

- The aforementioned purchase order form will be shown when the items are purchased, in order to be exempted from taxes.

(2) Construction Permits

Construction permits must be obtained from the Building Department for all public construction works.

(3) Banking Arrangement

The government of Zambia must establish an account in its name with an authorized bank in Japan with foreign exchange facilities. Grant aid cooperation will be implemented when the Japanese government deposits funds in yen to this account to repay the financial obligations paid by the Zambian government on behalf of this project, as delineated in the contract approved by the Japanese government.

(4) Issuance of Authorization to Pay

The aforementioned funds will be deposited by the government of Japan when the bank submits to the Japanese government an Authorization to Pay which has been issued by the appropriate designated government agency.

3.2 Costs to be shared by the Zambian side

The estimated costs for the Zambian side is about US\$5,000 or 6.19 million Kwacha, which is the cost for bank arrangement, etc.

(Mean exchange rate from March - September 1996, 1US\$ = 1,238.16 Kwacha)

3.3 Operation and Maintenance Plan

3.3.1 Operation and Maintenance Plan of Research and Production Activities

(1) Operational and Maintenance Plan

The following items of the operation and maintenance costs are examined.

1. Activity expenditure

- (1) Seed production costs
- (2) Research activity expenses

2. Earnings from sales operations

- (1) Earnings from sale of seeds
- (2) Earnings from sale of market-size fish

3. Facility maintenance and management costs

- (1) Civil works facilities
- (2) Construction facilities
- (3) Equipment

(1) Seed production costs

Based on the present seed production capacity of the Mwekera Aquaculture Station, (1) rearing costs (costs of broodstocks, spawning, feed, fertilizer, etc.) and (2) personnel expenses are estimated for producing 500,000 common carp and 100,000 tilapias. For details, see "Appendix 5.2 Cultivation Plan, Fishery 4. Seed Production Costs".

Table 20 Common carp and Tilapia Seed Production Cost

Fish	Production Target	Production Cost (K)	Unit Price (K/fish)
Common carp	500,000	3,796,925	7.6
Tilapias	100,000	737,385	7.4
Total	600,000	4,556,310	7.6

The unit price and source of the main feed used in seed production are as follows. All items except vitamin mixture can be procured in Kitwe City. In future, it is desired that the use of beer waste be promoted in the seed production system. Beer waste can be a substitute for vitamin mixture in view of its nutritive composition, and can be procured locally at a low price.

Table 21 Purchase Prices and Sources of Main Feed

Items	Unit Price (K/Kg)	Source	Notes
Maize bran	100	Flour mills	Includes transport cost
Wheat bran	50	Flour mills	Includes transport cost
Rice bran	50	Flour mills	Includes transport cost
Soya bean meal	400	Oil refinery	Includes transport cost
Beer waste	7	Beer brewery	Includes transport cost
Bone meal	450	Meat factory	Includes transport cost
Vitamin mixture	10,000	South Africa	Includes transport cost

(2) Operating costs for research activities

The operating expenses for the research activities are as follows, and for details, refer to "Appendix 5.2 Cultivation Plan, Fishery 5. Research Activity Expenses".

Table 22 Operation Cost For Research Activities

Experiment	Cost (K)	Remarks
1. Effects of fertilization and fertilizers		
2. Selection of tilapia spp. for culture		
3. Polyculture systems		
4. Evaluation of feed materials and ingredients		
5. Mass production of common carp seeds	-----	Included in Seed production cost
6. Artificial feed development		
TOTAL	K3,103,540	

NOTE: Because seeds used in experiments are produced at the station, they are not included in the estimated costs. Estimated cost for experiments 4 and 6 includes two cycles.

Based on the above data, the annual operating, maintenance and management expenditure for research is calculated at 3,103,540 Kwacha, and summarized as follows.

(1) Operating cost for production activities	K 505,080
(2) Operating cost for research activities	K 3,103,540
Total Operating cost	K 7,659,850

(3) Earnings from sales operations

Mwekera Aquaculture Station's revenues are generated from the sale of fingerling and market-size specimens of common carp and tilapias. The quantity of fingerling marketed to a total of 43 fish farmers in 1995 was 170,000 common carp and 90,000 tilapias, which generated a gross sales of 2,513,740 Kwacha. Although data on earnings generated from the sale of market-size fish for the same year was not available, 300kg were sold in 1993 and 219kg in 1994, generating estimated earnings of 500,000 Kwacha to 600,000 Kwacha. However, this sales volume is modest, in view of the scale of the facilities, and the marketed price of the fingerling is lower than the standard price.

In the past, the earnings generated by the station have been collected by the National Treasury, and this appears to be one of the factors which has contributed to the lowered motivation of staff personnel.

Table 23 Record of Sales of Market-size Fish at the Mwekera Aquaculture Station

Year	Tilapias		Common carp		Total	
	Number of Transactions	Sales Q'ty (kg)	Number of Transactions	Sales Q'ty (kg)	Number of Transactions	Sales Q'ty (kg)
1993	39	345	13	76	52	421
1994	62	453	1	10	63	463
1995	Unknown	Unknown	7	36		

Appropriation in Aid

In order to make up for the small operation budget, the Mwekera Aquaculture Station is examining the introduction of the Appropriation in Aid system. Presently, with the execution of the Appropriation in Aid system which will no longer require the station to turn over its earnings to the National Treasury, the possibility of applying these earnings to regular operating costs is being studied. Recently the Ministry of Finance has sent a circular to related government agencies regarding this system, and it is preparing for the introduction of the system. The procedure and the method are being scheduled to be completed this October and the matter has already been adopted by the Cabinet.

If a portion of the earnings generated by the station is allowed to be used for operating costs, it is anticipated that production and marketing plans will improve. The sales profit from sales of fingerling and market-size and adult fish at the Station was around 3 million Kwacha in 1995. This corresponds to 8% of the Station's budget. In view of the insufficient government budgets of the past, efforts to improve the station's marketing activities to secure research funds are essential.

However, the sales operation will not be started until the implementation of the Appropriation in Aid system. Hence, the project will not take into account the estimated profit from this operation. It is mentioned here only for reference in case the system is introduced in the future. For details, see "Appendix 5.2 Cultivation Plan, Fishery 6. Earnings From Sales Operation".

The annual earnings from sales operation will be as follows.

(1) Sales of fingerling	K 14,000,000
(2) Sales of market-size fish	K 3,103,540
(3) Utilization of idle ponds	K 3,292,512
Total Annual Earnings	K 19,252,512

3.3.2 Maintenance and Management Plan of the Facilities

(1) Maintenance and management cost related to civil works

The operations and maintenance personnel currently in charge of civil works are the water control supervisor (1 person) and the weeders (9 people). The only materials used for maintenance purposes is a small amount of cement. Presently, the weeders are temporary workers hired by the experts from MPTC. If weeders are employed by the Mwekera Aquaculture Station, maintenance costs are estimated at 88,000 Kwacha/person/month.

As to the annual maintenance/management cost of the planned facility, the personnel cost for five temporary weeders is estimated at 540,000 Kwacha and the repair cost of the access road within the station compound is estimated at about 60,000 Kwacha for materials.

(2) Building

The repair costs of the building at Mwekera Aquaculture Station for the past five years is shown below.

Table 24 Annual Repair Costs of the Mwekera Aquaculture Station

FY	1991	1992	1993	1994	1995
Cost	K90,000	K110,000	K800,000	K393,000	K187,000

The expenditure for electricity at the Station in 1995 was approximately 200,000 Kwacha per month, including Government Excise Duty and Value Added Tax. Although a portion of its water supply is provided by the Department of Forestry, the water is mainly supplied by a well. Since the Department of Fisheries holds the water rights to the Mwekera River, the station is exempted from paying water rates.

The station's operation and maintenance system following project implementation will adequately fulfill the station's needs, in view of the scale and grade of the facilities, and the accessibility of materials and equipment. Operation and maintenance work will be shared by the staff members; and a minimum of three members, the plumber, carpenter, and electrician, is required. Their main work duties will involve repair work of buildings, electricity and plumbing, and purchase of spare parts of pump and generator.

Operation and maintenance expenditures will include repair costs of building facilities, electricity rates, purchase of spare parts of building materials, etc. The maintenance costs for the first three years will only be for electricity rates and fuel. A miscellaneous expenditure of 200,000 Kwacha a year for paint costs has been included. However, expenditures stemming from infrastructure improvements, furniture, etc. have not been included.

The total operation and maintenance expenditure including the estimated cost of electricity and other expenditures are shown below.

Research/Administration Bldg.	$3.0\text{KW/hour} \times 5\text{hour/day} \times 20\text{ days/month} =$	300 KW/month
Accommodation House	$1.5\text{KW/hour} \times 5\text{hour/day} \times 30\text{ days/month} =$	112 KW/month
Well/pump	$1.5\text{KW/hour/day} \times 16\text{hour/day} \times 12\text{ days/month} =$	228 KW/month
Total electricity consumption		700 KW/month
Annual electricity expenditure =	$700\text{ KW} \times \text{K}24 \times 12\text{ months} =$	K201,600 -----(1)
Basic electricity charge	$\text{K}3,100 \times 12\text{ months} =$	K37,200 -----(2)
<hr/>		
Sub-total (1) + (2)		K238,800
Miscellaneous expense		K200,000
<hr/>		
Total O & M Expenditure		K438,800

(3) Equipment

The annual operation and maintenance costs of the equipment which will be supplied by this project, by MPTC, and of the existing equipment are calculated below. The cost of consumables and repair parts is estimated at 1% of the equipment cost.

1) Equipment provided in this project

Depreciation costs/cost of repair parts of the equipment to be provided in this Project is estimated at K120,000 ----- (1)

2) Electricity Rate

$0.5\text{KW (total load)} \times 0.6\text{ (demand ratio)} \times 6\text{ hour (average hours used)} \times 20\text{ days (number of days per month)} \times \text{K}21/\text{KWh (electricity rate)} \times 12\text{ months} + 40,000\text{ (basic rate)} = \text{K}49,000$ ----- (2)

The total of (1) and (2) is K169,000

(4) Estimated annual income and expenditure of the Mwekera Aquaculture Station

Due to the introduction of the cash income and expenditure system by the Zambian government since 1995, the Mwekera Aquaculture Station's annual budget has decreased from 64.4 million Kwacha in 1994 to 37 million Kwacha in 1995.

It is estimated that the station earned some 3 million Kwacha for selling market-size fishes in 1995. The Appropriation in Aid system, which allows the station to use the income from the sales of fish, is however still under consideration for implementation and has not been adopted at present.

Income (FY1995 record)			(Unit: Kwacha)
Expense Item	Operating expenses	Personnel Expenses	Total
Budget	37,012,000	19,281,000	56,293,000

An amount of 125.4 thousand US dollars (134.4 million Kwacha) was approved for the station as the budget for 1996. However, since the budget includes an item on overseas training, which was not conducted before, the actual budget for operating expenses would be some 57.79 million Kwacha excluding such expenditure. The estimated budget for 1996 is as shown below.

Estimated budget for 1996			(Unit: Kwacha)
Expense Item	Operating expenses	Personnel Expenses	Total
Budget	57,790,000	32,000,000	89,790,000

This estimated 1996 budget is 1.6 times the previous year's budget, increasing by around 20.78 million Kwacha, which means a low-level budget increase compared with past budgets. However, in view of the previous records showing that the Station has only been securing around 70-80% of the approved budget, this amount is believed to be close to the actual figure.

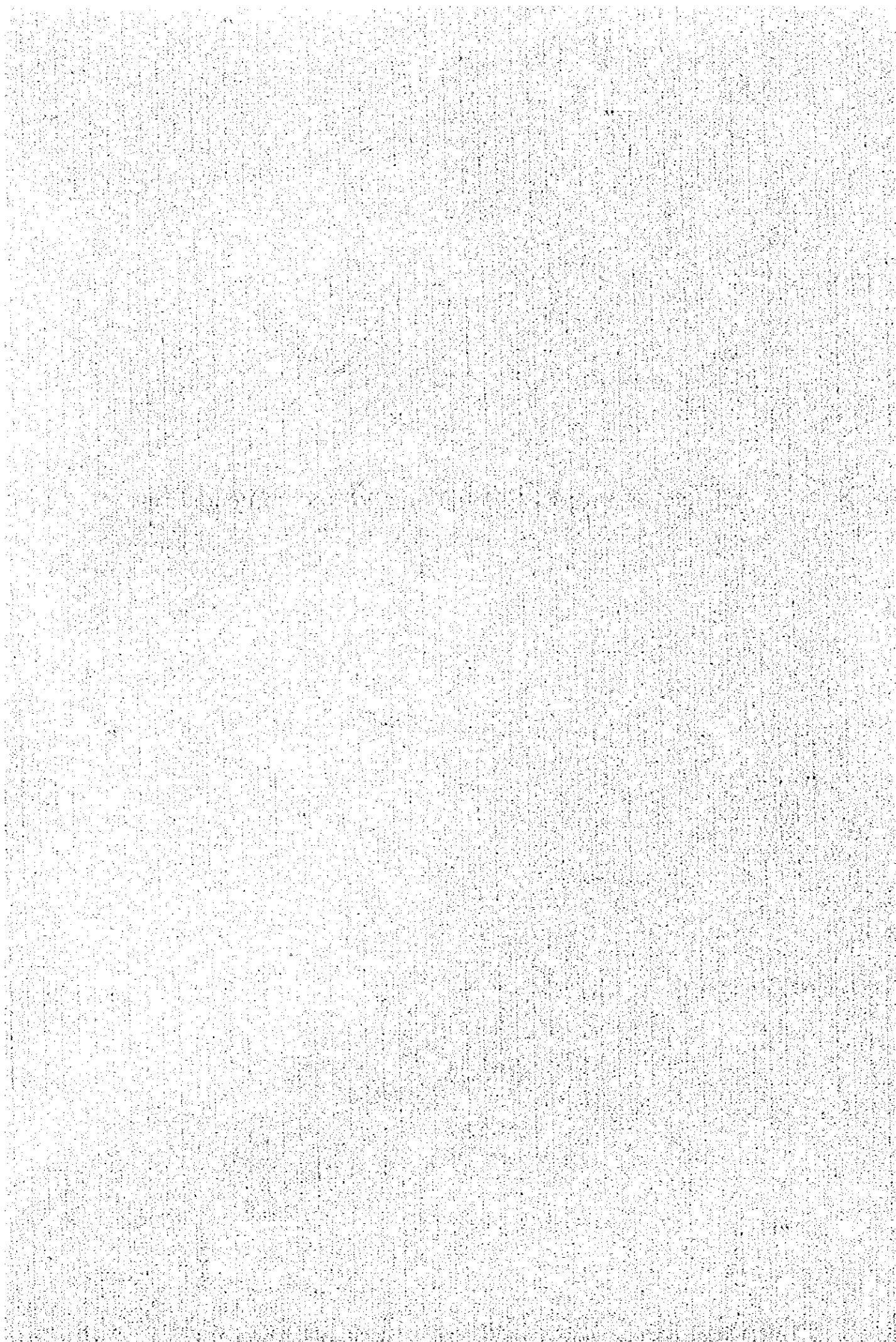
As the expenditures for production and research activities after the handing over of the facilities are assumed to be covered by the present budget, no additional budget is required for these activities.

Forecast Expenditures After Project Implementation			(Unit: Kwacha)
Expense Item	Operating expenses	Personnel Expenses	Notes
Profit from sale of seeds	(4,556,310)		Not included
Profit from sale of market-size fish	(3,103,540)		Not included
Research activities		700,000	Additional researcher K700,000 /year x 1
Maintenance and operation cost (Civil Works)	60,000	540,000	Part-time workers
(Buildings)	438,800		
(Equipment)	169,000		For this project
Total	667,780	1,244,000	

Forecast Expenditures
After Project Implementation: $667,780 + 1,244,000 = 1,907,800$

The estimates show that the operating expenses must be increased by around 2 million Kwacha after project implementation. The ratio of the amount of increase of 2 million Kwacha is around 3% of the total budget, an increase within the possible range.

Chapter 4 Project Evaluation and Recommendation



CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

4.1 Project Effect

The implementation of this project will strengthen the functions of the Mwekera Aquaculture Station which is the key establishment of aquaculture research in Zambia, and it will enable the efficient and appropriate operation of the facilities. While Zambia has a short history in the area of aquaculture in still water ponds, it is expected to result directly in stable supply of seeds through development of the production technique in general. This process is also expected to produce a secondary effect, i.e., developing the technical level of researchers at the station.

Moreover, the qualitative development of a public research and development institution such as this station can be expected to stabilize the supply of seeds to small private fish farmers in the Copper Belt Province which is suitable for fish cultivation. The extension of the aquaculture techniques is also expected to improve the current low productivity and form the foundation of freshwater culture.

The implementation of this project is expected to produce the following benefits.

(1) Improvement of Aquaculture Technology

The improvement of the facilities will enable the use of 30 experimental ponds, which will enable the selection of species and strains of tilapias suited for cultivation by private fish farmers, the development of the technology for the polyculture of common carp and tilapias, and the improvement of the non-feeding culture techniques through establishment of the plankton propagation techniques. These will promote practical application experiments such as utilization of low-cost domestic raw materials as feed.

(2) Strengthening of the Technical Capacity of the Researchers

It is only in recent years that aquaculture has started to take root as a form of agriculture in Zambia. For further development, it is indispensable to develop the technology of small-scale private fish farmers. The technology developed at the Mwekera Aquaculture Station will be transferred first to the 20 national aquaculture stations in the country through the implementation of joint experiments with these stations and technical training provided by the Fisheries Department. It will then be extended to private fish farmers in each region. The strengthening of the functions of the Mwekera Aquaculture Station will result in the upgrading of the technical level of the 31 research staff members of the station, and subsequently that of the 885 personnel of the Fisheries Department throughout the country.

(3) **Strengthening of the Functions of the Facilities to Cope with Medium and Long Term Plans**

ASIP, which is a priority program related to this sector, is designed to improve and develop the Mwekera Aquaculture Station, and thereby strengthen the functions of the Fisheries Department through R&D for seed production, increase supply of seeds to private fish farmers, and enrichment of facilities and equipment. The implementation of this project will become an assistance in accomplishing this program.

(4) **Increase of Income and Improvement of Nutritional Status of Small Farm Households Through Stabilizing Seed Supply**

The Copper Belt Province is endowed with water resources, and small private fish farmers are highly interested in aquaculture. These fish farmers in and around Kitwe City are said to number around 1,500 households, and they are practicing rudimentary culture through trial and error due to shortage of seed and lack of technical information. If these farmers can secure stable seed supply and acquire appropriate culture techniques through the implementation of this project, it could contribute to the supply of protein and increase the income of the low-income fish farmers in this region.

4.2 Recommendation

The implementation of this project will consolidate the function of the facilities of the Mwekera Aquaculture Station for the development of the fundamental techniques of aquaculture. In order to utilize effectively these facilities in the future, it is important to train the personnel who can cope with the research issues, constantly maintain and manage the facilities' functions, and secure the necessary financial resources. For the time being, the activities of the Station will have to cover the demand of the small fish farmers in the Copper Belt Province. However, if the Station is to function as a national core of the promotion of aquaculture in the future, it will be necessary for it not just to devote itself to local activities but to strengthen its functions, formulate its operation plans, and strengthen the cooperation with other stations within the framework of the aquaculture promotion plan.

As specific measures for achieving the above objectives, we propose that the Station make efforts to implement the following measures.

(1) Stable supply of seed coping with demand from the private sector

The production of fingerling should be stable to cope with the demand. Those engaged in aquaculture should be increased by strengthening the system of seed supply by actively distributing the seed to small fish farmers who have no means of transport.

(2) Securing of budget for the operation and management of the facilities

The ASIP budget for operating the Mwekera Aquaculture Station should be secured for certain. Moreover, in order to expand the sales operation, efforts should be made to secure the Station's own operating funds by quickly introducing the Appropriation in Aid system.

(3) Daily and regular maintenance of the facilities

After the facilities of the Mwekera Aquaculture Station have been developed through this project, it is indispensable to carry out daily maintenance and management works such as weeding of drainage canals and fishponds, draining of ponds, removing of sediments, and repairs of the walls of earthen ponds to maintain stable and smooth functions of the facilities. These maintenance works should be regularly carried out.

(4) Enrichment of the research staff and development of technical capacity

In order to promote basic research, training designed to develop the technical capacity of researchers should be promoted. Personnel should also be increased.

(5) Continuation of Technical Cooperation

As the developmental direction of technical cooperation in the future is based on the results of the MPTC activities which have mainly consisted of direct technology transfer, a request should be made for experts who can provide advice on general matters related to the efficient operation of the station such as the operation and management of the station and the formulation of research programs.

Appendices

Appendices

Appendix 1. Member List of the Survey Team

Basic Design Study

Mr. Kastuhiro SASAKI	Team Leader	Director of General Affairs Division Kanagawa International Fisheries Training Centre Japan International Cooperation
Mr. Shin'ichi NAKAMURA	Technical Advisor	Technical Official Office of the Overseas Fisheries Cooperation Oceanic Fishery Department, Fisheries Agency
Mr. Shunji SUGIYAMA	Coordinator	Associate Specialist in Fisheries Development Second Basic Design Study Div., Grant Aid Study & Design Dept., JICA
Mr. Fumio TASHIRO	Chief Consultant cum Aquaculture Planner	System Science Consultants Inc.
Mr. Tadaharu AKESAKA	Facility Planner	System Science Consultants Inc.
Mr. Akira IWAMOTO	Fisheries Engineer	System Science Consultants Inc.
Mr. Hiroshi KISHIMOTO	Equipment Planner	System Science Consultants Inc.
Mr. Yoshihiko NISHIKAWA	Natural & Environmental Condition Surveyor	System Science Consultants Inc.
Mr. Osamu SUZUKI	Construction Planner cum Quantity Surveyor	System Science Consultants Inc.

Draft Basic Design Study

Mr. Eiji EGASHIRA	Team Leader	Deputy Director of 3rd. Expert Dispatch Div., Expert Dispatch Department, Japan International Cooperation Agency(JICA)
Mr. Shin'ichi NAKAMURA	Technical Advisor	Technical Official Office of the Overseas Fisheries Cooperation Oceanic Fishery Department, Fisheries Agency
Mr. Fumio TASHIRO	Chief Consultant cum Aquaculture Planner	System Science Consultants Inc.
Mr. Akira IWAMOTO	Fisheries Engineer	System Science Consultants Inc.

Appendix 2. Survey Schedule

Basic Design Study

Officials	Chief Consultant cum Aquaculture Planner	Equipment Engineer	Facility Planner	Fisheries Planner	Natural & environmental Condition Surveyor	Construction Planner/Quantity Surveyor
Three Members	Fumio TASHIRO	Hiroshi KUSHIMOTO	Tadaharu AKESAKA	Akira IWAMOTO	Yoshihiko NISHIKAWA	Osuno SUZUKI
Leave Narita to London NH201						
Leave London to Lusaka BA045						
Arrive Lusaka 9:50						
Courtesy call at Embassy of Japan, JICA, Ministry of Agriculture, Food & Fisheries						
Lusaka - Kitwe (am) Meeting with MPCP Specialists in Kitwe (p.m.)					Arrange & Prepare	Construction Survey
Courtesy call and discussion at Mwekera Aquaculture Station					Arrange & Prepare	Construction Survey
Site Survey at Kitwe Market & Fish Farming Stations					Arrange & Prepare	Construction Survey
Discussion with Mwekera Aquaculture Station					Lusaka - Kitwe	Construction Survey
Kitwe - Lusaka (a.m.), Research on Fish Farming Station around Lusaka (p.m.)					Data Analysis	Quantity Survey
Analysis of data						Quantity Survey
Discussion with the MAFF on the basic plan					Order to start the survey	Quantity Survey
Courtesy call at NCDP, Discussion on "the Minutes of Discussion" at MAFF			Lusaka - Kitwe		Supervising on the survey	Quantity Survey
Sign on "the Minutes of Discussion" at MAFF, Report to Embassy of Japan, JICA			Site Survey at Mwekera Aquaculture Station		Supervising on the survey	Quantity Survey
Leave to Japan	Lusaka - Kitwe, Discussion with Mwekera Aquaculture Station					Leave for London
Via JNB	Ditto		Site Survey at Mwekera Aquaculture Station		Headwater Survey	Leave for Japan
Arrive Japan	Discussion with Mwekera Aquaculture Station					Arrive Tokyo
Kitwe-Lusaka						
Kitwe - Lusaka (a.m.), Research on Fish Farming Station around Lusaka (p.m.)						
Discussion with the MAFF			Construction Survey		Environment Survey	
Discussion with the MAFF/Report to Embassy of Japan, JICA						
Leave for JNB SA65			Construction Survey		Water & Climate Survey	
Leave for SIN SA282			Construction Survey		Discussion with the MAFF	
Leave for JPN NH902			Data Analysis		Data Analysis	
Arrive Tokyo			Data Analysis			
			Construction Survey		Lusaka - Kitwe	
			Construction Survey		Supervising the Site	
			Construction Survey		Supervising the Site	
			Leave for JNB SA65		Kitwe - Lusaka	
			Leave for SIN SA282		Discussion with DOF	
			Leave for JPN NH902		Data Analysis	
			Arrive Tokyo			
			Data Collection & Analysis			
			Data Collection & Analysis			
			Data Collection & Analysis			
			Data Collection & Analysis			
			Leave for JNB SA65			
			Leave for SIN SA282			
			Leave for JPN NH902			
			Arrive Tokyo			

Draft Basic Design Study

Date	Day	Itinerary
18-Jun	Tue	Leave Narita to London BA008
19-Jun	Wed	Leave London to Lusaka BA053
20-Jun	Thu	Arrive Lusaka(a.m.) / Discussion with DOF(p.m.)
21-Jun	Fri	Courtesy call at Embassy of Japan, JICA, Ministry of Agriculture, Food & Fisheries(MAFF)
22-Jun	Sat	Lusaka - Kitwe (am) Meeting with MPCP Experts, Site Survey (p.m.)
23-Jun	Sun	Site Survey at Mwekera Aquaculture Station
24-Jun	Mon	Discussion with Mwekera Aquaculture Station(a.m.), Kitwe - Lusaka (p.m.)
25-Jun	Tue	Discussion at NCDP, DOF
26-Jun	Wed	Study at NCDP, MAFF / Discussion on "the Minutes of Discussion" at DOF
27-Jun	Thu	Sign on "the Minutes of Discussion" at MAFF, Report to Embassy of Japan, JICA
28-Jun	Fri	Leave for Z9-104
29-Jun	Sat	Leave for SEN SQ405
30-Jun	Sun	Leave for JPN JL710
1-July	Mon	Arrive Tokyo

Appendix 3. List of Party Concerned in the Recipient Country

[Basic Design Study]

1. Ministry of Agriculture, Food and Fisheries (MAFF)

Mr. Namukolo Mukutu	Permanent Secretary
Mr. H. G. Mudenda	Director, Department of Fisheries (DOF)
Mr. C. T. Maguswi	A/Assistant Director, Aquaculture Division, DOF
Mr. J. C. T. Maluti	Chief Fisheries Development Officer, DOF
Mr. K. P. Banda	Senior Aquaculturist, DOF
Mr. E. H. M. Ncheema	Chief Accountant

2. Mwekera Aquaculture Station (DOF)

Mr. Cyprian T. Tembo	Officer in Charge
Mr. Debson Nyirongo	Extension Officer
Mr. Munalula M. Muyunda	Aquacultural Research Officer (Fish propagation)
Mr. Henry C. Kabunda	Provincial Aquaculturist

3. Masaiti Branch Station (DOF)

Ms. Margaret Nyankata	Fisheries Assistant
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4. Food and Agriculture Organization of the United Nations (FAO)

Mr. George Mburai	Resident Representative
Mr. Robert Houthuyzen	Aquaculturist (Aquaculture for Local Community Development Programme - ALCOM)
Mr. Chistine Blehle	Aquaculturist, ALCOM

5. Royal Norwegian Embassy (NORAD)

Mr. Arne Sandnes	First Secretary (Agriculture)
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6. Embassy of Japan

Tadashi Masui
Takayuki Miyashita
Tatsuro Koga
Hisatoshi Shimada

Ambassador
Counsellor
First Secretary
Second Secretary

7. JICA Zambia Office

Yoshitoku Ebata
Kozo Tsukada
Yoshinori Kitamura

Resident Representative
Vice Resident Representative
Assistant Resident Representative

8. MPTC Experts

Katsumasa Soma
Chiaki Kuma
Tuguhiko Yokokawa

Seed Production Techniques
Feed Production Techniques
Plankton Culture Techniques

9. JOCV

Sayoko Nakamae

Aquaculture

10. Private Fish Farmers

Mr. Creig Wright
Mr. L. G. Cornelius
Mr. Chandalala
Mr. L. J. Nkhoma
Mr. Fergus Flynn
Mr. Rob Munro

Riverane farm, Kitwe
General Manager, Macadamia farms Ltd., Kitwe
Farm manager, Macadamia farms, Kitwe
Manton farm, Luansha
General Manager, Kafue Fisheries, Kafue
Kafue Fisheries, Kafue

[Draft Basic Design Study]

1. Ministry of Agriculture, Food & Fisheries (MAFF)

Mr. A. K. Banda	Director, Policy & Planning Division
Dr. A. Mwanaumo	Assistant Director, Policy & Planning Division
Mr. G. Mbozi	Head, Budget Analysis Unit P. & P. Div.
Mr. E. H. Ncheema	Chief Accountant, Financial Management Unit
Mr. H. G. Mudenda	Director, Department of Fisheries, DOF
Mr. C. T. Maguswi	A/Assistant Director, Aquaculture Division, DOF
Mr. K. P. Banda	Senior Aquaculturist, DOF
Mr. M. A. Katundu	Chief Fish Research Officer, DOF
Mr. M. M. Munalula	Aquaculture Research Officer, DOF
Mr. M. V. Musonda	Aquaculture Research Officer, DOF
Mr. C. T. Tembo	Officer in Charge, DOF

2. National Commission for Development and Planning(NCDP)

Mr. M.Mwanza	Director (R.C.)
Mr. W. Imakando	Principal Economist

3. Embassy of Japan

Tadashi Masui	Ambassador
Takayuki Miyashita	Counsellor
Tatsuro Koga	First Secretary
Hisatoshi Shimada	Second Secretary

4. JICA Zambia Office

Yoshitoku Ebata	Resident Representative
Kozo Tsukada	Vice Resident Representative
Yoshinori Kitamura	Assistant Resident Representative

5. MPTC Experts

Katsumasa Soma	Seed Production Techniques
Chiaki Kuma	Feed Production Techniques
Tuguhiko Yokokawa	Plankton Culture Techniques

Appendix 4. Minutes of Discussions

MINUTES OF DISCUSSIONS

BASIC DESIGN STUDY

ON THE

PROJECT FOR UPGRADING OF MWEKERA AQUACULTURE STATION IN THE
REPUBLIC OF ZAMBIA

(Consultation on the Draft Basic Design)

The Japan International Cooperation Agency (JICA) dispatched a Basic Design Study Team on the Project for Upgrading of Mwekera Aquaculture Station (hereinafter referred to as "the Project") to the Republic of Zambia in March 1996. As a result of the series of discussions, field survey in Zambia, and technical examination of the results in Japan, JICA prepared the Draft Basic Design of the Project.

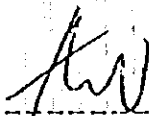
To inform the Zambian side with the components of the Draft Basic Design, JICA sent to Zambia a Study Team headed by Mr. Eiji EGASHIRA, Deputy Director of 3rd Expert Dispatch Division, Expert Dispatch Department, JICA. The Team is scheduled to stay in the country from June 20 to June 28, 1996.

As a result of discussions, both sides have confirmed the main items described on the attached sheets. The Team will proceed to further works and finalize the Basic Design Study Report.

Lusaka, June 27, 1996



Mr. EIJI EGASHIRA
Leader
Basic Design Study Team
JICA



Mr. A.K. BANDA
Director of Policy & Planning Division
Ministry of Agriculture, Food & Fisheries
Government of Zambia

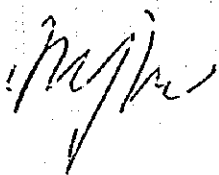
Witnessed by



Mr. MISHECK MWANZA
Director (RC)
National Commission for Development
and Planning (NCDP)
Office of the President

ATTACHMENT

1. **Components of the Draft Basic Design**
The Government of Zambia has accepted the components of the Draft Basic Design proposed by the Team.
2. **Responsible & Executing Agency**
 - 1) The Ministry of Agriculture, Food and Fisheries (MAFF) is responsible for administration and execution of the Project.
 - 2) The Research & Specialist Service Department of MAFF is responsible for execution, operation and maintenance of the Project in close coordination with the Field Service Department of MAFF.
3. **Proper Operation & Maintenance**
 - 1) MAFF is responsible for the allocation of appropriate budget, personnel and whatever measures are necessary to ensure the proper operation and maintenance of such facilities and equipment procured under the Project.
 - 2) The Government of Zambia shall take necessary arrangements to ensure that funds generated from sales of fingerlings and other income be solely directed toward the operation, maintenance and relevant activities of the Mwekera Aquaculture Station.
4. **Value Added Tax (VAT)**
The Government of Zambia shall make necessary arrangements to assure that, with respect to the supply of materials, equipment and services under the Project, VAT be exempted.
5. **Japan's Grant Aid System**
 - 1) The Government of Zambia has understood the system of Japan's Grant Aid explained by the Team; the main feature is described in ANNEX I.
 - 2) The Government of Zambia will take necessary measures, described in ANNEX II for smooth implementation of the Project if the Grant Aid by the Government of Japan is extended to the Project.
6. **Further Schedule**
JICA will complete the Basic Design Study Report in accordance with the confirmed items, and forward it in its final form to the Government of Zambia in September 1996.



ANNEX I: JAPAN'S GRANT AID SCHEME

1. Grant Aid Procedure

1) Japan's Grant Aid Program is executed through the following procedures.

Application Study	(Request made by a recipient country) (Basic Design Study conducted by JICA)
Appraisal & Approval	(Appraisal by the Government of Japan and Approval by Cabinet)
Determination of Implementation	(The Notes exchanged between the Governments of Japan and the recipient country)

2) Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study), using Japanese consulting firms.

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and the recipient country.

Finally, for the implementation of the project, JICA assists the recipient country in such matters as preparing tenders, contracts and so on.

2. Basic Design Study

1) Contents of the Study

The aim of the Basic Design Study (hereinafter referred to as "the Study"), conducted by JICA on a requested project (hereinafter referred to as "the Project"), is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows:

- a) confirmation of the background, objectives and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation;
- b) evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from the technical, social and economic points of view;
- c) confirmation of items agreed on by both parties concerning the basic concept of the Project;
- d) preparation of a basic design of the Project; and
- e) estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whatever measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even through they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

2) Selection of Consultants

For the smooth implementation of the Study, JICA uses a consulting firm selected through its own procedure (competitive proposal). The selected firm participate the Study and prepare a report based upon the terms of reference set by JICA.

At the beginning of implementation after the Exchange of Notes, for the services of the Detailed Design and Construction Supervision of the Project, JICA recommends the same consulting firm which participated in the Study to the recipient country, in order to maintain the technical consistency between the Basic Design and Detailed Design as well as to avoid any undue delay caused by the selection of a new consulting firm.

3. Japan's Grant Aid Scheme

1) What is Grant Aid?

The Grant Aid Program provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. Grant Aid is not supplied through the donation of materials as such.

2) Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

- 3) "The period of the Grant" means the one fiscal year which the Cabinet approves the project for. Within the fiscal year, all procedure such as exchanging of the Notes, concluding contracts with consulting firms and contractors and final payment to them must be completed.

However, in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual agreement between the two Governments.

- 4) Under the Grant, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely consulting, contracting and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

- 5) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability of Japanese taxpayers.

- 6) Undertakings required to the Government of the recipient country

- a) to secure a lot of land necessary for the construction of the Project and to clear the site;
- b) to provide facilities for distribution of electricity, water supply and drainage and other incidental facilities outside the site;
- c) to ensure prompt unloading and customs clearance at ports of disembarkation in the recipient country and internal transportation therein of the products purchased under the Grant Aid;
- d) to exempt Japanese nationals from customs duties, internal taxes and fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts;
- e) to accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contracts such as facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work;
- f) to ensure that the facilities constructed and products purchased under the Grant Aid be maintained and used properly and effectively for the Project; and
- g) to bear all the expenses, other than those covered by the Grant Aid, necessary for the Project.

- 7) "Proper Use"

The recipient country is required to maintain and use the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign the necessary staff for operation and maintenance of them as well as to bear all the expenses other than those covered by the Grant Aid.

8) "Re-export"

The products purchased under the Grant Aid shall not be re-exported from the recipient country.

9) Banking Arrangement (B/A)

- a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in an authorized foreign exchange bank in Japan (hereinafter referred to as "the Bank". The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the verified contracts.
- b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to Pay (A/P) issued by the Government of recipient country or its designated authority.

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ANNEX II: UNDERTAKINGS BY THE GOVERNMENT OF ZAMBIA

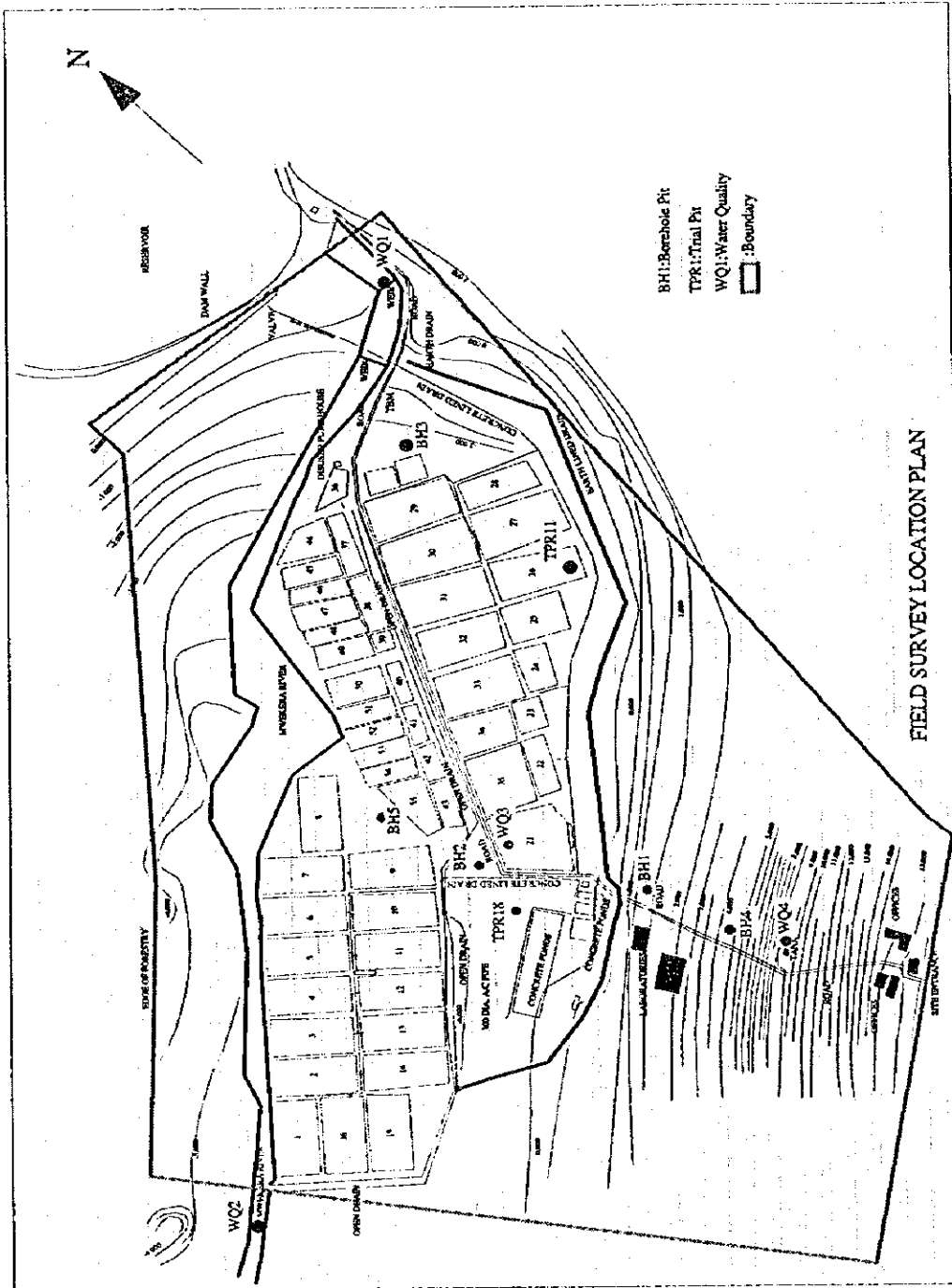
1. To secure a lot of land necessary for the Project;
2. to clear and level the site for the Project prior to the commencement of the construction;
3. to provide a proper access road to the Project site;
4. to provide facilities for distribution of electricity, water supply and drainage and other incidental facilities outside the site;
5. to undertake incidental outdoor works, such as gardening, fencing, exterior lighting, and other incidental facilities in and around the Project site, if necessary;
6. to ensure prompt customs clearance and internal transportation in Zambia of the products purchased under the Japan's Grant Aid;
7. to exempt Japanese nationals from customs duties, internal taxes and fiscal levies which may be imposed in Zambia with respect to the supply of the products and services under the verified contracts;
8. 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 Zambia and stay therein for the performance of their work;
9. to bear commissions, namely advising commissions of an Authorization to Pay (A/P) and payment commissions, to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement (B/A);
10. to provide necessary permissions, licenses, and other authorization for implementing the Project, if necessary;
11. to ensure that the facilities constructed and equipment purchased under the Japan's Grant Aid be maintained and used properly and effectively for the Project; and
12. to bear all the expenses, other than those covered by the Japan's Grant Aid, necessary for the Project.



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Appendix 5.1 Natural and Environmental Condition Study

1. Field Survey Location Plan



Appendix 5.1 Natural and Environmental Condition Study

2. Results of Geological Test

Test	BH1	BH2	BH3	BH4	BH5
Total Depth (m)	15.0	15.0	10.0	7.0	10.0
Soil Description	0-4m Grey, Sandy Silty Clay, Firm, Moist 4-8m Gray to Yellowish Micaceous Sandy-Silty, Moist, Firm Clay 8-15m Dark Brown Micaceous Fine to Medium Sandy Silty, Moist Firm Clay	0-6m Dark Gray Medium Sandy Silty Clay Firm, Moist 6-8m Gray Loose Sand 8-15m Greyish Micaceous Sandy Silty, Moist	0-2m Dark Gray Decomposed Sandy Clay, Moist, Firm 2-3m Mottled-Yellowish Sandy Silt, Moist, Firm 3-8m Light Gray Moist Sandy Silt 8-10m Sandy Silt, Quartz, Gravel	0-5m Brownish, Very Hard Clay 5-6m Clay in Brownish Pulverized Sandy Silt 8-7m Pulverized Gravel in Yellowish, Graded, Sandy Silt, No Water	0-3m Light to Dark Gray and Yellowish Silt in Highly Plastic Stiff Clay Poorly Graded, Highly Moist 3-4m As Above, but Very Stiff 4-7m Light to Dark Gray, Yellowish Silt in Highly Plastic Fine Sandy Clay, Very Wet 7-13m Dark Green and White Silty schist Clay Poorly Graded, Soft, Very Wet
Water level (m)	11.0	8.0	0.5	-	4.0
"N" Value					
1m	18	7	-	16	-
2m	27	5	-	25	-
3m	27	2	19	18	7
4m	13	6	24	15	-
5m	12	5	23	-	6
Insitu Permeability	-	-	-	41.20 cm/sec*10 ⁻⁴	-
Laboratory Permeability	-	3.02-3.44 cm/sec*10 ⁻⁴	-	3.05-7.38 cm/sec*10 ⁻⁴	-

Appendix 5.1 Natural and Environmental Condition Study

3. Results of Water Quality Analysis

Analyses	WQ1	WQ2	WQ3	WQ4	WHO	Tanzania
Total Hardness	24	22	37	26	500	600
Turbidity	4.0	4.8	85.5	4.8	5	30
Fe (mg/lit.)	0.60	0.62	2.1	0.56	0.3	1
Mn (mg/lit.)	<0.05	<0.05	<0.05	<0.05	0.3	0.5
pH	7.0	7.0	7.4	7.6	6.5-8.5	6.5-9.2
NO ₃ (mg/lit.)	<0.5	<0.5	<0.5	<0.5	45	100
SO ₄ (mg/lit.)	12	14	21	12	400	600
F ⁻ (mg/lit.)	<0.1	<0.1	<0.1	<0.1	1.5	8.0
Cl ⁻ (mg/lit.)	<0.1	<0.1	1.0	<0.1	250	800
As ⁺ (mg/lit.)	0.1	<0.1	<0.1	<0.1	0.05	0.05
Cd ⁺ (mg/lit.)	<0.05	<0.05	<0.05	<0.05	0.005	0.05
Cr (mg/lit.)	<0.05	<0.05	<0.05	<0.05	0.05	0.05
Cu (mg/lit.)	0.06	<0.05	0.06	<0.05	1.0	3.0
Pb (mg/lit.)	<0.1	<0.1	<0.1	<0.1	0.05	0.1
Hg (mg/lit.)	<0.1	<0.1	<0.1	<0.1	0.001	0.01
Se (mg/lit.)	<0.1	<0.1	<0.1	<0.1	0.01	0.05
Cn (mg/lit.)	<0.01	<0.01	<0.01	<0.01	0.1	0.2
Coliform bacilli MPN100ml	900	275	1800+	350	0	-
Escherichia coli. MPN100ml	10	8	150	5	0	-

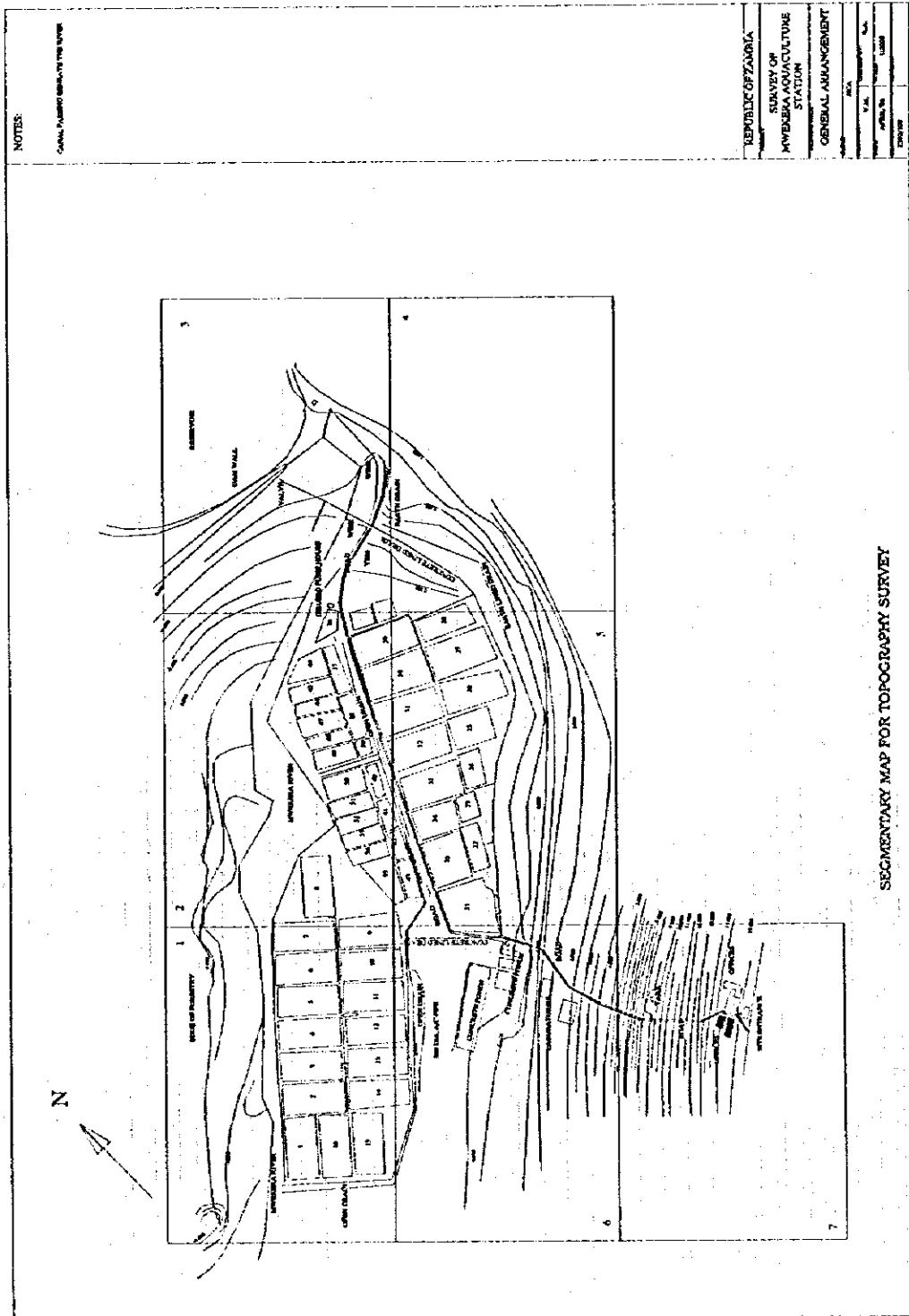
Appendix 5.1 Natural and Environmental Condition Study

4. Observation record of Kafironda Station

		10	11	12	1	2	3	4	5	6	7	8	9	Mean
Temp (°C)	Mean	21.9	25.2	23.4	22.2	21.9	21.5	19.7	17.6	15.4	16.3	17.1	20.2	20.2
	Max.	34.0	34.8	30.6	28.9	28.6	28.4	28.9	28.6	26.6	28.1	29.7	32.0	29.9
	Min.	9.8	15.5	16.1	15.4	15.2	14.6	10.4	6.5	4.1	4.4	4.5	8.4	10.4
Rain (mm)	Max.	1.0	17.5	56.0	25.4	52.5	41.6	38.3	0.0	0.0	0.0	0.0	6.5	19.9
	T/M	1.0	57.4	381.6	175.4	215.1	222.9	127.7	0.0	0.0	0.0	0.0	19.0	100.0
Wind Speed	Mean	3	3	2	2	2	2	2	2	2	2	2	2	2
	Max.	5	4	3	3	3	2	2	4	3	4	5	3	3

Appendix 5.1 Natural and Environmental Condition Study

5. Segmentary Map for Topography Survey



Appendix 5.2 Cultivation Plan Fishery 1. Annual Schedule of Experimental Ponds Usage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Notes	
250m ² pond	(1) Tilapias Variety Comparison Experiment													
1	Conservation of original strain												Conservation of original strain	
2	→ Year-round use →												"	
3	→ Year-round use →												"	
4	→ Year-round use →												"	
	Comparative rearing													
5	Discharge	→	Interim measurement	→	Interim measurement	→	Interim measurement	→	Harvest					Tilapias
6	Discharge	→	Interim measurement	→	Interim measurement	→	Interim measurement	→	Harvest					"
7	Discharge	→	Interim measurement	→	Interim measurement	→	Interim measurement	→	Harvest					"
8	Discharge	→	Interim measurement	→	Interim measurement	→	Interim measurement	→	Harvest					"
250m ² pond	(2) Feed experiment													
	Common Carp			Tilapias			Comparison by size							
9	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
10	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
11	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
12	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
13	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
14	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
15	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
16	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest	Start	→	Harvest		
750m ² pond	(3) Fertilizing comparison experiment													
	(Wet season)						Additional fertilization (dry season)						Fertiliser Volume (t/ha)	
1	→ Completion						Start	→ Completion						0/ha
2	→ Completion						Start	→ Completion						0/ha
3	→ Completion						Start	→ Completion						2/ha
4	→ Completion						Start	→ Completion						2/ha
5	→ Completion						Start	→ Completion						4/ha
6	→ Completion						Start	→ Completion						4/ha
7	→ Completion						Start	→ Completion						8/ha
8	→ Completion						Start	→ Completion						8/ha
750m ² pond	(4) Polyculture Experiment (Time of start depends on the size of fingerling/juvenile)												Tilapias : Common Carp	
9	Start	→ Year-round rearing						→ Harvest						1:1
10	Start	→ Year-round rearing						→ Harvest						1:1
11	Start	→ Year-round rearing						→ Harvest						1:2
12	Start	→ Year-round rearing						→ Harvest						1:2
13	Start	→ Year-round rearing						→ Harvest						2:1
14	Start	→ Year-round rearing						→ Harvest						2:1

**Appendix 5.2 Cultivation Plan
Fishery 2. Comparison of Pond Structure**

	Earthen pond	Vinyl-sheeted pond	Concrete-walled pond
Construction cost	Lowest	Medium	Highest
Suitability as an experimental pond	Even if the pond is properly managed, changes in its rearing environment and conditions due to collapse of pond walls by nibbling behavior of common carp and overgrowth of weeds are unavoidable. Hence, this type of pond is not suited as an experimental pond. However, data applicability to local fish farms is high.	Vinyl-sheeting of the pond can eliminate the left problems. The suitability as an experimental pond is medium.	The pond's physical environment does not change even when used for a long time. The suitability as an experimental pond is high. However, data applicability to local fish farms is low.
Suitability as a culture pond	The existing culture ponds are mainly earthen ponds. This type of pond is hence most suitable in extending technology to the surrounding areas.	This type of pond is useful for demonstration purposes.	This type of pond will be useful for demonstration purposes in the future.
Maintenance and management costs	Requires personnel expenses for repairing collapsed walls, holes, etc.	The frequency of repairs will be reduced in comparison to earthen ponds. However, replacement of the sheet will become necessary, requiring the highest cost.	Basically, the maintenance and management cost is the lowest.
Maintenance and management system	The trouble required for maintaining and managing the pond environment such as weeding and wall repairs is the greatest.	The trouble required for maintaining and managing the pond environment is medium.	The trouble required for maintaining and managing the pond environment is the least.
Repair system	Can be repaired locally.	Can be repaired locally.	The basic repairs can be carried out locally.

Appendix 5.2 Cultivation Plan

Fishery 3. Estimation of the Scale of the Spawning Pond

Number of eggs required to produce seed in one cycle

At present, common carp seeds are being produced through the following process.

1. Place hormone-injected spawners in the spawning tank.
2. Hatch the eggs in an indoor incubation tank.
3. Transfer the larvae (7 day hatchlings) to an outdoor 625m² tank.
4. Transfer fry (0.4-1g) to a large pond (2,500m²) for second rearing.

According to data at the Mwekera Aquaculture Station, it took 40 to 60 days for larvae to develop into fry in 1995. The season of common carp seed production lasts for four months, from September to December. If the period of the operation of seed production of one cycle including the preparation period is 60 days, it is possible to harvest seeds from two cycles within a four month period. As mentioned earlier (3.3.1), it is planned to produce 500,000 fry in two cycles (250,000 x 2 = 500,000). If the 250,000 fry are to be produced in four 625 m² tanks, the stocking density and the number of eggs required are computed as follows.

Total pond area: 625m² x 4 ponds = 2,500m²

Number of larvae stocked per unit area: 100 larvae/m²

Required number of larvae: 2,500m² x 100 larvae/m² = 250,000 larvae

The average hatching rate of eggs is 35% and the survival rate from hatching to larvae is around 70%. Therefore, at 250,000/0.35/0.70 = 1,020,408, around one million eggs will be needed for one cycle of seed production.

Scale of the spawning pond

The area of the spawning pond is to be determined as follows.

Planned pond area (m²) = Planned spawner weight (kg) / Planned spawner stocking density

(kg/m²) = [Necessary spawner weight (kg) / Spawning rate] / Planned spawner stocking density

(kg/m²) = [(Necessary female spawner weight (kg) + Male spawner of the same weight (Note 1) (kg)) / Spawning rate] / Planned spawner stocking density (kg/m²)

Here,

Planned spawner stocking density = 1 kg/m^2 (The actual value at the Mwekera Aquaculture Station, as well as ordinary density)

Spawning rate = 0.33 (Actual value at the Mwekera Aquaculture Station)

Necessary spawner weight = Target number of eggs / Planned number of eggs to be spawned per kg of female spawner weight (eggs/kg)(Note 2) = 1 million (eggs) / 100,000 (eggs/kg) = 10 kg

Therefore,

$$\begin{aligned} \text{Planned pond area (m}^2\text{)} &= \{10 \text{ (kg)} + 10 \text{ (kg)} / 0.33\} 1 \text{ (kg/m}^2\text{)} \\ &= 60.6 \text{ m}^2 \sim 60 \text{ m}^2 \end{aligned}$$

Notes:

1. Spawning is ordinarily carried out using a male and a female of the same weight.
2. Planned number of eggs to be spawned per kg of female spawner (eggs/kg): Zambia lacks this data. Hence, this project will be using 100,000 eggs/kg, which is estimated by Japanese experts based on the hatching data at the Mwekera Aquaculture Station. In using this value, its appropriateness was examined as follows.

a) Estimation by Japanese experts of the number of eggs spawned by common carp at the Mwekera Aquaculture Station

The table below shows the number of eggs spawned per kilogram of female spawner estimated by Japanese experts based on the number of larvae hatched and the estimated hatching rate at the Mwekera Aquaculture Station.

Estimated Number of Eggs Spawned by Carps At the Mwekera Aquaculture Station (1995)

Date	No. hatched/kg	Estimated hatching rate	No. of eggs spawned/kg
Jul. 25	44,350	35%	126,714
Aug. 5	20,409	35%	58,311
Aug. 16	48,659	35%	139,025
Aug. 24	57,600	35%	164,571
Aug. 29	approx. 40,000	35%	114,285
Sept. 4	56,521	35%	161,488
Sept. 11	approx. 39,873	35%	113,925
Sept. 19	20,914	35%	59,754
Mar. 10	approx. 40,000	35%	114,285
Mar. 10	37,200	35%	106,285
Total	405,526	35%	1,158,643
Average	40,553	35%	115,864

b) Examination

Based on the foregoing, the average number of eggs spawned by common carp at the Mwekera Aquaculture Station can be estimated to be around 100,000 per kilogram of weight. In general, common carp spawn once a year in the temperate regions. In tropical regions, they perform multiple spawning. In the former case, the number of eggs spawned is large, and in the latter, the number is small.

Zambia is located in a tropical region. However, because the Mwekera Aquaculture Station is located at a height of 1,280 m, its climate is mild. Because of this, the Station's common carp spawn only once a year after August when the water temperature starts to rise. Therefore, for the carps, the climate at the Station is believed to comprise that of a temperate region. Not just in the case of Japan, but in the case of Indian heights and China as shown below, if the common carp spawns once a year, the average number of eggs spawned ranges from around 100,000 to 120,000/kg. Hence, it is believed appropriate to use 100,000 eggs/kg in this project as estimated by Japanese experts at the Mwekera Aquaculture Station.

- The average number of eggs spawned by common carp 25-35 cm in standard length in India: 97,000 eggs (based on *A Hatchery Manual for the Common, Chinese and Indian Major Carps* - Asian Development Bank).
- The average number of eggs spawned by common carp 40 cm in standard length in China: 128,000 eggs (based on *Chinese Freshwater Cultivation* edited by the Chinese General Committee on Experience of Freshwater Fish Farming).

Appendix 5.2 Cultivation Plan

Fishery 4. Seed Production Costs

- Rearing expenses

Cost for rearing broodstock for spawning

- Quantity of broodstock possessed by the Station: 60 kg (females and males)
- If the spawning rate is 35%, the quantity to be possessed will be 200 kg.

1) Cost of broodstock to be supplemented

This will be for 20% of the possessed broodstock.

$$200 \text{ (kg)} \times 0.2 = 40 \text{ (kg)}$$

The cost of rearing broodstock is estimated as 50% of the sales price:

$$1,000 \text{ (K/kg)} / 2 = 500 \text{ (K/kg): Cost of rearing broodstock per kg.}$$

$$40 \text{ (kg)} \times 500 \text{ (K/kg)} = 20,000 \text{ (K)}$$

2) Spawning cost (cost of hormone injection)

10 mg/fish

$$2,000 \text{ (K/10 mg)} \times 50 \text{ (fishes)} = 100,000 \text{ (K)}$$

3) Cost of feed

a) For broodstock rearing

If the annual growth is assumed to be 1.5 times the initial weight,

$$200 \text{ (kg)} \times 1.5 = 300 \text{ (kg)}$$

$$\text{Then, the necessary cost will be } 300 \text{ (kg)} - 200 \text{ (kg)} = 100 \text{ (kg)}$$

If the feed efficiency is assumed to be 20% with feeds consisting mainly of maize and other cereals, the necessary amount of feeds will be $100 \times 5 = 500 \text{ (kg)}$.

$$\text{If the feed costs } 75 \text{ (K/kg)}, 500 \times 75 = 37,500 \text{ (K)}$$

b) For fry/fingerling rearing

Initial artificial feed (hen eggs, MBD, etc.)

$$11,250 \text{ (K)}$$

4) Costs of fertilization, etc.

Assuming that fertilization of fertilizer valued at K76,375 every three months is conducted to produce 500kg of market-size fish, K305,580 will be required annually.

$$305,580 \text{ (K/broodstock)} + 27,000 \text{ (K/seeds)} = 511,000 \text{ (K)}$$

• Personnel expenses

- 1) Spawning period: 4 persons x 90 days = 360 persons/day
- 2) Seed rearing period: 4 persons x 90 days = 360 persons/day
- 3) Ordinary management: 2 persons x 270 days = 540 persons/day
- Total: 1,260 persons/day

$$1,260 \text{ persons/day} \times 2,200 \text{ (K)} = 2,772,000 \text{ (K)}$$

Breakdown of the Production Cost of Common Carp Seeds (Unit: 500,000 fishes)

Item	Cost (K)
• Rearing costs	
1) Broodstock costs (supplement)	20,000
2) Spawning costs (hormone cost, etc.)	100,000
3) Feed costs	48,750
4) Fertilization costs	511,000
• Personnel expenses	2,772,000
Subtotal	3,451,750
• Cost of supplies, marketing expenses [(1) + (2)] x 10%	345,175
Total	3,796,925

In the case of tilapias, the major difference from common carp is that the costs for spawning such as hormone treatment are unnecessary. The cost is estimated as follows.

$$3,451,750 - 100,000 \text{ (Spawning cost)} = 3,351,750 \text{ (K)}$$

If the cost of supplies and marketing expenses are assumed to be 10% of the entire production cost, the cost of production of seeds per 100,000 tilapias is estimated as follows.

$$(3,351,750 + 3,351,750 \times 0.1) \times 1/5 = 737,385 \text{ (K)}$$

Cost of Production of Carp and Tilapias Seeds

Fish Species	Target Production Quantity	Production Cost (K)	Unit Price of Seeds (K/fish)
Common carp	500,000	3,796,925	7.6
Tilapias	100,000	737,385	7.4
Total	600,000	4,556,310	7.6

Based on the above data, the annual operating, maintenance, and management costs required for the production activities is estimated to be K4,556,310.

Appendix 5.2 Cultivation Plan
Fishery 5. Research Activity Expenses

	Experiment	Volume	Cost (K)	Remarks
1.	Effects of fertilization and fertilizers			
	Chicken manure	42.0 t	588,000	K14,000/t
	Brewery waste	42.0 t	294,000	K7,000/t
	Lime	3.0 t	300,000	K2,500/t
2.	Selection of tilapias for culture			
	Chicken manure	3.3 t	46,200	K14,000/t
	Brewery waste	3.3 t	23,100	K7,000/t
	Lime	0.3 t	30,000	K2,500/t
3.	Polyculture			
	Chicken manure	2.5 t	35,000	K14,000/t
	Brewery waste	2.5 t	17,500	K7,000/t
	Lime	0.2 t	500	K2,500/t
4.	Locally procurable feeds and raw materials			
	Chicken manure	3.4 t	47,600	K14,000/t
	Maize husks	3.2 t	70,400	K22,000/t
	Brewery waste	3.2 t	22,400	K7,000/t
	Bran	3.2 t	228,000	K90/kg
5.	Production of carp seeds	-	-	Included in seed production cost
6.	Development of artificial feeds			
	Dried small shrimp	840 kg	42,000	K50/kg
	Meat and bone meals	840 kg	100,800	K120/kg
	Mixed vitamins	120 kg	1,200,000	K10,000/kg
	Chicken manure	1.0 t	14,000	K14,000/t
	Brewery waste	120 kg	840	K7,000/t
	Bran	480 kg	43,200	K90/kg
	Total		3,103,540	

Notes: The cost of the seed production for experiments is not included since these are produced at the Station.

The cost of the experiments related to 4. and 6. is for two runs of experiment.

Based on the above observations, the annual operation, maintenance, and management cost required for the research activities is estimated to be K3,103,540.

Appendix 5.2 Cultivation Plan
Fishery 6. Earnings From Sales Operation

1) Seed sales plan

Due to the spread of aquaculture, the number of small private fish farmers to which seeds are to be distributed is believed to increase gradually in the future. If these farmers develop their production capacity through technical guidance, etc., and the entire level rises, seed sales can be expected to increase in the future.

The Mwekera Aquaculture Station has been receiving many inquiries regarding purchase of seeds, those of common carp in particular. From an interview survey conducted at a market in Kitwe City, the general public were highly interested in carp. Hence, the potential demand is considered to be quite high.

Given the local conditions, it is not easy to sell seeds if their unit price is high. The Station will have to examine ways to increase the supply volume with the present unit price. The sales prices of seeds are as shown in the table below, the price of 1.0-3.0g seeds sold being K20-30/seed.

Prices of Sales of Products of the Mwekera Aquaculture Station

Common carp	Sales Price (K)	Tilapias	Sales Price (K)
Under 0.5g	10/seed		
0.6 - 1.0 g	20/seed	0.6 - 1.0 g	20/seed
1.1 - 3.0 g	30/seed	1.1 - 3.0 g	30/seed
3.1 - 5.0 g	50/seed	3.1 - 5.0 g	50/seed
Table size	1,000/kg	Table size	1,000/kg

The 1995 seed production records were 550,000 common carp and 200,000 tilapias. The number of carp sold remained at 172,000 due to structural defects associated with the production pond. If the station solves this problem, it can be expected to supply around 500,000 fry/fingerling. By assuming sales of 300,000 1g-seeds and 200,000 2g-seeds of common carp, and as for tilapias using the figure close to the 1995 sales record, the earnings from the sale of seeds are estimated as follows.

Seed Marketing Plan

Seed	1g	2g	Total
Common carp	300,000 seeds x K20 = K6,000,000	200,000 seeds x K30 = K6,000,000	K12,000,000
Tilapias	100,000 seeds x K20 = K2,000,000		K2,000,000
Total	K8,000,000	K6,000,000	K14,000,000

Based on these calculation, the annual earnings from the sale of seeds are estimated to be K14 million.

2) Marketing plan for table-size fish

As to the production of market-size fish for sale, production of fish can be expected through the process of broodstock rearing and from experiments and research. It is possible to sell around 2.0 tons (K2 million) of fish with which experiments and research have completed.

As to the impact of the shipment of these market-size specimens on the market, difference in harvesting time should be considered. The impact is considered rather little, because of possible dispersed shipment as these fish are stocked in idle ponds and readily shipped at any time desired.

a) Comparative experiment for tilapias

$$1,000 \text{ (fish/pond)} \times 4 \text{ (ponds)} = 4,000 \text{ (fish)}$$

If the survival rate at completion of the experiments is assumed to be 60%,

$$2,400 \text{ (fish)} \times 0.2 \text{ (kg/fish)} = 480 \text{ kg.}$$

Half of this is sold and the rest is kept for further experiments.

$$480 \text{ (kg)} / 2 = 240 \text{ (kg)}$$

b) Polyculture experiment

$$1,500 \text{ (fish/pond)} \times 6 \text{ (ponds)} = 9,000 \text{ (fish)}$$

If the survival rate at the completion of the experiments is assumed to be 60%,

$$9,000 \text{ (fish)} \times 0.6 = 5,400 \text{ (fish)}$$

If these are harvested when their weight is 0.2kg,

$$5,400 \text{ (fish)} \times 0.2 = 1,080 \text{ kg}$$

c) Feed experiment

$$1,000 \text{ (fish/pond)} \times 8 \text{ (ponds)} = 8,000 \text{ (fish)}$$

If the survival rate at the completion of the experiments every three months is 80%,

$$8,000 \text{ (fish)} \times 0.8 = 6,400 \text{ (fish)}$$

$$6,400 \text{ (fish)} \times 0.1 = 640 \text{ kg}$$

$$a) + b) + c) = 1,960 \text{ kg}$$

$$1,960 \text{ (kg)} \times 1,000 \text{ (K/kg)} = \text{K}1,960,000$$

Based on these calculation, the annual earnings from the sale of market-size fish are estimated to be K1,960,000.

3) Plan of the utilization of idle ponds

It is possible to utilize ponds which are not planned to be used under the seed production and the experiment programs. This section examines the sales plan when these idle ponds are utilized in the future.

Given the present situation that the production volume of seeds is small, it is considered possible to use about ten 2,500m² ponds. If the Station conducts market fish production, the economic performance will be as in the table below. Based on this estimation, the Station can acquire earnings of about K3.3 million.

Estimation of Profit From Sale of Adult Fish From Use of Idle Ponds

(When the productivity is assumed to be 2 tons/ha.)

Item	Quantity	Amount (K)	Remarks
Expenses		682,995	
1. Chicken manure	5.5 t	117,000	Chicken manure 350/25kg, transport cost K40,000
2. Brewery waste	5.5 t	38,500	7,000/t
3. Lime	500 kg	50,000	2,500/kg
4. Temporary workers	50 persons/day	100,000	2,000/person/day
5. Transport cost for sale	-	350,000	
6. Cost of seeds	3,000 fingerling	27,495	
Sales		2,000,000	
1. Common carp	2 t	2,000,000	
Profit		1,317,005	

The income when using ten 0.25 ha ponds (2.5 ha) for production and sale of adult fish is obtained as follows.

$$1,317,005 \times 2.5 = K3,292,512.5$$

Based on these estimation, the annual earnings from the sale of market-size fish using idle ponds is estimated to be K3,292,512.5.

Incorporating all these observations, the annual earnings from the sales operations will be as follows.

(1) Seed sales	K14,000,000
(2) Market-size fish sales	K1,960,000
(3) Use of idle ponds	K3,292,512
Total	K19,252,512

Appendix 5.3 Equipment
Equipment 1. List of Equipment

No.	Item	Unit	Quantity		Remarks
			Requested	Planned	
1.	Survey equipment				Included in MPTC
1	Plankton net, XX13	Sets	1	-	"
2	Plankton net, GG54	Sets	1	-	"
3	Plankton net, 100mWXX13	m	5	-	"
4	Plankton net, 100mWGG54	m	5	-	"
5	Transparency plate	Units	2	2	
6	Digital thermometer	Units	1	-	Can be replaced with a water quality analyzer
7	Portable water quality analyzer	Units	3	-	MPTC has one
8	Portable COD gauge	Units	1	-	DO gauge can be used
9	Portable BOD gauge	Units	1	-	Not so necessary
10	Body length measurement plate	Units	3	3	
11	Spring top-pan scale, 0-10kg (0.1kg)	Units	2	-	Included in MPTC
12	Spring hand scale, 0-10kg	Units	3	3	
13	Measuring equipment	Sets	2	-	Requires expertise, personnel not available
2	Meteorological observation equipment				
1	Aneroid barometer	Units	1	1	
2	Maximum/minimum thermometer	Units	1	1	
3	Thermometer/hygrometer	Units	1	1	
4	Anemoscope/anemometer	Units	1	1	
5	Rain gauge	Units	1	1	
6	Instrument screen shelter with legs	Units	1	1	

No.	Item	Unit	Quantity		Remarks
			Requested	Planned	
3	Laboratory equipment				
1	Microscope camera	Units	1	-	Included in MPTC
2	Stereo zoom microscope	Units	2	-	"
3	Dissection kit	Units	3	-	MPTC has 2
4	Universal projector	Units	1	-	Available
5	Electronic top-pan scale, 0-300g (1mg)	Units	1	-	Included in MPTC
6	DO gauge	Units	1	-	"
7	PH gauge	Units	1	-	"
8	Chemical scale, 0-200g (0.1mg)	Units	1	-	"
9	Conductivity gauge	Units	2	-	Water quality analyzer can be used
10	Laboratory mill	Units	1	1	
11	Hand meat chopper	Units	1	1	
12	Blender	Units	1	1	
13	Protein analyzer	Units	1	-	Not so necessary
14	Fat analyzer	Units	1	-	Included in MPTC
15	Fiber analyzer	Units	1	-	Fiber analysis is not conducted
16	Refrigerator for storing samples	Units	1	1	
17	Freezer for storing samples	Units	1	-	Not so necessary
18	Central laboratory table	Units	2	-	MPTC has one, installed in the laboratory
19	Desk	Units	6	-	Believed to be an item to be made available by the Zambian side
20	Chair	Units	6	-	"
21	Chemicals vault	Units	6	-	MPTC has 2, 1 each in laboratory and feed plant
22	Beaker, 2000ml	Pieces	20	-	Included in MPTC
23	Beaker, 1000ml	Pieces	20	-	"
24	Beaker, 500ml	Pieces	20	-	"

No.	Item	Unit	Quantity		Remarks
			Requested	Planned	
25	Beaker, 100ml	Pieces	20	-	"
26	Beaker, 50ml	Pieces	20	-	"
27	Flask, 2000ml	Pieces	20	5	Not often used
28	Flask, 1000ml	Pieces	20	3	MPTC has 2, not often used
29	Flask 500ml	Pieces	20	20	
30	Flask 100ml	Pieces	20	15	MPTC has 5
31	Flask 50ml	Pieces	20	15	MPTC has 5
4	Feed manufacturing equipment				
1	Grinder	Units	1	-	Available
2	Cooker	Units	2	-	Unnecessary because raw materials requiring boiling are not used
3	Pellet maker	Units	1	-	Available
4	Hopper	Units	1	-	For large plants. Unnecessary at the Station
5	Platform scale	Units	1	-	Included in MPTC
5	Vehicles				
1	4WD truck, 7 tons	Units	1	-	Included in MPTC
2	4WD car	Units	1	-	"
3	4WD pickup truck	Units	2	-	Not so necessary, trucks can be used
4	Mini-bus	Units	1	-	Not so necessary
6	Darkroom equipment (color and B&W)				
1	Extender	Units		-	Not so necessary
2	Development tank, tray	Units		-	"
3	Photographic paper, film	Units		-	"
4	Developing chemical	Units		-	"
5	Slide projector	Units		-	"

No.	Item	Unit	Quantity		Remarks
			Requested	Planned	
7	Other equipment				
1	Live fish transport tank, 11	Units	8	2	Two are sufficient given the seed supply quantity
2	Bed and mattress	Units	20	-	Believed to be items to be made available by the Zambian side
3	Video equipment	Units	1	-	Not so necessary
4	Personal computer software	Sets	1	-	Included in MPTC
5	SSB wireless equipment	Units	1	-	Not so necessary
6	Color copier	Units	1	-	Included in MPTC. Color not necessary
7	Spare power generator, 20kVA	Units		-	Included in MPTC, 10kVA
8	Lap-top computer	Units	1	-	Included in MPTC
9	Desktop computer	Units	1	-	"
10	Night working light	Units	8	-	Believed to be an item to be made available by the Zambian side
11	Bookbinder	Units	1	-	Not so necessary
12	Laboratory uniform	Sets			"

Appendix 6. Data collected

A. Fisheries

1	ANNUAL FISH PRODUCTION FOR ALL MAJOR FISHERIES OF ZAMBIA	DEPARTMENT OF FISHERIES
2	A.S.I.P. AGRICULTURAL SECTOR INVESTMENT PROGRAMME EXTENSION AND INFORMATION SUB-PROGRAMME	MINISTRY OF AGRICULTURE, FOOD AND FISHERIES 1995
3	A.S.I.P. AGRICULTURAL SECTOR INVESTMENT PROGRAMME FISHERIES SUB-PROGRAMME	MINISTRY OF AGRICULTURE, FOOD AND FISHERIES 1995
4	A.S.I.P. AGRICULTURAL SECTOR INVESTMENT PROGRAMME NATIONAL AGRICULTURE POLICY	MINISTRY OF AGRICULTURE, FOOD AND FISHERIES 1995
5	AQUACULTURE DEVELOPMENT AND RESEARCH IN SUB-SAHARAN AFRICA	FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)
6	AQUACULTURE INTO THE 21ST CENTURY IN SOUTHERN AFRICA	AGRICULTURE FOR LOCAL COMMUNITY DEVELOPMENT PROGRAMME (ALCOM) NOVEMBER 1993
7	BETTER FRESHWATER FISH FARMING IN ZAMBIA	ALCOM 1994
8	FISH CULTURE DEVELOPMENT PROJECT / PROJECT REVIEW 1993	NORWEGIAN AGENCY FOR DEVELOPMENT COOPERATION (NORAD)
9	FISH CULTURE DEVELOPMENT IN NORTHERN PROVINCE, ZAMBIA	NORAD SEPTEMBER 1988
10	1992 FISHERIES STATISTICS	MINISTRY OF AGRICULTURE, FOOD AND FISHERIES 1993
11	INTRODUCTION OF AQUATIC SPECIES INTO ZAMBIAN WATERS, AND THEIR IMPORTANCE FOR AQUACULTURE AND FISHERIES	DIRK F. E. THYS VAN DEN AUDENAERDE (ALCOM)
12	MARKETING AND CONSUMPTION OF FISH IN EASTERN AND SOUTHERN AFRICA	FAO
13	REPORT ON THE SEMINAR ON AQUACULTURE EXTENSION IN ZAMBIA	HENK VAN DER MHEEN, ALCOM 2-6 OCTOBER 1995
14	SADC RFTP MANAGEMENT COMMITTEE MEETING, SADC REGIONAL FISHERIES TRAINING PROGRAMME	SOUTHERN AFRICAN DEVELOPMENT COMMUNITY APRIL 1995
15	SOCIO-ECONOMIC STUDY OF FISHING COMMUNITIES ALONG LAKE MWERU, LUAPULA PROVINCE, ZAMBIA	TILLEKE KIEWIED, ALCOM
16	TILAPIA CULTURE BY FARMERS IN LUAPULA PROVINCE, ZAMBIA	U. N. WIJKSTROM, KARL OTTO WAHLSTROM - ALCOM

B. Development Programme

1	NEW ECONOMIC RECOVERY PROGRAMME / ECONOMIC AND FINANCIAL POLICY FRAMEWORK 1992-1994	MINISTRY OF FINANCE
2	PUBLIC INVESTMENT PROGRAMME 1994-1996	OFFICE OF THE PRESIDENT / NATIONAL COMMISSION FOR DEVELOPMENT PLANNING 1994
3	FINAL RESTRUCTURING REPORT OF THE MINISTRY OF AGRICULTURE, FOOD AND FISHERIES	MANAGEMENT DEVELOPMENT DIVISION, CABINET OFFICE
4	REPORT ON THE REHABILITATION AND MAINTENANCE OF ROADS PROVINCIAL COST ESTIMATES FOR PAVED ROADS REHABILITATIONS WORK	KITWE CITY COUNCIL 1995

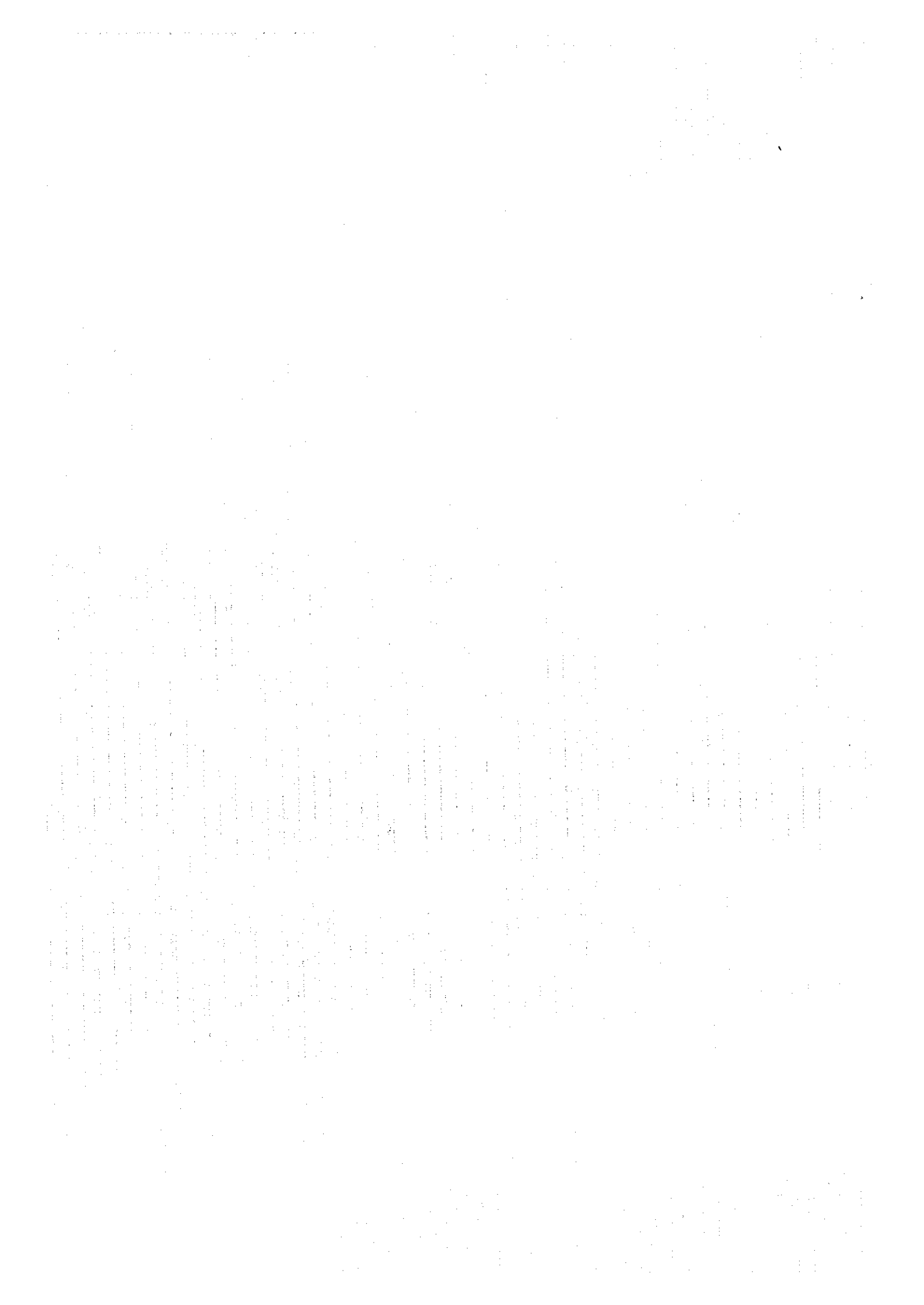
C. Statistics

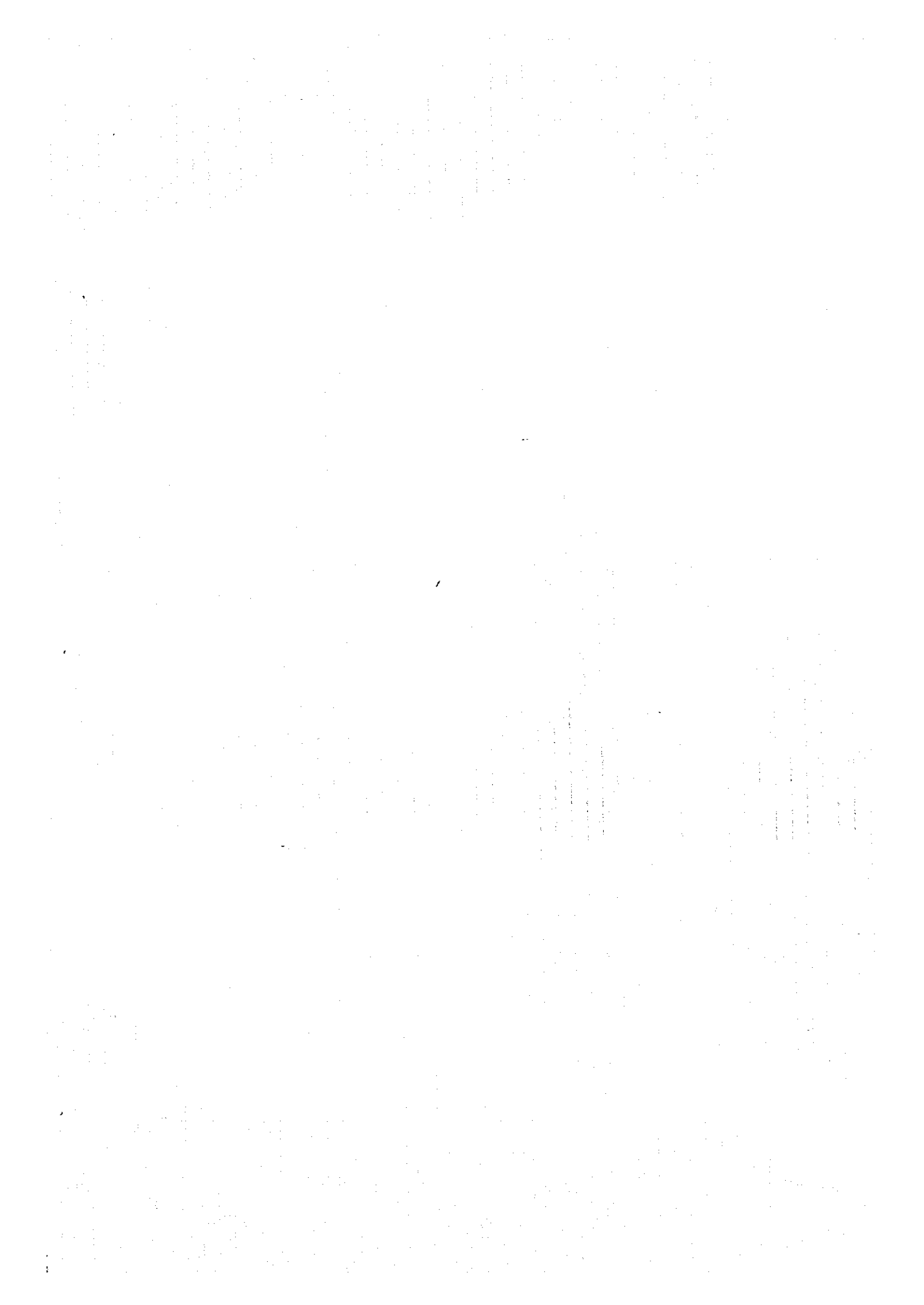
1	COMPLEMENTS AND GRADING OF POSTS IN MINISTRIES AND PROVINCES TO SUPPORT ESTIMATES OF EXPENDITURE FOR THE YEAR 1996	PUBLIC SERVICE MANAGEMENT DIVISION
2	ZAMBIA PROSPECTS FOR SUSTAINABLE AND EQUITABLE GROWTH	WORLD BANK
3	ESTABLISHMENT REGISTER / SUPPORTING THE ESTIMATES OF EXPENDITURE	GOVERNMENT PRINTER 1995

D. Natural and Environmental Condition

1	NATIONAL WATER POLICY	MINISTRY OF ENERGY AND WATER DEVELOPMENT
2	WATER RIGHT	MINISTRY OF ENERGY AND WATER DEVELOPMENT
3	ACT NO.12 (THE ENVIRONMENTAL PROTECTION AND POLLUTION CONTROL)	GOVERNMENT OF ZAMBIA 1990
4	METEOROLOGICAL DATA (KAFIRONDA, NDOLA.)	DEPARTMENT OF METROLOGY, MAFF
5	HYDROLOGICAL DATA (KAFUE, KAMFINSA.)	MINISTRY OF ENERGY AND WATER DEVELOPMENT







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