2-2-8 Present Agricultural Development Policy

After the country's independence, the Government of Zambia established the Urgent Development Plan, the Tentative Development Plan, and the First, Second, and Third National Development Plans, making every effort to extricate the country from the colonial conditions and the copper related monocultural economic conditions. The main objective of the country's development policy was to increase agricultural production. However, the production of the country's staple crops was self-sufficient, while other food items were purchase from oversea markets with money earned from copper exports. Therefore, the country was not overly eager to increase its agricultural output.

However, with the fall of copper prices and the decrease in agricultural production, the condition of the country's economic conditioned worsened, forcing the government to alter its economic plan into being an agricultural oriented policy.

In the Third National Development Plan (TNDP), the government gave the first priority to agricultural development. In May of 1980 the government announced a food production increase plan, the "Operation Food Production 1980-1990".

In the TNDP, the following aspects are described for agricultural development:

(i) To achieve self-reliance and self-sufficiency in the production of staple foods, wherever feasible both nationally and regionally, and to provide raw materials to the agro-industries.

(ii) To stimulate and increase production for exports.

(iii) To increase the contribution of the rural sector to GDP and to promote the diversification of the rural economy.

(iv) To improve rural standards of living and nutritional status, and to create a self-reliant and progressive rural society.

(v) To create new employment and income opportunities in rural areas in order to counteract rural-urban migration, and to improve infrastructural services related to productivity increase.

In the Operation Food Production 1980-1990, similar aspects are described as mentioned above. In this plan, the means to achieve its objectives are to activate cooperatives' activities, the extension of commercial oriented farmers, and large-scale state farm concepts. It is different to achieve the objectives of the large-scale state farm concepts under the government's present financial situation. Therefore, the government has requested aid from foreign countries. However, reaction by these countries is not favorable. As a consequence, the government has been planning to reduce the size of the state farms and emphasize middle and small size commercial farms.

Since 1981, the southern part of Zambia have suffered from occasional droughts. Adding this to the fall of copper prices, the country's economy and the government's financial situation worsened, making it more difficult to achieve the development objectives.

Because of the above mentioned situations, the government established the following middle-size farm agricultural development objectives in order to stabilize food production, increase export oriented agricultural production, and to make the agricultural sector the major source of the country's economic resuscitation:

1. To achieve a satisfactory level of self-sufficiency in the production of staple foods.
2. To expand the production of agricultural exports.
3. To increase the import substitution of agricultural products or inputs.
4. To improve the rural employment opportunities and incomes.

The objectives and targets of the above mentioned plan for 1986 were as follows:

(i) To achieve a sectoral growth of 11 percent.

(ii) To achieve a satisfactory degree of success in attaining self-reliance and self-sufficiency in the production of staple food grans, plarticularly maize, cassava, sorghum, millet, livestock and fish products.

(iii) To increase the contribution of agricultural exports from three percent in 1985 to five percent in 1986.

(iv) To increase the agricultural sector's contribution towards the GDP from 13 percent in 1985 to 15 percent in 1986.

(v) To improve the standard of living and the nutritional levels in rural areas and to create a self-reliant and progressive rural economy.

As for reaching the above objectives and targets, agricultural performance during the 1985-86 plan period showed some positive growth. This was partly accomplished because of the favorable weather conditions that prevailed and the more concerted efforts by both the government and the farming communities: re-examination of the government's purchase prices for staple crops, increased farmers' competitiveness to increase their production, and the improvement of the farm products marketing system. The actual agricultural output of the 1985-86 season was higher than the previous season. The sector's contribution to the GDPL was expected to be higher than the 17.3 percent achieved during the 1984-85 season. The production of maize, groundnuts, millet, beans (mixed), sunflower seeds, soybeans, and tobacco increased markedly in the 1985-86 season. However, the marketed outputs of wheat and rice was disappointing.

Agricultural production has been on the increase. However, the introduction of the foreign currency auctioning system and the following depreciation of the kwacha has led to high rises in the cost of agricultural imports, such as fertilizers. Therefore, the government revised producer prices upwards in order to

cushion farmers against the impact of higher input costs. The government further decided that a maize marketing subsidy should be offered in order to keep mealie prices to the consumer at acceptable levels.

The government emphasized its economic policy to continue the agricultural development plan for the country's economic recovery and set up the following objectives and targets for the 1987 agricultural sector:

(i) To achieve a sectorial growth of 11 percent.

(ii) To achieve a satisfactory degree towards self-sreliance and self-sufficiency in staple food grains, especially maize, cassava, sorghum, millet, livestock and fish products.

(iii) To increase the agricultural sector's contribution to the GDP from 17.3 percent in 1986 to 18 percent in 1987.

(iv) To increase the contribution of agricultural exports from five percent in 1986 to six percent in 1987.

(v) To create new employment and income opportunities in rural areas and to improve related infrastructural services so as to promote productivity in the sector.

(vi) To improve the standard of living and nutritional levels in the rural areas and to create a self-reliant and progressive rural economy.

2-2-9 International Cooperation in the Agricultural Sector

For Zambian economy, economical cooperation from advanced countries and international organizations is extremely important. Reliance on foreign funds for the government development projects' expenditures were six percent of the total projects' costs in FNDP, 34 percent in SNDP, and 40 percent in TNDP.

Recently, the country's economy and the government's financial situations are in very poor condition. The government accepted the recommendations of the International Monetary Fund (IMF) and

introduced the foreign currency auctioning system. The government reduced the rate of state subsidies for certain food items and consumption goods, and abolished state subsidies for some other items. On the other hand, the government relaxed the interest rates, price control regulations, and import regulations. However, the government is in urgent need of foreign economic aid in order to restore the country's economy.

In 1986, reliance on foreign funds for the government's development projects reached 65 percent of the total projects' cost. The government's overall strategy is to make the agricultural sector play a prominent role in resuscitating the country's economy. Sixty-six percent of acquired foreign funds in 1986 was allocated to the agricultural sector. The amount of foreign funds agreed upon in 1986 were 229.93 million kwachas for bi-national aid and 218.23 million kwachas for multi-national aid.

Major foreign aid agreed upon in 1986 were as follows:

(i) Bi-national and multi-national aid to supply funds for projects and equipment.

(ii) Technical cooperation by dispatching specialists and volunterrs.

(iii) Acceptance of trainees.

(iv) Loans to import construction material and to implement special development projects.

(v) Costs for consulting services.

Aid for government projects came from many countries as well as from many international organizations, such as England, the United States, Canada, West Germany, Sweden, Norway, Finland, Japan, China, the Soviet Union, Yugoslavia, the United Nations Development Plan (UNDP), the World Food Plan (WFP), the Food and Agricultural Organization (FAO), International Bank for Reconstruction and Development, the African Development Bank, the

European Development Fund, etc. The area covered by aid varies depending upon what country or organization provides the aid. However, in accordance with the government's development policy, which emphasizes agricultural development, most countries and organizations provide aid for use in the agricultural sector.

There is a variety of aid for the agricultural sector. Some countries concentrate on certain areas - the Netherlands concentrates on the Western Province, while Norway concentrates n the Northern Province. Some countries concentrate of certain types of projects - West Germany concentrates on water supply facilities; Finland concentrates on forestry projects. Basically, the aid can be classified into the following categories:

(i) Aid to the Ministry of Agriculture and Water Development in the field of project plan development. Example: Technical Cooperation for Agricultural Development (1978-1990) by Canada.

(ii) Aid to the University of Zambia, Agricultural Department, and agricultural colleges, to provide for education in the field of agriculture. Example: Agricultural Training and Extension Plan (1985) by Sweden.

(iii) Aid to extension activities and extension workers. (Agriculture Extension and Training Plan by the Netherlands.)

(iv) Aid to Mt. Macrue Agricultural Research Center for agricultural research. (Study on Zambian Agriculture Development and Extension Plan by the United States.)

(v) Aid to procure food, fertilizers, and insecticides. (FAO Fertilizer Project (1982-1987) by Denmark.)

(vi) Aid to agricultural products and marketing systems, such as various cooperatives, the National Agricultural Marketing Board, etc. (Aid Plan to Northern Province Cooperatives (1983-1987) by West Germany.)

(vii) Aid to Settlement Schemes. (Jiwundu and Nyangombe Settlement Schemes.)

(viii) Aid to construct pilot farms. (Mubongwe Pilot Farm Construction Plan by the E.E.C.)

(ix) Aid to integrated Rural Development Plans by U.K. in Serenje, Mpika Chinsali district.

(x) Aid to the Overall Farming Village Development Plans. (Seleju, Pica, and Chinsali Districts Overall Farming Village Development Plan (1980-1986) by England.)

Data on economic aid from socialistic countries was not available. Judging from import statistics and balance of liabilities, it is assumed that most of aid from these countries was based on export credit. There was no aid for the agricultural sector.

Japanese economic cooperation in the agricultural field consisted mainly of providing food aid, food production increase aid (fertilizers, agricultural medicines, and agricultural machines), providing trucks for transporting agricultural products, commodity aid, and technical cooperation activities by dispatching technicians and specialists. Since 1983, in addition to this aid, Japan contributed to the implementation of large projects, such as the Construction Plan of a Veterinary Department for the Zambia University, and the Construction Plan for Grain Storage.

In the year following President Kaunda's visit to Japan (1981) Japanese economic cooperation to the country with grant aid commenced. By 1986, economic aid was provided for twenty-six different projects and amounted to 14.945 billion yen. Aid, in the amount of 11.411 bill yen, was provided for twenty projects in the agricultural sector; this represents 76 percent of the total aid given.

21.292 billion yen was loaned for the rehabilitation of the Kafue Sulfate Factory, and the Nitrogenous Fertilizer Factory, and for the purchase of fertilizers, train cars, and trucks. Table 2-9 shows the economic cooperation provided for the Japanese government.

In 1972 the Japanese government began sending Japanese Overseas Cooperation Volunteers to Zambia. By 1985, 275 volunteers had been sent. Sixty-eight volunteers were assigned to agriculture (including veterinary), forestry, and fishery fields. Most of the cooperation volunteers continue working for the District Agriculture Offices that are under the supervision of the Agricultural Department of the Ministry of Agriculture and Water Development. One agriculture specialist was dispatched to the Agricultural Department in May 1985; he provides advice on such matters as project planning and the selection of project areas. In October of 1986, a dry field farming specialist was sent to the country and is now working in the Kaunga Area. In the veterinary field, six specialists are working on the technical cooperation program project at the Veterinary Department of the Zambia University.

Table 2-9 Aid to Zambian Agricultural Development Projects
(Agreed on projects only)

(Unit: Million Yen)

Date of Agreement	Amount	Project Name
81. 1.29	250	Japanese Rice
81. 3.27	300	Agricultural Transportation Improvement Plan
81. 7. 1	1,300	Infant Treatment Center Zambia Univ.
81.11.13	287	Japanese Rice
81. 7. 7	300	Food Production Increase (Agricultural Machines)
81. 7. 7	300	Agricultural Transportation Improvement Plan
82. 7. 7	1,000	Infant Treatment Center Zambia Univ.
82.12.20	500	Road Preparation Plan
82.12.20	473	Japanese Rice
82.12.20	300	Food Production Increase (Agricultural Medicine)
83. 8.30	2,400	Establishment of Veterinary Dept. Zambia Univ.
83. 8.30	105	Agricultural Technique Extension Plan
83.12.16	476	Japanese Rice
83.12.16	400	Food Production Increase (Fertilizer)
84. 6.28	1,483	Establishment of Veterinary Dept. Zambia Univ.
84. 6.28	400	Burmese Rice
84. 6.28	400	Food Production Increase (Fertilizer and Agricultural Mac.)
84.12.28	1,001	Construction of Grain Storage Plan
85. 5.31	54	Agricultural Transportation Improvement Plan
85.10. 8	626	Ground Water Development Plan
85.10. 8	500	Zimbabwe White Maize
85.10. 8	800	Food Production Increase (Agricultural Machines and Fert.)
85.11.20	600	Agricultural Transportation Improvement Plan (SJP)
85.10. 8	45	Establishment of Science Dept. Zambia Univ.
86. 3.18	550	Mehaba Destitute Camp Middle School Plan (I)
86. 3.18	556	Construction of Grain Storage Plan
86.10. 6	139	Mehaba Destitute Camp Middle School Plan (II)
86.11.21	28	L.L. System Equipment Zambia Univ.
87. 1. 6	928	Rusaka City Water Development Plan
87. 1.15	500	Zimbabwe White Maize
87. 1.15	800	Food Production Increase (Fertilizer)
87. 3.29	623	Agricultural Farmland Development Plan
87. 3.29	750	Zambian Personality Development Plan
87. 4.30	200	Food Production Increase (Fertilizer)
Total	19,374	

Source: Ministry of Foreign Affiars, Present Situation and Problems for Economic Aid.

2-3 Request for the Project

2-3-1 Particulars of the Request

When Foreign Minister Abe of the Government of Japan visited Zambia in November 1984, the Government of the Republic of Zambia requested Japan to provide grant aid to develop ground water resources and to construct grain storages in order to reduce the effects of drought in the Southern Provinces. In response to the request, Foreign Minister Abe expressed the necessity of Japanese grant aid to construct grain storages, develop ground water resources, and improve the means of transporting agricultural products. In 1985, in according to the Foreign Minister's statement, a grant aid agreement was signed to construct a grain storage facility. In August 1985, the Government of the Republic of Zambia requested a grant aid from the Government of Japan for a rural development program in the Kaunga area in order to meet the following objectives:

a) To reduce the risk of future drought damage by growing appropriate crops.

b) To improve water supply systems in certain areas of Zambia that are most seriously affected by drought.

c) To intensify small-scale irrigation development.

d) To improve extension services in the affected areas by providing transportation.

e) To improve food production.

In response to the request of the Government of the Republic of Zambia, the Japan International Cooperation Agency (JICA) sent a preliminary study team to the Republic of Zambia. The study team was headed by Mr. Sota Iwamoto, Director, the First Survey and Research Department, the Japanese Institute of Irrigation and Drainage. The preliminary study team was in Zambia from 28 November to 17 December 1986 and confirmed the purpose of the request, the location of the Project area, and determined what administrative agency was responsible for the Project. The study team summarized the Project request by separating it into the following three categories:

a) Establishment of an experimental farm, including irrigation facilities, and development of the field).

b) Project Office (office building, storehouse, nursery room, workshop, well, etc.).

c) Equipment (meteorological and hydrological survey equipment, agricultural machinery, etc.).

As a result of the preliminary study, the study team concluded that the implementation of the Project would be a big step for preventing future drought damage in Zambia.

Based on the results of the preliminary study, the JICA sent a study team, headed by Mr. Sota Iwamoto, to the Republic of Zambia from 5 April to 4 May 1987. The study team confirmed the objectives of the request, the name of the Project area, the Project activities, the administrative and operating office responsible for the Project, and the necessary measures to be undertaken by the Government of the Republic of Zambia.

2-3-2 Details of the Request

1. Project Name: The Rural Development Programme in Kaunga Area.

2. Purpose: To establish a model for the rural development programme in the southern provinces affected by drought, aiming at reducing the risk of further drought damages by furnishing small-scale irrigation faoilities for expanding the cropping season, growing appropriate crops, and improving food production.

3. The site of the Project is located in the Kaunga area, Luangwa District, Lusaka Province.

4. The Project consists of the following:
   a. Establishment of the Project Office with an experimental farm.

b. Development of model small-scale irrigation field.

5. The activities of the Project Office are as follows:

   a. Testing and demonstration of crop cultivation suitable to the Project area on the experimental farm equipped with irrigation facilities.

   b. Guidance and application of irrigated agriculture in the Project area.

   c. Organization of a farmers' committee to be in charge of the operation and maintenance of the model small-scale irrigation field.

   d. Extension of the model of the rural development programme to other areas in the southern provinces affected by drought.

6. The Department of Agriculture, Ministry of Agriculture and Water Development is responsible for the administration and execution of the Project.

7. The administration and operation of the Project Office is undertaken by the Zambian staff, such as the director of the Office, irrigation engineer, agronomist, extension officer, etc. appointed by the Department of Agriculture.

8. The items requested by the Government of the Republic of Zambia with grant aid from the Government of Japan are as follows:

   (1) Project Office with an experimental farm:

      a. Project Office and related facilities (office, conference room, workshop, storehouse, water supply system, accommodation facilities, etc.).

      b. Experimental farm with irrigation facilities.

      c. Equipment (agricultural machinery, vehicles, meteorological and hydrological survey equipment, etc.).

   (2) Irrigation and drainage facilities:

      a. Intake facilities.

      b. Irrigation water conveyance system.

c. Drainage system.

d. Distribution ponds.

e. Land consolidation.

9. Necessary measures to be undertaken by the Government of the Republic of Zambia:

The Government of the Republic of Zambia will take the following necessary measures for the implementation of the Project:

(1) To secure the land and water rights for the proposed Project facilities.

(2) To clear and reclaim the above land as required before the start of construction, if necessary.

(3) To bear commissions to a Japanese foreign exchange bank for the banking services based upon the Banking Arrangement.

(4) To exempt and take necessary measures for custom clearance of material and equipment obtained for the Project and brought to the port of disembarkation.

(5) To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into the Republic of Zambia and their stay during the course of the performance of their work.

(6) To organize the Project Office and to secure the Project's staffs.

(7) To secure the annual budget for the Project Office.

(8) To maintain and properly and effectively use the facilities constructed and the equipment purchased under the grant aid.

(9) To bear all expenses, other than those to be borne by the grant aid, necessary for construction of facilities as well as for transportation and installation of equipment.

10. The Government of the Republic of Zambia expressed their desire to the study team for the Government of Japan to extend the following cooperation for the proper future operation of the Project:

    a. To dispatch experts and Japan Overseas Cooperation Volunteers to the Project.

    b. To train, in Japan, Zambian personnel in matters relating to the operation and administration of the Project.

CHAPTER 3 OUTLINE OF THE PROJECT SITE

CHAPTER 3 OUTLINE OF THE PROJECT SITE

3-1 Location and Topography

The Kaunga area, the Project site, is located at longitude 30° 10'E and latitude 15° 05'S in the Luangwa District of the Lusaka Province. It is approximately 250 km east of the country's capital, Lusaka. The area is approximately 300-400 meters above sea level and situates between the Luangwa River, which is the border line between the country and Mozambique, and a plateau that is approximately 500-700 meters above sea level. The area is on the alluvial cone that was developed by the tributary of the Luangwa River, the Kaunga River. The topography of the area is very flat; its average slope is 1/500-1/1,000.

The access route to the Kaunga area from Lusaka is the Great East Road, which leads eastward to Malawi, and a provincial road, No.216, which reaches Luangwa from a point approximately 15 km before the Luangawa Bridge to the south. The area is approximately 15 km south of the junction point of the Great East Road and the provincial road No.216, (Fig. 3-1).

3-2 Society and Economic Conditions

The Lusaka Province has a population of 860,000. It is the second most populated province in the country after the Copperbelt province. In the Lusaka Province there are three districts: Lusaka urban, Lusaka Rural, and Luangwa with populations of 580,000, 268,000, and 12,000, and farmland of 19,488 ha, 22,150 ha, and 1691 ha respectively. The Luangwa District, in which the Project area locates in the Kaunga area, is comparatively low land, and is less developed, and less populated than other areas in the country. The temperatures and rainfall in this area is higher than elsewhere in the country.

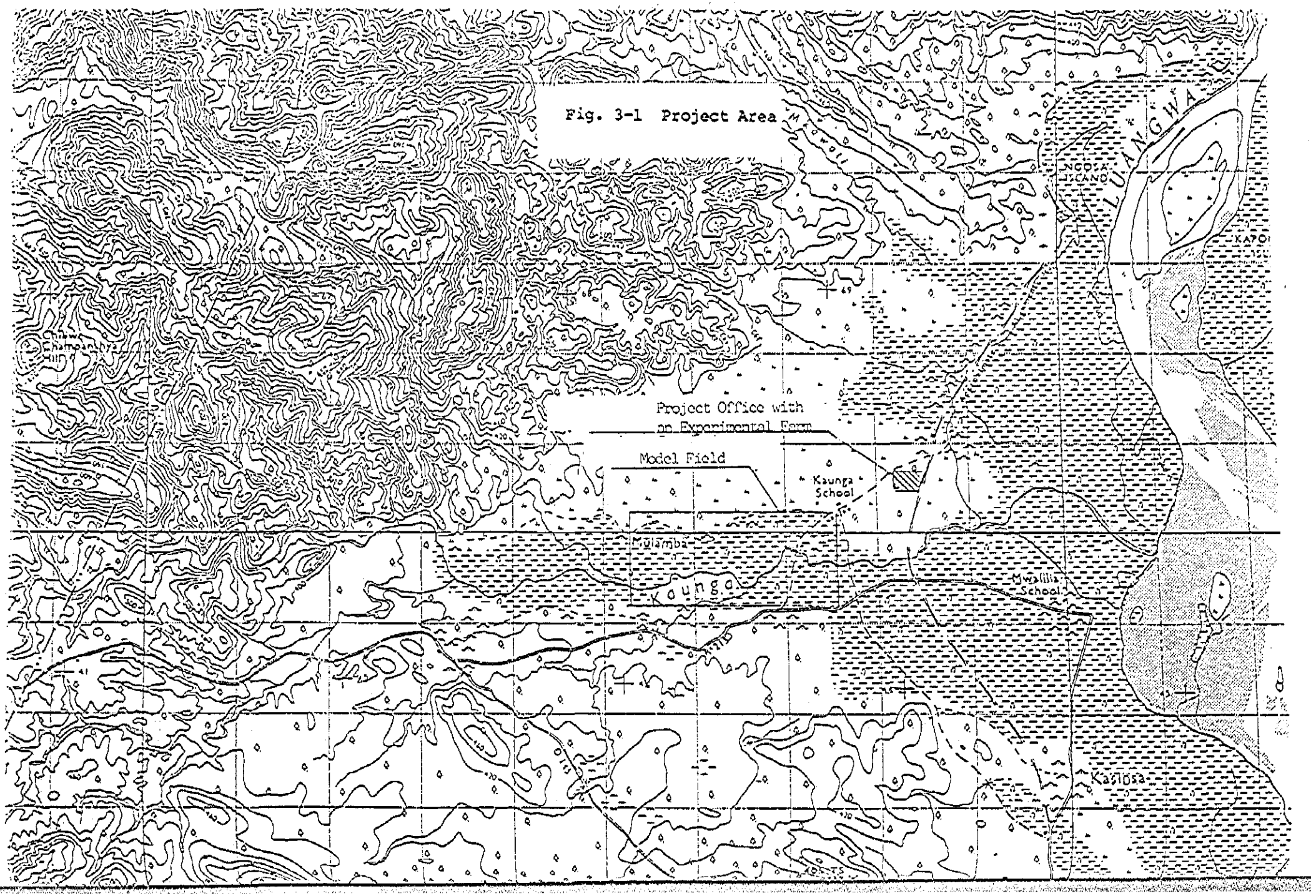


Fig. 3-1 Project Area

The Kaunga area is a typical rural area having ten villages. 268 families farm in the area. It is reported that there are 449 workers, and that 49 percent of the population is below 14 years old. The estimated population in the area is 880. There are a few clothing stores and grocery stores here, but no food markets exist. Therefore, it is difficult to buy staple food, even by those who have money, under famine conditions. School teachers buy maize flour periodically. During periods of famine, the school is the only possible place where maize flour may be available.

At a mill in Luangwa Boma, flour is generally obtainable, but this village is very far away from the Kaunga area (80 km). People who obtain flour in the Luangwa village must wait for days to get transportation back to their homes. It was reported that some people went to the Great East Road in an effort to purchase maize flour from passing trucks during a time when the mill was closed for one month. The closest market from the Kaunga area is at Chitope, about 15 km away, where only bananas and maize are obtainable. In Luangwa village, there is a small market where tomatoes, cowpea leaves, groundnuts, fresh and dry fish are available.

The Kaunga Elementary School and a church are 800 meters from Rural Road No.216; many people are attracted to this the center of the Kaunga area.

There are no lodging facilities in the Kaunga area. There is a lodge about 15 km away from the area, at the junction of the Great East Road and Rural Road No.216, that is used by the people traveling by car. At Chitope there is a government-owned lodge that is also used by persons traveling by car. About 60 km from the area, in Luangwa village, there is a government-owned guest house. Approximately 80 km from the area there is a privately owned motel at Kacholora, which is on the Chipata side of the Great East Road.

There are no gasoline stations in the Kaunga area. The nearest gasoline station is at Kacholora, about 80 km away. However, even here, the desired amounts of gasoline and kerosene are not always available. The gasoline pump is operated an electric motor connected to a diesel generator and is only in use in the mornings and evenings. It is very inconvenient to obtain fuel here.

As for health care facilities, there is the Katondwe Mission Hospital, having about 100 beds, located in a village nearly 20 km away from the Kaunga area. The hospital is run by Polish doctors and Zambian sisters. Many patients visit the hospital daily. There is a mobile team that visits villages to provide health care.

As for the government office, an agricultural extension office with the Block Officer and the Camp Officer is located at Chitope, about 15 km away from the Kaunga area. The office Personnel conduct agricultural extension activities in the Kaunga area. In the Luangwa Boma, approximately 80 km away from the Kaunga area, there is the Luangwa District Agricultural Office which controls the agricultural administration of the Luangwa District.

Each village in the Kaunga area has one well that was dug by the government and is used for drinking water. The depth of the wells is 9.0 - 18.0 m. The water level in the wells is 7 - 8 m below ground level. A bucket, tied with a rope or chain, is used to draw the water. No hand pumps were seen during the area study. Most of the wells have good quality water. However, a few wells do have saline water. Water levels in the wells vary about 1.0 m during the dry and rainy seasons. The wells, however, are never without water. The study team found that two wells were not being used because either the rope or chain was missing. Other than the wells mentioned above, the villagers use river water from the Kaunga River and water from small streams for drinking.

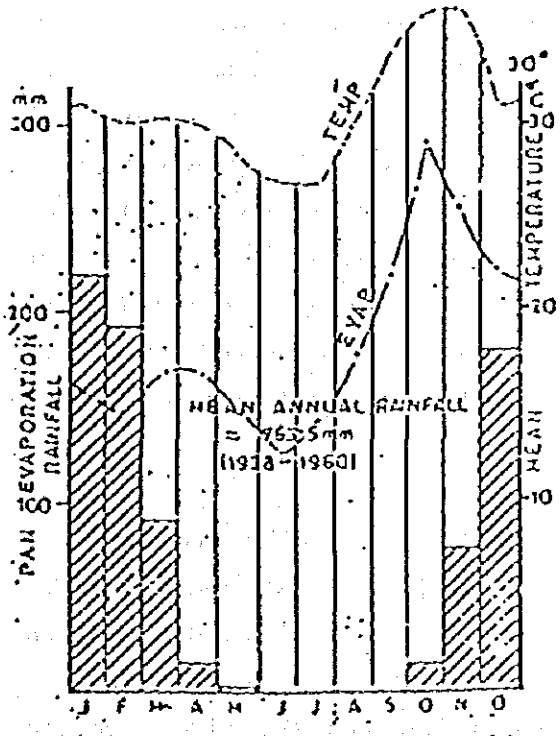
3-3 Natural Conditions

3-3-1 Weather:

The weather in Zambia can be divided into three seasons. The weather data for the Luangwa District is recorded at two weather stations; one at the Luangwa Bridge, about 16 km away from the Kaunga area, and the other is in the district capital Luangwa Boma, about 80 km away from the area, where the Luangwa River joints the Zambesi River. The weather data at these two stations are shown in Fig. 3-2 and 3-3. The average annual rainfalls are 760 mm at the Luangwa Bridge and 720 mm at Luangwa Boma. The average monthly rainfall recorded at the Kaunga area from March 1978 to March 1984 are shown in Table 3-2.

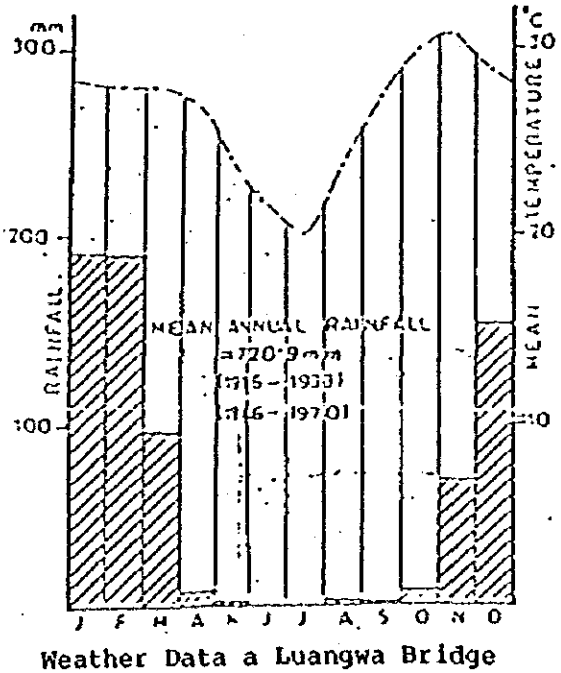
Table 3-1 Average Seasonal Temperature

Month	Season	Temperature
1 May - August	Cool Dry Season	7.7 - 21.8°C
2 September - November	Hot Dry Season	11.6 - 29.6°C
3 December - April	Hot Rainy Season	12.1 - 26.0°C



Weather Data at Luangwa Bridge

Fig. 3-2



Weather Data a Luangwa Bridge

Fig. 3-3

Table 3-2 Monthly Data of Rainfall in Kaunga Area

	-1978		1978-1979		1979-1980		1980-1981		1981-1982		1982-1983		1983-1984	
	Rainfall (mm)	Day	Rainfall (mm)	Day	Rainfall (mm)	Day	Rainfall (mm)	Day	Rainfall (mm)	Day	Rainfall (mm)	Day	Rainfall (mm)	Day
Jul.														
Aug.														
Sep.														
Oct.							38.1	1			60.2	2		
Nov.			97.0	5	131.3	5	82.3	6	25.1	2	56.1	2	45.5	2
Dec.			445.0	15	119.4	8	130.3	9	31.5	1	153.4	6	63.5	9
Jan.			63.0	5	92.5	6	203.5	15	260.1	11	279.9	11	28.7	2
Feb.			170.7	7	220.5	11	270.5	7	59.7	4	233.4	9	165.9	5
Mar.	134.6	6	72.6	7	123.0	6	19.1	2	0		71.4	2	58.7	2
Apr.	36.8	2			12.4	2	78.0	3			73.9	1		
May									12.4	1				
June														
Total			848.3	39	704.6	38	822.3	43	388.8	19	928.8	88	362.3	20

The last rain in the rainy season of 1986: mid February
The last rain in the rainy season of 1985: 29 January

Source: Luangwa District Office

3-3-2 Hydrology:

The Kaunga River that flows through the Project area, starts from a plateau that rises 500 - 700 meters above sea level and meanders down to the Luangwa River. The river has a catchment area of 260 km^2, is 53 km long, and slopes 1/50 in hilly areas and 1/400 in plain areas. The river flows through an alluvial cone that is filled with reeds and bushes up to a point approximately 4.5 km upstream from the intersection with the rural road. Further downstream, areas are filled with low trees. While other areas that can be conveniently irrigated have been developed as farm land.

At a point approximately 4.5 km upstream from the Project area there is a mountain on the left bank of the river. There is also a mountain on the right bank of the river about 800 meters further upstream. At a point some 6 km upstream from the Project area, mountains push out from both sides, and the river becomes

very narrow with towering rock on either side. Up to this point, the river bed material is a mixture of sand and gravel, and is without any rocks. 200 m further upstream, big rocks, 1.0 - 1.5 m in diameter appear. Bare rocks can be seen still further upstream, and the river slope becomes steeper. However, mountains on both sides of the river become milder and the valley becomes wider.

The geological formation of the Kaunga River consists of sandstone, granite, and gneiss. The soil in the area is classified as loamy sand - sandy loam, which is produced from the bare rocks. The soil is of high quality with good permeability.

The vegetation in the area consists of good quality grass and low trees. Along the Kaunga River, the trees grow to heights of about 5 - 10 m. Considering the above soil and vegative conditions, it is judged that the water content of the area is in the low-medium range. The measured topographical features of the Kaunga River basin are listed in Table 3-3.

Table 3-3 Topographical Features of the Kaunga River Basin

Item	Measured Value	Remarks
Catchment Area: A (km^2)	260	Total runoff correlates to its discharge peak
River Length: L (km)	53	
Average Width of the Basin: A/L (km)	4.9	Large figure of A/L indicates a short channel length and a short runoff time
Area Length: M km	89	
Area Concentration Rate: R/M		R is the circumference of a circle that has some area as the catchment area. If the rate is close to 1, the shape of the catchment area is close to a circle. Thus, the area's discharge peak becomes higher.
Area Ratio: R/L		R is the diameter of a circle which as the same area as the catchment area. If the rate is close to 1, the shape of the catchment area is close to a circle. Thus, the area's discharge peak becomes higher.
Highest Point: Hh (km)	1.10	Above sea level
Lowest Point: Hl (km)	0.38	Above sea level
Height Difference: H (km)	0.72	Hh - Hl
Average Slope of Main River Channel	13.6/1,000	
Length of Tributaries	5 - 25 Km	Average length: Approximate 10 km.

Until approximately two months after the rainy season, the surface water of the Kaunga River flows into the Luangwa River. After that time, the surface water seeps into the sandy river bed and disappears. The lowest point of the surface water gradually moves upstream until, within a month, the continuous flow of surface water ceases.

About 2 km upstream from the point where the flatland ends, the Kaunga River becomes narrow with a rocky bed as it cuts through a plateau. Four to five months after the rainy season ends, only a small amount of water flows in this area. Table 3-4 shows the surface water condition of the Kaunga River in this area.

Table 3-4 Surface Water Condition in the Upstream Area of the Kaunga River after the Rainy Season

Number of Days	Width of River Flow	Depth
30 Days	Approx. 40 m	Approx. 0.25 m
60 Days	Approx. 0.6 m	Approx. 0.10 m
90 Days	Approx. 0.2 m	Approx. 0.03 m

In the areas further upstream from this point where two mountains push out to the river, no houses or farm land exists.

The Luangwa River, into which the Kaunga River flows, is an international river as it is the boundary line between Zambia and Mozambique. The river flows the year round; however, the water level varies six to seven meters annually.

3-3-3 Geology

(1) Soil in the Kaunga River Plain:

The soil in the Kaunga River basin consists of sand, loamy sand, and sandy sand that is produced by the base rocks of sandstone, granite, and gneiss.

During the study period, the study team investigated soil by digging in nine locations and conducting sieve-analysis tests of soil samples that were collected at five locations. Fig. 3-4 shows the investigation locations, and Fig. 3-5 shows the results of the soil investigation. Table 3-5 shows the soil classification and the results of the sieve-analysis tests.

Table 3-5 Investigated Soil and Sieve-Analysis Test Results

Sample No.	Site Observation	Sieve-Analysis	Classification
1	Sand	Sand 63%	Sandy Loam
2	Sand		
3	Sandy Loam	Sand 30%	Sandy Loam-Loam
4	Sandy Loam		
5	Sand		
6	Sand	Sand 59%	Sandy Loam
7	-		
8	Sandy Loam	Sand 16%	Loam
9	Sandy Loam	Sand 27%	Sandy Loam-Loam

Table 3-6 Soil Classification Standard
(International Society of Soil Science)

I	Soil of less than 15% clay	
	Sand (S)	Less than 5% clay, more than 85% sand
	Loamy Sand (LS)	More than 85% sand
	Sandy Loam (SL)	65-85% sand
	Loam (L)	Less than 45% silt & less than 85% sand
	Silty Loam (SiL)	More than 45% silt
II	Soil of 15-25% clay	
	Sandy Clay Loam (SCL)	Less than 20% silt
	Clay Loam (CL)	20-45% silt
	Silty Clay Loam (SiCL)	More than 45% silt
III	Soil of 25-45% clay	
	Sandy Clay (SC)	More than 55% sand
	Light Clay (LiC)	Less than 45% silt & less than 55% sand
	Silty Clay (SiC)	More than 45% silt
IV	Soil of more than 45% clay	
	Heavy Clay (HC)	

The area observation found that sand dominates the areas close to the river and gradually loam increases as the distance from the river increases. Sieve-analysis tests show that the soil contains more sand in the upstream area, while, moving downstream, there is more loam. Therefore, the soil in the area ranges from sandy loam to loam. In some areas, organic soil layers are thin, yet it is suitable for planting crops. As shown in Table 3-7 it is possible to apply furrow irrigation to areas having sandy loam to loam soil.

Table 3-7 Maximum Allowable Furrow Length for Irrigation of Various Soil

Soil	Root Length	Irrigation Water Depth (one time)	Maximum Furrow Length
Sand	40 cm	16 mm	4 m
Volcanic Ash Soil	40 cm	44 mm	29 m
Sandy Loam	40 cm	34 mm	36 m
Loam	40 cm	38 mm	99 m
Clay	40 cm	44 mm	121 m

Note: All furrow slopes are 10 percent.

(2) Soil at Upstream Areas of the Kaunga River:

In the upstream area of the Kaunga River, where the water intake structure is planned, rocks are exposed sides of the river. The river bed is sand covered. However, at a depth of from 2.3 to 2.7 m, rock was found by means of a boring test. Fig. 3-5 shows the location of the boring test.

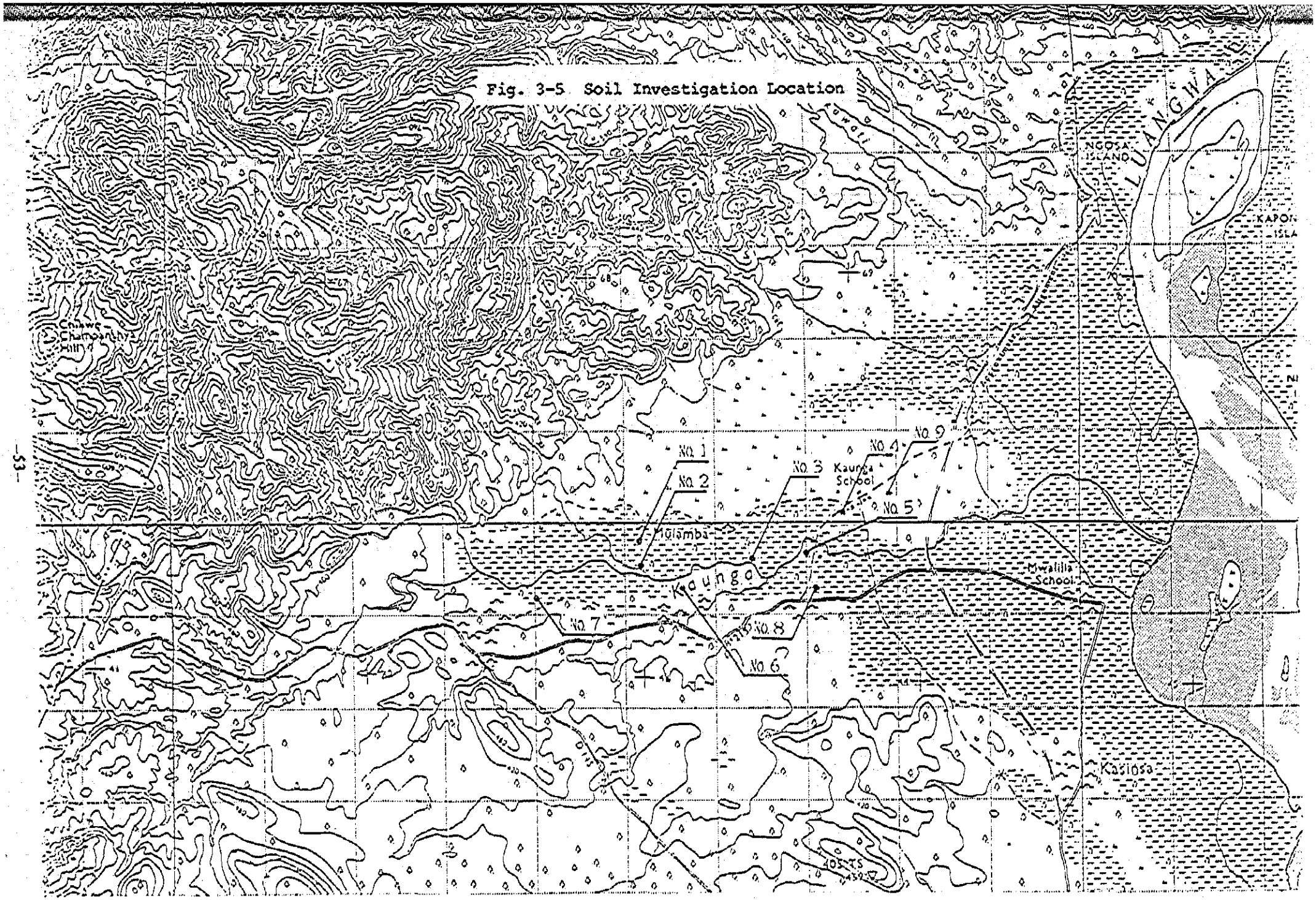


Fig. 3-5 Soil Investigation Location

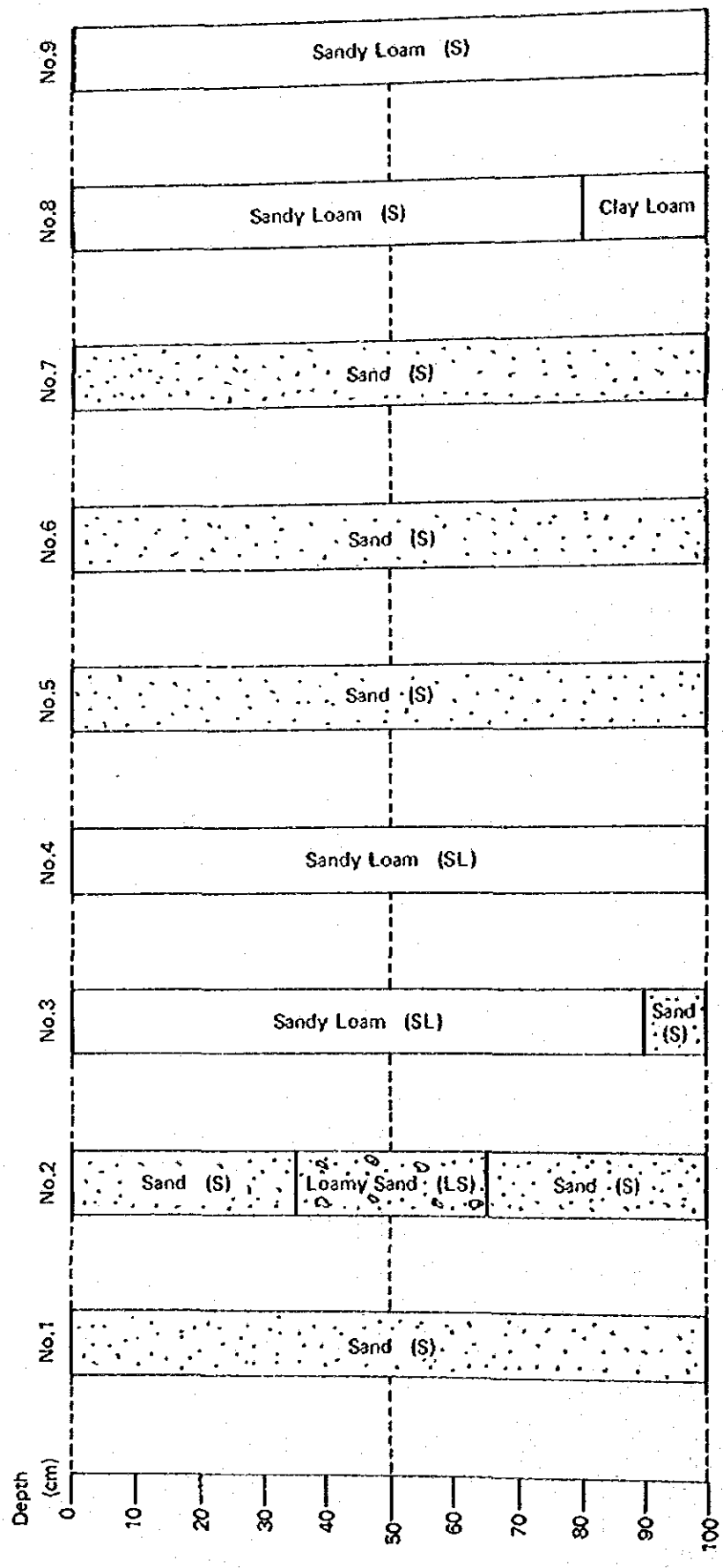
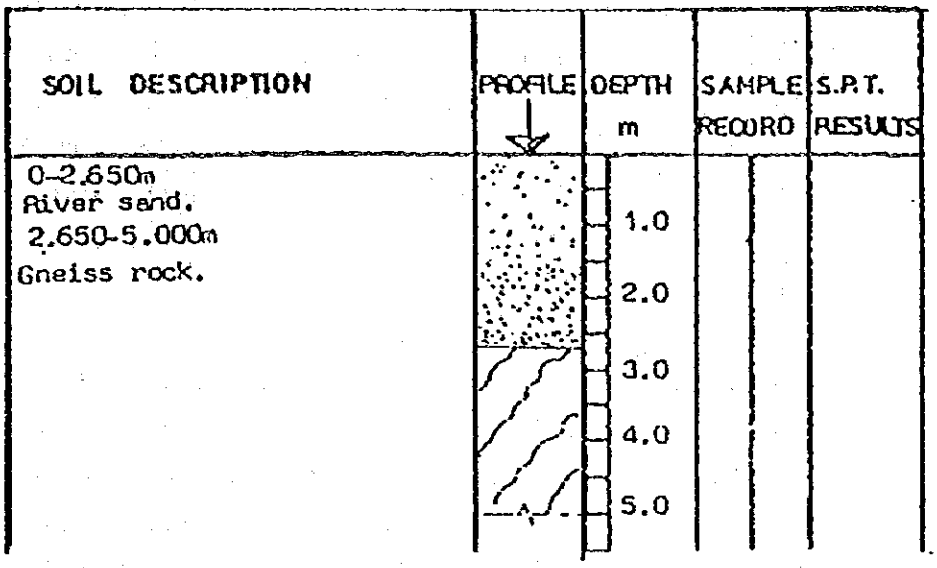


Fig. 3-6 Investigation Soil and Steve Analysis Test

Table 3-5 shows the boring core analysis.

In the upstream area from the boring test point, the river bed is covered with large round rocks with diameters of 1.0 -1.5 meters. In further upstream areas, rock is exposed in the river bed.

Fig. 3-7 Boring Core



3-3-4 Estimate of the Kaunga River's Discharge:

The Kaunga River is a wadi that drys during the dry season. Therefore, the discharge of the river gradually decreases after a rainy season. The discharge was estimated by the following method:

- Estimated Method:

The study team found practically no recorded data that could be used for the discharge analysis of the Kaunga River wherein a water intake facility is planned. As for rainfall, only the monthly rainfall data for the area was available. As a result of the area investigation, including interviews with local people, the study team obtained various data concerning the relationships between river water flow and seasons, and the

conditions whereby the river water dissipates during dry seasons, etc. Using this data, the study team analyzed the discharge of the river qualitatively and quantitatively based on the following concepts:

1 Relationship between Rainfall and River Water Flow:

Runoff from the basin can be divided into direct runoff, intermediate runoff, and base flow. The base flow is the usable water for irrigation purposes in the area. The base flow is the runoff from infiltrated water in the soil and flows laterally in the surface soil to a stream channel. There is a close relationship between soil moisture and the base flow. Knowing this relationship, it is possible to estimate the base flow discharge.

Based on this concpet, it was assumed that the base flow runoff gradually becomes depleted in proportion to the soil moisture content which could be obtained by using the A.P.I. Method (Antecedent Precipitation Index). By changing the coefficient K of the A.P.I. Method, and then placing the soil moisture dissipation curve on the river water discharge curve that was derived from actual water flow measurements, a depletion curve for the river was obtained.

2 Discharge Calculations:

i) Discharge after last rainfall:

Based on the data shown in Table 3-4 the river discharge was calculated with the Manning Equation as follows:

- Discharge 30 days after the last rainfall:

$A = 4.0 \times 0.25 = 1.00\ m^2$

$P = 4.0 + 0.25 \times 2 = 4.50$

$R = A/P = 0.222,\ R^{2/3} = 0.367$

$V = 1/n \times R^{2/3} \times I^{1/2} = 0.706\ m/s$

$Q = A \times 4 = 0.700\ m^3/s$

- Discharge 60 and 90 days after the last rainfall:

Using the above calculations, the discharges for 60 and 90 days after the last rainfall were obtained as follows:

60 days after: $Q = 0.020\ m^3/s$

90 days after: $Q = 0.001\ m^3/s$

ii) Rainfall during the last month of the rainy season:

By using the rainfall data for the last month of each rainy season from 1978 through 1984, an average monthly rainfall was obtained as follows:

$$\frac{36.8/2+72.7/7+12.4/2+78.0/3+59.7/4+73.9/1+58.7/2}{7}=25.6mm$$

The arrived at monthly rainfall data will be needed in estimating the amount of possible intake water.

iii) Catchment Area:

$260\ km^2$.

iv) Runoff Coefficient:

The catchment area of the Kaunga River can classified as a grass land (sandy loam - silty loam) with 10-30% slope. The runoff coefficient of the area was determined to be 0.2 (see Table 3-7). This figure (0.2) is exactly the same as the one estimated for the entire African continent (average rainfall 686 mm).

v) River Discharge:

The dissipation equation of soil moisture content ($It = Io \cdot k^t$) was converted into the discharge equation:

$It = Io \cdot K^t$ $\qquad$ $Q^t = Qo \cdot K^t$

where, Qo is the product of the average daily rainfall and the runoff coefficient (0.2) of the area. Based on the assumption that the base flow is one-tenth of the peak discharge; Qo was calculated as follows:

$Qo = 68.5\ mm/30\ days \times 0.20 \times 137.42\ m^3/s$

Table 3-7 Values for the runoff coefficient C in Q = CIA

		Sandy loam	Clay, silt loam	Dense clay
Forest Slope (%)	0-5	0.10	0.30	0.40
	5-10	0.25	0.35	0.60
	10-30	0.30	0.50	0.60
Pastures Slope (%)	0-5	0.10	0.30	0.40
	5-10	0.15	0.35	0.55
	10-30	0.30	0.40	0.60
Arable land Slope (%)	0-5	0.30	0.50	0.60
	5-10	0.40	0.60	0.70
	10-30	0.50	0.70	0.80

- K value for the discharge 90 days after the rainy season:

$$Q90 = Qo \cdot K^{90}$$

$$0.001 = 15.41 \times K^{90}$$

$$K^{90} = \frac{0.001}{15.41} = 0.0000649, \qquad K = 0.898$$

- K value for the discharge 60 days after the rainy season:

$$Q60 = Qo \cdot K^{60}$$

$$0.020 = 15.41 \times K^{60}$$

$$K^{60} = \frac{0.020}{15.41} = 0.00130$$

$$K = 0.895$$

- K value for the discharge 30 days after the rainy season:

$$Q30 = Qo \cdot K^{30}$$

$$0.700 = 15.41 \times K^{30}$$

$$K^{30} = \frac{0.700}{15.41} = 0.04543$$

$$K = 0.902$$

The average of the K values is:

$$K = \frac{0.898 + 0.895 + 0.902}{3} = 0.8983$$

$$= 0.9$$

Therefore, the river water discharge equation becomes as follows:

$$Qt = Qo \times 0.90^t,$$

where t is the number of days after the rainy season.

Discharge Equation:

1 $Qo = 25.6\ mm \times 0.20 \times 260{,}000{,}000 \div 86.400 = 15.41\ m^3/s$

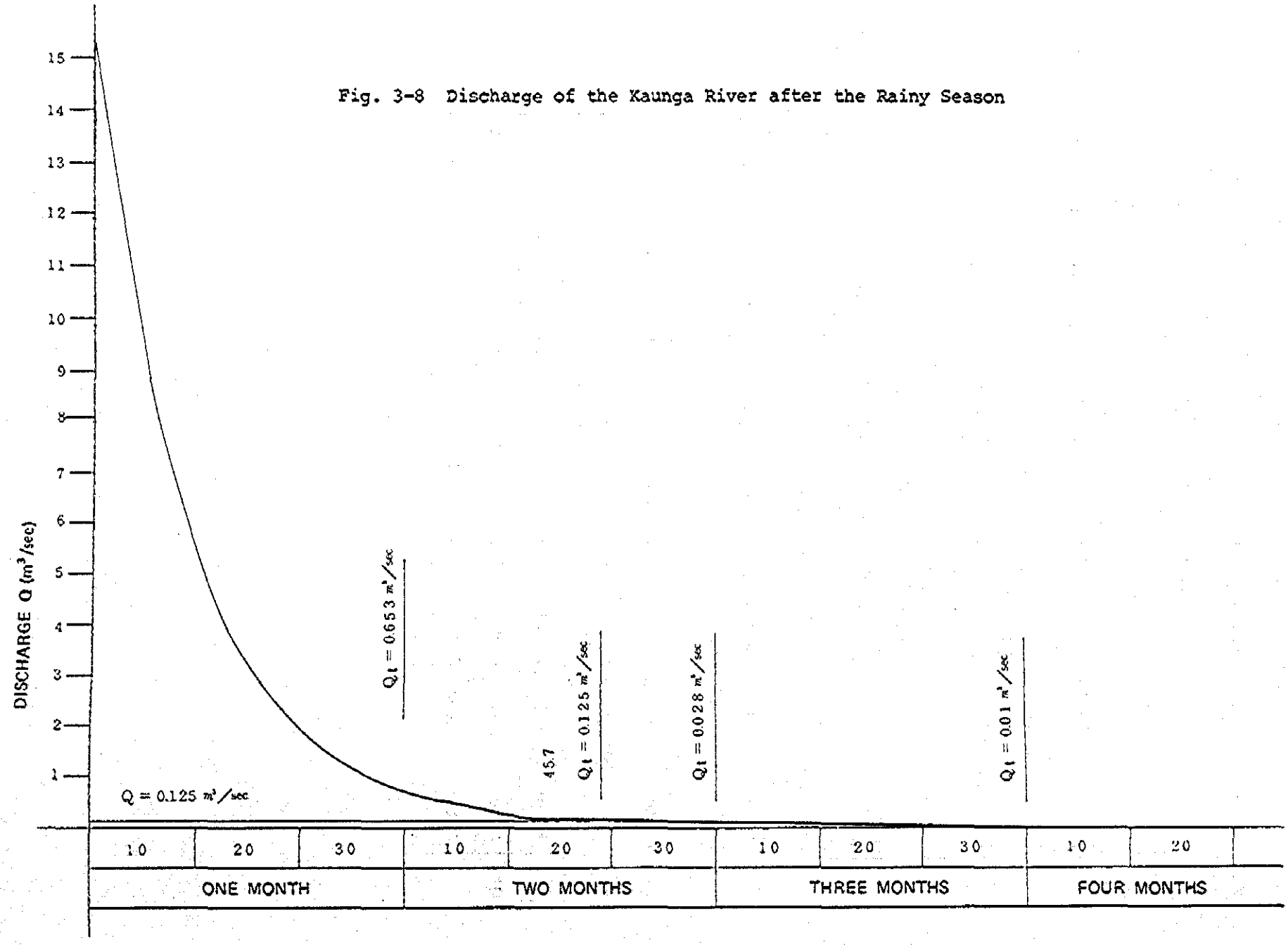
$$Qt = 15.41 \times 0.90^t$$

The results of teh calculations are shown in Table 3-8 and Fig. 3-9.

Table 3-8 Discharge of the Kaunga River after the Rainy Season

Month		5 days	10 days	15 days	20 days	25 days	30 days
Qt_1	After 1 month	9.099	5.373	3.173	1.873	1.106	0.653
	After 2 months	0.386	0.228	0.134	0.079	0.047	0.028
	After 3 months	0.016	0.010	0.006	0.003	0.002	0.001

Fig. 3-8 Discharge of the Kaunga River after the Rainy Season



3-4 Outlook of Farming Conditions

Soils in the Luangwa areas vary from sand to loam, and the layer of fertile soil is relatively thin. Farmland is developed along the Luangwa River and its tributaries. In this area, hoe cultivation is dominant. Animals are not used for plowing because of tsetse flies that increase in numbers in proportion to the number of animals.

The farmers in the area usually have their farmland in two different locations. Their main farm is fairly close to their permanent homes, i.e., away from the Luangwa River. This farmland is used during the rainy season. During the dry season, the cultivate their farmland along the river. Cropping on this land is done in an attempt to obtain a second harvest if the harvest in the rainy season has failed or is insufficient to meet their needs until the next year.

In the area by the river, fertile soil is covered with a 30 - 50 cm thick sand layer and farmers must dig pits for seeding. The distance from their homes to the land is 2 - 5 km. Therefore, hard labor is required to cultivate the land along the river.

Weather conditions in the area is very severe. Commonly, the farmers experience four years of drought, while every fifth year they get enough rain for a good harvest. However, it is not unusual for the fifth year to be a year of flooding. In 1985, all crops were destroyed by a severe flood. Farmers had to buy maize flour; they even ate the immature maize planted during the dry season. About twenty percent of the farmers were unable to purchase seeds for planting in the next rainy season.

The Launga area is close to the National Park where wild animals are protected. In the daytime, monkeys and baboons come to the farmland and eat the crops and seedlings. At night the hippopotami come up from the river to graze. Birds and wart hogs also cause considerable damage to the farmland. Therefore, farmers must exert great effort in protecting their land.

In the Kaunga area, the Project location, there are ten villages, and 268 families farm 298 ha of land. Some families have 2 - 4 ha of land. The average land per family is 1.1 ha. The average family has two or three of its members doing the farming. Land per farmer varies from 0.5 - 0.9 ha, with the average being 0.67 ha. The "cut-and-burn" farming method is used in the area, and weather conditions determine the success or failure of crops. Irrigation farming methods are not employed in the area. Water rights to the Kaunga River, therefore, are non-existent.

Table 3-9 Number of Families and Farmers, and Land per Capita in the Kaunga Area

Name of Village	Number of Familes	Number of Farmers	Farmland (ha)	Farmland per Family (ha)	Farmland per Farmer (ha)
Sipopa	31	59	30.25	0.98	0.51
Chikokola	21	29	16.25	0.77	0.56
Balakasau	13	21	18.25	1.40	0.87
Mpona	44	71	42.50	0.97	0.60
Mulanba	11	18	13.25	1.20	0.74
Mkando	23	41	31	1.35	0.76
Kanaventi	14	24	14.75	1.05	0.61
Chitowa	7	13	9.75	1.39	0.75
Chikuma	44	69	46.00	1.05	0.67
Chimera	60	104	76.75	1.23	0.74
Total	268	449	298.75	1.11	0.67

Source: Chitope Camp Officer

In the Kaunga area, maize, sorghum, groundnuts, soybeans, tomatoes, pumpking, okra, cotton, and sunflower are planted. However, maize is the staple food that is grown by the farmers for their own consumption. Cotton and sunflower seeds are cash crops. Maize is sown during the December-January period (approximately three months prior to the ending of the rainy season), and is harvested in April or May.

Lusaka Provincial Cooperative Union buys cash crops and excess crops at prices set by the government. The agricultural products in the Kaunga area are collected at Chitope (15 km from the area), and are sent to Lusaka.

Cotton is the most attractive cash crop for farmers. Extension workers have a positive attitude towards planting more cotton. However, if farmers do plant more cotton on their land, they will have to reduce the amount of land normally alloted to growing maize. The effect of cash crops on the farmers is negative. As there are no markets in the area, the farmer cannot purchase maize even if they have money.

Table 3-10 lists the government's set prices for agricultural products. Table 3-11 shows, in units per area, the crop yield in the Kaunga area.

Oranges, mangoes, and bananas are planted only in very limited amounts in the Kaunga area. The representatives of the Zambia Horticultural Products, Ltd., periodically come from Lusaka to purchase these products.

Table 3-10 Government Set Prices for Various Crops

Unit: Kwacha

Drop	Unit	Price 1985-86	1986-87
Maize	1 bag-90 Kg	55.0	78.0
Sunflower Seed	1 bag=50 Kg	41.95	70.0
Wheat	1 bag=90 Kg	84.40	111.0
Sorghum	1 bag=90 Kg	52.25	74.0
Cotton	= 1 Kg	0.97	1.60
Soybeans	1 bag=90 Kg	112.10	148.0

Source: Louangwa Agricultural Office

Table 3-11 Crop Yield per Unit Area (1 ha)

Crop	Number of Bags	Kg.
Maize	12-16 bag/ha	1,030-1,440 kg/ha
Sorghum	8 bag/ha	720 kg/ha
Groundnuts	8 bag/ha	640 kg/ha
Sunflower	20 bag/ha	1,000 kg/ha
Soybeans	4 bag/ha	360 kg/ha

Source: Chtope Camp Officer

3-5 Infrastructure

The main access roads from Lukasa to the Kaunga area are the Great East Road that leads to Malawai, and a rural road, No.216, which runs along the Luangwa River, from approximately 1.5 km before the Luangwa Bridge, to Luangwa. The Great East Road is paved; however, the rural road No.216 is unpaved and it becomes muddy during the rainy season. There is a road along the Kaunga River that leads from the Project area to the Great East Road; this road is not properly maintained.

In the Project area, the conditions of the existing agricultural roads are poor, but there are no cars in the area. Therefore, it will be necessary to improve the roads in order to transport the materials and equipment necessary to implement the Project.

No electricity is supplied to the Kaunga Area. At Luangwa Boma they have their own power station, a diesel generator.

Telephone cables are installed along the Great East Road and the rural road No.216. It is possible to make telephone calls in Luangwa Boma.

There is a water supply system installed at Luangwa Boma. However, in the Kaunga area there is no such system and the villagers must draw water from wells, streams, springs, and the river.

No sewer system exists in the area.

The main fuels used for cooking are wood and charcoal. On a lesser scale, kerosene stoves are used.

3-6 Construction Situation

There is very little construction work going on in the area except for road maintenance and repair. Therefore, it will be necessary either to bring construction machinery and materials, or utilize contractors from Lusaka for the implementation of the Project.

Before the construction work commences, it will be necessary to confirm water rights to the Kaunga River. The Agricultural Department of the Ministry of Agriculture and Water Development must apply to the Department of Water Affairs in accordance with the Water Act (Laws, Vol. V, Capter 312).

As for the design of various facilities, it will be necessary to proceed in accordance with the contracting methods, consultant fees, etc., stipulated in the "Architects and Quality Surveyors, Chapter 825 of the Laws of Zambia."

Construction work shall be conducted based on the Zambian "General Specification."

CHAPTER 4 PROJECT DESCRIPTION

CHAPTER 4 PROJECT DESCRIPTION

4-1 Objective

The objective of the Project is to establish a model rural development programme in the southern provinces affected by droughts, aiming at reducing the risk of further droughts by installing small-scale irrigation facilities to expand the cropping season, growing appropriate crops and improving food production.

The Project involves the establishment of the Project Office with an experimental farm, and aims to develop a model small-scale irrigation field with grant aid from the Japanese Government.

4-2 Evaluation of the Requested Financial Assistance

4-2-1 Evaluation of the Project

Traditional Zambian farming method can be considered to be one of "cut-and-burn." Tree branches and grass are cut and burned during the dry season, and seeds are sown during the rainy season. Irrigation farming is hardly conducted. Irrigated farmland constitutes less than one percent of the country's total farmland. Therefore, in the southern provinces, where the average annual rainfall is 650 - 800 mm (rainfall pattern varies from year to year), crop harvests vary yearly as they are affected by the weather and are vulnerable to drought damage. The droughts experienced in the late 1970's and early 1980's dealt a severe blow, not only to the farmers of the southern provinces, but to the Government of Zambia which was in the process of carrying out the TNDP. As Zambian agriculture is extremely drought prone, a basic requirement is to introduce and extend irrigation farming by installing appropriate irrigation facilities in order to steer the southern provinces away from its present unreliable farming methods. However, most of the farmers in the area have neither

sufficient funds nor know-how to install irrigation systems. Furthermore, the farmers do not seem to recognize the need of irrigation farming. In order to introduce and extend irrigation farming in the southern provinces it will be necessary to increase the farmers awareness to this method; this may be done by demonstrating the following effects:

1 In Zambia the rainy season is generally from November to April; crops are planted at this time. Occasionally there is insufficient rain in the southern provinces for cropping. In order to alleviate the situation, in an attempt to increase farm production, the installation of irrigation facilities and the supply of adequate water is essential.

2 At times the normal rainfall pattern changes; the rainy season may end January - February instead of April. When this occurs, crops that expected to be harvested in March - April are subjected to severe drought damage. In order to resolve this type of problem, an attempt must be made reduce the damage by collecting the subsurface river water flow, using it for irrigating crops at the beginning of the dry season.

3 In years having normal rainfall patterns, the subsurface river water may be collected and used to expand the cropping season and for the growing of suitable crops.

Based on the above concept, the Project aims at establishing a model for the Rural Development Programme in the southern provinces affected by drought in an effort to reduce the risk of further drought damage. A Project Office will be set up having an experimental farm. A small-scale irrigation field will also be developed. The Project Office will be used for the extension of irrigation farming by training farmers and demonstrating the results of various studies on the test cropping of newly introduced cultivated produce. The model farm will be furnished with small-scale facilities that will not be expensive, but will be easy to operate and maintain without the need for special

knowledge. The model farm will actually be cultivated by farmers.

4-2-2 Selection of the Project Area

In the request by the Government of the Republic of Zambia, the Project area was designated as the Kasinsa area. However, the preliminary study team learned that the area was actually called the Kaunga area. Therefore, the Project area was revised to be the Kaunga area. This area was selected for the following reasons:

1 The areas represents the typical natural conditions in the southern provinces, i.e., the main river has enough water, but, during the dry season, its tributaries become wadis.

2 The area is located relatively close to the country's capital, Lusaka (about 3 hours drive via the Great East Road).

3 The area has the potential of being developed as a key agricultural point in the southern provinces.

4-2-3 Location of Model Farm

The model farm will actually be cultivated by farmers using irrigation facilities and their individual skills, and, as a result, this newly introduced farming method will be extended throughout the southern provinces. As for the location of the model farm, it would be most desirable to select an area where farmers are now working the land. In this manner, they will be able to compare their products, grown by traditional methods, with those grown using the new irrigation farming techniques. Of course, the location of the model farm should also be based on the cost of such a facility, including the method of water intake. Further, the model farm should be appropriately located in a vicinity that is similar to other southern province areas. Taking into account the aforementioned aspects, it is felt that

the best location for the model farm would be at the downstream area of the Kaunga River.

Since the model farm will take up land presently cultivated by the farmers in their areas, there is no need to have title deeds to that land.

4-2-4 Water Source of the Model Farm

The water source of the model farm can be either river or ground water. To utilize ground water, it would be necessary to dig a deep well and use a pump to bring the water up. Judging from the farmers' living standards, it is understandable that it would be extremely difficult for them to buy the fuel and provide maintenance and repair to the pump. As the previous small-scale irrigation study reported, the attempts to introduce a diesel engine operated pump met with failure. Therefore, it can not be considered practical to draw ground water from a deep well.

Water is available from both the Kaunga River and Luangwa River. The Luangwa River has the greatest quantity of water. However, it would be very difficult to take water from the Luangwa River by gravity flow for topographic reasons. Pumping it would require the installation of a water course running six kilometers from the pumping station to the irrigation area. Hence, it is desirable to use the water from the Kaunga River.

Water intake at the downstream area of the Kaunga River would have to be accomplished, because of topographical reasons, by pumping. Taking water from this location would not, and for the same reasons given in the case of deep well pumping, be practical.

It would be possible to supply water by gravity flow from the upstream area of the Kaunga River to the model farm. In this case, the water supply system would not be difficult to operate and maintain. As a conclusion, it is considered that the bet

water source for the model farm would be from the upstream area of the Kaunga River.

4-2-5 Location of the Project Office and an Experimental Farm

Judging from the activities of the Project Office - described in Chapter 4-2-1 - its location shall meet the following conditions:

1 Be in a place from which office personnel and extension workers can easily travel to neighboring areas in order to perform their activities.

2 Be close to the model farm so that members of the organized farmer groups who are in charge of the operations and maintenance of the irrigation facilities can easily attend the training programs and the seminars given by Project Office personnel.

3 Be located where the farmers in neighboring areas can easily come for training purposes or to attend seminars pertaining to the introduction and growing of suitable crops.

4 Be at a place where those passing by can easily see the condition or the growing crops and the planting method.

5 Be at a place where people gather daily or periodically for certain purposes, i.e., near to a church, market, or school, and where the greatest number of people can have an opportunity of actually seeing the office.

Taking the above conditions into consideration, the best possible location for the Project Office would be in the area near the center of the Kaunga area where there is a school and a church, and facing the district road.

4-2-6 Water Source for the Experimental Farm

In order to utilize the water from the Kaunga River by constructing a water intake facility, it will be necessary to install a water supply pipe line that is 125 mm in diameter and 6.5 km long. The cost in this case would be extremely high.

On the other hand, by using ground water, a well with a depth of approximately 60 meters, could be dug to provide a sufficient quantity of water throughout the year. The cost in this case would be much lower than that of constructing the long pipe supply line to use river water. A pumping facility would have to be installed to bring up water from the well. Further, the well water could be utilized by the office personnel for drinking.

4-2-7 Necessary Facilities and Equipment

(1) Model Farm:

The following facilities are required for farmers operating the model farm:

- A water intake facility for irrigation water.
- A water supply line from the intake facility to the model farm.
- Irrigation channels.
- Distribution ponds for irrigation ad for farmers' domestic use.
- Reclamation work for farms along the irrigation channels.

(2) The Project Office and Experiment Farm:

The following facilities and equipment are required to carry out Project work:

a. The Project Office:

- A building for offices and conference room.
- A Farmers' Training Center building.
- A garage for a truck and extension workers' cars, and with a repair shop and fueling station.

- A storage building for seeds, agricultural products, fertilizers agricultural medicines, and agricultural machines.
- Lodging for personnel visiting the area from Lusaka to engage in the Project's work.
- An open area with concrete pavement for crop drying.

b. Experimental Farm:

- A farm for test cropping and demonstration.
- Irrigation facilities.
- A deep well capable of supplying water all year round.

c. Equipment and Machinery:

- Vehicles for extension activities at neighboring farms.
- Agricultural machinery for the experimental farm and the model farm.
- Machinery for reclamation work to develop irrigation fields in neighboring areas.
- Weather and hydrological data collecting equipment Data will be provide the basic information for the advancement of the future agricultural development plan.

4-2-8 Management Plan

The responsible agency for the Project is the Department of Agriculture of the Ministry of Agriculture and Water Development. It is certain that the Department of Agriculture will send a manager and three specialists in the farms of irrigation facilities, farming, and extension activities. However, the actual management system of the Project has yet to be established.

Judging from the scope of the Project, an office clerk, typist, draft person, machinery operator, and machinery repair personnel are required. In the early stages of the Project, it will be necessary to provide Japanese technical assistance in conducting test cropping at the experimental farm, to offer guidance to farmers on matters pertaining to irrigation methods in the

experimental farm, and to extend the suitable crops to neighboring areas. It will be beneficial to station Japanese specialists in the area to provide advice about dry farming, extension farming methods, agricultural machinery and agricultural civil engineering.

The Government of the Republic of Zambia has agreed to finance the costs of the Project's management.

4-3 Description of the Project

4-3-1 Executive Agency

The Project executive agency is the Department of Agriculture, the Ministry of Agriculture and Water Development, the Government of the Republic of Zambia.

4-3-2 The Project

(1) Model Farm

In this Project, it is planned that farmers will cultivate the model fields equipped with small-scale irrigation facilities, and will attempt to increase the agricultural production under the guidance of extension workers. By demonstrating model farming, the Project intends to motivate the farmers in the southern provinces into developing irrigation farming. The irrigation facilities must be of low cost and easy to construct, and must be of such a design as to be operated and maintained easily by local personnel.

(2) The Project Office and the Experimental Farm:

The purpose of the Project Office is to manage and carry out the entire Project under the supervision of the Department of Agriculture of the Ministry of Agriculture and Water Development by means of the following:

1 Test cropping on the irrigated experimental farm for the purpose of finding suitable crops for the Project area and for demonstrating cropping techniques to the farmers:

In the southern provinces the traditional farming method (("cut-and burn") is widely employed, but, because of the weather, an uncontrollable factor, the farming season and the types of crops that can be planted are limited. In order to emerge from this condition, the Project will try to find suitable crops

for the areas by test cropping local crops as well as possible new types, such as corn, sunflowers, vegetables, cotton, rice, and cassava in the irrigated experimental farm. Further, the Project will subject crops to a series of aptitude tests (temperature, humidity, soil, water quality, amount of irrigation water, and area specifics through comparison of irrigation methods, production changes with the use of different fertilizer amounts, damages by insects and disease, and the efficiency of cropping). Other aims of the Project are to demonstrate cropping conditions and methods to the farmers and to inform them, through means of extension workers, of the suitable crops and cropping methods appropriate for their farms.

2 Guidance and Application of Irrigated Agriculture to the Project Area:

In addition to demonstrating irrigation farming methods to the farmers at the experimental farm extension workers will visit model irrigation fields giving technical guidance to the farmers. The extension workers will also give positive aid to farmers who are willing to develop irrigation farming, and will extend irrigation farming to neighboring areas.

3 Organization of Farmers' Committees to be in charge of the operation and maintenance of model small-scale irrigation farms.

Model fields will be equipped with a water intake facility, water supply system, irrigation channels, and distribution points. The farmers will have to operate and maintain these facilities by themselves. However, as these facilities will be new to the area, no one here has previous experience in the operation and maintenance of them; therefore, Project Office personnel will give positive aid and guidance to farms in forming organized farmer committees to be in charge of operations and maintenance of irrigation facilities and to allocate land to the farmers.

4 Extension of the Rural Development Programme to other areas in the southern provinces that are affected by drought:

The Project aims eventually at extending irrigation farming to the southern provinces. In order to do this efficiently and smoothly, the Project has a schedule for collecting weather and hydrological data in the Luangwa River and Kaunga River areas that will provide the necessary basic information.

4-3-3 Testing and Research Plan

On the experimental farm, various testing and research programs will be carried out in an effort to extend irrigation farming in the southern provinces, and to introduce suitable crops to the Project area.

There are no farms utilizing river water for irrigation purposes along the Kaunga River. The farmers here have no experience in irrigation farming. For this reason, the testing and research at the experimental farm will be primarily in the realm of irrigation farming. The major aspects of the testing and research to be carried out at the experimental farm are as follows:

- Relationship between crop output and irrigation method
- Planting of introduced crops.
- Relationship between seeding time and output.
- Relationship between farm conditions and planting methods.
- Finding the best soil moisture content in which to grow crops.
- Prevention of insects and disease.
- Determining the effects of applying different quantities of fertilizer during different growing stages.
- Determining the proper amount of water to be supplied.

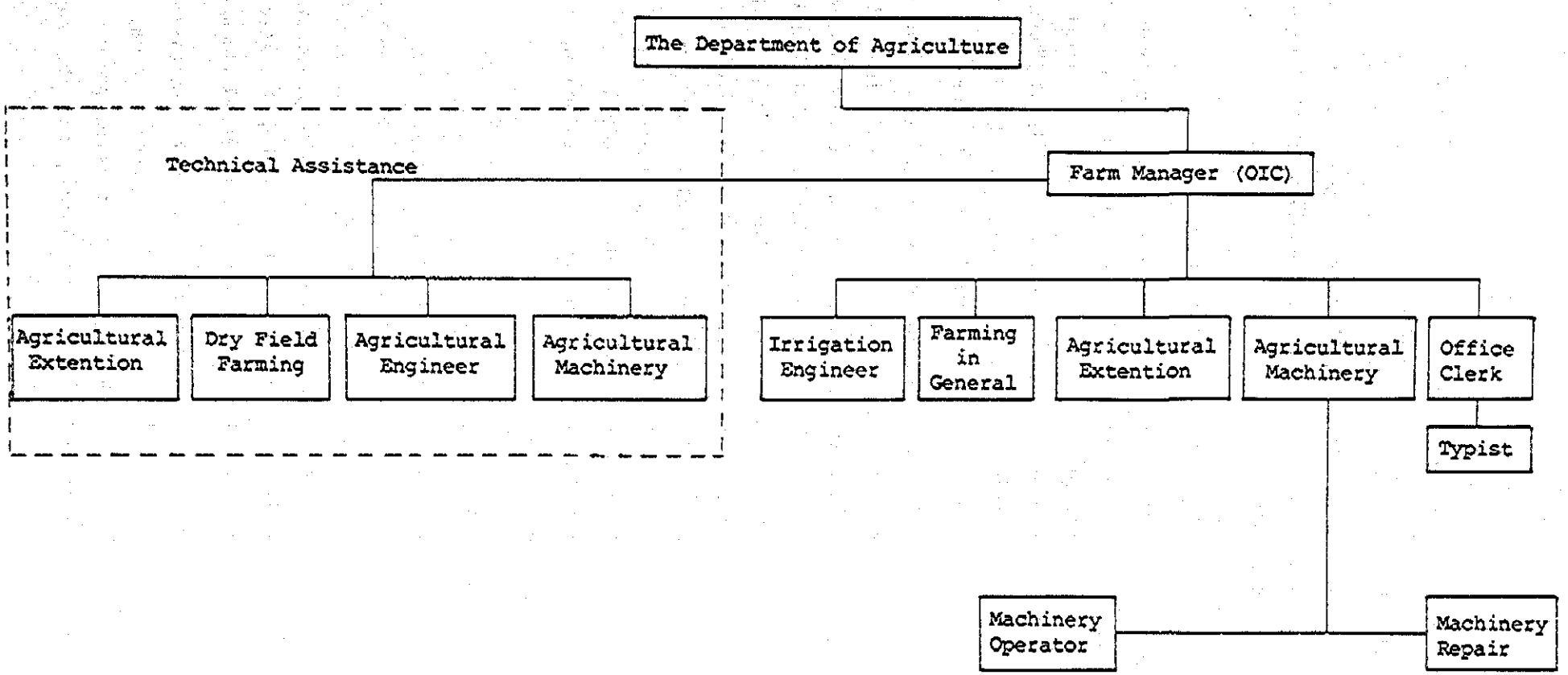
For research purposes it is planned to grow maize, sorghum, and millet at the irrigation farm. In addition to these grains

already being grown in the area, cotton, sunflowers, groundnuts, vegetables, rice, fruit, and cassava will be grown on the experimental farm with the intention of introducing them to southern province areas.

4-3-4 Operational and Managerial Structure

The Project Office will be operated and managed by the Department of Agriculture, the Ministry of Agriculture and Water Development of the Government of the Republic of Zambia. The personnel of the Project will consist of a manager, and one each of the following: farming specialist, extension worker, irrigation facilities specialist, clerk, machinery repairman, machinery operator, draft person, and typist. They will be selected by the Department of Agriculture. In order to implement the Project efficiently and effectively, it is understood that the Japanese technical assistance shall be given in dry field farming, agricultural extension work, agricultural civil engineering, and agricultural machinery to their Zambian counterparts during the early stages of the Project. Fig. 4-1 shows the operational and managerial structure of the Project.

Fig. 4-1 Organization of Operation and Management for the Project



4-3-5 Equipment and Facilities

(1) Model Farm

The model farm shall have a water intake facility, water supply line, irrigation channels, distribution ponds, and farmland.

(a) Water Intake Facility:

Approximately one month after the rainy season, the surface flow of the Kaunga River ceases in the downstream area. However, a certain amount of subsurface water still flows. In the upstream area, a little amount of surface water flows until approximately two months after the rainy season.

The water intake shall be at the upstream point by constructing a cutoff wall and installing a water collecting culvert. During the dry season, subsurface water will be collected by the cutoff wall and will be taken through the water collecting culvert. The basin's water content capacity is considered as medium-poor, and it is not possible to obtain a large amount of subsurface water. Judging from Fig. 3-8 it can be assumed that a sufficient amount of subsurface water for the model field can be obtained up to two months after the rainy season.

(b) Water Supply Line:

Irrigation water shall be conveyed by a water supply line from an intake point to the model field. The cross-section of the Kaunga River is relatively narrow in the upstream area. There are projecting cliffs on either side of the river. Going downstream the river becomes wider; the high-water channel changes yearly.

The water supply line shall be installed along the Kaunga River. In the upstream area, the supply linemust cross the river at three points to avoid the projecting cliffs. Therefore, for the supply line it

would be suitable to install a pipeline rather than an open channel line. Control valves, air relief valves, and flushing valves shall be installed in the pipeline.

(c) Irrigation Channels:

Irrigation channels will be installed parallel to the Kaunga River on the flat arable lands on both sides. The main irrigation channels shall be open channel type. As the soils in the area are sandy loam and loam, the open channels shall have concrete linings.

(d) Distribution Ponds:

Distribution Ponds shall be dug near each village along the irrigation channels. These ponds will be used for irrigation as well as for the villagers' domestic use.

(e) Development of Model Farm:

The flat land along the irrigation channels on both sides of the Kaunga River that is suitable for farming shall be developed. The most suitable land for irrigation farming shall be developed based on the amount of available irrigation water, possible irrigation period, and the necessary irrigation periods for crops.

(2) The Project Office and the Experiment Farm:

a. The Project Office and its Facilities:

1 Offices and Conference Room

A total of twelve (12) people will run the Project Office, giving technical guidance to farmers' tests, planting of crops, planning the Rural Development Programme, and promoting the Agricultural Development Programme.

2 Farmers Training Center

There is a facility at Chongwe in the Lusaka Rural District that is being used as a place for training and study by farmers. There is no such facility in the Kaunga District. During the early phases of the Project, farmer training and study shall be scheduled for the Kaunga area. It is also intended that educational and training programs will be expanded to include the entire Luangwa District.

It is reported that there is a total of 1,691 ha of farmland in the Luangwa District. Based on the assumption that the land per farmer is the same in the Luangwa District as it is in the Kaunga area (0.67 ha/farmer), it can be estimated that there are approximately 2,500 farmers in the Luangwa District.

By planning the farmers' education and training programs to cover a five month period (June - October), with classes two to three times a week, it will be possible to have fifty programs in one year. Thus, the one-time attendance will be 2,500/50 = 50 farmers.

The education and training programs entail having lectures and actual training in the following areas: proper time of seeding, planting methods of crops suitable for the area, prevention of insects and disease damage, proper timing and proper amounts of fertilizer applications, the effects of irrigation farming, etc. Having fifty farmers attending each class would be ideal.

3 Garage with Repair Shop and Fueling Station:

The garage will handle mobile extension workers' vehicles, agricultural technicians' jeep and motorcycles, trucks carrying fertilizers, agricultural medicines, and agricultural products for use at the experimental farm.

The repair shop will do the repair and maintenance work to the vehicles noted above, but will also provide service to agricultural machinery utilized for cultivation at the experimental farm and reclamation work at neighboring farms.

The fueling station will store and supply gasoline and kerosene to vehicles, agricultural machinery and power generator.

4 Storage Building:

The storage building is for keeping seeds for the experimental farm, and the storage of fertilizer, agricultural medicines, grain crops, and agricultural machinery.

5 Lodging Facility:

The personnel of the Project Office will be selected and assigned by the Department of Agriculture of the Ministry of Agriculture and Water Development. Most of the personnel's families will remain in Lusaka. The personnel will stay at the Project Office Monday through Friday, spending weekends with their families. Project Office personnel, as well as visitors coming to the area for special guidance or inspections, will stay at the lodging facility.

6 Drying Area:

Crops harvested at the experimental farm will be dried on the open drying area.

7 Water Supply System:

Pumped well water will be supplied to each facility.

8 Power Generation and Distribution Facilities:

The nearest power station to the Project area is at Luangwa Boma, but power is not provided to the Kaunga area. Power will be generated in the Project area and will be distributed to each facility for pumping wells, etc.

b. Experimental Farm

Judging from the diverse use of the farm, the uniformity of farm blocks and furrows, arrangement of crops, and the land rotation for each research theme, the entire expermental farm will have irrigation facilities. If it becomes necessary to have unirrigated conditions for some research project, the irrigation system can be shut off during the period of the research.

The main irrigation facility will be a ground-surface irrigation (furrow irrigation) the same as to be used at model fields. Also, sprinkler irrigation and fixed pipe irrigation (dip irrigation) facilities that have a variety of uses for different purposes, will be installed in order to expand the scope of the research activities.

c. Equipment

Necessary equipment for the Project can be classed into two groups; one for the extension of agricultural development, such as for the operation and management of the experimental farm and the model field and for the application of irrigated agriculture in the Project area; the other is for collecting weather and hydrological data to use as the basic data for the extension of the Rural Development Programmes in the southern provinces.

① Equipment for the Extension of Agricultural Development

i) For the purpose of test cropping at the experimental farm, a tractor, plough, harrow, cultivator, sprayer for agricultural medicines, and trailer will be required. Other equipment for maintaining irrigation facilities and roads in the Project area will also be required.

ii) Equipment for Extension Activities:

Vehicles will be required for extension activities and for travelling to neighboring areas to provide technical guidance, and for use when inspecting plants and farms. The vehicles will also be used by a total of six extension workers and specialists during visits to the Department of Agriculture in Lusaka and the District Agricultural Office in Luangwa. They will be used to carry equipment necessary for extension activities. For these purposes, station wagons, four-wheel drive trucks, and motorcycles shall be selected.

② Equipment for Collecting Weather and Hydrological Data:

The Government of the Republic of Zambia has a plan to develop agriculture in the southern provinces by means of the extension of the model of Rural Development Programme and the results of the experimental farm. For effective and efficient project planning and implementation, weather and hydrological data in the areas will be very important factors. For the weather data, the temperature, humidity, insolation, evaporation, wind direction, wind speed, and rainfall shall be measured. For the hydrological data, the water level, current, channel sections of the Kaunga and Laungwa rivers, and ground water levels of the areas shall be measured.

4-4 Technical Assistance

In order to implement and operate the Project efficiently and effectively, the Government of the Republic of Zambia requested the Government of Japan to provide the following technical assistance:

a. To dispatch experts and Japan Overseas Cooperation Volunteers to Zambia.

b. To provide training in Japan for Zambian personnel on the operation and administration of the Project.

In Zambia, irrigation farming is practiced only in limited areas. Most of the Zambian agriculture extension workers only have a slight knowledge of, and no experience with, irrigation farming. At the stages of implementation and operation of the Project, a total of four experts and Japanese Overseas Volunteers shall be stationed at the Project Office and shall perform, along with the Zambian personnel, the activities of test cropping, the extension of suitable crops to the area, provision of technical guidance relating to irrigation farming techniques, and the development of farmland in the area. Their activities will help to carry out the Project effectively, and will permit the transfer of techniques and knowledge about irrigation farming to the Zambian farmers.

The technical training received in Japan by the Zambian personnel who will be engaged in the administrative work of the Project will provide them with the techniques and knowledge essential for irrigation farming, and will help to promote the smooth operation of the Project by deepening their understanding of the Japanese technical assistance.

CHAPTER 5 BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5-1 Basic Design Policies

For the Rural Development Programme in the Kaunga area, facilities are needed for operations, education and training, testing and research, extension activities, and personnel lodging. To derive the greatest benefits from these facilities, the following basic design policies were established with emphasis placed on the functions of each facility:

(1) Functional facilities:

The types, quantities (or areas), structures, and arrangement of the facilities shall meet the needs of research, development, education and training at the Project for the Rural Development Programme in the Kaunga area. Each facility shall be so arranged that activities can be performed effectively by maintaining close relationships between other offices. Further, the arrangements should be such that the facilities can become the center of extension activities to farmers. By providing a comfortable atmosphere, those attending training programs can better grasp the meaning of rural development.

(2) Facilities that are easy to operate and maintain:

The arrangement of the facilities shall be such that future changes, expansion, and reorganization of Project activities will be possible. The facilities shall be planned so that close relationships between the Project's operations, training and education, and experimental farm can be maintained, and that the maintenance costs become minimized.

(3) Buildings suitable to the natural conditions of Zambia:

Buildings shall be designed to provide and maintain comfortable working conditions. The design should take into

account construction conditions and weather conditions in Kaunga, an area having one of the lowest altitudes in Zambia.

(4) To reduce construction costs by utilizing Zambian building methods:

Unit construction costs for buildings shall be kept to a minimum. Local design standards and building methods shall be applied, and local construction equipment and material shall be utilized.

(5) To reduce the construction period:

In order to use the facilities as soon as possible, the facilities' construction period shall be reduced as much as possible by avoiding the use of imported material - delivery times are long and import procedures are time consuming - and utilize construction equipment and material available in Zambia.

i) The installation of power operated equipment within buildings shall be avoided as much as possible; by using natural air ventilation and sunlight, comfortable working conditions can be created. To this end, buildings should not be very wide, and room sizes and ceiling heights should be designed to permit natural ventilation.

ii) Buildings should have long eaves to provide protection from the strong sunlight of the tropics, windblown rain, and hot humid weather. The space between buildings should be wide enough to allow for natural ventilation. Also, the sides of the buildings should have maximum sized openings.

iii) In order to keep the maintenance costs low, the buildings should be constructed strong and easy to clean. Building materials and methods should be of types that can be maintained and repaired locally.

iv) When selecting equipment, the number of types should be kept to a minimum and should be compatible. The equipment must be easy to maintain, and require only a limited number of spare parts. Buildings should be designed so that easily obtainable local items, i.e., light bulbs, can be used.

v) The facilities should be equipped with systems that can easily be revised or extended in the event that the Rural Development Programme might expand.

5-2 Design Criteria

5-2-1 Design Criteria for the Facilities

(1) Model Farm

1 Planned Area:

Kaunga River Basin

2 Villages, Farms, and Populations

Eight villages

Number of farms: 164

Work force: 276

Population: 541 persons (estimated)

3 Planned Crop:

Maize

4 Irrigation Water Intake Point:

Upstream point of the Kaunga River

5 Soil:

Upper side of the Kaunga River: Sandy loam

Lower side of the Kaunga River: Loam

6 Crop Water Requirement:

The crop water requirement of the model field is the same as for the experimental farm.

7 Irrigation Efficiency (Consumptive Use):

The irrigation efficiency of the model field is the same as for the experimental farm.

(2) The Operation and Management Office

The Operation and Management Office and its Facilities:

① The design of the Operation and Management Office and the Experimental Farm shall be based on the following personnel component:

Office Personnel:		12 - 14
Farm Manager (O.I.C.)	1	
Engineers:	6 - 8	
Secretary:	1	
Typist:	1	
Draftsperson:	1	
Machinery Operator:	1	
Machinery Repairman:	1	
Trainees:		50

② The equipment to be provided by Japanese Grant Aid to the Project will be as follows:

Vehicles:

Station Wagon	1 ea.	(1,500cc)
4-wheel drive Jeep	1 ea.	(1,300cc)
Pickup truck	1 ea.	(2 ton)
Motorcycles	3 ea.	(125cc)

Agricultural's Equipment

Tractor (with seat)	2 ea.	
Rotary Tiller	2 ea.	
Hand-tractor	2 ea.	
Trailer	1 ea.	(2 ton)
Powered sprayer	1 ea.	(500 liter)
Repair tools & Machinery	1 set	
Hydrological data collecting equipment	4 set	
Weather data collecting equipment	4 set	
Blackboard	2 ea.	
Projector	2 set	

③ Storage building shall be divided to accommodate the following items:

i) Seeds
ii) Fertilizer
iii) Agricultural Medicines
iv) Tools (2 locations)
v) Spare parts (2 locations)

④ The drying area shall be designed to sufficiently handle the produce of the 3 ha experimental farm.

⑤ Facilities:

i) Power generating house:

The power generating house shall be large enough to accommodate the following generators:

a)	20 kva	2 ea.	For offices and lodging facilities
b)	37 kva	1 ea.	For the experimental farm

c) Fuel tank
(installed in power generating house)

ii) Water supplying system:

A water supply systems shall be designed to adequately handle the requirements of the office building, garage and repair shop, storage houses, power generating house, fuel supply station, and the experimental farm.

iii) Drainage System:

Design the drainage system for the Project Office complex.

(3) Experimental Farm

① Staffing Plan:

A total of six (6) to eight (8) engineer is required to staff the experimental farm: one each for extension worker, irrigation engineer, dry field farming, and agricultural machinery, and two to four Japanese Experts and Japan Overseas Cooperation Volunteers.

② Field of Research:

- Effects of irrigation
- Whole year cropping test
- Plant breeding test
- Green manure cropping test
- Seed collection, etc.

③ Testing Crops:

- Staple: Maize
- Cash Crops: Oil seeds (beans, sunflower, cotton)
- Rice: Paddy rice, dry land rice
- Others: Flowers, garden plants

④ Cropping Method Tests:

- Intercropping: Maize and vegetables
- Mixed Cropping: Dry land rice, maize, and cassava
- Multi-intercropping: Maize, sunflower, cotton, and groundnuts
- Mixed cropping with trees: Mango tree and vegetables

⑤ Irrigation Method:

- Furrow irrigation
- Sprinkler irrigation
- Dripping irrigation

⑥ Soil:

Sandy loam - loam

⑦ Irrigation Water Requirement:

a. Crop water requirement:

The crop water requirement is the amount of water contained in the soil which will be consumed by a particular crop in order for it be healthy and of high quality, and to have maximum yield. Class "A" Pan Method and Blaney-Criddle Method are used to estimate the crop water requirement in the area.

i) The Class "A" Pan Method is based on the Guidelines for Predicting Crop Water Requirements (FAO).

Eto = Kp · Epan

where, Eto: reference crop evapo-transpiration (mm/day)

Epan: evaporation from a Class "A" Pan (mm/day)

Kp: pa coefficient

Table 5-1 lists the weather data at the Luangwa Bridge. The greatest amount of evaporation occurs in December (8.8 mm /day) which is in the December to July cropping season. Therefore, the crop water requirement should be calculated by using the weather data for December.

The relative humidity in December is 76%; this classified as high in Table 5-1.

Assuming that the closest greenery is 100 meters from the weather observation station at the Luangwa Bridge, the pan coefficient of the area can be found as Kp = 0.65 from Table 5-2 based on the wind speed of 207 km/day (2.4 m/sec x 24 x 60 x 60). Therefore, Eto = 0.65 x 8.8 = 5.7 mm/day. The relationship between the Reference Crop Evaporation and the Eto are as follows:

Et crop = Kc · Eto where, Kc: crop coefficient Planned crops in the model farm are corn, cotton, and vegetables. Thus, Kc 1. From Table 5-2, ET cropo = 6.3 mm/day.

ii) Blaney-Criddle Method:

This method of calculating the crop water requirement is based on temperature, possible maximum insolation, and the crop coefficient.

Eto = C · P · (0.46 T + 8) mm/day

where, Eto: Reference Crop Evaporation

T: Percentage of daily insolation to the yearly insolation

C: Coefficient derived from insolation and wind speed in the area.

From Tables 5-1 and 5-3,

T = 28.2°C, latitude 15°36'S, altitude 329 m, P = 0.29. The lowest relative humidity RH min is not recorded in the area. So, RH mm is assumed as being high.

Table 5-1 Weather Data at Luangwa Bridge

Item \ Month	11	12	1	2	3	4	
	5	6	7	8	9	10	
Daily Average Temp. °C	30.4	28.2	28.2	28.8	28.5	27.4	(a)
	24.3	22.5	20.9	23.2	27.1	29.4	
Rainfall mm	70	175	220	195 90	15		(b)
	5	0	0	0	0	10	
Class A Plan Evaporation mm/day	10.8	8.8	6.2	5.7	6.6	6.6	(c)
	6.0	5.0	5.6	6.7	8.4	11.8	
Wind speed m/seo	2.9	2.4	2.1	1.9	3.2	3.7	(a)
	3.7	4.0	4.0	4.4	4.6	3.8	
Relative Humidity %	61	76	82	85	75		(d)
		53	54		41		
Insolation per day hr	6.9	5.5	5.1	5.2	6.9	8.5	"
	9	8.9	8.7	9.6	9.7	8.7	
Max. possible insolation per day hr	12.8	13.0	12.9	12.6	12.25	11.8	(e)
	11.4	11.2	11.3	11.6	12.0	12.5	

Source:
a) Climatological Summaries (Luangwa)
b) Patent, Study by Brain (Luangwa Brige)
c) Pan Fyap, in Zambia (Luangwa Brige)
d) Climate Summaries (Lusaka)
e) Guidelines by FAO

Table 5-2 Pan Coefficient (Kp) for Class A Pan for Different Groundcover and Levels of Mean Relative Humidity and 24 Hour Wind

Class A pan	Case A: Pan placed in short green cropped area				Case B[1]/ Pan placed in dry fallow area			
RH mean %		low 40	medium 40-70	high 70		low 40	medium 4-70	high 70
Wind km/day	Windward side distance of green crop m				Windward side distance of dry fallow m			
Light 175	1	.55	.65	.75	1	.7	.8	.85
	10	.65	.75	.85	10	.6	.7	.8
	100	.7	.8	.85	100	.55	.65	.75
	1,000	.75	.85	.85	1,000	.5	.6	.7
Moderate 175-425	1	.5	.6	.65	1	.65	.75	.8
	10	.6	.7	.75	10	.55	.65	.7
	100	.65	.75	.8	100	.5	.6	.65
	1,000	.7	.8	.8	1,000	.45	.55	.6
Strong 425-700	1	.45	.5	.6	1	.6	.65	.7
	10	.55	.6	.65	10	.5	.55	.65
	100	.6	.65	.7	100	.45	.5	.6
	1,000	.65	.7	.75	1,000	.4	.45	.55
Very strong 700	1	.4	.45	.5	1	.5	.6	.65
	10	.45	.55	.6	10	.45	.5	.55
	100	.5	.6	.65	100	.4	.45	.5
	1,000	.55	.6	.65	1,000	.35	.4	.45

From Table 5-1,

n/N = 5.5/13.0 = 0.42; this is low.

where, n: daily insolation (hr)

N: maximum possible daily insolation (hr).

U daytime (wind speed) = 2.4 x 1.33 = 3.2 m/sec; this is moderate.

From Fig. 5-2,

Eto = 4.5 mm/day

From Fig. 5-1,

ET crop = 6.0 mm/day

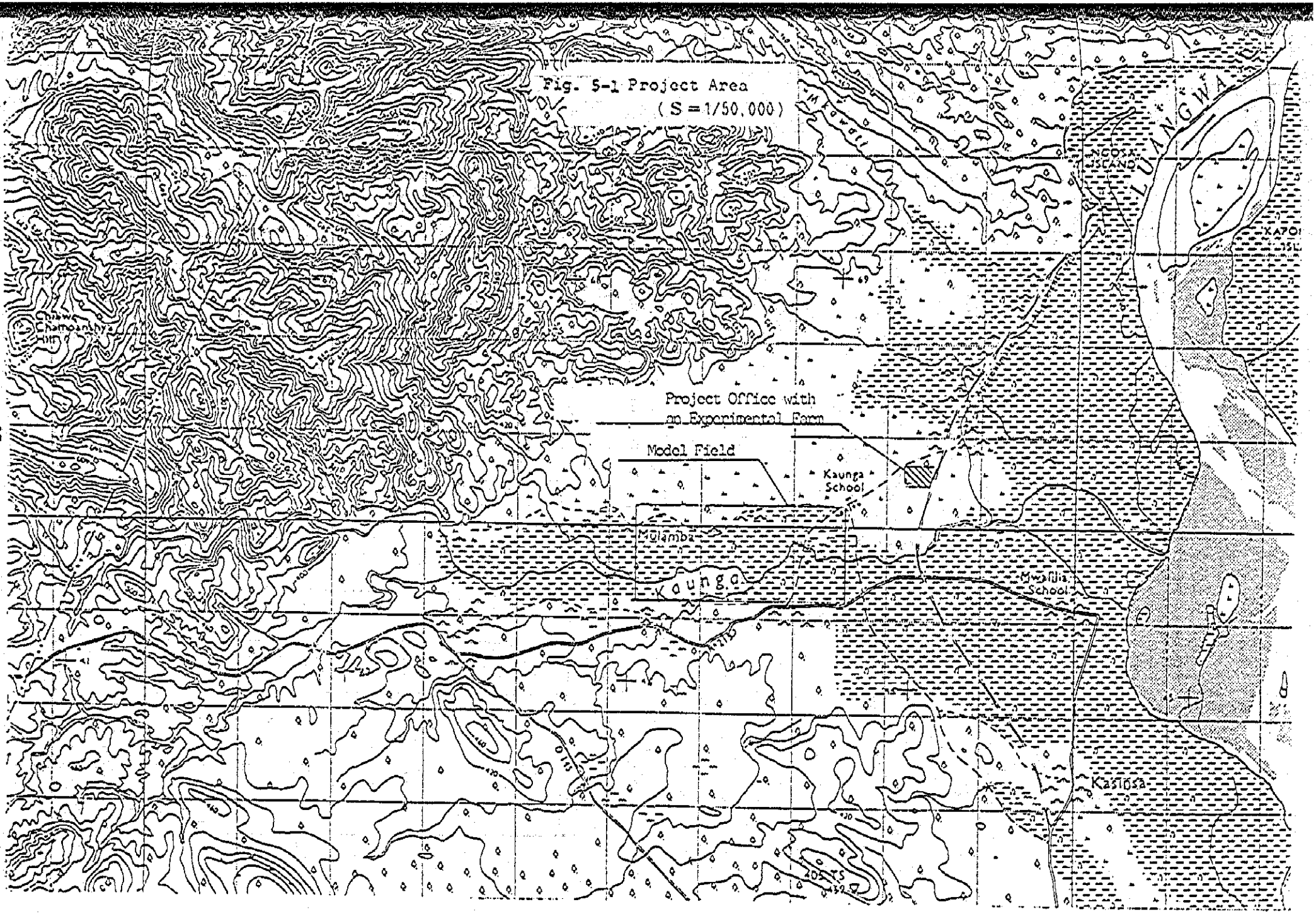


Fig. 5-1 Project Area
(S=1/50,000)

Fig. 5-2 ET Crop as Compared to ETo

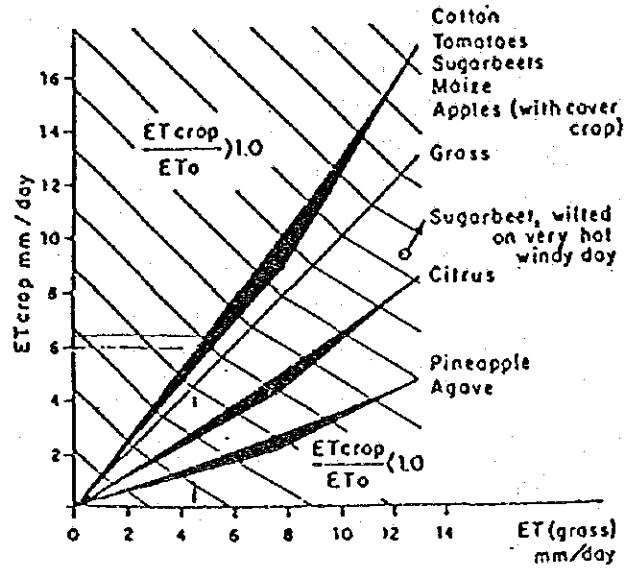


Table 5-3 Mean Daily Percentage (p) of Annual Daytime Hours for Different Latitudes

Latitude North / South 1/	Jan July	Feb Aug	Mar Sept	Apr Oct	May Nov	June Dec	July Jan	Aug Feb	Sept Mar	Oct Apr	Nov May	Dec June
60°	.15	.20	.26	.32	.38	.41	.40	.34	.28	.22	.17	.13
58	.16	.21	.26	.32	.37	.40	.39	.34	.28	.23	.18	.15
56	.17	.21	.26	.32	.36	.39	.38	.33	.28	.23	.18	.16
54	.18	.22	.26	.31	.36	.38	.37	.33	.28	.23	.19	.17
52	.19	.22	.27	.31	.35	.37	.36	.33	.28	.24	.20	.17
50	.19	.23	.27	.31	.34	.36	.35	.32	.28	.24	.20	.18
48	.20	.23	.27	.31	.34	.36	.35	.32	.28	.24	.21	.19
46	.20	.23	.27	.30	.34	.35	.34	.32	.28	.24	.21	.20
44	.21	.24	.27	.30	.33	.34	.33	.31	.28	.25	.22	.21
42	.21	.24	.27	.30	.33	.34	.33	.31	.28	.25	.22	.21
40	.22	.24	.27	.30	.32	.34	.33	.31	.28	.25	.22	.21
35	.23	.25	.27	.29	.31	.32	.32	.30	.28	.25	.23	.22
30	.24	.25	.27	.29	.31	.32	.31	.30	.28	.26	.24	.23
25	.24	.26	.27	.29	.30	.31	.31	.29	.28	.26	.25	.24
20	.25	.26	.27	.28	.29	.30	.30	.29	.28	.26	.25	.25
15	.26	.26	.27	.28	.29	.29	.29	.28	.28	.27	.26	.25
10	.26	.27	.27	.28	.28	.29	.29	.28	.28	.27	.26	.26
5	.27	.27	.27	.28	.28	.28	.28	.28	.28	.27	.27	.27
0	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27

1/ Southern latitudes: apply 6 month difference as shown.

iii) Crop Water Requirement in the Project Area:

The calculated crop water requirements are 6.3 mm/day with Class "A" Pan Method and 6.0 mm/day with Blaney - Criddle Method respectively. Because these values were calculated by using the weather of Luangwa (Luangwa Bridge) and Lusaka weather stations, they are not accurate and are not to be used for the Project area. Thus, including a safety factor, the following crop water requirement will be used in the Project area:

ET crop = 6.5 mm/day.

7 Irrigation Efficienty (Consumptive Use):

The consumptive use can be derived from the irrigation water application rate which includes water conveyance loss rate and irrigation efficiency. In the Project area, surface irrigation methods (furrow irrigation) will be used. Therefore, 60 percent of the irrigation efficiency will be used in the Project area.

Table 5-4 Irrigation Efficiency

Irrigation Method	Irrigation water application rate	Conveyance loss rate	Irrigation efficiency
Sprinkler irrigation	80-90%	5-10%	70-85%
Surface irrigation	70%	5-10%	60-65%

Source: Dry field irrigation plan, Design Criteria of Land Improvement Project Planning, Japan.

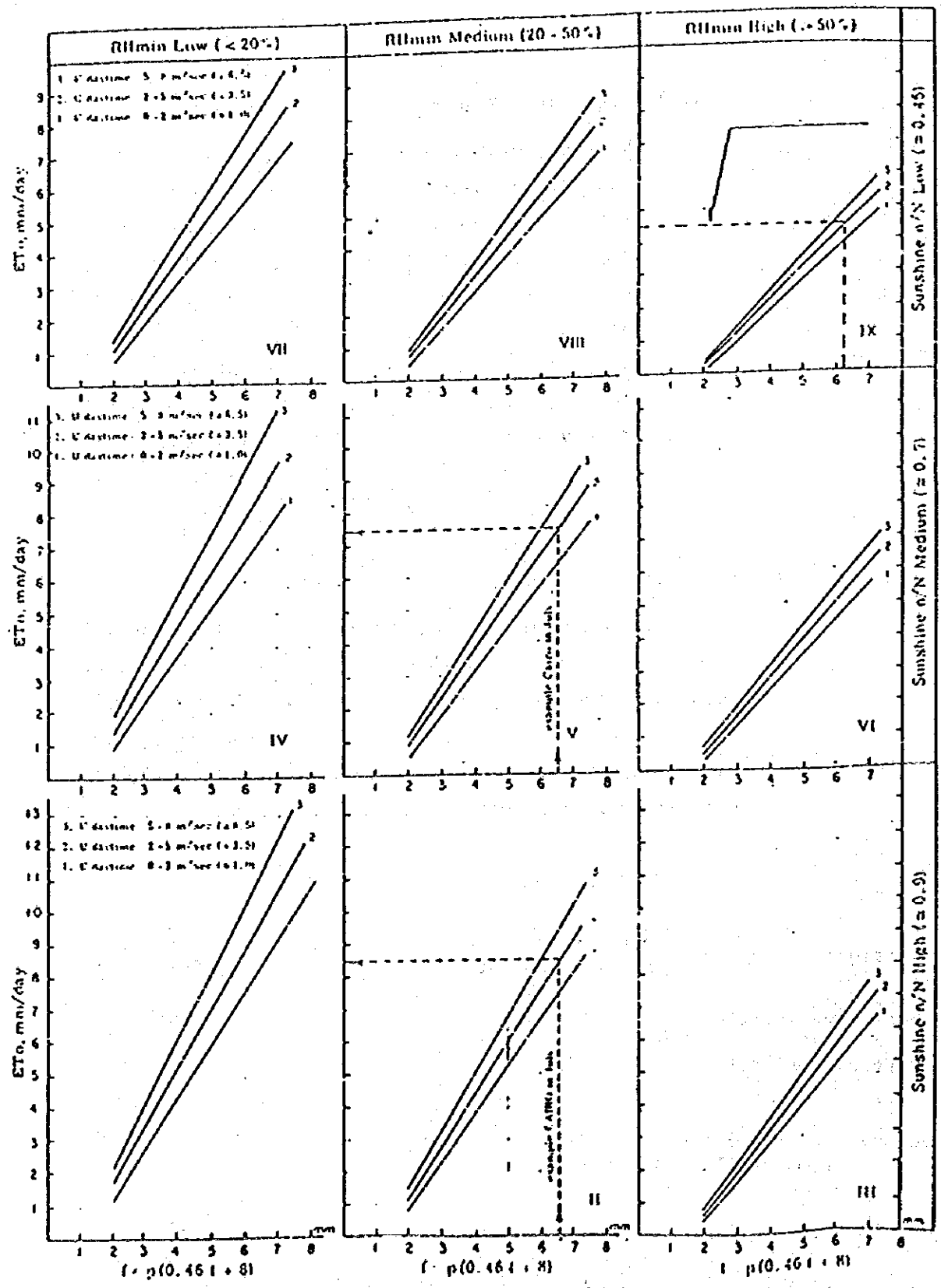


Fig. 5-3 Prediction of ETo from Blaney - Criddle f factor for different conditions of minimum relative humidity, sunshine, duration and day time wind

5-2-2 Criteria for Equipment Selection

(1) Policy of Equipment Selection:

Equipment for the Rural Development Programme shall be provided to meet the needs for implementing the Project. Generally, all equipment shall be procured from Japan. Only these that does not meet the Zambian standards shall be replaced by foreign made. The types of foreign made equipment shall be considered for selection based on the availability of operating supplies, ease of operation and maintenance, and the availability of spare/repair parts. The equipment needed for planning, operations, management, and publicity, shall be selected and installed in such a manner that the personnel using them shall be able to perform their work efficiently and accurately.

(2) Outline of Equipment:

1 Based on the discussions between the study team and the Department of Agriculture, two groups of equipment were selected; one for extension activities and the other for supporting infrastructure.

2 A sufficient quantity of agricultural machinery units shall be selected to meet the immediate needs of the Project. However, the quantities will be subject to change depending upon any modifications that may be made to Programme activity.

5-3 Basic Design of Facilities

5-3-1 Arrangement Plan of Facilities

1. Model Farm:

The model farm is planned to be located in the Kaunga River area; it will be used as a facility whereon irrigation may be practiced. Irrigation water intake and water conveyance will be by gravity flow. The model farm areas will be located along the water conveyance route. The irrigation channel routes shall be chosen to follow the high ground areas of the model farm, allowing beter water flow to the farming areas.

2. The Project Office and the Experimental Farm:

(1) The Project facilities can be classified into three groups: 1 the management and research group; 2 the operations group; 3 living quarters (lodging) group. Judging from the work flow of the Project programme, the management and research group should be located near the entrance of the Project complex. The operations group should be close to the experimental farm side, i.e., the north side of the area, allowing direct access to the farm. Thus, the management office building should be located close to the main gate of the complex. The Training Center building which must be under close observation is to be situated next to the management office building. The garage and agricultural machinery storage buildings will be situated next to the Training Center in such a manner as to prevent vehicular traffic from interfering with the movement of agricultural equipment. Buildings for lodging shall be located at a distance behind the management office building, Training Center building, and the garage to ensure quiet surroundings. The power generating house will be located in an area far removed from other buildings to prevent noise intrusion. The fueling station will be close to the management

building but will also be convenient for use by vehicles and agricultural equipment.

- Weather data collecting facility:

  The weather data collecting facility is to be located in an area that is free from vibrations caused by vehicles and agricultural equipment.

- Water supply facility:

  A well will be located at the highest point in the Project area. A septic tank and an infiltration tank will be located at the Kaunga riverside on the Project complex.

Facility arrangements are shown on the following layout map:

Fig. 5-4 Arrangement of Office Facilities