.33	0.87	0.26
1977	0.00	0.84	1.19	2.06	0.70	0.03	0.00	0.47	0.96	1.02	0.65	0.39
1978	0.24	0.69	0.96	1.58	0.14	0.90	0.94	1.41	1.60	1.41	0.92	0.26
Average	0.65	0.91	1.33	2.04	0.95	1.06	1.16	1.03	1.30	1.19	0.77	0.35

Source : Prepared by JICA Study Team

Table VII-13 (b) Unit Water Requirement of Crop

Short Rains Paddy

Description		July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
Cropping pattern													
a) Land preparation		4.17	4.17	4.17	4.17								
b) Topping up			1.50	1.50	1.50	1.50							
c) Re-flooding				2.50	2.50	2.50	2.50						
d) Sub-total		4.17	5.67	8.17	8.17	4.00	2.50						
e) Half-monthly rainfall	1978	43.7	43.0	54.0	21.8	17.2	15.9	16.1	39.7	60.3	9.9	8.1	32.3
f) Converted to daily rainfall		2.73	2.86	3.38	1.45	1.15	1.06	1.00	2.65	4.02	0.66	0.50	2.15
g) Effective rainfall		1.91	2.01	2.36	1.02	0.80	0.74	0.70	1.85	2.81	0.46	0.35	1.51
h) Water requirement d)-g)		2.26	3.66	5.81	7.15	3.20	1.76						
i) Crop coefficient, Kc					1.00	1.00	1.05	1.05	0.95	0.95			
						1.00	1.00	1.05	1.05	0.95	0.95		
							1.00	1.00	1.05	1.05	0.95	0.95	
								1.00	1.00	1.05	1.05	0.95	0.95
j) Average Kc					1.00	1.00	1.02	1.03	1.01	1.00	0.98	0.95	0.95
k) ETo					5.35	5.35	5.64	5.64	5.24	5.24	5.50	5.50	5.78
l) Consumptive use j)x k)					5.35	5.35	5.73	5.78	5.31	5.24	5.41	5.23	5.49
m) Percolation rate					4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
n) Water requirement l)+m)-g)					8.33	8.55	8.99	9.08	7.45	6.43	8.94	8.87	7.98
o) Cropping area					0.25	0.50	0.75	1.00	1.00	1.00	0.75	0.50	0.25
p) Net water req. n)x o)					2.08	4.27	6.74	9.08	7.45	6.43	6.71	4.44	2.00
q) Total water req. h)+p)		2.26	3.66	5.81	9.24	7.47	8.50	9.08	7.45	6.43	6.71	4.44	2.00
r) Gross water req. q)/oief		4.5	7.3	11.6	18.5	14.9	17.0	18.2	14.9	12.9	13.4	8.9	4.0
s) -ditto-	(l/sec/ha)	0.52	0.85	1.34	2.14	1.73	1.97	2.10	1.73	1.49	1.55	1.03	0.46

Average: 1.41   Annual: 16.4 (1000 m3 in 1 ha)   Max.: 2.14

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), i), g) and o)

Unit Water Requirement of Short rains paddy

Year	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
1960	0.86	1.11	1.65	1.98	1.58	1.41	1.80	1.76	1.54	1.57	1.04	0.53
1961	0.77	0.47	0.90	1.57	1.19	1.44	1.82	0.00	0.00	0.00	0.21	0.42
1962	0.60	1.22	1.59	1.60	1.67	1.64	1.82	2.10	1.32	1.44	0.72	0.34
1963	0.75	1.03	1.75	2.43	1.90	2.10	2.20	1.85	0.97	0.73	0.74	0.34
1964	0.59	1.05	1.42	2.08	0.42	1.60	1.90	2.15	2.13	1.28	0.89	0.53
1965	0.85	1.26	1.74	2.21	1.88	1.84	1.74	1.83	1.68	1.52	0.95	0.55
1966	0.66	1.31	0.67	1.52	1.64	1.74	2.12	1.80	2.14	1.47	1.04	0.52
1967	0.49	0.92	1.66	2.27	1.62	1.70	2.02	1.89	0.97	1.06	0.90	0.55
1968	0.71	0.06	1.14	2.07	1.99	1.88	1.82	1.76	1.54	1.15	1.06	0.51
1969	0.53	1.08	1.65	1.72	1.91	0.77	1.94	2.08	1.47	1.44	0.98	0.50
1970	0.64	0.86	1.30	1.93	1.97	2.14	2.01	2.09	1.86	1.07	0.76	0.54
1971	0.87	1.09	1.60	2.26	1.15	1.52	1.97	1.90	1.82	1.50	1.00	0.46
1972	0.67	0.86	1.22	1.17	1.11	1.77	1.78	0.94	2.00	1.53	1.00	0.36
1973	0.93	0.30	1.35	2.32	1.90	2.01	2.12	1.70	1.91	1.30	0.90	0.44
1974	0.72	0.60	1.12	1.18	1.13	2.04	1.95	1.99	2.03	1.62	0.81	0.53
1975	0.60	0.41	0.83	1.14	0.78	1.44	1.82	2.06	2.00	1.41	0.95	0.54
1976	0.53	0.74	1.21	1.94	1.54	1.99	2.11	1.74	1.51	0.65	0.57	0.13
1977	0.79	0.88	1.38	2.14	1.73	0.98	1.36	1.09	0.52	1.42	0.96	0.37
1978	0.52	0.85	1.34	2.14	1.73	1.97	2.10	1.73	1.49	1.55	1.03	0.46
Average	0.69	0.85	1.34	1.88	1.52	1.68	1.92	1.71	1.52	1.25	0.87	0.45

Source : Prepared by JICA Study Team

Table VII-13 (c) Unit Water Requirement of Crop

Maize-1

Description		Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First
Cropping pattern													
a) Land preparation		2.50	2.50	2.50	2.50								
b) Topping up													
c) Re-flooding													
d) Sub-total		2.50	2.50	2.50	2.50								
e) Half monthly rainfall	1978	72	57	46	65	199	87	112	58	41	4	4	79
f) Effective rainfall			1.42	1.15	1.48	3.33	2.12	2.75	1.53	0.97	0.00	0.00	1.83
g) Water requirement		2.50	2.50	2.50	2.50								
h) Crop coefficient, Kc			0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00			
				0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00		
					0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00	
						0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00
i) Average Kc			0.40	0.40	0.53	0.60	0.75	0.90	0.95	1.00	1.00	1.00	1.00
j) ETo			6.08	6.08	5.91	5.91	5.16	5.16	4.74	4.74	4.41	4.41	4.40
k) Consumptive use i)x j)			2.43	2.43	3.15	3.55	3.87	4.64	4.50	4.74	4.41	4.41	4.40
-ditto- (in one month)			73	73	95	106	116	139	135	142	132	132	132
l) Water requirement k)-f)			1.02	1.28	1.67	0.21	1.75	1.89	2.97	3.77	4.41	4.41	2.57
m) Cropping area			0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50
n) Net water req. l)x m)			0.25	0.64	1.25	0.21	1.75	1.89	2.97	3.77	4.41	3.31	1.28
o) Total water req. g)+n)		2.50	2.75	3.14	3.75	0.21	1.75	1.89	2.97	3.77	4.41	3.31	1.28
p) Gross water req. o)/oief		5.00	5.51	6.28	7.50	0.43	3.49	3.79	5.94	7.53	8.82	6.62	2.57
q) -ditto-	(l/sec/ha)	0.58	0.64	0.73	0.87	0.05	0.40	0.44	0.69	0.87	1.02	0.77	0.30

Average: 0.61 Annual: 7.14 (1000 m3 in 1 ha) Max.: 1.02

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Unit Water Requirement of Maize-1

Year	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First
1960	0.58	0.65	0.76	0.97	0.24	0.47	0.57	0.49	0.65	0.95	0.71	0.44
1961	0.58	0.69	0.83	0.97	0.30	0.54	0.63	0.37	0.59	0.95	0.71	0.40
1962	0.58	0.72	0.76	1.02	0.09	0.47	0.92	0.08	0.28	0.88	0.30	0.33
1963	0.58	0.64	0.83	0.87	0.30	0.61	0.20	0.37	0.34	0.88	0.77	0.33
1964	0.58	0.65	0.76	0.97	0.68	0.54	0.15	0.82	0.95	0.88	0.50	0.23
1965	0.58	0.70	0.86	1.13	0.61	0.47	0.44	0.62	0.95	0.88	0.77	0.40
1966	0.58	0.70	0.61	1.07	0.05	0.68	0.57	0.90	0.87	0.80	0.77	0.40
1967	0.58	0.65	0.86	1.07	0.41	0.01	0.63	0.62	0.72	0.95	0.13	0.30
1968	0.58	0.64	0.67	0.87	0.61	0.47	0.05	0.55	0.72	0.88	0.71	0.26
1969	0.58	0.61	0.76	1.07	0.05	0.68	0.85	0.49	0.28	0.74	0.77	0.44
1970	0.58	0.65	0.76	0.82	0.24	0.61	0.57	0.69	1.02	0.80	0.66	0.37
1971	0.58	0.72	0.86	1.13	0.68	0.68	0.57	0.49	0.95	0.74	0.66	0.37
1972	0.58	0.67	0.83	0.92	0.75	0.90	0.85	0.90	0.80	0.80	0.71	0.51
1973	0.58	0.69	0.83	1.13	0.75	0.34	0.63	0.11	0.80	0.47	0.66	0.51
1974	0.58	0.70	0.86	1.07	0.36	0.16	0.92	0.55	0.34	0.88	0.66	0.47
1975	0.58	0.64	0.86	0.82	0.24	0.40	0.85	0.42	0.65	0.74	0.60	0.47
1976	0.58	0.67	0.79	1.13	0.75	0.68	0.77	0.62	0.80	0.95	0.71	0.30
1977	0.58	0.67	0.76	1.02	0.36	0.00	0.00	0.26	0.52	0.74	0.55	0.44
1978	0.58	0.64	0.73	0.87	0.05	0.40	0.44	0.69	0.87	1.02	0.77	0.30
Averave	0.58	0.67	0.79	1.00	0.40	0.48	0.56	0.53	0.69	0.84	0.64	0.38

Source : Prepared by JICA Study Team

Table VII-13 (d) Unit Water Requirement of Crop

Maize-2

Description		Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last
Cropping pattern													
a) Land preparation		2.50	2.50	2.50	2.50								
b) Topping up													
c) Re-flooding													
d) Sub-total		2.50	2.50	2.50	2.50								
e) Half monthly rainfall	1978	66	72	57	46	65	199	87	112	58	41	4	4
f) Effective rainfall			1.66	1.42	1.19	1.48	4.17	2.20	2.75	1.62	0.97	0.00	0.00
g) Water requirement		2.50	2.50	2.50	2.50								
h) Crop coefficient, Kc			0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00			
				0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00		
					0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00	
						0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00
i) Average Kc			0.40	0.40	0.53	0.60	0.75	0.90	0.95	1.00	1.00	1.00	1.00
j) ETo			5.78	6.08	6.08	5.91	5.91	5.16	5.16	4.74	4.74	4.41	4.41
k) Consumptive use i)x j)			2.31	2.43	3.24	3.55	4.43	4.64	4.90	4.74	4.74	4.41	4.41
-ditto- (in one month)			69	73	97	106	133	139	147	142	142	132	132
l) Water requirement k)-f)			0.66	1.02	2.05	2.06	0.27	2.44	2.15	3.12	3.77	4.41	4.41
m) Cropping area			0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50
n) Net water req. l)x m)			0.16	0.51	1.54	2.06	0.27	2.44	2.15	3.12	3.77	3.31	2.21
o) Total water req. g)+n)		2.50	2.66	3.01	4.04	2.06	0.27	2.44	2.15	3.12	3.77	3.31	2.21
p) Gross water req. o)/oief		5.00	5.33	6.02	8.08	4.13	0.53	4.89	4.30	6.25	7.53	6.62	4.41
q) -ditto- (l/sec/ha)		0.58	0.62	0.70	0.94	0.48	0.06	0.57	0.50	0.72	0.87	0.77	0.51

Average: 0.61 Anuual: 7.10 (1000 m3 in 1 ha) Max.: 0.94

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Unit Water Requirement of Maize-2

Year	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last
1960	0.58	0.70	0.73	0.98	0.61	0.41	0.63	0.63	0.52	0.65	0.71	0.47
1961	0.58	0.70	0.79	1.09	0.61	0.47	0.70	0.69	0.40	0.59	0.71	0.47
1962	0.58	0.63	0.86	0.98	0.68	0.24	0.63	0.98	0.00	0.28	0.66	0.20
1963	0.58	0.65	0.70	1.09	0.48	0.47	0.77	0.26	0.40	0.34	0.66	0.51
1964	0.58	0.71	0.73	0.98	0.61	0.88	0.70	0.21	0.87	0.95	0.66	0.33
1965	0.58	0.70	0.83	1.14	0.82	0.81	0.63	0.50	0.65	0.95	0.66	0.51
1966	0.58	0.68	0.83	0.75	0.75	0.09	0.85	0.63	0.95	0.87	0.60	0.51
1967	0.58	0.70	0.73	1.14	0.75	0.60	0.15	0.69	0.65	0.72	0.71	0.09
1968	0.58	0.70	0.70	0.84	0.48	0.81	0.63	0.11	0.59	0.72	0.66	0.47
1969	0.58	0.58	0.64	0.98	0.75	0.06	0.85	0.91	0.52	0.28	0.55	0.51
1970	0.58	0.65	0.73	0.98	0.41	0.41	0.77	0.63	0.72	1.02	0.60	0.44
1971	0.58	0.68	0.86	1.14	0.82	0.88	0.85	0.63	0.52	0.95	0.55	0.44
1972	0.58	0.68	0.76	1.09	0.55	0.96	1.07	0.91	0.95	0.80	0.60	0.47
1973	0.58	0.70	0.79	1.09	0.82	0.96	0.50	0.69	0.13	0.80	0.35	0.44
1974	0.58	0.71	0.83	1.14	0.75	0.53	0.31	0.98	0.59	0.34	0.66	0.44
1975	0.58	0.70	0.70	1.14	0.41	0.41	0.57	0.91	0.46	0.65	0.55	0.40
1976	0.58	0.71	0.76	1.04	0.82	0.96	0.85	0.83	0.65	0.80	0.71	0.47
1977	0.58	0.58	0.76	0.98	0.68	0.53	0.05	0.00	0.28	0.52	0.55	0.37
1978	0.58	0.62	0.70	0.94	0.48	0.06	0.57	0.50	0.72	0.87	0.77	0.51
Average	0.58	0.67	0.76	1.03	0.65	0.55	0.64	0.61	0.56	0.69	0.63	0.43

Source : Prepared by JICA Study Team

Table VII-13 (e) Unit Water Requirement of Crop

Maize-3

Description		Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last
Cropping pattern													
a) Land preparation		2.50	2.50	2.50	2.50								
b) Topping up													
c) Re-flooding													
d) Sub-total		2.50	2.50	2.50	2.50								
e) Half monthly rainfall	1978	57	46	65	199	87	112	58	41	4	4	79	44
f) Effective rainfall			1.15	1.42	3.33	2.01	2.67	1.53	0.94	0.00	0.00	1.83	0.94
g) Water requirement		2.50	2.50	2.50	2.50								
h) Crop coefficient, Kc			0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00			
				0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00		
					0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00	
						0.40	0.40	0.80	0.80	1.00	1.00	1.00	1.00
i) Average Kc			0.40	0.40	0.53	0.60	0.75	0.90	0.95	1.00	1.00	1.00	1.00
j) ETo			6.08	5.91	5.91	5.16	5.16	4.74	4.74	4.41	4.41	4.40	4.40
k) Consumptive use i)x j)			2.43	2.36	3.15	3.10	3.87	4.27	4.50	4.41	4.41	4.40	4.40
-ditto- (in one month)			73	71	95	93	116	128	135	132	132	132	132
l) Water requirement k)-f)			1.28	0.95	0.00	1.09	1.20	2.73	3.56	4.41	4.41	2.57	3.46
m) Cropping area			0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50
n) Net water req. g)x m)			0.32	0.47	0.00	1.09	1.20	2.73	3.56	4.41	4.41	1.93	1.73
o) Total water req. f)+n)		2.50	2.82	2.97	2.50	1.09	1.20	2.73	3.56	4.41	4.41	1.93	1.73
p) Gross water req. o)/oief		5.00	5.64	5.95	5.00	2.18	2.39	5.47	7.13	8.82	8.82	3.85	3.46
q) -ditto- (l/sec/ha)		0.58	0.65	0.69	0.58	0.25	0.28	0.63	0.82	1.02	1.02	0.45	0.40

Average: 0.61 Annual: 7.17 (1000 m3 in 1 ha) Max.: 1.02

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Irrigation Water Requirement of Maize-3

Year	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last
1960	0.58	0.67	0.75	0.69	0.31	0.40	0.43	0.62	0.95	0.95	0.66	0.47
1961	0.58	0.70	0.75	0.73	0.37	0.47	0.31	0.55	0.95	0.95	0.60	0.44
1962	0.58	0.67	0.78	0.58	0.31	0.75	0.02	0.26	0.88	0.40	0.50	0.40
1963	0.58	0.70	0.69	0.73	0.44	0.05	0.31	0.31	0.88	1.02	0.50	0.44
1964	0.58	0.67	0.75	1.02	0.37	0.01	0.77	0.90	0.88	0.67	0.35	0.40
1965	0.58	0.72	0.85	0.97	0.31	0.28	0.56	0.90	0.88	1.02	0.60	0.47
1966	0.58	0.60	0.82	0.58	0.50	0.40	0.84	0.82	0.80	1.02	0.60	0.44
1967	0.58	0.72	0.82	0.82	0.00	0.47	0.56	0.69	0.95	0.18	0.45	0.37
1968	0.58	0.62	0.69	0.97	0.31	0.00	0.50	0.69	0.88	0.95	0.40	0.44
1969	0.58	0.67	0.82	0.58	0.50	0.68	0.43	0.26	0.74	1.02	0.66	0.40
1970	0.58	0.67	0.66	0.69	0.44	0.40	0.63	0.97	0.80	0.88	0.55	0.40
1971	0.58	0.72	0.85	1.02	0.50	0.40	0.43	0.90	0.74	0.88	0.55	0.47
1972	0.58	0.70	0.72	1.07	0.72	0.68	0.84	0.76	0.80	0.95	0.76	0.44
1973	0.58	0.70	0.85	1.07	0.19	0.47	0.05	0.76	0.47	0.88	0.76	0.51
1974	0.58	0.72	0.82	0.78	0.03	0.75	0.50	0.31	0.88	0.88	0.71	0.44
1975	0.58	0.72	0.66	0.69	0.25	0.68	0.37	0.62	0.74	0.80	0.71	0.40
1976	0.58	0.69	0.85	1.07	0.50	0.61	0.56	0.76	0.95	0.95	0.45	0.40
1977	0.58	0.67	0.78	0.78	0.00	0.00	0.20	0.49	0.74	0.74	0.66	0.47
1978	0.58	0.65	0.69	0.58	0.25	0.28	0.63	0.82	1.02	1.02	0.45	0.40
Average	0.58	0.68	0.77	0.81	0.33	0.41	0.47	0.65	0.84	0.85	0.57	0.43

Source : Prepared by JICA Study Team

Table VII-13 (f) Unit Water Requirement of Crop

Cotton

Description	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
Cropping pattern													
a) Land preparation	2.50	2.50	2.50	2.50									
b) Topping up													
c) Re-flooding													
d) Sub-total	2.50	2.50	2.50	2.50									
e) Half monthly rainfall 1978	79	44	43	54	22	17	16	16	40	60	10	8	32
f) Effective rainfall		0.80	0.80	1.15	0.58	0.30	0.31	0.33	0.97	1.62	0.33	0.33	1.02
g) Water requirement	2.50	2.50	2.50	2.50									
h) Crop coefficient, Kc		0.35	0.35	0.70	0.70	0.90	0.90	0.95	0.95	0.95			
			0.35	0.35	0.70	0.70	0.90	0.90	0.95	0.95	0.95		
				0.35	0.35	0.70	0.70	0.90	0.90	0.95	0.95	0.95	
					0.35	0.35	0.70	0.70	0.90	0.90	0.95	0.95	0.95
i) Average Kc		0.35	0.35	0.47	0.53	0.66	0.80	0.86	0.93	0.94	0.95	0.95	0.95
j) ETo		4.40	4.77	4.77	5.35	5.35	5.64	5.64	5.24	5.24	5.50	5.50	5.78
k) Consumptive use i)x j)		1.54	1.67	2.23	2.81	3.54	4.51	4.86	4.85	4.91	5.22	5.23	5.49
-ditto- (in one month)		46	50	67	84	106	135	146	145	147	157	157	165
l) Water requirement k)-f)		0.74	0.87	1.08	2.23	3.24	4.21	4.53	3.87	3.30	4.89	4.89	4.47
m) Cropping area		0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.50
n) Net water req. l)x m)		0.19	0.43	0.81	2.23	3.24	4.21	4.53	3.87	3.30	4.89	3.67	2.24
o) Total water req. g)+n)	2.50	2.69	2.93	3.31	2.23	3.24	4.21	4.53	3.87	3.30	4.89	3.67	2.24
p) Gross water req. o)/oief	5.00	5.37	5.87	6.61	4.45	6.49	8.41	9.06	7.75	6.59	9.78	7.34	4.47
q) -ditto- (l/sec/ha)	0.58	0.62	0.68	0.77	0.52	0.75	0.97	1.05	0.90	0.76	1.13	0.85	0.52

Average: 0.78 Annual: 10 (1000 m3 in 1 ha) Max.: 1.13

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Unit Water Requirement of Cotton

Year	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
1960	0.58	0.65	0.71	0.86	0.45	0.68	0.76	0.83	0.90	0.84	1.13	0.91	0.60
1961	0.58	0.64	0.59	0.60	0.32	0.54	0.76	0.83	0.10	0.00	0.10	0.21	0.48
1962	0.58	0.62	0.74	0.86	0.32	0.68	0.83	0.83	1.12	0.69	1.06	0.57	0.40
1963	0.58	0.64	0.71	0.91	0.65	0.75	0.97	1.05	0.97	0.50	0.57	0.63	0.52
1964	0.58	0.62	0.71	0.77	0.52	0.19	0.83	0.90	1.12	1.14	0.98	0.74	0.60
1965	0.58	0.65	0.77	0.91	0.58	0.75	0.90	0.83	0.97	0.91	1.13	0.79	0.64
1966	0.58	0.64	0.77	0.58	0.32	0.68	0.90	1.05	0.90	1.14	1.06	0.85	0.60
1967	0.58	0.61	0.68	0.86	0.58	0.68	0.90	0.97	0.97	0.50	0.77	0.74	0.64
1968	0.58	0.64	0.58	0.68	0.52	0.82	0.90	0.90	0.90	0.84	0.84	0.91	0.60
1969	0.58	0.62	0.71	0.86	0.38	0.75	0.43	0.90	1.04	0.76	1.06	0.85	0.56
1970	0.58	0.62	0.68	0.72	0.45	0.82	0.97	0.97	1.04	0.99	0.77	0.63	0.64
1971	0.58	0.65	0.71	0.86	0.58	0.54	0.83	0.97	0.97	0.99	1.13	0.85	0.52
1972	0.58	0.64	0.68	0.72	0.16	0.54	0.90	0.83	0.49	1.06	1.13	0.85	0.40
1973	0.58	0.67	0.58	0.77	0.58	0.75	0.97	1.05	0.90	0.99	0.98	0.74	0.52
1974	0.58	0.64	0.62	0.68	0.21	0.54	0.97	0.90	1.04	1.06	1.21	0.68	0.60
1975	0.58	0.62	0.58	0.60	0.16	0.41	0.76	0.83	1.04	1.06	1.06	0.79	0.64
1976	0.58	0.62	0.65	0.72	0.45	0.68	0.97	1.05	0.90	0.76	0.51	0.48	0.20
1977	0.58	0.65	0.68	0.77	0.52	0.75	0.55	0.62	0.55	0.32	1.06	0.79	0.44
1978	0.58	0.62	0.68	0.77	0.52	0.75	0.97	1.05	0.90	0.76	1.13	0.85	0.52
Average	0.58	0.63	0.68	0.76	0.44	0.65	0.85	0.91	0.88	0.81	0.93	0.73	0.53

Source : Prepared by JICA Study Team

Table VII-13 (g) Unit Water Requirement of Crop

Greengrams

Description	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
Cropping pattern											
a) Land preparation	2.50	2.50	2.50	2.50							
b) Topping up											
c) Re-flooding											
d) Sub-total	2.50	2.50	2.50	2.50							
e) Half monthly rainfall 1978	43.0	54	22	17	16	16	40	60	10	8	32
f) Effective rainfall		1.15	0.58	0.30	0.31	0.33	0.97	1.53	0.31	0.31	0.87
g) Water requirement	2.50	2.50	2.50	2.50							
h) Crop coefficient, Kc		0.50	0.50	0.95	0.95	0.90	0.90	0.50			
			0.50	0.50	0.95	0.95	0.90	0.90	0.50		
				0.50	0.50	0.95	0.95	0.90	0.90	0.50	
					0.50	0.50	0.95	0.95	0.90	0.90	0.50
i) Average Kc		0.50	0.50	0.65	0.73	0.83	0.93	0.81	0.77	0.70	0.50
j) ETo		4.77	5.35	5.35	5.64	5.64	5.24	5.24	5.50	5.50	5.78
k) Consumptive use i)x j)		2.39	2.68	3.48	4.09	4.65	4.85	4.26	4.22	3.85	2.89
-ditto- (in one month)		72	80	104	123	140	145	128	127	116	87
l) Water requirement k)-f)		1.24	2.09	3.18	3.78	4.32	3.87	2.72	3.91	3.54	2.02
m) Cropping area		0.25	0.50	0.75	1.00	1.00	1.00	1.00	0.75	0.50	0.25
n) Net water req. l)x m)		0.31	1.05	2.38	3.78	4.32	3.87	2.72	2.93	1.77	0.50
o) Total water req. g)+n)	2.50	2.81	3.55	4.88	3.78	4.32	3.87	2.72	2.93	1.77	0.50
p) Gross water req. o)/oief	5.00	5.62	7.09	9.77	7.56	8.64	7.75	5.45	5.87	3.54	1.01
q) -ditto- (l/sec/ha)	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.68	0.41	0.12

Average: 0.71 Annual: 7.34 (1000 m3 in 1 ha) Max.: 1.13

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Unit Water Requirement of Green gram

Year	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
1960	0.58	0.68	0.79	1.08	0.66	0.78	0.90	0.70	0.68	0.45	0.15
1961	0.58	0.59	0.72	0.98	0.66	0.78	0.10	0.02	0.01	0.00	0.10
1962	0.58	0.68	0.72	1.08	0.73	0.78	1.12	0.56	0.63	0.23	0.07
1963	0.58	0.70	0.89	1.13	0.88	1.00	0.97	0.37	0.27	0.27	0.07
1964	0.58	0.65	0.82	0.71	0.73	0.85	1.12	0.99	0.57	0.34	0.15
1965	0.58	0.70	0.85	1.13	0.80	0.78	0.97	0.77	0.68	0.37	0.17
1966	0.58	0.58	0.72	1.08	0.80	1.00	0.90	0.99	0.63	0.41	0.15
1967	0.58	0.68	0.85	1.08	0.80	0.93	0.97	0.37	0.41	0.34	0.17
1968	0.58	0.62	0.82	1.18	0.80	0.85	0.90	0.70	0.47	0.45	0.15
1969	0.58	0.68	0.76	1.13	0.33	0.85	1.04	0.63	0.63	0.41	0.13
1970	0.58	0.63	0.79	1.18	0.88	0.93	1.04	0.84	0.41	0.27	0.17
1971	0.58	0.68	0.85	0.98	0.73	0.93	0.97	0.84	0.68	0.41	0.12
1972	0.58	0.63	0.64	0.98	0.80	0.78	0.49	0.91	0.68	0.41	0.07
1973	0.58	0.65	0.85	1.13	0.88	1.00	0.90	0.84	0.57	0.34	0.12
1974	0.58	0.62	0.67	0.98	0.88	0.85	1.04	0.91	0.73	0.30	0.15
1975	0.58	0.59	0.64	0.88	0.66	0.78	1.04	0.91	0.63	0.37	0.17
1976	0.58	0.63	0.79	1.08	0.88	1.00	0.90	0.63	0.22	0.17	0.02
1977	0.58	0.65	0.82	1.13	0.46	0.57	0.55	0.20	0.63	0.37	0.09
1978	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.68	0.41	0.12
Average	0.58	0.65	0.78	1.05	0.75	0.86	0.88	0.67	0.54	0.33	0.12

Source : Prepared by JICA Study Team

Table VII-13 (h) Unit Water Requirement of Crop

Groundnut

Description		Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
Cropping pattern												
a) Land preparation		2.50	2.50	2.50	2.50							
b) Re-flooding												
c) Topping up												
d) Sub-total		2.50	2.50	2.50	2.50							
e) Half monthly rainfall	1978	43.0	54.0	21.8	17.2	15.9	16.1	39.7	60.3	9.9	8.1	32.3
f) Effective rainfall			1.15	0.58	0.30	0.31	0.33	0.97	1.53	0.31	0.31	0.87
g) Water requirement		2.50	2.50	2.50	2.50							
h) Crop coefficient, Kc			0.50	0.50	0.95	0.95	0.90	0.90	0.50			
				0.50	0.50	0.95	0.95	0.90	0.90	0.50		
					0.50	0.50	0.95	0.95	0.90	0.90	0.50	
						0.50	0.50	0.95	0.95	0.90	0.90	0.50
i) Average Kc			0.50	0.50	0.65	0.73	0.83	0.93	0.81	0.77	0.70	0.50
j) ETo			4.77	5.35	5.35	5.64	5.64	5.24	5.24	5.50	5.50	5.78
k) Consumptive use i)x j)			2.39	2.68	3.48	4.09	4.65	4.85	4.26	4.22	3.85	2.89
-ditto- (in one month)			72	80	104	123	140	145	128	127	116	87
l) Water requirement k)-f)			1.24	2.09	3.18	3.78	4.32	3.87	2.72	3.91	3.54	2.02
m) Cropping area			0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75
n) Net water req. l)x m)			0.31	1.05	2.38	3.78	4.32	3.87	2.72	3.91	3.54	1.51
o) Total water req. g)+n)		2.50	2.81	3.55	4.88	3.78	4.32	3.87	2.72	3.91	3.54	1.51
p) Gross water req. o)/oief		5.00	5.62	7.09	9.77	7.56	8.64	7.75	5.45	7.82	7.09	3.03
q) -ditto-	(l/sec/ha)	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.91	0.82	0.35

Average: 0.79 Annual: 8.16 (1000 m3 in 1 ha) Max.: 1.13

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Unit Water Requirement of Ground nut

Year	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last	Jan. First
1960	0.58	0.68	0.79	1.08	0.66	0.78	0.90	0.70	0.91	0.89	0.21
1961	0.58	0.59	0.72	0.98	0.66	0.78	0.10	0.02	0.01	0.00	0.45
1962	0.58	0.68	0.72	1.08	0.73	0.78	1.12	0.56	0.83	0.47	0.40
1963	0.58	0.70	0.89	1.13	0.88	1.00	0.97	0.37	0.36	0.54	0.40
1964	0.58	0.65	0.82	0.71	0.73	0.85	1.12	0.99	0.76	0.67	0.50
1965	0.58	0.70	0.85	1.13	0.80	0.78	0.97	0.77	0.91	0.75	0.50
1966	0.58	0.58	0.72	1.08	0.80	1.00	0.90	0.99	0.83	0.82	0.35
1967	0.58	0.68	0.85	1.08	0.80	0.93	0.97	0.37	0.55	0.67	0.09
1968	0.58	0.62	0.82	1.18	0.80	0.85	0.90	0.70	0.62	0.89	0.40
1969	0.58	0.68	0.76	1.13	0.33	0.85	1.04	0.63	0.83	0.82	0.35
1970	0.58	0.63	0.79	1.18	0.88	0.93	1.04	0.84	0.55	0.54	0.50
1971	0.58	0.68	0.85	0.98	0.73	0.93	0.97	0.84	0.91	0.82	0.35
1972	0.58	0.63	0.64	0.98	0.80	0.78	0.49	0.91	0.91	0.82	0.21
1973	0.58	0.65	0.85	1.13	0.88	1.00	0.90	0.84	0.76	0.67	0.35
1974	0.58	0.62	0.67	0.98	0.88	0.85	1.04	0.91	0.98	0.61	0.45
1975	0.58	0.59	0.64	0.88	0.66	0.78	1.04	0.91	0.83	0.75	0.50
1976	0.58	0.63	0.79	1.08	0.88	1.00	0.90	0.63	0.30	0.34	0.07
1977	0.58	0.65	0.82	1.13	0.46	0.57	0.55	0.20	0.83	0.75	0.26
1978	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.91	0.82	0.35
Average	0.58	0.65	0.78	1.05	0.75	0.86	0.88	0.67	0.71	0.67	0.35

Source : Prepared by JICA Study Team

Table VII-13 (i) Unit Water Requirement of Crop

Vegetable-1

Description		July	Aug.		Sep.		Oct.		Nov.		Dec.		Jan.	
		Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Cropping pattern														
a) Land preparation		2.50	2.50	2.50	2.50	2.50	2.50							
b) Topping up														
c) Re-flooding														
d) Sub-total		2.50	2.50	2.50	2.50	2.50	2.50							
e) Half monthly rainfall	1977	17.0	40	51	22	17	88	89	99	150	26	21	66	72
f) Effective rainfall			0.87	1.15	0.60	0.31	2.12	2.12	2.40	3.40	0.62	0.62	1.53	1.66
g) Water requirement		2.50	2.50	2.50	2.50	2.50	2.50							
h) Crop coefficient, Kc			0.50	0.50	0.95	0.95	0.90	0.90	0.50					
				0.50	0.50	0.95	0.95	0.90	0.90	0.50				
					0.50	0.50	0.95	0.95	0.90	0.90	0.50			
						0.50	0.50	0.95	0.95	0.90	0.90	0.50		
							0.50	0.50	0.95	0.95	0.90	0.90	0.50	
								0.50	0.50	0.95	0.95	0.90	0.90	0.50
i) Average Kc			0.50	0.50	0.65	0.73	0.76	0.78	0.78	0.84	0.81	0.77	0.70	0.50
j) ETo			4.77	4.77	5.35	5.35	5.64	5.64	5.24	5.24	5.50	5.50	5.78	5.78
k) Consumptive use i)x j)			2.39	2.39	3.48	3.88	4.29	4.42	4.10	4.40	4.47	4.22	4.05	2.89
-ditto- (in one month)			72	72	104	116	129	133	123	132	134	127	121	87
l) Water requirement k)-f)			1.51	1.24	2.88	3.57	2.16	2.29	1.70	1.00	3.85	3.60	2.51	1.23
m) Cropping area			0.17	0.33	0.50	0.67	0.83	1.00	1.00	0.83	0.67	0.50	0.33	0.17
n) Net water req. l)x m)			0.26	0.41	1.44	2.39	1.80	2.29	1.70	0.83	2.58	1.80	0.83	0.21
o) Total water req. g)+n)		2.50	2.76	2.91	3.94	4.89	4.30	2.29	1.70	0.83	2.58	1.80	0.83	0.21
p) Gross water req. o)/oief		5.00	5.51	5.82	7.88	9.79	8.6	4.59	3.41	1.66	5.16	3.60	1.66	0.42
q) -ditto-	(l/sec/ha)	0.58	0.64	0.67	0.91	1.13	0.99	0.53	0.39	0.19	0.60	0.42	0.19	0.05

Average: 0.56 Annual: 5.82 (1000 m3 in 1 ha) Max.: 1.13

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Unit Water Requirement of Vegetable-1

Year	July	Aug.		Sep.		Oct.		Nov.		Dec.		Jan.	
	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
1960	0.58	0.65	0.72	0.88	1.08	1.17	0.74	0.73	0.61	0.65	0.49	0.29	0.10
1961	0.58	0.61	0.60	0.81	0.99	1.17	0.74	0.00	0.05	0.05	0.04	0.22	0.06
1962	0.58	0.66	0.72	0.81	1.08	1.22	0.74	0.95	0.49	0.60	0.28	0.17	0.07
1963	0.58	0.65	0.74	0.98	1.13	1.34	0.95	0.81	0.33	0.28	0.31	0.24	0.11
1964	0.58	0.65	0.67	0.91	0.73	1.22	0.81	0.95	0.85	0.55	0.38	0.29	0.10
1965	0.58	0.67	0.74	0.95	1.13	1.28	0.74	0.81	0.67	0.65	0.42	0.31	0.09
1966	0.58	0.67	0.58	0.81	1.08	1.28	0.95	0.73	0.85	0.60	0.45	0.29	0.10
1967	0.58	0.64	0.72	0.95	1.08	1.28	0.88	0.81	0.33	0.41	0.38	0.31	0.10
1968	0.58	0.58	0.63	0.91	1.18	1.28	0.81	0.73	0.61	0.46	0.49	0.29	0.02
1969	0.58	0.65	0.72	0.84	1.13	0.89	0.81	0.88	0.55	0.60	0.45	0.26	0.07
1970	0.58	0.64	0.65	0.88	1.18	1.34	0.88	0.88	0.73	0.41	0.31	0.31	0.09
1971	0.58	0.65	0.72	0.95	0.99	1.22	0.88	0.81	0.73	0.65	0.45	0.24	0.09
1972	0.58	0.64	0.65	0.72	0.99	1.28	0.74	0.33	0.79	0.65	0.45	0.17	0.10
1973	0.58	0.59	0.67	0.95	1.13	1.34	0.95	0.73	0.73	0.55	0.38	0.24	0.11
1974	0.58	0.62	0.63	0.75	0.99	1.34	0.81	0.88	0.79	0.69	0.35	0.29	0.10
1975	0.58	0.60	0.60	0.72	0.90	1.17	0.74	0.88	0.79	0.60	0.42	0.31	0.11
1976	0.58	0.63	0.65	0.88	1.08	1.34	0.95	0.73	0.55	0.24	0.21	0.05	0.02
1977	0.58	0.64	0.67	0.91	1.13	0.99	0.53	0.39	0.19	0.60	0.42	0.19	0.05
1978	0.58	0.64	0.67	0.91	1.13	1.34	0.95	0.73	0.55	0.65	0.45	0.24	0.08
Average	0.58	0.63	0.67	0.87	1.06	1.24	0.82	0.72	0.59	0.52	0.37	0.25	0.08

Source : Prepared by JICA Study Team

Table VII-13 (j) Unit Water Requirement of Crop

Vegetable-2

Description		Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last
Cropping pattern														
a) Land preparation		2.50	2.50	2.50	2.50	2.50	2.50							
b) Topping up														
c) Re-flooding														
d) Sub-total		2.50	2.50	2.50	2.50	2.50	2.50							
e) Half monthly rainfall	1978	72.0	57	46	65	199	87	112	58	41	4	4	79	44
f) Effective rainfall			1.48	1.19	1.53	4.17	2.12	2.50	1.48	0.94	0.00	0.00	1.76	0.87
g) Water requirement		2.50	2.50	2.50	2.50	2.50	2.50							
h) Crop coefficient, Kc			0.50	0.50	0.95	0.95	0.90	0.90	0.50					
				0.50	0.50	0.95	0.95	0.90	0.90	0.50				
					0.50	0.50	0.95	0.95	0.90	0.90	0.50			
						0.50	0.50	0.95	0.95	0.90	0.90	0.50		
							0.50	0.50	0.95	0.95	0.90	0.90	0.50	
								0.50	0.50	0.95	0.95	0.90	0.90	0.50
i) Average Kc			0.50	0.50	0.65	0.73	0.76	0.78	0.78	0.84	0.81	0.77	0.70	0.50
j) ETo			6.08	6.08	5.91	5.91	5.16	4.74	4.74	4.74	4.41	4.41	4.40	4.40
k) Consumptive use i)x j)			3.04	3.04	3.84	4.28	3.92	3.71	3.71	3.98	3.58	3.38	3.08	2.20
-ditto- (in one month)			91	91	115	129	118	111	111	119	107	101	92	66
l) Water requirement k)-f)			1.56	1.85	2.31	0.12	1.80	1.21	2.23	3.04	3.58	3.38	1.32	1.33
m) Cropping area			0.17	0.33	0.50	0.67	0.83	1.00	1.00	0.83	0.67	0.50	0.33	0.17
n) Net water req. l)x m)			0.26	0.61	1.15	0.08	1.49	1.21	2.23	2.52	2.40	1.69	0.44	0.23
o) Total water req. g)+n)		2.50	2.76	3.11	3.65	2.58	3.99	1.21	2.23	2.52	2.40	1.69	0.44	0.23
p) Gross water req. o)/oief		5.00	5.53	6.22	7.31	5.16	8.0	2.43	4.46	5.05	4.80	3.38	0.87	0.45
q) -ditto-	(l/sec/ha)	0.58	0.64	0.72	0.85	0.60	0.92	0.28	0.52	0.58	0.56	0.39	0.10	0.05

Average: 0.52 Annual: 5.41 (1000 m3 in 1 ha) Max.: 0.92

Note: oief; overall irrigation efficiency = 50%

Unit for all items is mm/day except e), h), i), m) and q)

Unit Water Requirement of Vegetable-2

Year	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last
1960	0.58	0.65	0.74	0.91	0.83	0.98	0.39	0.34	0.41	0.51	0.36	0.19	0.08
1961	0.58	0.67	0.79	0.91	0.87	1.04	0.45	0.23	0.36	0.51	0.36	0.17	0.06
1962	0.58	0.70	0.74	0.95	0.72	0.98	0.72	0.09	0.11	0.46	0.10	0.12	0.05
1963	0.58	0.64	0.79	0.85	0.87	1.10	0.09	0.23	0.16	0.46	0.39	0.12	0.06
1964	0.58	0.65	0.74	0.91	1.15	1.04	0.09	0.65	0.65	0.46	0.22	0.06	0.05
1965	0.58	0.69	0.81	1.02	1.10	0.98	0.28	0.45	0.65	0.46	0.39	0.17	0.08
1966	0.58	0.69	0.64	0.99	0.62	1.15	0.39	0.72	0.58	0.41	0.39	0.17	0.06
1967	0.58	0.65	0.81	0.99	0.96	0.60	0.45	0.45	0.47	0.51	0.01	0.10	0.04
1968	0.58	0.64	0.68	0.85	1.10	0.98	0.09	0.39	0.47	0.46	0.36	0.08	0.06
1969	0.58	0.62	0.74	0.99	0.60	1.15	0.65	0.34	0.11	0.37	0.39	0.19	0.05
1970	0.58	0.65	0.74	0.81	0.83	1.10	0.39	0.52	0.71	0.41	0.32	0.14	0.05
1971	0.58	0.70	0.81	1.02	1.15	1.15	0.39	0.34	0.65	0.37	0.32	0.14	0.08
1972	0.58	0.66	0.79	0.88	1.20	1.33	0.65	0.72	0.53	0.41	0.36	0.24	0.06
1973	0.58	0.67	0.79	1.02	1.20	0.87	0.45	0.09	0.53	0.21	0.32	0.24	0.09
1974	0.58	0.69	0.81	0.99	0.91	0.72	0.72	0.39	0.16	0.46	0.32	0.21	0.06
1975	0.58	0.64	0.81	0.81	0.83	0.92	0.65	0.28	0.41	0.37	0.29	0.21	0.05
1976	0.58	0.66	0.77	1.02	1.20	1.15	0.58	0.45	0.53	0.51	0.36	0.10	0.05
1977	0.58	0.66	0.74	0.95	0.91	0.58	0.09	0.12	0.30	0.37	0.25	0.19	0.08
1978	0.58	0.64	0.72	0.85	0.60	0.92	0.28	0.52	0.58	0.56	0.39	0.10	0.05
Average	0.58	0.66	0.76	0.93	0.93	0.99	0.41	0.39	0.44	0.44	0.31	0.15	0.06

Source : Prepared by JICA Study Team

Table VII-13 (k)　　Unit Water Requirement of Crop (1/2)

Sugar cane (1/2)

Description	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last
a) Land preparation	1.43	1.43	1.43	1.43												1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
b) Topping up																								
c) Re-flooding																								
d) Sub-total	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	0.00	0.00	0.00	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
e) Half monthly rainfall 1978	66	72	57	46	65	199	87	112	58	41	4	4	79	44	43	54	22	17	16	16	40	60	10	8
f) Effective rainfall	1.53	1.83	1.62	1.30	1.62	4.43	2.20	2.75	1.53	0.97	0.00	0.00	1.83	0.94	0.97	1.30	0.66	0.33	0.33	0.33	0.94	1.53	0.31	0.31
g) Water requirement	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	0.00	0.00	0.00	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
h) Crop coefficient, Kc	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54	0.54	0.67	0.67	0.72	0.72	0.68	0.68
	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54	0.54	0.67	0.67	0.72	0.72	0.68
	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54	0.54	0.67	0.67	0.72	0.72
	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54	0.54	0.67	0.67	0.72
	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54	0.54	0.67	0.67
	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54	0.54	0.67
	0.67	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54	0.54
	0.54	0.67	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					0.54
	0.54	0.54	0.67	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
		0.54	0.54	0.67	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
			0.54	0.54	0.67	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
				0.54	0.54	0.67	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
					0.54	0.54	0.67	0.67	0.72	0.72	0.68	0.68	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
i) Average Kc	0.69	0.72	0.76	0.81	0.84	0.88	0.90	0.93	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.90	0.86	0.82	0.79	0.76	0.73	0.69
j) ETo	5.78	5.78	6.08	6.08	5.91	5.91	5.16	5.16	4.74	4.74	4.41	4.41	4.40	4.40	4.77	4.77	5.35	5.35	5.64	5.64	5.24	5.24	5.50	5.50
k) Consumptive use i)x j)	3.98	4.15	4.65	4.92	4.98	5.18	4.66	4.81	4.57	4.72	4.40	4.41	4.39	4.39	4.77	4.77	5.08	4.80	4.86	4.65	4.16	3.99	4.00	3.80
-ditto- (in one month)	119	125	139	148	149	155	140	144	137	142	132	132	132	132	143	143	152	144	146	139	125	120	120	114
l) Water requirement k)-f)	2.45	2.32	3.03	3.62	3.37	0.74	2.46	2.06	3.04	3.75	4.40	4.41	2.55	3.45	3.80	3.47	4.42	4.47	4.52	4.32	3.22	2.46	3.69	3.49
m) Cropping area	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.92	0.85	0.77	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
n) Net water req. l)x m)	1.69	1.60	2.09	2.50	2.32	0.51	1.70	1.42	2.09	2.59	3.04	3.04	2.35	2.93	2.92	2.39	3.05	3.08	3.12	2.98	2.22	1.70	2.55	2.41
o) Total water req. g)+n)	3.12	3.03	3.52	3.93	3.75	1.94	3.13	2.85	3.52	4.02	4.47	4.47	2.35	2.93	2.92	3.82	4.48	4.51	4.55	4.41	3.65	3.13	3.98	3.84
p) Gross water req. o)/oief	6.24	6.06	7.04	7.86	7.50	3.89	6.26	5.70	7.05	8.03	8.93	8.95	4.70	5.87	5.85	7.65	8.96	9.03	9.10	8.82	7.30	6.26	7.95	7.68
q) -ditto- (l/sec/ha)	0.72	0.70	0.81	0.91	0.87	0.45	0.72	0.66	0.82	0.93	1.03	1.04	0.54	0.68	0.68	0.88	1.04	1.04	1.05	1.02	0.84	0.72	0.92	0.89

Note: oief; overall irrigation efficiency = 50%　Average: 0.83　Annual: 21.6 (1000 m3 in 1 ha)　Max.: 1.05

Unit for all items is mm/day except e), h), i), m) and q)

Table VII-13 (k) Unit Water Requirement of Crop (2/2)

Sugar cane (2/2)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
1960	0.92	0.94	0.87	0.96	0.97	0.72	0.77	0.75	0.68	0.78	0.99	0.99	0.80	0.80	0.73	0.99	0.99	0.99	0.90	0.87	0.84	0.77	0.92	0.94
1961	0.92	0.94	0.97	1.06	0.97	0.76	0.82	0.79	0.59	0.73	0.99	0.99	0.73	0.74	0.51	0.70	0.88	0.89	0.90	0.87	0.33	0.33	0.33	0.33
1962	0.77	0.75	1.07	0.96	1.02	0.59	0.77	0.99	0.40	0.52	0.94	0.61	0.61	0.68	0.79	0.99	0.88	0.99	0.95	0.87	0.99	0.68	0.87	0.64
1963	0.67	0.80	0.81	1.06	0.87	0.76	0.87	0.50	0.59	0.56	0.94	1.04	0.61	0.74	0.73	1.04	1.14	1.04	1.05	1.02	0.90	0.54	0.54	0.69
1964	0.82	0.99	0.87	0.96	0.97	1.05	0.82	0.46	0.91	0.98	0.94	0.79	0.42	0.68	0.73	0.88	1.04	0.62	0.95	0.92	0.99	0.97	0.82	0.79
1965	0.92	0.94	1.02	1.12	1.13	1.00	0.77	0.66	0.77	0.98	0.94	1.04	0.73	0.80	0.85	1.04	1.09	1.04	1.00	0.87	0.90	0.82	0.92	0.84
1966	0.97	0.90	1.02	0.72	1.07	0.49	0.92	0.75	0.96	0.93	0.88	1.04	0.73	0.74	0.85	0.61	0.88	0.99	1.00	1.02	0.84	0.97	0.87	0.89
1967	0.92	0.94	0.87	1.12	1.07	0.85	0.44	0.79	0.77	0.83	0.99	0.46	0.54	0.62	0.68	0.99	1.09	0.99	1.00	0.97	0.90	0.54	0.68	0.79
1968	0.97	0.94	0.81	0.81	0.87	1.00	0.77	0.39	0.72	0.83	0.94	0.99	0.48	0.74	0.36	0.79	1.04	1.10	1.00	0.92	0.84	0.77	0.72	0.94
1969	0.92	0.53	0.72	0.96	1.07	0.36	0.92	0.94	0.68	0.52	0.84	1.04	0.80	0.68	0.73	0.99	0.93	1.04	0.67	0.92	0.94	0.72	0.87	0.89
1970	0.87	0.80	0.87	0.96	0.82	0.72	0.87	0.75	0.82	1.03	0.88	0.94	0.67	0.68	0.68	0.83	0.99	1.10	1.05	0.97	0.94	0.87	0.68	0.69
1971	0.97	0.90	1.07	1.12	1.13	1.05	0.92	0.75	0.68	0.98	0.84	0.94	0.67	0.80	0.73	0.99	1.09	0.89	0.95	0.97	0.90	0.87	0.92	0.89
1972	0.82	0.90	0.92	1.06	0.92	1.10	1.08	0.94	0.96	0.88	0.88	0.99	0.93	0.74	0.68	0.83	0.75	0.89	1.00	0.87	0.57	0.92	0.92	0.89
1973	0.67	0.94	0.97	1.06	1.13	1.10	0.68	0.79	0.42	0.88	0.65	0.94	0.93	0.86	0.41	0.88	1.09	1.04	1.05	1.02	0.84	0.87	0.82	0.79
1974	0.82	0.99	1.02	1.12	1.07	0.81	0.55	0.99	0.72	0.56	0.94	0.94	0.87	0.74	0.56	0.79	0.79	0.89	1.05	0.92	0.94	0.92	0.97	0.74
1975	0.92	0.94	0.81	1.12	0.82	0.72	0.72	0.94	0.63	0.78	0.84	0.89	0.87	0.68	0.46	0.70	0.75	0.79	0.90	0.87	0.94	0.92	0.87	0.84
1976	0.97	0.99	0.92	1.01	1.13	1.10	0.92	0.89	0.77	0.88	0.99	0.99	0.54	0.68	0.62	0.83	0.99	0.99	1.05	1.02	0.84	0.72	0.50	0.55
1977	0.42	0.41	0.92	0.96	1.02	0.81	0.37	0.33	0.52	0.69	0.84	0.84	0.80	0.80	0.68	0.88	1.04	1.04	0.75	0.72	0.61	0.43	0.87	0.84
1978	0.72	0.70	0.81	0.91	0.87	0.45	0.72	0.66	0.82	0.93	1.03	1.04	0.54	0.68	0.68	0.88	1.04	1.04	1.05	1.02	0.84	0.72	0.92	0.89
Aerage	0.84	0.86	0.91	1.00	1.00	0.81	0.77	0.74	0.71	0.80	0.91	0.92	0.70	0.73	0.65	0.88	0.97	0.97	0.96	0.93	0.84	0.76	0.79	0.78

Source : Prepared by JICA Study Team

Table VII-13 (L) Unit Water Requirement of Crop

Passion fruit

Description		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
		First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
e) Half monthly rainfall	1978	66	72	57	46	65	199	87	112	58	41	4	4	79	44	43	54	22	17	16	16	40	60	10	8
f) Effective rainfall		1.48	1.76	1.48	1.19	1.48	3.33	2.01	2.50	1.42	0.87	0.00	0.00	1.66	0.87	0.87	1.15	0.60	0.30	0.30	0.30	0.92	1.48	0.30	0.30
g) Water requirement		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
i) Average crop coefficient Kc		0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
j) ETo		5.78	5.78	6.08	6.08	5.91	5.91	5.16	5.16	4.74	4.74	4.41	4.41	4.40	4.40	4.77	4.77	5.35	5.35	5.64	5.64	5.24	5.24	5.50	5.50
k) Consumptive use i)x j)		3.47	3.47	3.65	3.65	3.55	3.55	3.10	3.10	2.84	2.84	2.65	2.65	2.64	2.64	2.86	2.86	3.21	3.21	3.38	3.38	3.14	3.14	3.30	3.30
-ditto- (in one month)		104	104	109	109	106	106	93	93	85	85	79	79	79	79	86	86	96	96	102	102	94	94	99	99
l) Water requirement k)-f)		1.98	1.71	2.16	2.46	2.06	0.21	1.09	0.60	1.43	1.97	2.65	2.65	0.98	1.77	1.99	1.71	2.61	2.91	3.08	3.08	2.23	1.66	3.00	3.00
m) Cropping area		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
n) Net water req. l)x m)		1.98	1.71	2.16	2.46	2.06	0.21	1.09	0.60	1.43	1.97	2.65	2.65	0.98	1.77	1.99	1.71	2.61	2.91	3.08	3.08	2.23	1.66	3.00	3.00
o) Total water req. g)+n)		1.98	1.71	2.16	2.46	2.06	0.21	1.09	0.60	1.43	1.97	2.65	2.65	0.98	1.77	1.99	1.71	2.61	2.91	3.08	3.08	2.23	1.66	3.00	3.00
p) Gross water req. o)/oief		3.97	3.42	4.33	4.92	4.13	0.43	2.18	1.19	2.85	3.94	5.29	5.29	1.97	3.53	3.98	3.42	5.22	5.82	6.17	6.17	4.45	3.32	6.00	6.00
q) -ditto- (l/sec/ha)		0.46	0.40	0.50	0.57	0.48	0.05	0.25	0.14	0.33	0.46	0.61	0.61	0.23	0.41	0.46	0.40	0.60	0.67	0.71	0.71	0.51	0.38	0.69	0.69

Annual: 12.2 (1000 m3 in 1 ha) Max.: 0.71

Unit Water Requirement of Passion fruit 50%

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
1960	0.73	0.73	0.57	0.63	0.61	0.24	0.31	0.25	0.17	0.27	0.55	0.55	0.48	0.54	0.53	0.53	0.53	0.60	0.51	0.51	0.51	0.45	0.69	0.76
1961	0.73	0.73	0.71	0.78	0.61	0.30	0.37	0.31	0.08	0.22	0.55	0.55	0.41	0.48	0.28	0.17	0.40	0.47	0.51	0.51	0.00	0.00	0.00	0.00
1962	0.53	0.46	0.84	0.63	0.68	0.09	0.31	0.58	0.08	0.08	0.48	0.07	0.28	0.41	0.59	0.53	0.40	0.60	0.57	0.51	0.73	0.32	0.62	0.36
1963	0.40	0.53	0.50	0.78	0.48	0.30	0.44	0.00	0.08	0.08	0.48	0.61	0.28	0.48	0.53	0.59	0.74	0.67	0.71	0.71	0.59	0.15	0.18	0.42
1964	0.59	0.80	0.57	0.63	0.61	0.68	0.37	0.00	0.46	0.52	0.48	0.28	0.12	0.41	0.53	0.40	0.60	0.11	0.57	0.57	0.73	0.73	0.55	0.55
1965	0.73	0.73	0.78	0.84	0.82	0.61	0.31	0.14	0.27	0.52	0.48	0.61	0.41	0.54	0.66	0.59	0.67	0.67	0.64	0.51	0.59	0.51	0.69	0.62
1966	0.80	0.66	0.78	0.32	0.75	0.05	0.50	0.25	0.52	0.46	0.41	0.61	0.41	0.48	0.66	0.08	0.40	0.60	0.64	0.71	0.51	0.73	0.62	0.69
1967	0.73	0.73	0.57	0.84	0.75	0.41	0.00	0.31	0.27	0.33	0.55	0.03	0.23	0.34	0.46	0.53	0.67	0.60	0.64	0.64	0.59	0.15	0.36	0.55
1968	0.80	0.73	0.50	0.44	0.48	0.61	0.31	0.00	0.22	0.33	0.48	0.55	0.17	0.48	0.12	0.28	0.60	0.74	0.64	0.57	0.51	0.45	0.42	0.76
1969	0.73	0.17	0.38	0.63	0.75	0.05	0.50	0.50	0.17	0.08	0.35	0.61	0.48	0.41	0.53	0.53	0.47	0.67	0.20	0.57	0.66	0.38	0.62	0.69
1970	0.66	0.53	0.57	0.63	0.41	0.24	0.44	0.25	0.33	0.59	0.41	0.48	0.34	0.41	0.46	0.33	0.53	0.74	0.71	0.64	0.66	0.59	0.36	0.42
1971	0.80	0.66	0.84	0.84	0.82	0.68	0.50	0.25	0.17	0.52	0.35	0.48	0.34	0.54	0.53	0.53	0.67	0.47	0.57	0.64	0.59	0.59	0.69	0.69
1972	0.59	0.66	0.63	0.78	0.55	0.75	0.72	0.50	0.52	0.39	0.41	0.55	0.61	0.48	0.46	0.33	0.22	0.47	0.64	0.51	0.15	0.66	0.69	0.69
1973	0.40	0.73	0.71	0.78	0.82	0.75	0.19	0.31	0.08	0.39	0.12	0.48	0.61	0.61	0.17	0.40	0.67	0.67	0.71	0.71	0.51	0.59	0.55	0.55
1974	0.59	0.80	0.78	0.84	0.75	0.36	0.03	0.58	0.22	0.08	0.48	0.48	0.54	0.48	0.33	0.28	0.28	0.47	0.71	0.57	0.66	0.66	0.76	0.49
1975	0.73	0.73	0.50	0.84	0.41	0.24	0.25	0.50	0.11	0.27	0.35	0.41	0.54	0.41	0.22	0.17	0.22	0.34	0.51	0.51	0.66	0.66	0.62	0.62
1976	0.80	0.80	0.63	0.71	0.82	0.75	0.50	0.44	0.27	0.39	0.55	0.55	0.23	0.41	0.40	0.33	0.53	0.60	0.71	0.71	0.51	0.38	0.13	0.24
1977	0.07	0.03	0.63	0.63	0.68	0.36	0.00	0.00	0.08	0.17	0.35	0.35	0.48	0.54	0.46	0.40	0.60	0.67	0.32	0.32	0.21	0.00	0.62	0.62
1978	0.46	0.40	0.50	0.57	0.48	0.05	0.25	0.14	0.33	0.46	0.61	0.61	0.23	0.41	0.46	0.40	0.60	0.67	0.71	0.71	0.51	0.38	0.69	0.69
Aerage	0.63	0.61	0.63	0.69	0.65	0.40	0.33	0.28	0.23	0.32	0.44	0.47	0.38	0.47	0.44	0.39	0.52	0.57	0.59	0.59	0.52	0.44	0.52	0.55

Source : Prepared by JICA Study Team

Table VII-14 (a)   Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
		First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
LrPaddy /	1960	0.15	0.84	0.78	1.10	1.96	0.58	1.03	1.16	0.91	1.26	1.39	0.91	0.42	0.00	0.58	0.68	0.79	1.08	0.66	0.78	0.90	0.70	0.68	0.45
Beans	1961	0.10	0.88	1.09	1.56	2.02	0.64	1.14	1.35	0.70	1.12	1.34	0.88	0.38	0.00	0.58	0.59	0.72	0.98	0.66	0.78	0.10	0.02	0.01	0.00
	1962	0.07	0.28	1.26	1.16	2.09	0.37	0.98	1.82	0.00	0.49	1.26	0.35	0.30	0.00	0.58	0.68	0.72	1.08	0.73	0.78	1.12	0.56	0.63	0.23
	1963	0.07	0.44	0.69	1.67	1.64	0.65	1.35	0.41	0.75	0.66	1.26	0.94	0.31	0.00	0.58	0.70	0.89	1.13	0.88	1.00	0.97	0.37	0.27	0.27
	1964	0.15	0.94	0.82	1.09	2.03	1.74	1.11	0.23	1.64	1.79	1.24	0.58	0.19	0.00	0.58	0.65	0.82	0.71	0.73	0.85	1.12	0.99	0.57	0.34
	1965	0.17	0.89	1.22	1.89	2.41	1.44	0.98	0.90	1.26	1.81	1.23	0.92	0.36	0.00	0.58	0.70	0.85	1.13	0.80	0.78	0.97	0.77	0.68	0.37
	1966	0.15	0.76	1.12	0.00	2.34	0.22	1.38	1.19	1.81	1.67	1.19	0.95	0.38	0.00	0.58	0.58	0.72	1.08	0.80	1.00	0.90	0.99	0.63	0.41
	1967	0.17	0.86	0.74	1.89	2.29	0.89	0.19	1.36	1.27	1.35	1.31	0.09	0.27	0.00	0.58	0.68	0.85	1.08	0.80	0.93	0.97	0.37	0.41	0.34
	1968	0.15	0.87	0.65	0.40	1.57	1.43	0.96	0.00	1.05	1.36	1.21	0.90	0.25	0.00	0.58	0.62	0.82	1.18	0.80	0.85	0.90	0.70	0.47	0.45
	1969	0.13	0.00	0.43	1.20	2.28	0.02	1.59	1.80	0.94	0.47	1.02	0.93	0.39	0.00	0.58	0.66	0.76	1.13	0.33	0.85	1.04	0.63	0.63	0.41
	1970	0.17	0.50	0.78	1.10	1.40	0.59	1.16	1.26	1.34	1.90	1.17	0.81	0.34	0.00	0.58	0.63	0.79	1.18	0.88	0.93	1.04	0.84	0.41	0.27
	1971	0.12	0.74	1.28	1.83	2.46	1.74	1.45	1.24	0.92	1.83	1.04	0.78	0.34	0.00	0.58	0.68	0.85	0.98	0.73	0.93	0.97	0.84	0.68	0.41
	1972	0.07	0.76	0.91	1.63	1.87	1.86	2.14	1.77	1.79	1.57	1.13	0.89	0.46	0.00	0.58	0.63	0.64	0.98	0.80	0.78	0.49	0.91	0.68	0.41
	1973	0.12	0.78	1.09	1.60	2.46	1.81	0.81	1.38	0.07	1.57	0.68	0.79	0.47	0.00	0.58	0.65	0.85	1.13	0.88	1.00	0.90	0.84	0.57	0.34
	1974	0.15	0.96	1.19	1.89	2.31	0.68	0.52	1.89	1.10	0.59	1.24	0.78	0.43	0.00	0.58	0.62	0.67	0.98	0.88	0.85	1.04	0.91	0.73	0.30
	1975	0.17	0.78	0.70	1.79	1.50	0.59	0.93	1.70	0.78	1.24	1.05	0.78	0.43	0.00	0.58	0.59	0.64	0.88	0.66	0.78	1.04	0.91	0.63	0.37
	1976	0.02	0.91	0.97	1.38	2.42	1.93	1.46	1.62	1.29	1.52	1.33	0.87	0.26	0.00	0.58	0.63	0.79	1.08	0.88	1.00	0.90	0.63	0.22	0.17
	1977	0.09	0.00	0.84	1.19	2.06	0.70	0.03	0.00	0.47	0.96	1.02	0.65	0.39	0.00	0.58	0.65	0.82	1.13	0.46	0.57	0.55	0.20	0.63	0.37
	1978	0.12	0.24	0.69	0.96	1.58	0.14	0.90	0.94	1.41	1.60	1.41	0.92	0.26	0.00	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.68	0.41
	Average	0.12	0.65	0.91	1.33	2.04	0.95	1.06	1.16	1.03	1.30	1.19	0.77	0.35	0.00	0.58	0.65	0.78	1.05	0.75	0.86	0.88	0.67	0.54	0.33

Table VII-14 (b)   Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
		First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Maize-1 /	1960	0.53	0.58	0.65	0.76	0.97	0.24	0.47	0.57	0.49	0.65	0.95	0.71	0.44	0.86	1.11	1.65	1.98	1.58	1.41	1.80	1.76	1.54	1.57	1.04
SrPaddy	1961	0.42	0.58	0.69	0.83	0.97	0.30	0.54	0.63	0.37	0.59	0.95	0.71	0.40	0.77	0.47	0.90	1.57	1.19	1.44	1.82	0.00	0.00	0.00	0.21
	1962	0.34	0.58	0.72	0.76	1.02	0.09	0.47	0.92	0.08	0.28	0.88	0.30	0.33	0.60	1.22	1.59	1.60	1.67	1.64	1.82	2.10	1.32	1.44	0.72
	1963	0.34	0.56	0.64	0.83	0.87	0.30	0.61	0.20	0.37	0.34	0.88	0.77	0.33	0.75	1.03	1.75	2.43	1.90	2.10	2.20	1.85	0.97	0.73	0.74
	1964	0.53	0.58	0.65	0.76	0.97	0.68	0.54	0.15	0.82	0.95	0.88	0.50	0.23	0.59	1.05	1.42	2.08	0.42	1.60	1.90	2.15	2.13	1.28	0.89
	1965	0.55	0.58	0.70	0.86	1.13	0.61	0.47	0.44	0.62	0.95	0.88	0.77	0.40	0.85	1.26	1.74	2.21	1.88	1.84	1.74	1.83	1.68	1.52	0.95
	1966	0.52	0.58	0.70	0.61	1.07	0.05	0.68	0.57	0.90	0.87	0.80	0.77	0.40	0.66	1.31	0.67	1.52	1.64	1.74	2.12	1.80	2.14	1.47	1.04
	1967	0.55	0.56	0.65	0.86	1.07	0.41	0.01	0.63	0.62	0.72	0.95	0.13	0.30	0.49	0.92	1.66	2.27	1.62	1.70	2.02	1.89	0.97	1.06	0.90
	1968	0.51	0.58	0.64	0.67	0.87	0.61	0.47	0.05	0.55	0.72	0.88	0.71	0.26	0.71	0.06	1.14	2.07	1.99	1.88	1.82	1.76	1.54	1.15	1.06
	1969	0.50	0.58	0.61	0.76	1.07	0.05	0.68	0.85	0.49	0.28	0.74	0.77	0.44	0.53	1.08	1.65	1.72	1.91	0.77	1.94	2.08	1.47	1.44	0.98
	1970	0.54	0.58	0.65	0.76	0.82	0.24	0.61	0.57	0.69	1.02	0.80	0.66	0.37	0.64	0.86	1.30	1.93	1.97	2.14	2.01	2.09	1.86	1.07	0.76
	1971	0.46	0.58	0.72	0.86	1.13	0.68	0.68	0.57	0.49	0.95	0.74	0.66	0.37	0.87	1.09	1.60	2.26	1.15	1.52	1.97	1.90	1.82	1.50	1.00
	1972	0.36	0.58	0.67	0.83	0.92	0.75	0.90	0.85	0.90	0.80	0.80	0.71	0.51	0.67	0.86	1.22	1.17	1.11	1.77	1.78	0.94	2.00	1.53	1.00
	1973	0.44	0.58	0.69	0.83	1.13	0.75	0.34	0.63	0.11	0.80	0.47	0.66	0.51	0.93	0.30	1.35	2.32	1.90	2.01	2.12	1.70	1.91	1.30	0.90
	1974	0.53	0.58	0.70	0.86	1.07	0.36	0.16	0.92	0.55	0.34	0.88	0.66	0.47	0.72	0.60	1.12	1.18	1.13	2.04	1.95	1.99	2.03	1.62	0.81
	1975	0.54	0.58	0.64	0.86	0.82	0.24	0.40	0.85	0.42	0.65	0.74	0.60	0.47	0.60	0.41	0.83	1.14	0.78	1.44	1.82	2.06	2.00	1.41	0.95
	1976	0.13	0.58	0.67	0.79	1.13	0.75	0.68	0.77	0.62	0.80	0.95	0.71	0.30	0.53	0.74	1.21	1.94	1.54	1.99	2.11	1.74	1.51	0.65	0.57
	1977	0.37	0.58	0.67	0.76	1.02	0.36	0.00	0.00	0.26	0.52	0.74	0.55	0.44	0.79	0.88	1.38	2.14	1.73	0.98	1.36	1.09	0.52	1.42	0.96
	1978	0.46	0.58	0.64	0.73	0.87	0.05	0.40	0.44	0.69	0.87	1.02	0.77	0.30	0.52	0.85	1.34	2.14	1.73	1.97	2.10	1.73	1.49	1.55	1.03
	Average	0.45	0.58	0.67	0.79	1.00	0.40	0.48	0.56	0.53	0.69	0.84	0.64	0.38	0.69	0.85	1.34	1.88	1.52	1.68	1.92	1.71	1.52	1.25	0.87

Table VII-14 (c) Unit Water Requirement by Cropping Pattern and by Year

		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
Description	Year	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Maize-1 /	1960	0.21	0.58	0.65	0.76	0.97	0.24	0.47	0.57	0.49	0.65	0.95	0.71	0.44	0.00	0.58	0.68	0.79	1.08	0.66	0.78	0.90	0.70	0.91	0.89
Groundnut	1961	0.45	0.58	0.69	0.83	0.97	0.30	0.54	0.63	0.37	0.59	0.95	0.71	0.40	0.00	0.58	0.59	0.72	0.98	0.66	0.78	0.10	0.02	0.01	0.00
	1962	0.40	0.58	0.72	0.76	1.02	0.09	0.47	0.92	0.08	0.28	0.88	0.30	0.33	0.00	0.58	0.68	0.72	1.08	0.73	0.78	1.12	0.56	0.83	0.47
	1963	0.40	0.58	0.64	0.83	0.87	0.30	0.61	0.20	0.37	0.34	0.88	0.77	0.33	0.00	0.58	0.70	0.89	1.13	0.88	1.00	0.97	0.37	0.36	0.54
	1964	0.50	0.58	0.65	0.76	0.97	0.68	0.54	0.15	0.82	0.95	0.88	0.50	0.23	0.00	0.58	0.65	0.82	0.71	0.73	0.85	1.12	0.99	0.76	0.67
	1965	0.50	0.58	0.70	0.86	1.13	0.61	0.47	0.44	0.62	0.95	0.88	0.77	0.40	0.00	0.58	0.70	0.85	1.13	0.80	0.78	0.97	0.77	0.91	0.75
	1966	0.35	0.58	0.70	0.61	1.07	0.05	0.68	0.57	0.90	0.87	0.80	0.77	0.40	0.00	0.58	0.58	0.72	1.08	0.80	1.00	0.90	0.99	0.83	0.82
	1967	0.09	0.58	0.65	0.86	1.07	0.41	0.01	0.63	0.62	0.72	0.95	0.13	0.30	0.00	0.58	0.68	0.85	1.08	0.80	0.93	0.97	0.37	0.55	0.67
	1968	0.40	0.58	0.64	0.67	0.87	0.61	0.47	0.05	0.55	0.72	0.88	0.71	0.26	0.00	0.58	0.62	0.82	1.18	0.80	0.85	0.90	0.70	0.62	0.89
	1969	0.35	0.58	0.61	0.76	1.07	0.05	0.68	0.85	0.49	0.28	0.74	0.77	0.44	0.00	0.58	0.68	0.76	1.13	0.33	0.85	1.04	0.63	0.83	0.82
	1970	0.50	0.58	0.65	0.76	0.82	0.24	0.61	0.57	0.69	1.02	0.80	0.66	0.37	0.00	0.58	0.63	0.79	1.18	0.88	0.93	1.04	0.84	0.55	0.54
	1971	0.35	0.58	0.72	0.86	1.13	0.68	0.68	0.57	0.49	0.95	0.74	0.66	0.37	0.00	0.58	0.68	0.85	0.98	0.73	0.93	0.97	0.84	0.91	0.82
	1972	0.21	0.58	0.67	0.83	0.92	0.75	0.90	0.85	0.90	0.80	0.80	0.71	0.51	0.00	0.58	0.63	0.64	0.98	0.80	0.78	0.49	0.91	0.91	0.82
	1973	0.35	0.58	0.69	0.83	1.13	0.75	0.34	0.63	0.11	0.80	0.47	0.66	0.51	0.00	0.58	0.65	0.85	1.13	0.88	1.00	0.90	0.84	0.76	0.67
	1974	0.45	0.58	0.70	0.86	1.07	0.36	0.16	0.92	0.55	0.34	0.88	0.66	0.47	0.00	0.58	0.62	0.67	0.98	0.88	0.85	1.04	0.91	0.98	0.61
	1975	0.50	0.58	0.64	0.86	0.82	0.24	0.40	0.85	0.42	0.65	0.74	0.60	0.47	0.00	0.58	0.59	0.64	0.88	0.66	0.78	1.04	0.91	0.83	0.75
	1976	0.07	0.58	0.67	0.79	1.13	0.75	0.68	0.77	0.62	0.80	0.95	0.71	0.30	0.00	0.58	0.63	0.79	1.08	0.88	1.00	0.90	0.63	0.30	0.34
	1977	0.26	0.58	0.67	0.76	1.02	0.36	0.00	0.00	0.26	0.52	0.74	0.55	0.44	0.00	0.58	0.65	0.82	1.13	0.46	0.57	0.55	0.20	0.83	0.75
	1978	0.35	0.58	0.64	0.73	0.87	0.05	0.40	0.44	0.69	0.87	1.02	0.77	0.30	0.00	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.91	0.82
	Average	0.35	0.58	0.67	0.79	1.00	0.40	0.48	0.56	0.53	0.69	0.84	0.64	0.38	0.00	0.58	0.65	0.78	1.05	0.75	0.86	0.88	0.67	0.71	0.67

Table VII-14 (d) Unit Water Requirement by Cropping Pattern and by Year

		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
Description	Year	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
Maize-1 /	1960	0.15	0.58	0.65	0.76	0.97	0.24	0.47	0.57	0.49	0.65	0.95	0.71	0.44	0.00	0.58	0.68	0.79	1.08	0.66	0.78	0.90	0.70	0.68	0.45
Greengram	1961	0.10	0.58	0.69	0.83	0.97	0.30	0.54	0.63	0.37	0.59	0.95	0.71	0.40	0.00	0.58	0.59	0.72	0.98	0.66	0.78	0.10	0.02	0.01	0.00
	1962	0.07	0.58	0.72	0.76	1.02	0.09	0.47	0.92	0.08	0.28	0.88	0.30	0.33	0.00	0.58	0.68	0.72	1.08	0.73	0.78	1.12	0.56	0.63	0.23
	1963	0.07	0.58	0.64	0.83	0.87	0.30	0.61	0.20	0.37	0.34	0.88	0.77	0.33	0.00	0.58	0.70	0.89	1.13	0.88	1.00	0.97	0.37	0.27	0.27
	1964	0.15	0.58	0.65	0.76	0.97	0.68	0.54	0.15	0.82	0.95	0.88	0.50	0.23	0.00	0.58	0.65	0.82	0.71	0.73	0.85	1.12	0.99	0.57	0.34
	1965	0.17	0.58	0.70	0.86	1.13	0.61	0.47	0.44	0.62	0.95	0.88	0.77	0.40	0.00	0.58	0.70	0.85	1.13	0.80	0.78	0.97	0.77	0.68	0.37
	1966	0.15	0.58	0.70	0.61	1.07	0.05	0.68	0.57	0.90	0.87	0.80	0.77	0.40	0.00	0.58	0.58	0.72	1.08	0.80	1.00	0.90	0.99	0.63	0.41
	1967	0.17	0.58	0.65	0.86	1.07	0.41	0.01	0.63	0.62	0.72	0.95	0.13	0.30	0.00	0.58	0.68	0.85	1.08	0.80	0.93	0.97	0.37	0.41	0.34
	1968	0.15	0.58	0.64	0.67	0.87	0.61	0.47	0.05	0.55	0.72	0.88	0.71	0.26	0.00	0.58	0.62	0.82	1.18	0.80	0.85	0.90	0.70	0.47	0.45
	1969	0.13	0.58	0.61	0.76	1.07	0.05	0.68	0.85	0.49	0.28	0.74	0.77	0.44	0.00	0.58	0.68	0.76	1.13	0.33	0.85	1.04	0.63	0.63	0.41
	1970	0.17	0.58	0.65	0.76	0.82	0.24	0.61	0.57	0.69	1.02	0.80	0.66	0.37	0.00	0.58	0.63	0.79	1.18	0.88	0.93	1.04	0.84	0.41	0.27
	1971	0.12	0.58	0.72	0.86	1.13	0.68	0.68	0.57	0.49	0.95	0.74	0.66	0.37	0.00	0.58	0.68	0.85	0.98	0.73	0.93	0.97	0.84	0.68	0.41
	1972	0.07	0.58	0.67	0.83	0.92	0.75	0.90	0.85	0.90	0.80	0.80	0.71	0.51	0.00	0.58	0.63	0.64	0.98	0.80	0.78	0.49	0.91	0.68	0.41
	1973	0.12	0.58	0.69	0.83	1.13	0.75	0.34	0.63	0.11	0.80	0.47	0.66	0.51	0.00	0.58	0.65	0.85	1.13	0.88	1.00	0.90	0.84	0.57	0.34
	1974	0.15	0.58	0.70	0.86	1.07	0.36	0.16	0.92	0.55	0.34	0.88	0.66	0.47	0.00	0.58	0.62	0.67	0.98	0.88	0.85	1.04	0.91	0.73	0.30
	1975	0.17	0.58	0.64	0.86	0.82	0.24	0.40	0.85	0.42	0.65	0.74	0.60	0.47	0.00	0.58	0.59	0.64	0.88	0.66	0.78	1.04	0.91	0.63	0.37
	1976	0.02	0.58	0.67	0.79	1.13	0.75	0.68	0.77	0.62	0.80	0.95	0.71	0.30	0.00	0.58	0.63	0.79	1.08	0.88	1.00	0.90	0.63	0.22	0.17
	1977	0.09	0.58	0.67	0.76	1.02	0.36	0.00	0.00	0.26	0.52	0.74	0.55	0.44	0.00	0.58	0.65	0.82	1.13	0.46	0.57	0.55	0.20	0.63	0.37
	1978	0.12	0.58	0.64	0.73	0.87	0.05	0.40	0.44	0.69	0.87	1.02	0.77	0.30	0.00	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.68	0.41
	Average	0.12	0.58	0.67	0.79	1.00	0.40	0.48	0.56	0.53	0.69	0.84	0.64	0.38	0.00	0.58	0.65	0.78	1.05	0.75	0.86	0.88	0.67	0.54	0.33

Table VII-14 (e) Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last
Vegetable	1960	0.29	0.68	0.65	0.74	0.91	0.83	0.98	0.39	0.34	0.41	0.51	0.36	0.19	0.65	1.30	1.43	1.75	2.17	2.33	1.48	1.47	1.22	1.29	0.98
	1961	0.22	0.64	0.67	0.79	0.91	0.87	1.04	0.45	0.23	0.36	0.51	0.36	0.17	0.64	0.61	0.60	0.81	0.99	1.17	0.74	0.00	0.05	0.05	0.04
	1962	0.17	0.65	0.70	0.74	0.95	0.72	0.98	0.72	0.09	0.11	0.46	0.10	0.12	0.63	0.66	0.72	0.81	1.08	1.22	0.74	0.95	0.49	0.60	0.28
	1963	0.24	0.69	0.64	0.79	0.85	0.87	1.10	0.09	0.23	0.16	0.46	0.39	0.12	0.64	0.65	0.74	0.98	1.13	1.34	0.95	0.81	0.33	0.28	0.31
	1964	0.29	0.68	0.65	0.74	0.91	1.15	1.04	0.09	0.65	0.65	0.46	0.22	0.06	0.63	0.65	0.67	0.91	0.73	1.22	0.81	0.95	0.85	0.55	0.38
	1965	0.31	0.67	0.69	0.81	1.02	1.10	0.98	0.28	0.45	0.65	0.46	0.39	0.17	0.65	0.67	0.74	0.95	1.13	1.28	0.74	0.81	0.67	0.65	0.42
	1966	0.29	0.68	0.69	0.64	0.99	0.62	1.15	0.39	0.72	0.58	0.41	0.39	0.17	0.64	0.67	0.58	0.81	1.08	1.28	0.95	0.73	0.85	0.60	0.45
	1967	0.31	0.68	0.65	0.81	0.99	0.96	0.60	0.45	0.45	0.47	0.51	0.01	0.10	0.62	0.64	0.72	0.95	1.08	1.28	0.88	0.81	0.33	0.41	0.38
	1968	0.29	0.59	0.64	0.68	0.85	1.10	0.98	0.09	0.39	0.47	0.46	0.36	0.08	0.64	0.58	0.63	0.91	1.18	1.28	0.81	0.73	0.61	0.46	0.49
	1969	0.26	0.65	0.62	0.74	0.99	0.60	1.15	0.65	0.34	0.11	0.37	0.39	0.19	0.63	0.65	0.72	0.84	1.13	0.89	0.81	0.88	0.55	0.60	0.45
	1970	0.31	0.67	0.65	0.74	0.81	0.83	1.10	0.39	0.52	0.71	0.41	0.32	0.14	0.63	0.64	0.65	0.88	1.18	1.34	0.88	0.88	0.73	0.41	0.31
	1971	0.24	0.67	0.70	0.81	1.02	1.15	1.15	0.39	0.34	0.65	0.37	0.32	0.14	0.65	0.65	0.72	0.95	0.99	1.22	0.88	0.81	0.73	0.65	0.45
	1972	0.17	0.68	0.66	0.79	0.88	1.20	1.33	0.65	0.72	0.53	0.41	0.36	0.24	0.64	0.64	0.65	0.72	0.99	1.28	0.74	0.33	0.79	0.65	0.45
	1973	0.24	0.69	0.67	0.79	1.02	1.20	0.87	0.45	0.09	0.53	0.21	0.32	0.24	0.67	0.59	0.67	0.95	1.13	1.34	0.95	0.73	0.73	0.55	0.38
	1974	0.29	0.68	0.69	0.81	0.99	0.91	0.72	0.72	0.39	0.16	0.46	0.32	0.21	0.64	0.62	0.63	0.75	0.99	1.34	0.81	0.88	0.79	0.69	0.35
	1975	0.31	0.69	0.64	0.81	0.81	0.83	0.92	0.65	0.28	0.41	0.37	0.29	0.21	0.63	0.60	0.60	0.72	0.90	1.17	0.74	0.88	0.79	0.60	0.42
	1976	0.05	0.59	0.66	0.77	1.02	1.20	1.15	0.58	0.45	0.53	0.51	0.36	0.10	0.63	0.63	0.65	0.88	1.08	1.34	0.95	0.73	0.55	0.24	0.21
	1977	0.19	0.63	0.66	0.74	0.95	0.91	0.58	0.09	0.12	0.30	0.37	0.25	0.19	0.65	0.64	0.67	0.91	1.13	0.99	0.53	0.39	0.19	0.60	0.42
	1978	0.24	0.66	0.64	0.72	0.85	0.60	0.92	0.28	0.52	0.58	0.56	0.39	0.10	0.63	0.64	0.67	0.91	1.13	1.34	0.95	0.73	0.55	0.65	0.45
	Average	0.25	0.66	0.66	0.76	0.93	0.93	0.99	0.41	0.39	0.44	0.44	0.31	0.15	0.64	0.67	0.71	0.91	1.12	1.30	0.86	0.76	0.62	0.55	0.40

Table VII-14 (f) Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last
Maize-2 /	1960	1.17	0.70	0.73	0.98	0.61	0.41	0.63	0.63	0.52	0.65	0.71	0.47	0.58	0.65	0.71	0.86	0.45	0.68	0.76	0.83	0.90	0.84	1.13	0.91
Cotton	1961	1.06	0.70	0.79	1.09	0.61	0.47	0.70	0.69	0.40	0.59	0.71	0.47	0.58	0.64	0.59	0.60	0.32	0.54	0.76	0.83	0.10	0.00	0.10	0.21
	1962	0.98	0.63	0.86	0.98	0.68	0.24	0.63	0.98	0.00	0.28	0.66	0.20	0.58	0.62	0.74	0.86	0.32	0.68	0.83	0.83	1.12	0.69	1.06	0.57
	1963	1.10	0.65	0.70	1.09	0.48	0.47	0.77	0.26	0.40	0.34	0.66	0.51	0.58	0.64	0.71	0.91	0.65	0.75	0.97	1.05	0.97	0.50	0.57	0.63
	1964	1.17	0.71	0.73	0.98	0.61	0.88	0.70	0.21	0.87	0.95	0.66	0.33	0.58	0.62	0.71	0.77	0.52	0.19	0.83	0.90	1.12	1.14	0.98	0.74
	1965	1.21	0.70	0.83	1.14	0.82	0.81	0.63	0.50	0.65	0.95	0.66	0.51	0.58	0.65	0.77	0.91	0.58	0.75	0.90	0.83	0.97	0.91	1.13	0.79
	1966	1.17	0.68	0.83	0.75	0.75	0.09	0.85	0.63	0.95	0.87	0.60	0.51	0.58	0.64	0.77	0.58	0.32	0.68	0.90	1.05	0.90	1.14	1.06	0.85
	1967	1.21	0.70	0.73	1.14	0.75	0.60	0.15	0.69	0.65	0.72	0.71	0.09	0.58	0.61	0.68	0.86	0.58	0.68	0.90	0.97	0.97	0.50	0.77	0.74
	1968	1.17	0.70	0.70	0.84	0.48	0.81	0.63	0.11	0.59	0.72	0.66	0.47	0.58	0.64	0.58	0.68	0.52	0.82	0.90	0.90	0.90	0.84	0.84	0.91
	1969	1.14	0.58	0.64	0.98	0.75	0.06	0.85	0.91	0.52	0.28	0.55	0.51	0.58	0.62	0.71	0.86	0.38	0.75	0.43	0.90	1.04	0.76	1.06	0.85
	1970	1.21	0.65	0.73	0.98	0.41	0.41	0.77	0.63	0.72	1.02	0.60	0.44	0.58	0.62	0.68	0.72	0.45	0.82	0.97	0.97	1.04	0.99	0.77	0.63
	1971	1.10	0.68	0.86	1.14	0.82	0.88	0.85	0.63	0.52	0.95	0.55	0.44	0.58	0.65	0.71	0.86	0.58	0.54	0.83	0.97	0.97	0.99	1.13	0.85
	1972	0.98	0.68	0.76	1.09	0.55	0.96	1.07	0.91	0.95	0.80	0.60	0.47	0.58	0.64	0.68	0.72	0.16	0.54	0.90	0.83	0.49	1.06	1.13	0.85
	1973	1.10	0.70	0.79	1.09	0.82	0.96	0.50	0.69	0.13	0.80	0.35	0.44	0.58	0.67	0.58	0.77	0.58	0.75	0.97	1.05	0.90	0.99	0.98	0.74
	1974	1.17	0.71	0.83	1.14	0.75	0.53	0.31	0.98	0.59	0.34	0.66	0.44	0.58	0.64	0.62	0.68	0.21	0.54	0.97	0.90	1.04	1.06	1.21	0.68
	1975	1.21	0.70	0.70	1.14	0.41	0.41	0.57	0.91	0.46	0.65	0.55	0.40	0.58	0.62	0.58	0.60	0.16	0.41	0.76	0.83	1.04	1.06	1.06	0.79
	1976	0.78	0.71	0.76	1.04	0.82	0.96	0.85	0.83	0.65	0.80	0.71	0.47	0.58	0.62	0.65	0.72	0.45	0.68	0.97	1.05	0.90	0.76	0.51	0.48
	1977	1.02	0.58	0.76	0.98	0.68	0.53	0.05	0.00	0.28	0.52	0.55	0.37	0.58	0.65	0.68	0.77	0.52	0.75	0.55	0.62	0.55	0.32	1.06	0.79
	1978	1.10	0.62	0.70	0.94	0.48	0.06	0.57	0.50	0.72	0.87	0.77	0.51	0.58	0.62	0.68	0.77	0.52	0.75	0.97	1.05	0.90	0.76	1.13	0.85
	Average	1.11	0.67	0.76	1.03	0.65	0.55	0.64	0.61	0.56	0.69	0.63	0.43	0.58	0.63	0.68	0.76	0.44	0.65	0.85	0.91	0.88	0.81	0.93	0.73

Table VII-14 (g) Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last
Maize-3 /	1960	0.15	0.00	0.58	0.67	0.75	0.69	0.31	0.40	0.43	0.62	0.95	0.95	0.66	0.47	0.58	0.68	0.79	1.08	0.66	0.78	0.90	0.70	0.68	0.45
Greengram	1961	0.10	0.00	0.58	0.70	0.75	0.73	0.37	0.47	0.31	0.55	0.95	0.95	0.60	0.44	0.58	0.59	0.72	0.98	0.66	0.78	0.10	0.02	0.01	0.00
	1962	0.07	0.00	0.58	0.67	0.78	0.58	0.31	0.75	0.02	0.26	0.88	0.40	0.50	0.40	0.58	0.68	0.72	1.08	0.73	0.78	1.12	0.56	0.63	0.23
	1963	0.07	0.00	0.58	0.70	0.69	0.73	0.44	0.05	0.31	0.31	0.88	1.02	0.50	0.44	0.58	0.70	0.89	1.13	0.88	1.00	0.97	0.37	0.27	0.27
	1964	0.15	0.00	0.58	0.67	0.75	1.02	0.37	0.01	0.77	0.90	0.88	0.67	0.35	0.40	0.58	0.65	0.82	0.71	0.73	0.85	1.12	0.99	0.57	0.34
	1965	0.17	0.00	0.58	0.72	0.85	0.97	0.31	0.28	0.56	0.90	0.88	1.02	0.60	0.47	0.58	0.70	0.85	1.13	0.80	0.78	0.97	0.77	0.68	0.37
	1966	0.15	0.00	0.58	0.60	0.82	0.58	0.50	0.40	0.84	0.82	0.80	1.02	0.60	0.44	0.58	0.58	0.72	1.08	0.80	1.00	0.90	0.99	0.63	0.41
	1967	0.17	0.00	0.58	0.72	0.82	0.82	0.00	0.47	0.56	0.69	0.95	0.18	0.45	0.37	0.58	0.68	0.85	1.08	0.80	0.93	0.97	0.37	0.41	0.34
	1968	0.15	0.00	0.58	0.62	0.69	0.97	0.31	0.00	0.50	0.69	0.88	0.95	0.40	0.44	0.58	0.62	0.82	1.18	0.80	0.85	0.90	0.70	0.47	0.45
	1969	0.13	0.00	0.58	0.67	0.82	0.58	0.50	0.68	0.43	0.26	0.74	1.02	0.66	0.40	0.58	0.68	0.76	1.13	0.33	0.85	1.04	0.63	0.63	0.41
	1970	0.17	0.00	0.58	0.67	0.66	0.69	0.44	0.40	0.63	0.97	0.80	0.88	0.55	0.40	0.58	0.63	0.79	1.18	0.88	0.93	1.04	0.84	0.41	0.27
	1971	0.12	0.00	0.58	0.72	0.85	1.02	0.50	0.40	0.43	0.90	0.74	0.88	0.55	0.47	0.58	0.68	0.85	0.98	0.73	0.93	0.97	0.84	0.68	0.41
	1972	0.07	0.00	0.58	0.70	0.72	1.07	0.72	0.68	0.84	0.76	0.80	0.95	0.76	0.44	0.58	0.63	0.64	0.98	0.80	0.78	0.49	0.91	0.68	0.41
	1973	0.12	0.00	0.58	0.70	0.85	1.07	0.19	0.47	0.05	0.76	0.47	0.88	0.76	0.51	0.58	0.65	0.85	1.13	0.88	1.00	0.90	0.84	0.57	0.34
	1974	0.15	0.00	0.58	0.72	0.82	0.78	0.03	0.75	0.50	0.31	0.88	0.88	0.71	0.44	0.58	0.62	0.67	0.98	0.88	0.85	1.04	0.91	0.73	0.30
	1975	0.17	0.00	0.58	0.72	0.66	0.69	0.25	0.68	0.37	0.62	0.74	0.80	0.71	0.40	0.58	0.59	0.64	0.88	0.66	0.78	1.04	0.91	0.63	0.37
	1976	0.02	0.00	0.58	0.69	0.85	1.07	0.50	0.61	0.56	0.76	0.95	0.95	0.45	0.40	0.58	0.63	0.79	1.08	0.88	1.00	0.90	0.63	0.22	0.17
	1977	0.09	0.00	0.58	0.67	0.78	0.78	0.00	0.00	0.20	0.49	0.74	0.74	0.66	0.47	0.58	0.65	0.82	1.13	0.46	0.57	0.55	0.20	0.63	0.37
	1978	0.12	0.00	0.58	0.65	0.69	0.58	0.25	0.28	0.63	0.82	1.02	1.02	0.45	0.40	0.58	0.65	0.82	1.13	0.88	1.00	0.90	0.63	0.68	0.41
	Average	0.12	0.00	0.58	0.68	0.77	0.81	0.33	0.41	0.47	0.65	0.84	0.85	0.57	0.43	0.58	0.65	0.78	1.05	0.75	0.86	0.88	0.67	0.54	0.33

Table VII-14 (h) Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last
Sugarcane	1960	0.92	0.94	0.87	0.96	0.97	0.72	0.77	0.75	0.68	0.78	0.99	0.99	0.80	0.80	0.73	0.99	0.99	0.99	0.90	0.87	0.84	0.77	0.92	0.94
	1961	0.92	0.94	0.97	1.06	0.97	0.76	0.82	0.79	0.59	0.73	0.99	0.99	0.73	0.74	0.51	0.70	0.88	0.89	0.90	0.87	0.33	0.33	0.33	0.33
	1962	0.77	0.75	1.07	0.96	1.02	0.59	0.77	0.99	0.40	0.52	0.94	0.61	0.61	0.68	0.79	0.99	0.88	0.99	0.95	0.87	0.99	0.68	0.87	0.64
	1963	0.67	0.80	0.81	1.06	0.87	0.76	0.87	0.50	0.59	0.56	0.94	1.04	0.61	0.74	0.73	1.04	1.14	1.04	1.05	1.02	0.90	0.54	0.54	0.69
	1964	0.82	0.99	0.87	0.96	0.97	1.05	0.82	0.46	0.91	0.98	0.94	0.79	0.42	0.68	0.73	0.88	1.04	0.62	0.95	0.92	0.99	0.97	0.82	0.79
	1965	0.92	0.94	1.02	1.12	1.13	1.00	0.77	0.66	0.77	0.98	0.94	1.04	0.73	0.80	0.85	1.04	1.09	1.04	1.00	0.87	0.90	0.82	0.92	0.84
	1966	0.97	0.90	1.02	0.72	1.07	0.49	0.92	0.75	0.96	0.93	0.88	1.04	0.73	0.74	0.85	0.61	0.88	0.99	1.00	1.02	0.84	0.97	0.87	0.89
	1967	0.92	0.94	0.87	1.12	1.07	0.85	0.44	0.79	0.77	0.83	0.99	0.46	0.54	0.62	0.68	0.99	1.09	0.99	1.00	0.97	0.90	0.54	0.68	0.79
	1968	0.97	0.94	0.81	0.81	0.87	1.00	0.77	0.39	0.72	0.83	0.94	0.99	0.48	0.74	0.36	0.79	1.04	1.10	1.00	0.92	0.84	0.77	0.72	0.94
	1969	0.92	0.53	0.72	0.96	1.07	0.36	0.92	0.94	0.68	0.52	0.84	1.04	0.80	0.68	0.73	0.99	0.93	1.04	0.67	0.92	0.94	0.72	0.87	0.89
	1970	0.87	0.80	0.87	0.96	0.82	0.72	0.87	0.75	0.82	1.03	0.88	0.94	0.67	0.68	0.68	0.83	0.99	1.10	1.05	0.97	0.94	0.87	0.68	0.69
	1971	0.97	0.90	1.07	1.12	1.13	1.05	0.92	0.75	0.68	0.98	0.84	0.94	0.67	0.80	0.73	0.99	1.09	0.89	0.95	0.97	0.90	0.87	0.92	0.89
	1972	0.82	0.90	0.92	1.06	0.92	1.10	1.08	0.94	0.96	0.88	0.88	0.99	0.93	0.74	0.68	0.83	0.75	0.89	1.00	0.87	0.57	0.92	0.92	0.89
	1973	0.67	0.94	0.97	1.06	1.13	1.10	0.68	0.79	0.42	0.88	0.65	0.94	0.93	0.86	0.41	0.88	1.09	1.04	1.05	1.02	0.84	0.87	0.82	0.79
	1974	0.82	0.99	1.02	1.12	1.07	0.81	0.55	0.99	0.72	0.56	0.94	0.94	0.87	0.74	0.56	0.79	0.79	0.89	1.05	0.92	0.94	0.92	0.97	0.74
	1975	0.92	0.94	0.81	1.12	0.82	0.72	0.72	0.94	0.63	0.78	0.84	0.89	0.87	0.68	0.46	0.70	0.75	0.79	0.90	0.87	0.94	0.92	0.87	0.84
	1976	0.97	0.99	0.92	1.01	1.13	1.10	0.92	0.89	0.77	0.88	0.99	0.99	0.54	0.68	0.62	0.83	0.99	0.99	1.05	1.02	0.84	0.72	0.50	0.55
	1977	0.42	0.41	0.92	0.96	1.02	0.81	0.37	0.33	0.52	0.69	0.84	0.84	0.80	0.80	0.68	0.88	1.04	1.04	0.75	0.72	0.61	0.43	0.87	0.84
	1978	0.72	0.70	0.81	0.91	0.87	0.45	0.72	0.66	0.82	0.93	1.03	1.04	0.54	0.68	0.68	0.88	1.04	1.04	1.05	1.02	0.84	0.72	0.92	0.89
	Average	0.84	0.86	0.91	1.00	1.00	0.81	0.77	0.74	0.71	0.80	0.91	0.92	0.70	0.73	0.65	0.88	0.97	0.97	0.96	0.93	0.84	0.76	0.79	0.78

Table VII-14 (i) Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last
Passion fruit	1960	0.73	0.73	0.57	0.63	0.61	0.24	0.31	0.25	0.17	0.27	0.55	0.55	0.48	0.54	0.53	0.53	0.53	0.60	0.51	0.51	0.51	0.45	0.69	0.76
	1961	0.73	0.73	0.71	0.78	0.61	0.30	0.37	0.31	0.08	0.22	0.55	0.55	0.41	0.48	0.28	0.17	0.40	0.47	0.51	0.51	0.00	0.00	0.00	0.00
	1962	0.53	0.46	0.84	0.63	0.68	0.09	0.31	0.58	0.08	0.08	0.48	0.07	0.28	0.41	0.59	0.53	0.40	0.60	0.57	0.51	0.73	0.32	0.62	0.36
	1963	0.40	0.53	0.50	0.78	0.48	0.30	0.44	0.00	0.08	0.08	0.48	0.61	0.28	0.48	0.53	0.59	0.74	0.67	0.71	0.71	0.59	0.15	0.18	0.42
	1964	0.59	0.80	0.57	0.63	0.61	0.68	0.37	0.00	0.46	0.52	0.48	0.28	0.12	0.41	0.53	0.40	0.60	0.11	0.57	0.57	0.73	0.73	0.55	0.55
	1965	0.73	0.73	0.78	0.84	0.82	0.61	0.31	0.14	0.27	0.52	0.48	0.61	0.41	0.54	0.66	0.59	0.67	0.67	0.64	0.51	0.59	0.51	0.69	0.62
	1966	0.80	0.66	0.78	0.32	0.75	0.05	0.50	0.25	0.52	0.46	0.41	0.61	0.41	0.48	0.66	0.08	0.40	0.60	0.64	0.71	0.51	0.73	0.62	0.69
	1967	0.73	0.73	0.57	0.84	0.75	0.41	0.00	0.31	0.27	0.33	0.55	0.03	0.23	0.34	0.46	0.53	0.67	0.60	0.64	0.64	0.59	0.15	0.36	0.55
	1968	0.80	0.73	0.50	0.44	0.48	0.61	0.31	0.00	0.22	0.33	0.48	0.55	0.17	0.48	0.12	0.28	0.60	0.74	0.64	0.57	0.51	0.45	0.42	0.76
	1969	0.73	0.17	0.38	0.63	0.75	0.05	0.50	0.50	0.17	0.08	0.35	0.61	0.48	0.41	0.53	0.53	0.47	0.67	0.20	0.57	0.66	0.38	0.62	0.69
	1970	0.66	0.53	0.57	0.63	0.41	0.24	0.44	0.25	0.33	0.59	0.41	0.48	0.34	0.41	0.46	0.33	0.53	0.74	0.71	0.64	0.66	0.59	0.36	0.42
	1971	0.80	0.66	0.84	0.84	0.82	0.68	0.50	0.25	0.17	0.52	0.35	0.48	0.34	0.54	0.53	0.53	0.67	0.47	0.57	0.64	0.59	0.59	0.69	0.69
	1972	0.59	0.66	0.63	0.78	0.55	0.75	0.72	0.50	0.52	0.39	0.41	0.55	0.61	0.48	0.46	0.33	0.22	0.47	0.64	0.51	0.15	0.66	0.69	0.69
	1973	0.40	0.73	0.71	0.78	0.82	0.75	0.19	0.31	0.08	0.39	0.12	0.48	0.61	0.61	0.17	0.40	0.67	0.67	0.71	0.71	0.51	0.59	0.55	0.55
	1974	0.59	0.80	0.78	0.84	0.75	0.36	0.03	0.58	0.22	0.08	0.48	0.48	0.54	0.48	0.33	0.28	0.28	0.47	0.71	0.57	0.66	0.66	0.76	0.49
	1975	0.73	0.73	0.50	0.84	0.41	0.24	0.25	0.50	0.11	0.27	0.35	0.41	0.54	0.41	0.22	0.17	0.22	0.34	0.51	0.51	0.66	0.66	0.62	0.62
	1976	0.80	0.80	0.63	0.71	0.82	0.75	0.50	0.44	0.27	0.39	0.55	0.55	0.23	0.41	0.40	0.33	0.53	0.60	0.71	0.71	0.51	0.38	0.13	0.24
	1977	0.07	0.03	0.63	0.63	0.68	0.36	0.00	0.00	0.08	0.17	0.35	0.35	0.48	0.54	0.46	0.40	0.60	0.67	0.32	0.32	0.21	0.00	0.62	0.62
	1978	0.46	0.40	0.50	0.57	0.48	0.05	0.25	0.14	0.33	0.46	0.61	0.61	0.23	0.41	0.46	0.40	0.60	0.67	0.71	0.71	0.51	0.38	0.69	0.69
	Average	0.63	0.61	0.63	0.69	0.65	0.40	0.33	0.28	0.23	0.32	0.44	0.47	0.38	0.47	0.44	0.39	0.52	0.57	0.59	0.59	0.52	0.44	0.52	0.55

Table VII-14 (j) Unit Water Requirement by Cropping Pattern and by Year

Description	Year	Jan. First	Jan. Last	Feb. First	Feb. Last	Mar. First	Mar. Last	Apr. First	Apr. Last	May First	May Last	June First	June Last	July First	July Last	Aug. First	Aug. Last	Sep. First	Sep. Last	Oct. First	Oct. Last	Nov. First	Nov. Last	Dec. First	Dec. Last
Napiar grass	1960	0.92	0.94	0.87	0.96	0.97	0.72	0.77	0.75	0.68	0.78	0.99	0.99	0.80	0.80	0.73	0.99	0.99	0.99	0.90	0.87	0.84	0.77	0.92	0.94
	1961	0.92	0.94	0.97	1.06	0.97	0.76	0.82	0.79	0.59	0.73	0.99	0.99	0.73	0.74	0.51	0.70	0.88	0.89	0.90	0.87	0.33	0.33	0.33	0.33
	1962	0.77	0.75	1.07	0.96	1.02	0.59	0.77	0.99	0.40	0.52	0.94	0.61	0.61	0.68	0.79	0.99	0.88	0.99	0.95	0.87	0.99	0.68	0.87	0.64
	1963	0.67	0.80	0.81	1.06	0.87	0.76	0.87	0.50	0.59	0.56	0.94	1.04	0.61	0.74	0.73	1.04	1.14	1.04	1.05	1.02	0.90	0.54	0.54	0.69
	1964	0.82	0.99	0.87	0.96	0.97	1.05	0.82	0.46	0.91	0.98	0.94	0.79	0.42	0.68	0.73	0.88	1.04	0.62	0.95	0.92	0.99	0.97	0.82	0.79
	1965	0.92	0.94	1.02	1.12	1.13	1.00	0.77	0.66	0.77	0.98	0.94	1.04	0.73	0.80	0.85	1.04	1.09	1.04	1.00	0.87	0.90	0.82	0.92	0.84
	1966	0.97	0.90	1.02	0.72	1.07	0.49	0.92	0.75	0.96	0.93	0.88	1.04	0.73	0.74	0.85	0.61	0.88	0.99	1.00	1.02	0.84	0.97	0.87	0.89
	1967	0.92	0.94	0.87	1.12	1.07	0.85	0.44	0.79	0.77	0.83	0.99	0.46	0.54	0.62	0.68	0.99	1.09	0.99	1.00	0.97	0.90	0.54	0.68	0.79
	1968	0.97	0.94	0.81	0.81	0.87	1.00	0.77	0.39	0.72	0.83	0.94	0.99	0.48	0.74	0.36	0.79	1.04	1.10	1.00	0.92	0.84	0.77	0.72	0.94
	1969	0.92	0.53	0.72	0.96	1.07	0.36	0.92	0.94	0.68	0.52	0.84	1.04	0.80	0.68	0.73	0.99	0.93	1.04	0.67	0.92	0.94	0.72	0.87	0.89
	1970	0.87	0.80	0.87	0.96	0.82	0.72	0.87	0.75	0.82	1.03	0.88	0.94	0.67	0.68	0.68	0.83	0.99	1.10	1.05	0.97	0.94	0.87	0.68	0.69
	1971	0.97	0.90	1.07	1.12	1.13	1.05	0.92	0.75	0.68	0.98	0.84	0.94	0.67	0.80	0.73	0.99	1.09	0.89	0.95	0.97	0.90	0.87	0.92	0.89
	1972	0.82	0.90	0.92	1.06	0.92	1.10	1.08	0.94	0.96	0.88	0.88	0.99	0.93	0.74	0.68	0.83	0.75	0.89	1.00	0.87	0.57	0.92	0.92	0.89
	1973	0.67	0.94	0.97	1.06	1.13	1.10	0.68	0.79	0.42	0.88	0.65	0.94	0.93	0.86	0.41	0.88	1.09	1.04	1.05	1.02	0.84	0.87	0.82	0.79
	1974	0.82	0.99	1.02	1.12	1.07	0.81	0.55	0.99	0.72	0.56	0.94	0.94	0.87	0.74	0.56	0.79	0.79	0.89	1.05	0.92	0.94	0.92	0.97	0.74
	1975	0.92	0.94	0.81	1.12	0.82	0.72	0.72	0.94	0.63	0.78	0.84	0.89	0.87	0.68	0.46	0.70	0.75	0.79	0.90	0.87	0.94	0.92	0.87	0.84
	1976	0.97	0.99	0.92	1.01	1.13	1.10	0.92	0.89	0.77	0.88	0.99	0.99	0.54	0.68	0.62	0.83	0.99	0.99	1.05	1.02	0.84	0.72	0.50	0.55
	1977	0.42	0.41	0.92	0.96	1.02	0.81	0.37	0.33	0.52	0.69	0.84	0.84	0.80	0.80	0.68	0.88	1.04	1.04	0.75	0.72	0.61	0.43	0.87	0.84
	1978	0.72	0.70	0.81	0.91	0.87	0.45	0.72	0.66	0.82	0.93	1.03	1.04	0.54	0.68	0.68	0.88	1.04	1.04	1.05	1.02	0.84	0.72	0.92	0.89
	Average	0.84	0.86	0.91	1.00	1.00	0.81	0.77	0.74	0.71	0.80	0.91	0.92	0.70	0.73	0.65	0.88	0.97	0.97	0.96	0.93	0.84	0.76	0.79	0.78

Table VII-15 Diversion Water Requirement of Case 1

Proposed Land Use		Sub area							
	Total area	1	2	3	4	5	6	7	8
LrPaddy/Beans	1710	0	110	300	200	100	400	200	400
Maize-1/SrPaddy	950	0	0	0	0	0	400	200	350
Maize-1/Groundnut	1910	660	1250	0	0	0	0	0	0
Maize-1/Greengram	5530	0	170	490	1110	0	1340	1100	1320
Vegetable	960	190	240	110	130	140	50	20	80
Maize-2/cotton	3840	150	640	710	1100	625	200	45	370
Maize-3/Greengram	3840	150	640	710	1100	625	200	45	370
Sugarcane	3870	0	0	290	290	1790	510	120	870
Napiar and other grass land	1610	100	180	170	240	220	210	60	430
Total	24220	1250	3230	2780	4170	3500	3310	1790	4190

Diversion Water Requirement by Year

		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	Year	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
	1960	12.4	14.6	17.9	21.6	20.6	11.0	14.4	15.8	14.1	17.8	22.5	18.7	13.3	9.3	16.5	20.5	19.9	23.2	21.6	22.4	21.4	18.6	21.4	16.8
	1961	11.6	15.0	18.8	22.6	22.9	15.1	14.9	16.8	12.2	16.3	22.5	18.7	13.5	9.7	14.2	16.5	18.2	21.2	18.2	18.4	2.8	2.1	2.7	3.8
	1962	10.2	12.5	20.0	21.8	22.0	9.8	13.3	19.8	5.9	10.6	19.1	10.7	11.3	8.2	16.2	19.8	18.7	23.5	19.1	19.0	22.5	15.3	18.7	11.7
	1963	10.5	13.0	15.6	19.9	19.5	12.3	15.3	9.3	11.1	12.1	20.4	18.5	12.4	9.5	15.8	20.3	23.0	25.5	24.0	24.9	19.2	11.5	10.7	11.2
	1964	12.2	14.8	16.3	18.9	22.9	20.7	13.1	7.3	20.9	23.3	20.3	14.6	9.3	7.6	15.9	18.9	21.2	18.7	21.3	22.2	26.6	24.6	17.3	13.4
	1965	12.8	14.3	19.6	24.0	23.6	17.2	13.2	12.7	18.6	23.4	21.6	19.5	13.5	9.9	16.7	20.4	21.3	24.3	20.1	18.4	23.8	21.0	18.5	13.7
	1966	12.5	14.3	17.7	15.8	21.4	7.0	16.3	14.6	24.1	23.7	20.0	19.0	12.7	8.9	16.2	16.4	18.3	23.3	20.1	21.6	22.0	23.3	19.9	15.7
	1967	12.4	15.0	17.5	24.4	25.2	16.7	7.6	14.3	14.8	19.5	21.2	9.8	11.9	8.8	15.6	20.3	22.4	22.1	22.3	23.1	22.5	11.5	14.2	12.6
	1968	13.0	14.9	15.8	15.6	18.9	22.4	14.4	4.0	18.3	17.6	20.9	16.7	11.3	9.5	14.5	17.6	21.7	26.4	22.3	21.4	22.7	17.4	13.9	15.5
	1969	11.6	10.8	15.6	20.2	23.5	9.2	18.9	17.5	15.4	13.1	18.4	18.0	14.0	8.6	16.1	19.5	19.9	26.0	15.7	23.5	22.8	17.7	18.2	15.6
	1970	11.9	12.0	17.5	19.6	20.5	11.5	14.1	15.9	18.9	25.0	18.2	16.9	11.5	9.1	15.3	16.7	20.1	27.5	24.0	24.5	24.2	20.7	14.8	12.8
	1971	11.9	14.5	20.3	24.4	26.1	23.6	15.2	14.7	13.3	22.0	18.5	14.1	13.0	9.5	15.9	19.1	21.9	23.0	21.3	23.9	23.1	18.0	21.3	14.0
	1972	9.8	14.5	17.3	22.1	22.2	23.8	20.8	17.5	21.3	19.9	18.7	18.7	14.8	9.5	15.9	18.0	16.1	20.5	23.2	18.4	13.2	21.0	19.1	15.6
	1973	10.3	14.0	18.5	19.5	27.2	25.1	14.7	18.9	6.6	16.9	15.0	17.9	15.6	9.1	13.5	17.5	21.8	24.7	23.4	24.2	18.8	22.6	19.4	14.6
	1974	12.4	15.3	19.5	24.5	24.7	11.4	5.3	21.6	15.0	14.0	21.0	16.4	13.1	9.8	15.2	16.9	18.7	21.8	23.4	23.5	24.2	20.3	21.6	11.9
	1975	12.8	14.8	16.4	23.9	17.8	13.1	13.6	22.6	14.4	18.5	18.4	17.1	13.9	8.0	14.5	13.6	17.6	20.7	21.2	20.4	26.2	24.3	18.2	14.5
	1976	9.4	14.0	18.1	21.8	26.5	23.8	17.5	18.9	17.9	21.2	21.2	17.7	10.7	8.0	14.7	17.7	20.0	23.9	24.2	25.5	22.0	18.3	11.7	10.0
	1977	9.1	11.3	17.2	19.6	23.2	15.3	5.7	6.1	11.9	16.6	17.8	14.9	13.7	9.6	15.4	18.6	21.2	25.4	15.9	16.2	14.7	10.4	19.8	14.9
	1978	10.8	12.3	16.2	18.8	19.4	8.0	11.7	12.1	19.7	22.9	22.8	19.0	10.3	7.7	15.3	18.5	20.6	24.3	21.8	22.2	22.8	19.0	18.0	14.1
Average	17.2	11.5	13.8	17.7	21.0	22.5	15.6	13.7	14.8	15.5	18.7	19.9	16.7	12.6	9.0	15.4	18.3	20.1	23.5	21.2	21.8	20.8	17.8	16.8	13.3

Source : Prepared by JICA Study Team

Table VII-16 Diversion Water Requirement of Case 2

Proposed Land Use	Total area	Sub area 1	2	3	4	5	6	7	8
LrPaddy/Beans	4400	0	110	650	1030	500	1210	500	400
Maize-1/SrPaddy	1560	0	0	0	0	0	810	400	350
Maize-1/Groundnut	1910	660	1250	0	0	0	0	0	0
Maize-1/Greengram	1400	0	270	180	280	0	60	610	0
Vegetable	720	190	140	110	130	120	10	20	0
Maize-2/cotton	2760	150	640	550	855	440	80	45	0
Maize-3/Greengram	2760	150	640	550	855	440	80	45	0
Sugarcane	3660	0	0	590	790	1790	370	120	0
Napiar and other grass land	1070	100	180	150	230	210	150	50	0
Total	20240	1250	3230	2780	4170	3500	2770	1790	750

Diversion Water Requirement by Year

		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	Year	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
	1960	10.4	13.1	15.6	19.3	20.2	10.2	13.6	15.0	13.1	16.6	20.2	16.2	11.1	8.0	14.1	17.8	17.6	19.9	18.4	19.2	18.6	16.3	18.4	14.6
	1961	9.7	13.7	16.9	21.0	22.4	13.5	14.4	16.1	11.1	15.3	20.1	16.2	10.9	8.2	11.9	14.1	16.1	18.1	15.7	16.5	2.5	1.8	2.3	3.1
	1962	8.6	9.9	18.4	19.8	21.7	8.5	12.8	19.8	4.6	9.4	17.4	8.7	9.1	6.8	13.9	17.3	16.5	20.3	16.7	16.8	20.3	13.3	16.3	9.8
	1963	8.6	10.7	12.9	18.0	18.7	11.3	15.1	8.3	10.5	10.9	18.4	16.4	9.7	8.1	13.5	17.7	20.5	22.1	20.8	21.7	17.4	9.9	9.1	9.7
	1964	10.2	13.5	13.9	16.2	22.4	20.1	13.0	6.4	19.9	22.0	18.4	12.3	7.2	6.3	13.6	16.3	18.8	15.2	18.4	19.3	23.1	21.5	15.0	11.6
	1965	10.9	12.8	17.9	22.9	23.7	16.7	12.8	12.1	17.2	22.3	19.2	17.0	10.8	8.4	14.4	17.8	19.0	21.0	17.6	16.4	20.6	18.1	16.4	12.1
	1966	10.6	12.7	15.7	11.6	21.6	6.1	16.1	14.2	22.8	22.1	17.9	16.7	10.4	7.5	14.0	13.8	16.2	20.0	17.7	19.6	19.1	20.6	17.0	13.6
	1967	10.3	13.7	15.0	23.3	24.8	15.2	6.4	14.3	14.4	18.2	19.2	7.1	9.1	7.4	13.2	17.6	19.9	19.0	19.4	20.2	19.7	10.0	12.2	11.1
	1968	10.9	13.6	13.2	12.2	18.0	21.0	13.5	3.3	16.5	16.8	18.6	15.0	8.6	8.0	12.0	15.1	19.3	22.9	19.3	18.8	19.5	15.4	12.2	13.8
	1969	9.7	7.4	12.6	17.9	23.4	7.0	18.4	17.8	14.1	11.1	16.3	16.1	11.4	7.2	13.8	17.1	17.6	22.4	12.9	20.1	20.3	15.3	16.0	13.5
	1970	10.3	9.8	15.0	17.1	19.3	10.5	14.0	15.3	17.6	23.6	16.6	14.8	9.5	7.7	13.0	14.4	17.9	23.7	20.8	21.1	21.2	18.2	12.6	10.7
	1971	10.1	13.0	18.6	23.4	26.0	22.6	15.5	14.4	12.4	21.3	16.4	12.9	10.3	8.1	13.6	16.7	19.5	19.5	18.3	20.8	20.2	16.4	18.2	12.5
	1972	8.1	13.0	15.1	20.6	21.6	22.9	21.0	17.8	20.6	19.1	16.8	16.3	12.4	8.1	13.6	15.5	14.1	17.5	20.1	16.4	11.3	18.8	16.7	13.5
	1973	8.7	12.3	16.6	17.5	27.0	23.9	13.3	17.8	5.3	16.8	12.8	15.3	12.8	7.9	11.1	15.2	19.4	21.3	20.5	21.3	16.9	19.5	16.4	12.3
	1974	10.4	14.2	17.7	23.4	24.6	10.8	5.5	21.2	14.3	12.2	18.7	14.4	11.2	8.3	12.8	14.5	16.3	18.6	20.4	20.2	21.2	18.2	18.7	10.5
	1975	10.8	13.4	13.8	22.7	17.1	11.6	12.8	21.5	12.9	17.1	16.3	14.6	11.7	6.7	12.0	11.3	15.3	17.4	18.1	17.8	22.6	21.0	15.9	12.6
	1976	8.0	12.6	16.0	19.9	26.3	23.1	17.1	18.6	16.7	19.7	19.2	15.5	8.5	6.7	12.4	15.2	17.8	20.5	21.1	22.2	19.0	15.7	9.5	8.2
	1977	7.1	8.2	14.8	17.3	22.8	13.7	4.6	4.8	10.2	15.0	15.9	12.8	11.2	8.2	13.1	16.1	18.9	21.9	13.3	14.1	12.6	8.5	17.0	12.8
	1978	9.0	9.5	13.6	16.1	18.5	6.5	11.4	11.6	18.5	21.3	20.6	16.6	8.3	6.4	13.0	16.0	18.4	21.0	19.0	20.0	19.6	16.2	16.0	12.6
Average	15.2	9.6	11.9	15.4	19.0	22.1	14.5	13.2	14.2	14.4	17.4	17.8	14.5	10.2	7.6	13.1	15.8	17.8	20.1	18.3	19.1	18.2	15.5	14.5	11.5

Source : Prepared by JICA Study Team

Table VII-17 Diversion Water Requirement of Case 3

Proposed Land Use		Sub area				
Proposed Land Use	Total area	1	2	3	4	5
LrPaddy/Beans	2290	0	110	650	1030	500
Maize-1/SrPaddy	0	0	0	0	0	0
Maize-1/Groundnut	1910	660	1250	0	0	0
Maize-1/Greengram	570	0	170	120	280	0
Vegetable	830	190	240	160	130	110
Maize-2/cotton	2360	150	615	550	605	440
Maize-3/Greengram	2360	150	615	550	605	440
Sugarcane	3670	0	0	590	1290	1790
Napiar and other grass land	940	100	230	160	230	220
Total	14930	1250	3230	2780	4170	2500

Diversion Water Requirement by Year

		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	Year	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
	1960	8.4	9.9	11.0	13.3	15.3	8.5	10.1	10.3	8.9	11.4	14.4	12.0	8.8	6.9	10.3	12.6	12.7	15.7	12.6	12.7	13.6	11.6	13.3	11.3
	1961	8.3	10.0	12.5	15.4	15.5	9.3	11.1	11.4	7.1	10.4	14.3	12.0	8.2	6.5	8.4	9.4	10.7	13.2	11.6	12.1	2.4	1.7	1.9	2.1
	1962	7.2	7.6	13.6	13.5	16.3	6.3	10.0	15.7	2.1	5.6	13.4	5.9	6.9	6.1	10.1	12.1	10.7	14.8	12.5	12.1	16.0	9.2	11.9	6.7
	1963	7.0	8.2	10.5	15.7	13.4	9.3	12.4	4.6	7.2	6.6	13.4	12.8	7.0	6.5	9.7	12.5	13.9	15.6	14.5	15.1	14.0	6.6	6.2	7.4
	1964	8.5	10.4	11.1	13.3	15.5	16.0	11.1	3.6	14.4	15.9	13.4	8.8	5.2	6.1	9.7	11.1	12.6	9.0	12.5	13.1	16.0	14.9	11.0	8.7
	1965	9.2	10.0	13.1	16.7	18.3	14.5	10.0	8.3	11.2	15.9	13.3	12.7	8.1	6.9	10.4	12.5	13.3	15.6	13.5	12.1	14.0	11.9	12.7	9.5
	1966	8.9	9.5	12.9	8.6	17.5	5.0	13.2	10.3	15.6	14.8	12.4	12.8	8.2	6.5	10.4	8.8	10.7	14.8	13.5	15.1	13.0	14.9	11.9	10.2
	1967	8.4	10.0	10.9	16.7	17.4	11.1	3.3	11.5	11.2	12.4	14.2	3.3	6.3	5.7	9.4	12.1	13.3	14.8	13.5	14.1	14.0	6.6	8.5	8.7
	1968	9.0	9.9	10.4	10.3	13.2	14.5	10.0	2.3	10.0	12.4	13.3	12.0	5.8	6.5	7.6	10.2	12.6	16.4	13.5	13.1	13.0	11.1	9.3	10.9
	1969	8.5	5.8	9.2	13.6	17.4	3.8	13.7	14.9	9.0	5.5	11.4	12.7	8.7	6.1	9.7	12.1	11.3	15.6	7.2	13.1	15.0	10.1	11.9	10.2
	1970	9.0	8.3	11.0	13.4	12.2	8.6	12.0	10.5	12.2	16.9	12.4	11.2	7.6	6.1	9.4	10.6	11.9	16.4	14.5	14.1	15.0	12.9	8.5	7.4
	1971	8.5	9.4	13.6	16.6	18.4	16.0	13.4	10.4	9.0	15.9	11.4	11.1	7.6	6.9	9.7	12.1	13.3	13.2	12.5	14.1	14.0	12.9	12.7	10.2
	1972	7.0	9.5	11.7	15.6	14.5	17.0	17.4	14.8	15.6	13.7	12.3	12.0	10.0	6.5	9.4	10.6	9.0	13.2	13.5	12.1	7.5	13.9	12.7	10.2
	1973	7.2	9.8	12.5	15.5	18.4	16.9	8.2	11.5	2.8	13.7	7.8	11.1	10.0	7.3	7.9	11.1	13.3	15.6	14.5	15.1	13.0	12.9	11.0	8.7
	1974	8.4	10.5	13.1	16.7	17.4	10.0	5.5	15.9	10.1	6.4	13.3	11.1	9.4	6.5	8.7	10.2	9.5	13.2	14.5	13.1	15.0	13.9	13.6	8.1
	1975	9.2	9.8	10.5	16.4	12.5	8.5	9.2	14.6	8.0	11.4	11.5	10.4	9.4	6.1	8.1	9.4	9.0	11.6	11.6	12.1	15.0	13.9	11.9	9.5
	1976	6.6	10.3	11.8	14.5	18.3	17.2	13.4	13.6	11.3	13.6	14.3	12.0	6.3	6.1	9.0	10.6	11.9	14.0	14.5	15.1	13.0	10.1	5.5	5.4
	1977	5.5	5.2	11.5	13.6	16.2	10.1	2.4	1.6	5.3	9.3	11.4	9.6	8.7	6.9	9.4	11.1	12.6	15.6	8.9	9.3	8.4	4.3	11.9	9.5
	1978	7.4	7.2	10.5	12.6	13.2	4.5	9.1	8.3	12.3	14.6	15.2	12.7	6.3	6.1	9.4	11.1	12.6	15.6	14.5	15.1	13.0	10.1	12.7	10.2
Average	11.0	8.0	9.0	11.6	14.3	15.8	10.9	10.3	10.2	9.7	11.9	12.8	10.9	7.8	6.4	9.3	11.0	11.8	14.4	12.9	13.3	12.9	10.7	10.5	8.7

Source : Prepared by JICA Study Team

Table VII-18 Diversion Water Requirement of the Project

Proposed Cropping Pattern	Total area	Sub area 1	2-1	2-2	3	4	5
LrPaddy / Beans	2690	240	0	110	1010	910	420
Maize-1 / SrPaddy	1740	0	0	0	70	990	680
Maize-1 / Groundnut	0	0	0	0	0	0	0
Maize-1 / Greengram	0	0	0	0	0	0	0
Vegetable / Vegetable	1570	100	190	1100	140	20	20
Maize-2 / cotton	765	50	100	505	60	30	20
Maize-3 / Greengram	765	50	100	505	60	30	20
Sugarcane	5130	0	0	0	1230	1830	2070
Napiar and other grass land	1270	60	70	300	210	360	270
Passion fruit	1000	100	190	710	0	0	0
Total	14930	600	650	3230	2780	4170	3500

Diversion Water Requirement of the Project as a Whole

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
Year	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last	First	Last
1960	9.4	11.6	11.4	13.5	16.3	9.0	11.1	10.5	9.0	11.4	14.3	12.2	8.7	9.1	11.7	15.0	16.1	17.4	15.3	14.8	15.1	13.1	14.5	12.3
1961	8.8	11.7	13.1	15.8	16.4	9.7	12.1	11.7	7.3	10.4	14.2	12.1	8.0	8.4	7.8	9.6	12.8	13.6	13.5	13.7	2.5	2.3	2.3	2.7
1962	7.3	8.5	14.5	13.7	17.2	6.8	11.0	15.9	2.9	5.8	13.3	6.0	6.6	7.6	11.4	13.8	12.8	15.8	14.6	13.7	17.0	10.2	12.6	7.4
1963	6.8	9.4	10.7	16.1	14.2	9.7	13.3	5.0	7.4	6.8	13.3	12.9	6.6	8.4	10.6	14.6	17.4	16.9	17.0	16.8	14.9	7.5	6.7	8.0
1964	8.6	12.3	11.5	13.5	16.5	16.6	12.0	4.1	14.4	15.7	13.2	8.9	4.5	7.5	10.6	12.4	15.5	8.5	14.5	14.6	17.0	16.2	11.6	9.5
1965	9.6	11.8	13.9	17.3	19.4	15.0	11.0	8.6	11.3	15.7	13.2	12.8	7.9	9.0	11.9	14.6	16.4	16.9	15.7	13.5	14.9	13.1	13.4	10.2
1966	9.8	11.0	13.7	8.0	18.5	5.3	14.1	10.6	15.6	14.6	12.4	12.9	8.0	8.2	12.0	8.5	12.7	15.8	15.6	16.7	14.0	16.2	12.7	11.0
1967	9.6	11.7	11.3	17.3	18.4	11.6	4.4	11.7	11.3	12.3	14.1	3.6	5.9	6.9	9.9	13.9	16.5	15.7	15.5	15.7	15.0	7.5	9.2	9.5
1968	9.7	11.6	10.6	10.0	14.0	15.0	10.9	2.8	10.1	12.3	13.1	12.2	5.3	8.3	5.9	11.0	15.5	17.8	15.8	14.5	13.9	12.1	10.0	11.6
1969	9.2	6.0	9.1	13.8	18.4	3.9	14.7	15.1	9.1	5.7	11.3	12.8	8.7	7.4	10.7	13.9	13.7	16.9	8.7	14.7	16.1	11.2	12.6	10.9
1970	9.2	9.5	11.4	13.5	13.0	9.0	12.8	10.8	12.2	16.7	12.3	11.3	7.3	7.6	9.8	11.7	14.6	17.8	17.1	15.7	16.1	14.2	9.2	8.1
1971	9.4	11.0	14.6	17.1	19.5	16.6	14.3	10.8	9.1	15.8	11.4	11.2	7.3	9.1	10.7	13.8	16.4	13.5	14.4	15.6	15.0	14.1	13.4	10.9
1972	7.7	11.0	12.2	16.0	15.4	17.5	18.4	15.0	15.6	13.6	12.2	12.1	10.1	8.2	9.8	11.6	10.5	13.4	15.6	13.6	8.0	15.2	13.5	10.9
1973	7.1	11.5	13.1	15.9	19.5	17.4	9.2	11.8	3.4	13.6	7.9	11.3	10.1	9.7	6.7	12.3	16.6	16.9	16.8	16.7	13.8	14.3	11.6	9.5
1974	8.6	12.4	13.9	17.3	18.5	10.4	6.6	16.1	10.2	6.6	13.2	11.2	9.4	8.3	8.4	10.9	11.0	13.5	16.9	14.7	16.0	15.3	14.3	8.8
1975	9.5	11.5	10.7	17.0	13.2	9.0	10.2	14.8	8.1	11.4	11.4	10.6	9.4	7.6	7.3	9.5	10.5	11.5	13.5	13.7	16.1	15.2	12.6	10.2
1976	8.0	12.1	12.3	14.8	19.4	17.8	14.4	13.9	11.4	13.5	14.2	12.1	5.9	7.4	9.1	11.6	14.7	15.6	16.8	16.7	13.9	11.3	6.0	6.1
1977	4.8	5.1	12.0	13.7	17.2	10.5	3.4	2.3	5.7	9.3	11.3	9.7	8.7	8.9	9.8	12.3	15.6	16.6	10.4	10.6	8.9	4.9	12.6	10.2
1978	7.5	8.0	10.7	12.6	14.0	4.8	10.1	8.7	12.4	14.4	15.0	12.8	5.9	7.4	9.8	12.3	15.6	16.6	16.7	16.6	13.9	11.2	13.5	10.9
Average 11.8	8.4	10.4	12.1	14.6	16.8	11.3	11.3	10.5	9.8	11.9	12.7	11.0	7.6	8.2	9.7	12.3	14.5	15.3	15.0	14.9	13.8	11.8	11.2	9.4

Source : Prepared by JICA Study Team

Table VII-19 Diversion Water Requirement of Each Sub- area

	Unit div. req. (lit/sec/ha)	Sub area (m3/sec)					
		1	2-1	2-2	3	4	5
LrPaddy/Beans	2.34	0.56	0.00	0.26	2.36	2.13	0.98
Maize-1/SrPaddy	1.07	0.00	0.00	0.00	0.07	1.06	0.73
Maize-1/Groundnut	1.07	0.00	0.00	0.00	0.00	0.00	0.00
Maize-1/Greengram	1.07	0.00	0.00	0.00	0.00	0.00	0.00
Vegetable	0.99	0.10	0.19	1.09	0.14	0.02	0.02
Maize-2/cotton	0.75	0.04	0.08	0.38	0.05	0.02	0.02
Maize-3/Greengram	0.82	0.04	0.08	0.41	0.05	0.02	0.02
Sugarcane	1.07	0.00	0.00	0.00	1.32	1.96	2.21
Napiar and other grass land	1.07	0.06	0.07	0.32	0.22	0.39	0.29
Passion fruit	0.75	0.08	0.14	0.53	0.00	0.00	0.00
Total diversion requirement m3/sec		0.9	0.6	3.0	4.2	5.6	4.3
Total div. req. in the Paddy area		0.56	0.00	0.26	2.44	3.19	1.71
Unit div. req. lit/sec/ha		2.34		2.34	2.26	1.68	1.55
Total div. req. in the upland area		0.32	0.56	2.74	1.77	2.41	2.56
Unit div. req. lit/sec/ha		0.88	0.87	0.88	1.04	1.06	1.06

Source : Prepared by JICA Study Team

Table VII-20 Numbers of Related Structures on the Irrigation Canals

Canal / Structure	Type	Unit	Sub-area I	II-1	II-2a	II-2b	III	IV	V	Total
Main Canals										
(1) South Nyanza main canal		(km)		6.0						6.0
(2) Nyakach-Kano main canal		(km)			5.4	5.1	6.5	13.3	12.3	45.6
Related structures	Type									
(1) Culvert	I	(nos.)			20	12				
	II	(nos.)					6			
	III	(nos.)					3			
	IV	(nos.)						4		
	V	(nos.)						3	7	
	VI	(nos.)							8	
	VII	(nos.)		10						
	VIII	(nos.)							1	
	Sub total	(nos.)		10	20	12	9	7	16	74
(2) Syphon and spillway		(nos.)		1	4	1	1	1	1	9
(3) Check	I	(nos.)			2	0				
	II	(nos.)			1	2	2			
	III	(nos.)						2		
	IV	(nos.)						2	1	
	V	(nos.)							1	
	VI	(nos.)		4						
	Sub total	(nos.)		4	3	2	2	4	2	17
(4) Drop	I	(nos.)		7						
	II	(nos.)		2						
	III	(nos.)		13						
	IV	(nos.)		5						
	V	(nos.)							1	
	VI	(nos.)							1	
	Sub total	(nos.)		27	0	0	0	0	2	29
(5) Turnout	I	(nos.)		6	7	4	1	1	3	
	II	(nos.)			3	0		1		
	III	(nos.)			0	1	1	3	2	
	IV	(nos.)					2			
	V	(nos.)							1	
	VI	(nos.)							1	
	Sub total	(nos.)		6	10	5	4	5	7	37
(6) Washibg step		(nos.)		6	8	5	6	13	13	51
Secondary Canals										
Length of Canals		(km)	11	6	32	11	45	51	57	213
Related structures										
Turnout		(nos.)	18	20	70	25	61	91	77	362
Check		(nos.)	10	12	39	14	41	61	52	229
Drop		(nos.)	80	43	236	84	118	133	149	843
Culvert		(nos.)	7	4	20	7	9	11	12	70
Washing step		(nos.)	10	5	31	11	45	51	57	210
Tertiary Canals										
Length of Canals		(km)	16	17	62	22	79	117	101	414
Related structures										
Division box		(nos.)	154	167	609	217	789	1161	1012	4109
Drop		(nos.)	71	77	283	101	181	268	233	1214
Pipe culvert		(nos.)	78	84	308	110	387	571	496	2034
On-farm works										
Upland field			360	650	2317	773	1700	2270	2400	10500
Paddy field			240	0	33	77	1080	1900	1100	4430

Table VII-21 Numbers of Related Structures on the Drains

Drain / Structure	Type	Unit	Sub-area I	II-1	II-2a	II-2b	III	IV	V	Total
Main and secondary drains										
Length of drains		(km)	11	14	46	17	35	99	44	266
Related structures	Type									
(1) Cross drain	A1	(nos.)		2	3					
	A2	(nos.)		1	2					
	B1	(nos.)						3		
	B2	(nos.)		1	0	4	1	1	2	
	B3	(nos.)					1	1		
	C1	(nos.)						1		
	C2	(nos.)						1	3	
	Sub total	(nos.)		4	5	4	2	7	5	27
(2) Drop		(nos.)	34	40	118	44	110	243	136	725
(3) Culvert		(nos.)	12	14	40	22	34	84	53	259
(4) Canal revetment		(m2)	2400	2700	9100	5500	7200	25300	8600	60800
Tertiary drains										
Length of drains		(km)	16	17	62	22	79	117	102	415
Related structures										
(1) Drop		(nos.)	8	9	33	12	65	96	83	306
(2) Cross drain		(nos.)	8	9	33	12	65	96	83	306
(3) Drainage culvert		(nos.)	8	9	33	12	65	96	83	306

Source : Prepared by JICA Study Team

Table VII-22 Irrigation Application Interval and Depth

Sandy soils	TRAM (mm)	ETcrop (mm/day)	Irrgation interval (day)	Net field irrigation requirement (mm)	Gross field irrigation requirement (mm)	ditto (m3/ha)
Cotton	55	1.5 - 5.5	10	55	79	790
Groundnuts	19	2.4 - 4.9	4	20	29	290
Maize	50	2.3 - 4.7	11	52	74	740
Onions	6	2.4 - 4.5	1	5	7	70
Peas	17	2.4 - 4.5	4	18	26	260
Sugarcane	62	4.0 - 5.2	12	62	89	890
Vegetable	6	2.4 - 4.5	1	5	7	70
Tomato	11	2.4 - 4.5	2	9	13	130
Cabbge	7	2.4 - 4.5	2	9	13	130

Loamy to calyey soils	TRAM (mm)	ETcrop (mm/day)	Irrgation interval (day)	Net field irrigation requirement (mm)	Gross field irrigation requirement (mm)	ditto (m3/ha)
Cotton	145	1.5 - 5.5	26	143	204	2040
Groundnuts	52	2.4 - 4.9	11	54	77	770
Maize	163	2.3 - 4.7	34	160	229	2290
Onions	16	2.4 - 4.5	4	18	26	260
Peas	45	2.4 - 4.5	10	45	64	640
Sugarcane	166	4.0 - 5.2	32	166	237	2370
Vegetable	16	2.4 - 4.5	4	18	26	260
Tomato	26	2.4 - 4.5	6	27	39	390
Cabbge	18	2.4 - 4.5	4	18	26	260

Source : Prepared by JICA Study Team

Table VII-23 Estimation of Stream Size and Irrigation Time

	Sandy soils			Cotton, Maize, Sugarcane slope 1%	2%	Groundnuts, Onions, Peas, Vegetable, Tomato, Cabbage slope 1%	2%
1	Irrgation interval		(day)	7	7	2	2
2	Depth of application including application losses, 70%		(mm)	52	52	14	14
3	Max. allowable non-erosive furrow stream (Ref.10)		(l/sec)	0.6	0.3	0.6	0.3
4	Length of furrow (Ref.10)		(m)	70	50	50	30
5	Furrow spacing		(m)	0.8	0.8	0.8	0.8
6	Area of application per furrow,	4*5	(m2)	56	40	40	24
7	Water volume of application,	2*6	(m3)	2.9	2.1	0.6	0.3
8	Required infiltration time per furrow	7/3	(min)	81	116	16	19
9	Area irrigated		(ha)	1.0	1.0	1.0	1.0
10	Total nos. of furrow,	9/6	(nos.)	179	250	250	417
11	Total irrigation time,	10*8	(hr)	241	481	65	130
12	Nos. of furrow operated simultaneously		(nos.)	20	30	20	20
13	Actual irrigation time	11/12	(hr)	12.0	16.0	3.2	6.5
14	Total flow required for area of 9	12*3	(l/sec)	12	9	12	6

	Loamy to clayey			Cotton, Maize, Groundnuts, Peas, Sugarcane slope 1%	2%	Onions, Vegetable, Tomato, Cabbage slope 1%	2%
1	Irrgation interval		(day)	7	7	4	4
2	Depth of application including (Ref.10) application losses, 70%		(mm)	50	50	26	26
3	Max. allowable non-erosive furrow stream (Ref.10)		(l/sec)	0.6	0.3	0.6	0.3
4	Length of furrow (Ref.10)		(m)	150	100	100	70
5	Furrow spacing		(m)	0.8	0.8	0.8	0.8
6	Area of application per furrow,	4*5	(m2)	120	80	80	56
7	Water volume of application,	2*6	(m3)	6.0	4.0	2.1	1.5
8	Required infiltration time per furrow	7/3	(min)	167	222	58	81
9	Area irrigated		(ha)	1.0	1.0	1.0	1.0
10	Total nos. of furrow,	9/6	(nos.)	83	125	125	179
11	Total irrigation time,	10*8	(hr)	231	463	120	241
12	Nos. of furrow operated simultaneously		(nos.)	20	30	20	20
13	Actual irrigation time	11/12	(hr)	11.6	15.4	6.0	12.0
14	Total flow required for area of 9	12*3	(l/sec)	12	9	12	6

Source : Prepared by JICA Study Team

Table VII-24 Canals and Related Structures in the Sample Area

		Sample area S5	Sample area S20	Total
Irrigation area	(ha)	372	1699	2071
Secondary canal				
Length of canal	(km)	3.1	15.1	18.2
Related structures				
Turnout	(nos.)	11	37	48
Check	(nos.)	6	25	31
Drop	(nos.)	23	40	63
Culvert	(nos.)	2	3	5
Washing step	(nos.)	3	15	18
Tertiary canals				
Length of canal	(km)	9.6	47.1	56.7
Related structures				
Division box	(nos.)	96	470	566
Drop	(nos.)	44	110	154
Pipe culvert	(nos.)	48	232	280
Tertiary drains				
Length of canal	(km)	9.6	47.1	56.7
Related structures				
Drop	(nos.)	5	37	42
Cross drain	(nos.)	5	37	42
Drainage culvert	(nos.)	5	37	42
Water courses				
Length of canal	(km)	37	174	211
Related structures				
Farm outlet	(nos.)	124	1679	1803
Field access	(nos.)	124	1679	1803
Field drains				
Length of canal	(km)	37	174	211

Source : Prepared by JICA Study Team

Figures

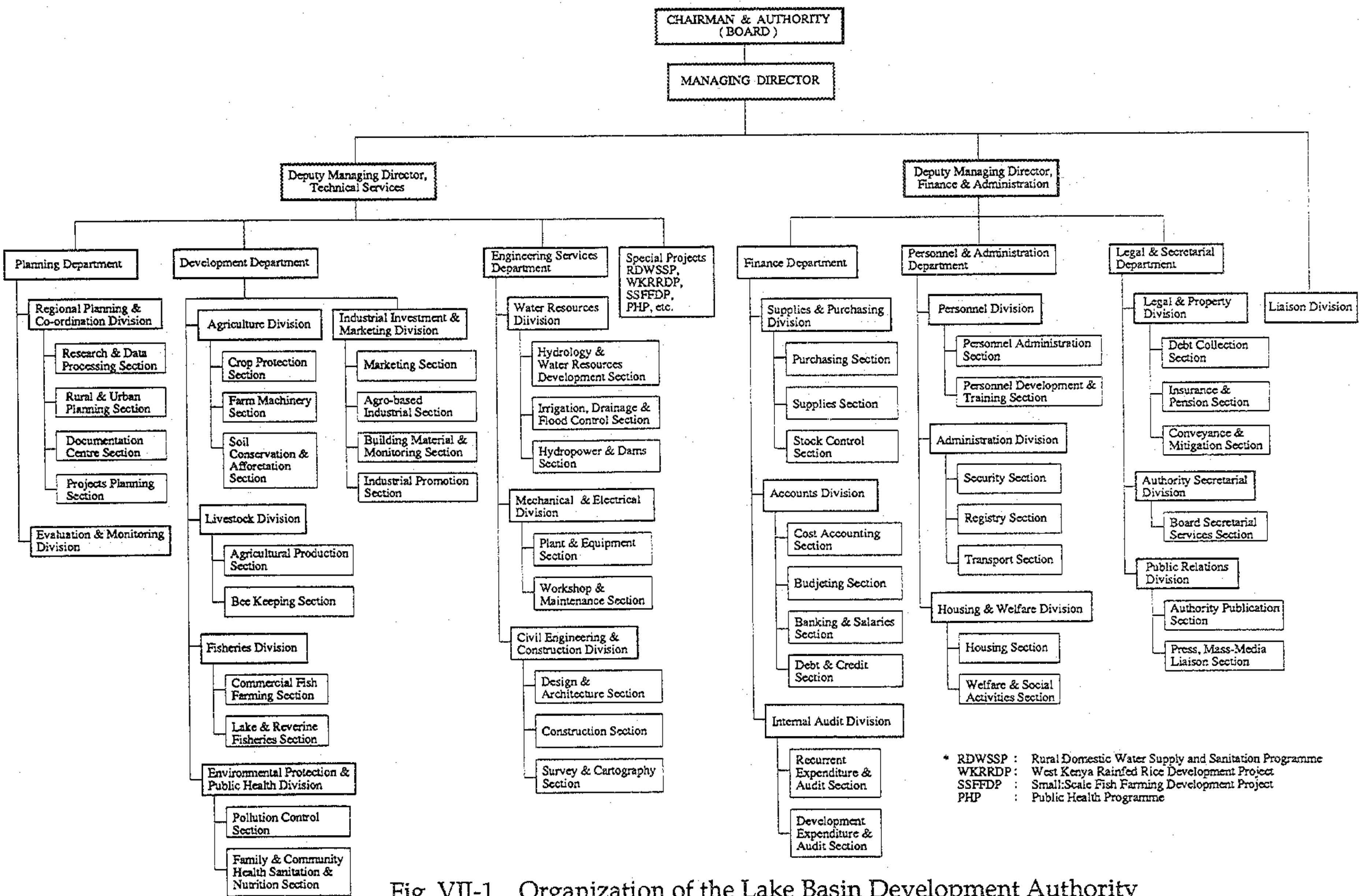


Fig. VII-1 Organization of the Lake Basin Development Authority

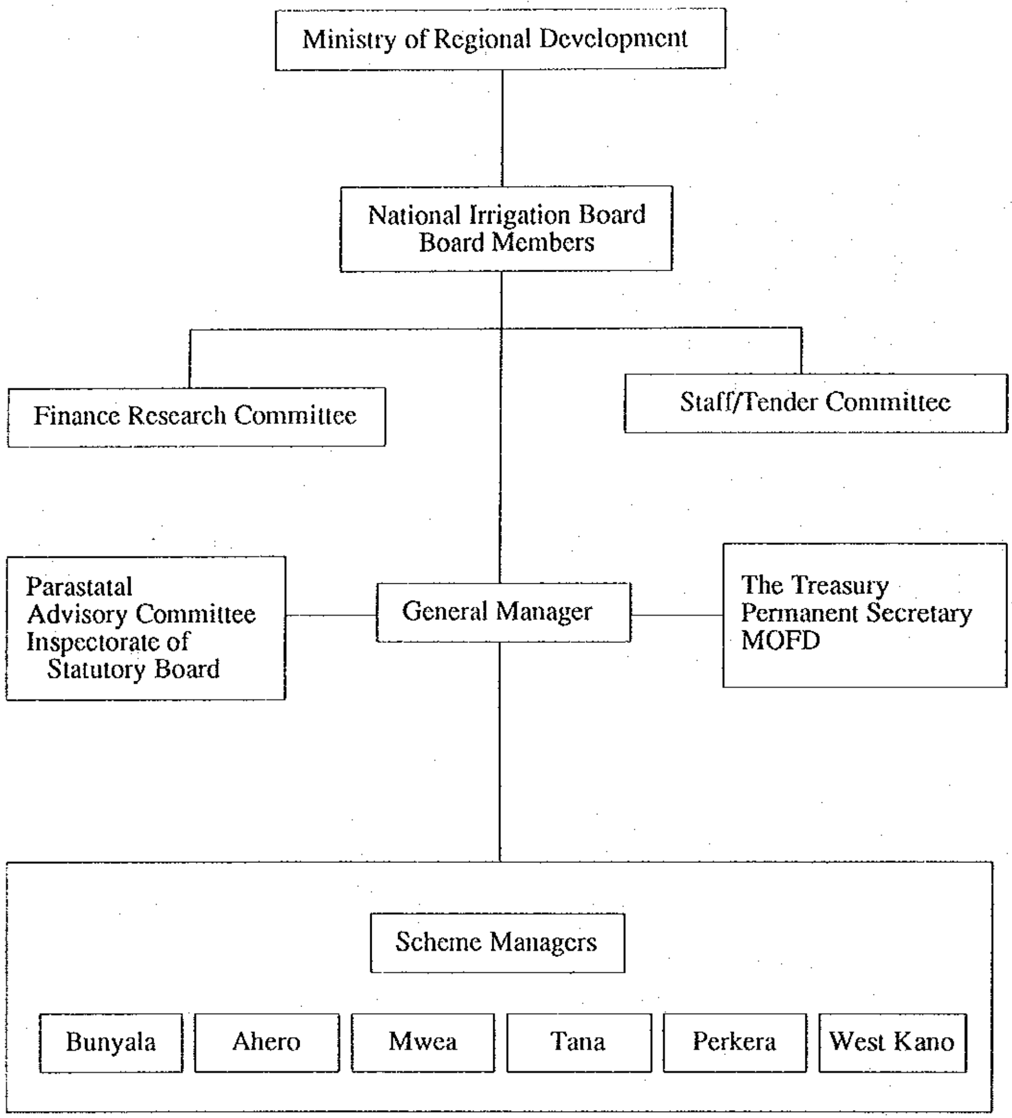
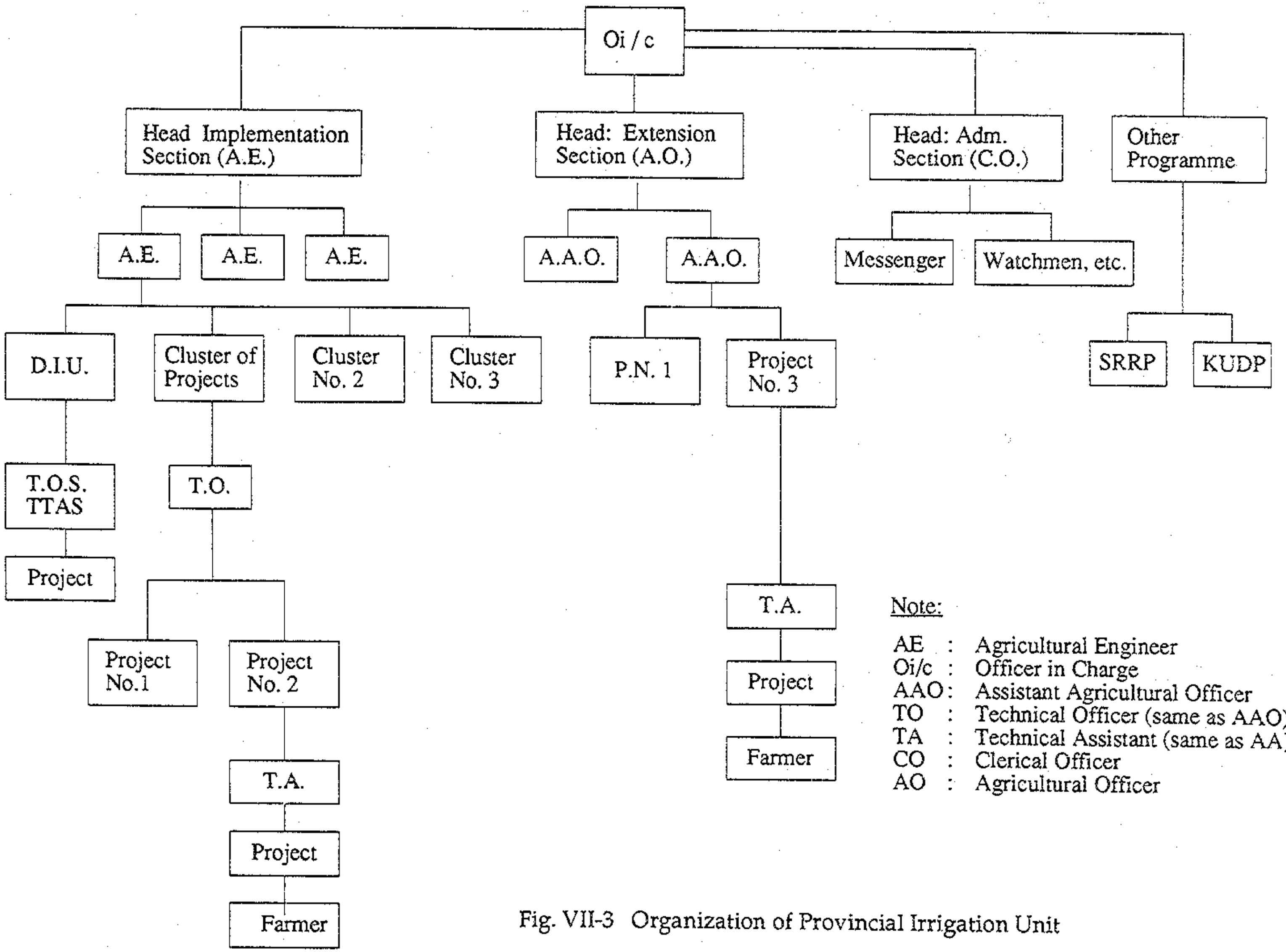


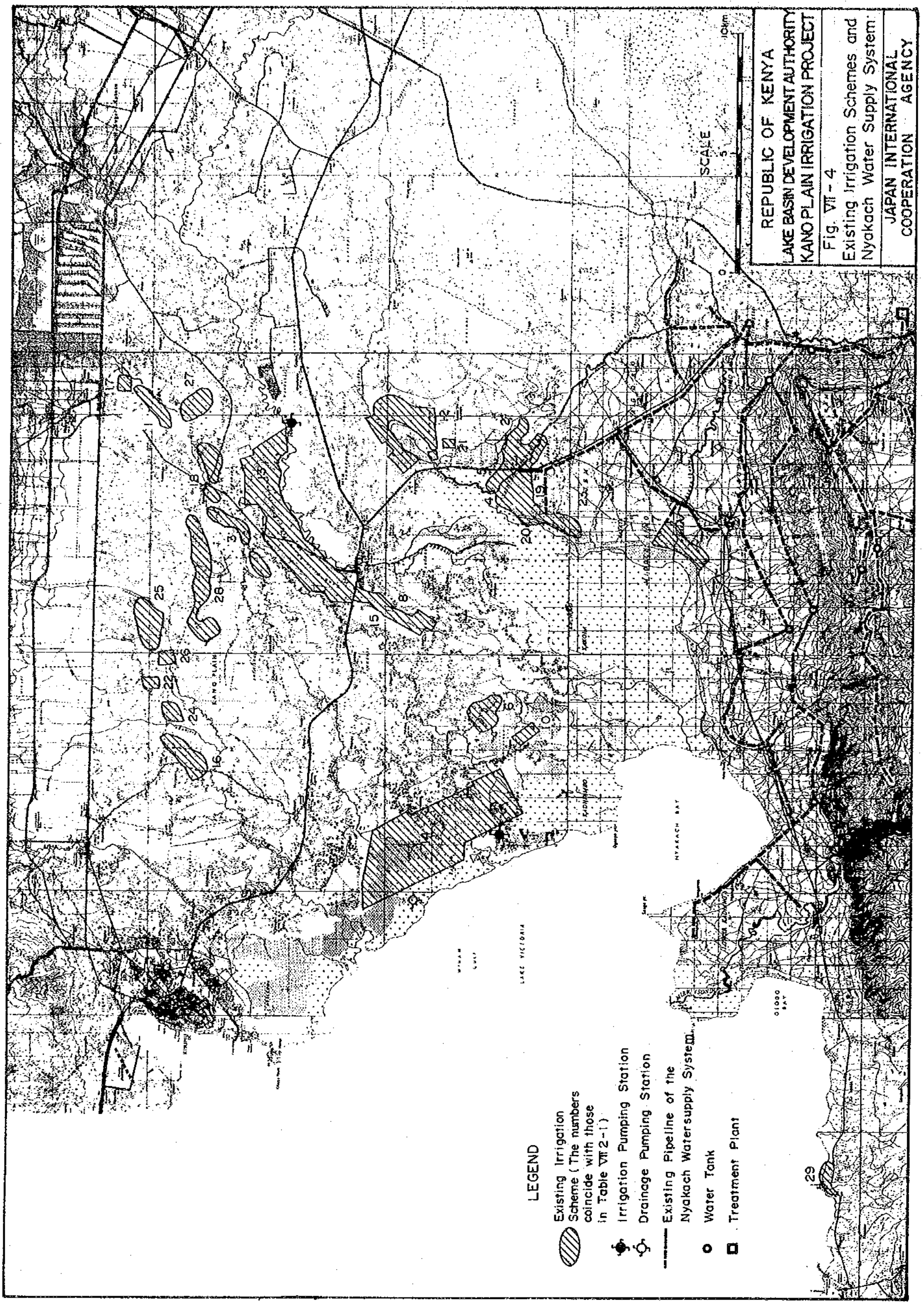
Fig. VII-2 Organization of National Irrigation Board

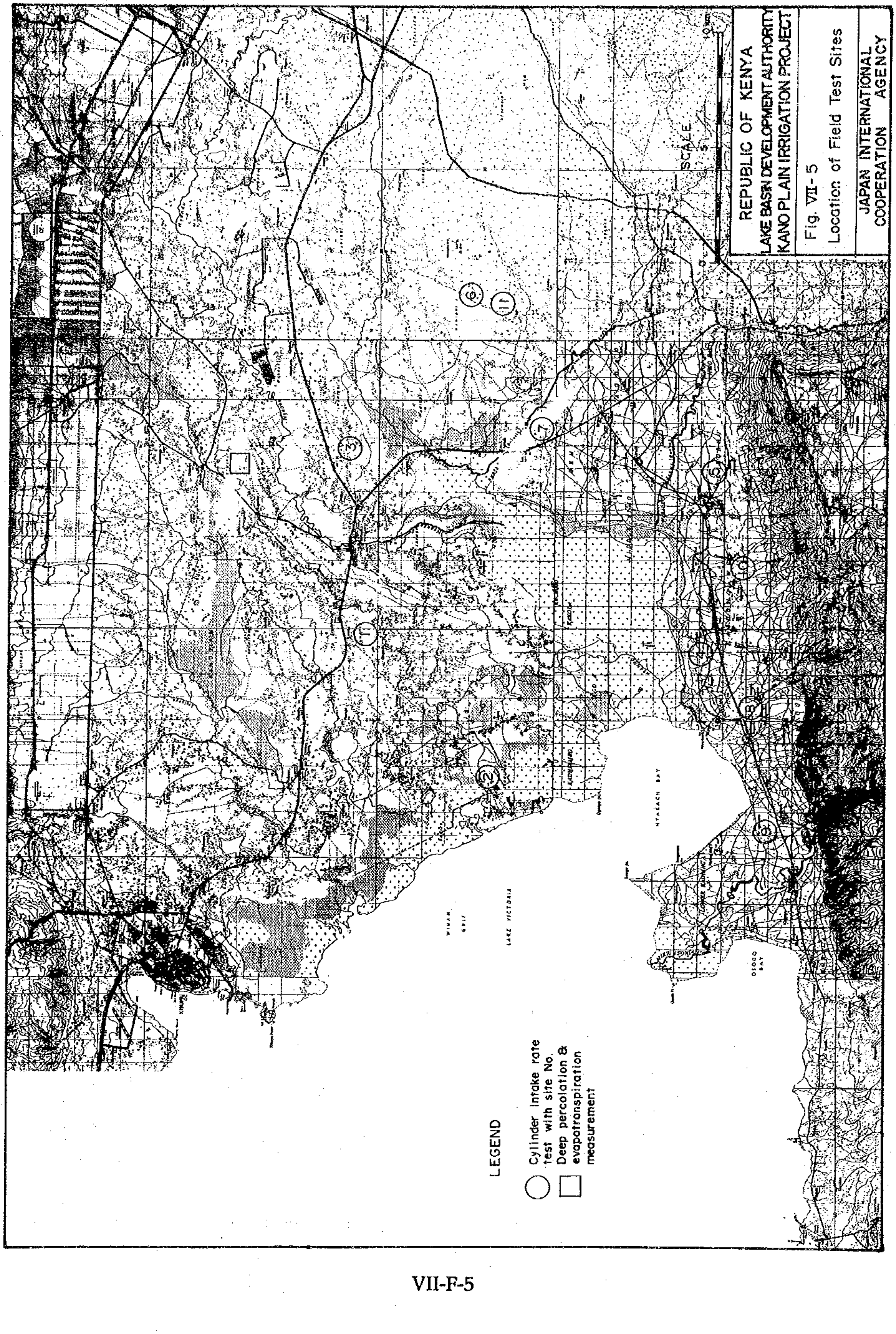


Note:

AE : Agricultural Engineer
Oi/c : Officer in Charge
AAO : Assistant Agricultural Officer
TO : Technical Officer (same as AAO)
TA : Technical Assistant (same as AA)
CO : Clerical Officer
AO : Agricultural Officer

Fig. VII-3 Organization of Provincial Irrigation Unit

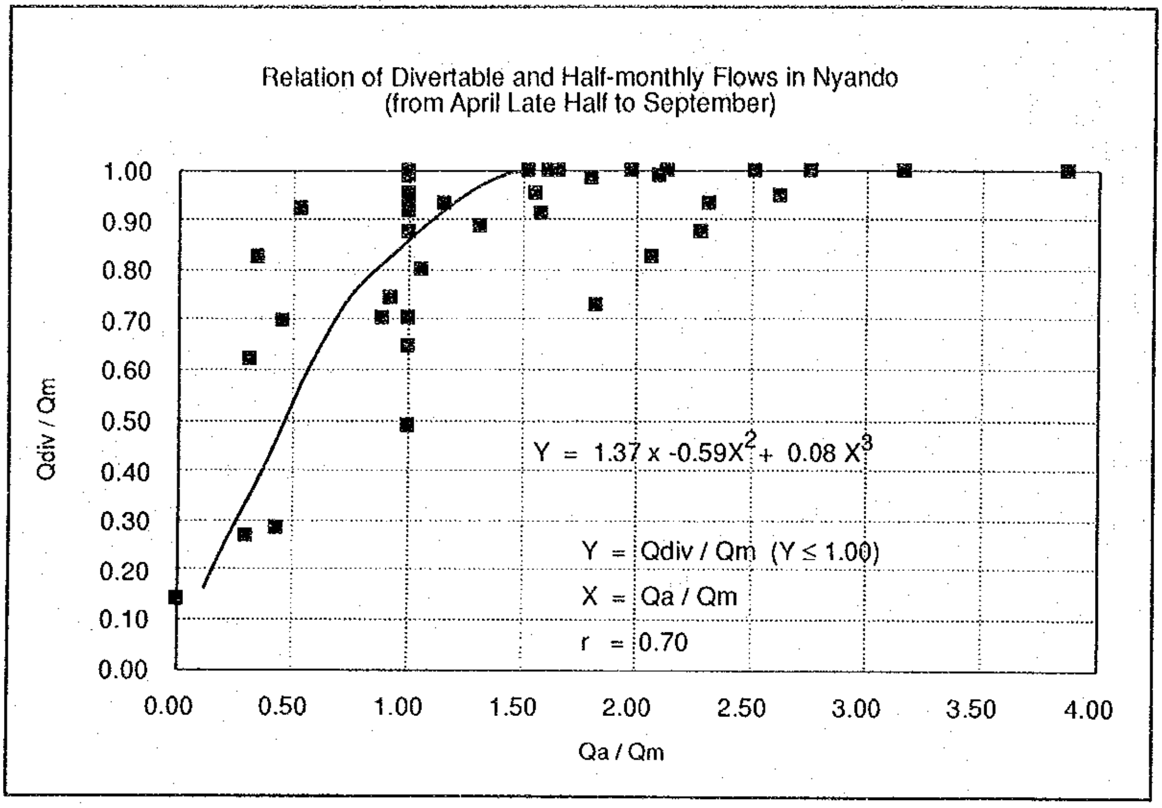

REPUBLIC OF KENYA
LAKE BASIN DEVELOPMENT AUTHORITY
KANO PLAIN IRRIGATION PROJECT
Fig. VII - 4
Existing Irrigation Schemes and Nyakach Water Supply System
JAPAN INTERNATIONAL COOPERATION AGENCY
SCALE
0
5
10km
LEGEND
Existing Irrigation Scheme (The numbers coincide with those in Table VII 2-1)
Irrigation Pumping Station
Drainage Pumping Station
Existing Pipeline of the Nyakach Watersupply System
Water Tank
Treatment Plant
LAKE VICTORIA
NYAKACH BAY
KANO PLAIN
29
25
26
22
24
16
28
27
18
3
15
8
19
20
21



REPUBLIC OF KENYA
LAKE BASIN DEVELOPMENT AUTHORITY
KANO PLAIN IRRIGATION PROJECT

Fig. VII-5
Location of Field Test Sites

JAPAN INTERNATIONAL COOPERATION AGENCY



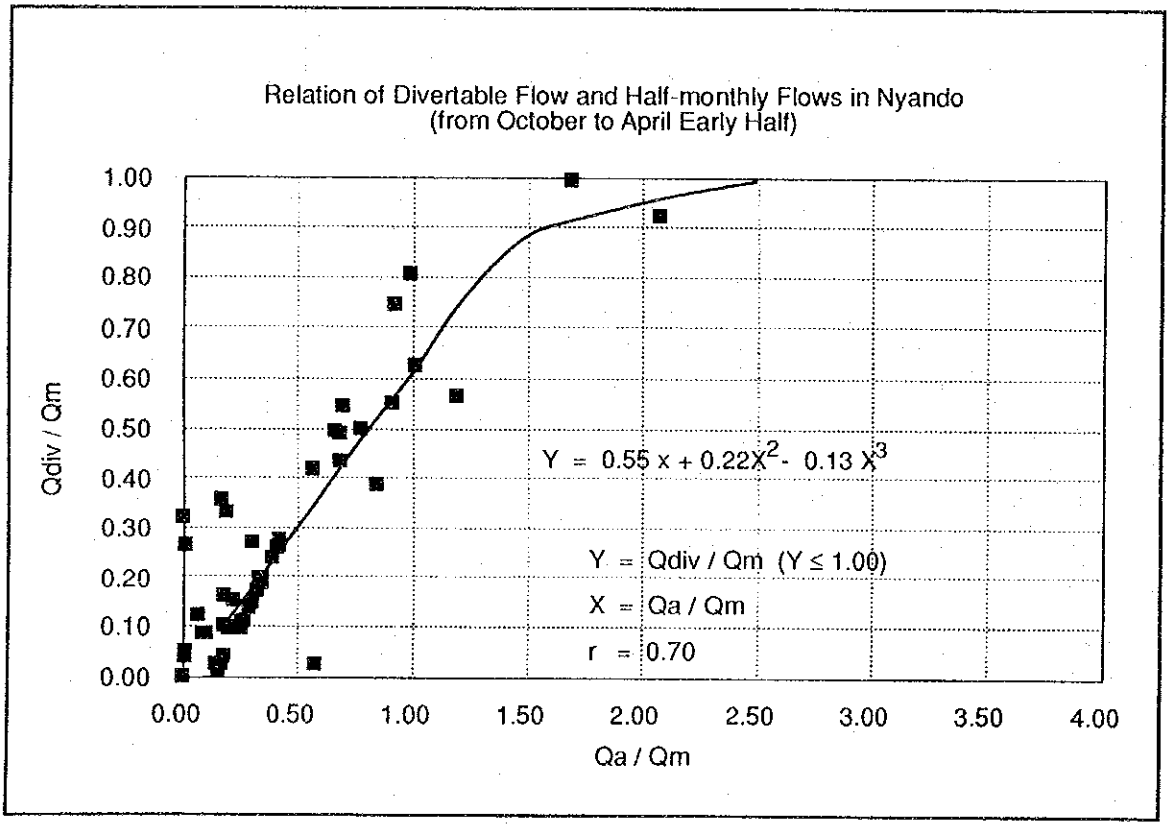


Fig. VII-6 Relation of Divertable Flow and Half-monthly Flow in the Nyando River