PD-AAD-135

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

A = Add
C = Change
D = Delete
A

Amendment Number

CODE 3

1. COUNTRY/ENTITY: Rwanda

3. PROJECT NUMBER: 696-0112

4. BUREAU/OFFICE: Africa 06

5. PROJECT TITLE (maximum 40 characters): Rwanda Fish Culture

6. PROJECT ASSISTANCE COMPLETION DATE (PACD): MM 09 DD 30 YY 85

7. ESTIMATED DATE OF OBLIGATION (Under 'B:' below, enter 1, 2, 3, or 4)
A. Initial FY 81 B. Quarter C. Final FY 84

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	148		148	1555	915	2470
(Grant)	( )	( )	( )	( )	( )	( )
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country			150		589	589
Other Donor(s)						
TOTALS	148		298	1555	1,504	3,059

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) ARDN	3233	319 B		-				2,470	-
(2)				-	-	2470	-		
(3)									
(4)									
TOTALS				-	-	2470	-	2,470	

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each)

11. SECONDARY PURPOSE CODE

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)
A. Code
B. Amount

13. PROJECT PURPOSE (maximum 480 characters).

Assist in the development of a Fisheries Extension Service that can provide the advice and assistance required by Rwandan farm families to: 1] bring back into production and effectively manage at least 80% of the existing fish ponds in Rwanda; and 2) establish 50-100 new ponds per year.

14. SCHEDULED EVALUATIONS
Interim MM 12 YY 81 MM YY Final MM 05 YY 83

15. SOURCE/ORIGIN OF GOODS AND SERVICES
☒ 000 ☒ 941 ☐ Local ☒ Other (Specify) 935

16. AMENDMENTS/NATURE OF CHANGE PROPOSED (This is page 1 of a ____ page PP Amendment)

N/A

17. APPROVED BY
Signature: Euguene Chiavaroli Alexander Love
Title: AID Affairs Officer, Rwanda
Date Signed MM DD YY

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
MM DD YY

AID 1330-4 (8-79)

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT DATA SHEET

A = Add
C = Change
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Amendment Number

CODE 3

2. COUNTRY/ENTITY
Rwanda

3. PROJECT NUMBER
696-0112

4. BUREAU/OFFICE
Africa 06

5. PROJECT TITLE (maximum 40 characters)
Rwanda Fish Culture

6. PROJECT ASSISTANCE COMPLETION DATE (PACD)
MM 09 DD 30 YY 85

7. ESTIMATED DATE OF OBLIGATION
(Under 'B:' below, enter 1, 2, 3, or 4)
A. Initial FY 81 B. Quarter C. Final FY 84

8. COSTS ($000 OR EQUIVALENT $1 =)

A. FUNDING SOURCE	FIRST FY B. FX	C. L/C	D. Total	LIFE OF PROJECT E. FX	F. L/C	G. Total
AID Appropriated Total	148		148	1555	915	2470
(Grant)	( )	( )	( )	( )	( )	( )
(Loan)	( )	( )	( )	( )	( )	( )
Other U.S. 1.						
Other U.S. 2.						
Host Country			150		589	589
Other Donor(s)						
TOTALS	148		298	1555	1,504	3,059

9. SCHEDULE OF AID FUNDING ($000)

A. APPROPRIATION	B. PRIMARY PURPOSE CODE	C. PRIMARY TECH. CODE 1. Grant	2. Loan	D. OBLIGATIONS TO DATE 1. Grant	2. Loan	E. AMOUNT APPROVED THIS ACTION 1. Grant	2. Loan	F. LIFE OF PROJECT 1. Grant	2. Loan
(1) ARDN	3233	319 B		-				2,470	-
(2)				-	-	2470	-		
(3)									
(4)									
TOTALS				-	-	2470	-	2,470	

10. SECONDARY TECHNICAL CODES (maximum 6 codes of 3 positions each)

11. SECONDARY PURPOSE CODE

12. SPECIAL CONCERNS CODES (maximum 7 codes of 4 positions each)
A. Code
B. Amount

13. PROJECT PURPOSE (maximum 480 characters).

Assist in the development of a Fisheries Extension Service that can provide the advice and assistance required by Rwandan farm families to: 1) bring back into production and effectively manage at least 80% of the existing fish ponds in Rwanda; and 2) establish 50-100 new ponds per year.

14. SCHEDULED EVALUATIONS
Interim MM 12 YY 81 MM YY Final MM 05 YY 83

15. SOURCE/ORIGIN OF GOODS AND SERVICES
☒ 000 ☒ 941 ☐ Local ☒ Other (Specify) 935

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Signature: Euguene Chiavaroli Alexander Love
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Date Signed MM DD YY

18. DATE DOCUMENT RECEIVED IN AID/W, OR FOR AID/W DOCUMENTS, DATE OF DISTRIBUTION
MM DD YY

AID 1330-4 (8-79)

ACTION MEMORANDUM FOR THE ADMINISTRATOR AUG 2 5 1981

THRU : ES

THRU : AA/PPC, Larry Smucker (Acting)

FROM : AA/AFR, F. S. Ruddy

SUBJECT : Rwanda Fish Culture Project (696-0112) - Project Authorization

Problem: Your approval is required to execute a grant of $2,470,000 from the ARDN appropriation for the Rwanda Fish Culture Project (696-0112). It is necessary to seek your approval because, along with the Project, the Africa Bureau is seeking several waivers, one of which - a nationality/non-competitive procurement waiver - exceeds the waiver authority of Geographic Bureau Assistant Administrators.

Subject to the availability of funds, $500,000 will be obligated in FY 1981, $1,165,000 in FY 1982, and $805,000 in FY 1983.

Discussion:

Project Background and Description

The possibility of A.I.D. participation in a fish culture project in Rwanda was first discussed in early 1977. At that time, the Government of Rwanda (GOR) proposed that A.I.D. assist in the construction of a government-owned fish pond in each of the country's 143 communes. After long negotiations, the present project has emerged. This project focuses much more on providing extension assistance and support directly to farmers and places less emphasis on construction of government-owned facilities.

The purpose of this Project is the development of a fisheries extension service in Rwanda that can provide the assistance and advice required by Rwandan farm families to: 1) bring back into production and effectively manage at least 80% of the 3,000 fish ponds which already exist in the country; and 2) establish 50-100 new ponds per year. The existing ponds were established during the colonial period but, primarily due to the absence of extension assistance, have never been effectively managed or exploited by Rwandan farmers. The majority of the ponds are not in use at all.

Through the Project, A.I.D. will provide assistance in the following areas:

- training of 12 aquaculture supervisors and 50 fish monitors who will provide the interaction with the farmers necessary to assure that the Project succeeds.

- renovation of the National Fisheries Training center at Kigembe and of the ten prefectural fish stations scattered throughout the country. These facilities will be used for training, for demonstration, for fingerling production and for research.

A.I.D. Country Strategy and Beneficiaries

The Project conforms to the A.I.D. country strategy as outlined in USAID/Rwanda's most recent CDSS. The immediate beneficiaries of the Project will be the approximately 60 employees in Rwanda's Ministry of Agriculture who will receive project-financed training in pond fish culture during the life of the Project. The ultimate beneficiaries will be the 2500 farm families who will receive extension assistance in establishing and managing productive fish ponds during the life of this Project, and the approximately 100 families per year who will receive assistance in establishing fish ponds after the Project is completed. The indeterminate number of farm families who establish fish ponds based on the demonstration effect of successful pond operations of neighbors and relatives can also be considered as beneficiaries of this Project.

Financial Summary

The total cost of the Project is $3,059,000. Of this amount, A.I.D. will be providing $2,470,000 over the five-year life of the Project. The GOR will contribute the remaining $589,000. Present plans are that $500,000 in AID funds will be obligated in FY 1981.

The dollar breakdown of the A.I.D. contribution for the first year and the life of the Project is as indicated below:

Item	First Year ($000)	Life of Project ($000)
Technical Assistance	$ 284	$ 1,104
Construction	178	338
Commodities		188
Training		97
Local Support Costs	38	157
Sub-total		1,884
Contingency		188
Inflation		398
Total	$ 500	$ 2,470

Project Committee Action

This Project was considered and discussed at an African Bureau Project Review Meeting (June 13, 1981) and by the Bureau's Executive Committee for Project Review (July 9, 1981).. Approval of the Project was recommended by both bodies.

The only substantive issues raised during the review process concerned: a) the proper specification of the Project's purpose; and b) the mission's proposal that project technical services be procured from the Food and Agriculture Organization of the U.N. (FAO) on a single source, noncompetitive basis in the event that no U.S. or other Code 941 firm can provide these services. These issues were dealt with as follows:

- Specification of Project Purpose. When originally submitted, the PP indicated that the Project's purpose was to "develop the capacity of Rwandan farm families to build and maintain productive on-farm fish ponds." AID/W reviewers of the Project thought this purpose was insufficiently specific and also, more importantly, thought it ignored the essential institution-building character of this Project. It seemed clear that what the Project was really about was the development of an effective Fisheries Extension Service in Rwanda. After some discussion, the mission accepted the reviewers' point of view. The PP and the Logical Framework were revised accordingly.

- Procurement of Technical Services. Because of concern about the difficulty of locating Code 941 firms, institutions, or individuals capable of and prepared to provide the technical assistance required for project implementation, and because of the AAO/Rwanda's extremely limited capabilities to provide support services to contracted technical assistance personnel, the mission had proposed that an agreement be concluded with the FAO wherein that agency would locate and field the required technicians and AID would reimburse the FAO for costs involved. In order for this to occur, a nationality waiver and a single source, non-competitive procurement waiver would be required. The mission had requested that these waivers be granted.

During the review process it was determined, however, that it might be possible to find an eligible firm capable of providing the assistance and that a search should be made for such a firm. As such, it was also decided that the requested waiver to allow contracting with the FAO should be made conditional on the failure of the effort to locate an eligible firm.

Analyses and Requirements

The AAO/Rwanda has found this Project to be technically, economically, and socially sound. The Project Review Committee concurs with this finding. The intent and requirements of Section 611(a) of the FAA have been fulfilled.

There are no human rights issues in Rwanda which would preclude approval of this Project.

Following an Initial Environmental Examination accomplished at the time the PID for this Project was prepared, the AAO/Rwanda requested that an Environmental Assessment be undertaken. This assessment has been accomplished and it has been determined that all environmental issues have been thoroughly addressed. No further environmental analysis is required. A copy of the Environmental Assessment is attached as Annex F to the PP.

Waivers

The Project Authorization includes the following waivers:

- a nationality waiver from Geographic Code 941 and a single-source, non-competitive procurement waiver to permit a host country contract, with an approximate value of $1,000,000, with the Food and Agriculture Organization of the United Nations for the provision of the long and short-term technical assistance required for this Project.

- a procurement source/origin waiver from Geographic Code 000 (U.S.) to Geographic Code 935 (Special Free World) and a waiver of Section 636(i) of the FAA to allow purchase of project vehicles, motorcycles, and spare parts with an approximate value of $95,000.

- a waiver of Section 110(a) of the FAA which requires that the cooperating country make a contribution of at least 25% of the costs of the Project.

Justification for these waivers are appended to this memorandum.

Conditions and Covenants

The Project Agreement will include conditions precedent to disbursement requiring that: (a) the GOR demonstrate that its accounting systems are appropriate for effective tracking of local currency expenditures under this Project; and b) that the GOR develop the work plans and budgets necessary for effective project implementation.

The Project Agreement will also include covenants covering the assignment, training, and retention of personnel necessary for project implementation.

Congressional Apprisement

Congress was advised of A.I.D.'s intent to finance this Project in the FY 1981 Congressional Presentation. No further notification is required.

Responsible Officers

The officer responsible for backstopping this Project in AID/W is Mr. Robert F. Barnes (AFR/DR/CCWAP). The AAO/Kigali will manage the Project in the field.

Recommendation:

That you sign the attached Project Authorization and thereby approve: a) a grant from the ARDN appropriation to the Government of Rwanda in the amount of $2,470,000 to finance the Rwanda Fish Culture Project (696-0112); and b) the waivers as described in this memorandum and its appendices.

Attachments:
3 Waiver Justifications
Project Authorization
Project Paper

Drafted by:AFR/DR/CCWAP:RFBarnes:cel:8/17/81.

Clearances:

General Counsel:JBolton JRB Date: 9/2/81

AAA/PPC/PDPR:JEriksson T. Arlelin for Date: 9-1-81

Justification for a nationality waiver and a single source, noncompetitive procurement waiver to permit a host country contract with the U.N. Food and Agriculture Organization (FAO) for the services listed in the Discussion section below.

A.	Cooperating Country:	Rwanda
B.	Authorizing Document:	Project Authorization
C.	Project:	Rwanda Fish Culture (969-0112)
D.	Nature of Funding:	Grant
E.	Description of Services:	Two long-term technicians (8 years total) and twelve months of short-term consultancies
F.	Approximate Value:	$1,000,000
G.	Probable Source:	Food and Agriculture Organization, U.N.

Background: The technical assistance being requested includes both a Fish Culture Extension Specialist and a Fish Culture Training Advisor for the four year life-of-project, and short-term consultancies in such fields as rural engineering, aquaculture, rural economics, sociology, marketing, research and environmental monitoring. The long-term technical assistants will be required to have experience in fish culture programs under conditions which are similar to those which exist in rural Rwanda, and to have French language fluency in order to assist in preparing training curricula and in conducting formal and on-the-job training. Short-term assistants will need to have comparable technical and language skills.

The technical assistance team will direct construction and renovation at the National Fisheries Center to permit training of extension workers and farmers, and at each of the ten prefectural fingerling production/demonstration stations.

The team will also direct the training of Rwandan extension staff which will be conducted in-country. Training of key personnel will take place in the Ivory Coast and Nigeria.

Local costs for in-country procurement and for support to the Extension Service which AID has agreed to bear on a phase-out basis will be released by the technical team to the Rwandan Fish Service, and the use of these funds will be monitored by the team.

Discussion:

In accordance with AID Handbook 1, Supplement B, Chapter 5, Paragraph 5A1c, Code 941 is the authorized source for grants to RLDC's. Handbook 1B, Chapter 5, Section 5C4a(2) permits a waiver of this requirement under "such . . . circumstances as are determined to be critical to the success of the project objectives." AID regulations generally require, also, that competitive procedures be followed in the procurement of project services. Handbook 1B, Chapter 12, Paragraph 12C4a(2)(a)4 permits single source, negotiated procurement, however, if:

> One institution or firm can be demonstrated to have the unique capability by reason of special experience or facilities, or specialized personnel who are recognized as predominant experts in the particular field, to perform the services required for the project.

Nationality and single source, non-competitive procurement waivers to permit a host country contract with the FAO are recommended for the following reasons:

(A) AID has had little success in recruiting technicians with experience and with French language capability who are prepared to live in rural Rwanda over an extended period of time. Over the past fifteen months efforts have been underway to find technicians for four projects with no one yet in sight. The language requirement, the isolation of Rwanda, the lack of education and health facilities for children and employment opportunities for dependents are the most prevalent constraints to recruitment for Rwanda. The AID projects have suffered serious delays in implementation because of our inability to provide the necessary technical assistance.

The Fish Culture Project site, Kigembe, offers even more of an obstacle than usual since it is located one hour from the nearest small town (Butare) and is virtually without basic comforts. Should the technicians live in Butare, the lack of English-speaking schools realistically limits the field of recruitment to unmarried technicians or childless couples and thus further restricts the possibility of providing experienced and timely technical assistance.

The FAO, on the other hand, has a wide field for recruitment which includes French speakers. The FAO has fish culture specialists in many countries of the third world, including Africa, and has a pool of well-qualified, experienced technicians from which to draw, technicians who will not find the foreign atmosphere, or the isolation, impediments to accepting a long assignment in Rwanda.

(B) Administrative support requirements placed on AID have to be kept to a minimum. The AID mission in Rwanda is small and is likely to remain so. Every attempt has to be made to allow the use of the limited U.S. and Rwandan personnel as effectively as possible, including reduction in the amount of attention given to administrative support of contractors. For AID to support a contract team of two families based in Kigembe, as well as 12 months of short-term assistance in four years, will be time-consuming and difficult. With FAO technicians, administrative actions required of USAID will be substantially reduced. They will find their own housing, purchase furniture and appliances, clear customs, pack and ship their effects, arrange air travel, and use the international mail system.

(C) The FAO is already engaged in a lake fisheries project in Rwanda, the development of which parallels the AID project for pond fish farming. Implementation of both of these elements of fish production by the same agency can result in certain economies, particularly of short-term technical assistance requirements, and an interchange of expertise and information. Moreover, the coordination of the two projects which will be essential in later years as increased production from both lakes and ponds demands increasing attention to commercialization, processing and preservation will be assured if the FAO is the single implementing agency.

The FAO and AID have long been discussing ways to combine our special strengths and resources for the benefit of the LDC's. Initiatives to enter into a cooperative working relationship with FAO are under way. The arrangement requested herein is clearly in line with the AID policy of "doing more with less" by utilizing the expertise and administrative abilities of international organizations.

Recommendation. That you (a) approve a nationality waiver from Code 941 to Code 935 to allow procurement of the required technical services from FAO; (b) certify that the interests of the United States are best served by permitting the procurement of these services from Free World Countries other than the Cooperating Country and countries included in Code 941; and (c) approve a waiver permitting single source, non-competitive procurement of FAO's services.

Justification for a Procurement Source/Origin Waiver and a Waiver of Section 636(i) of the FAA for the Purchase of Project Vehicles and Motorcycles

A.	Cooperating Country	:	Rwanda	
B.	Name of Project	:	Fish Culture Project 696-0112	
C.	Nature of Funding	:	Grant	
D.	Description of Commodities	:	4 light pickup trucks	40,800
			1 small, light passenger car	7,300
			22 Motorcycles (125cc)	34,100
			Spare parts (15%)	12,330
				94,530
E.	Probable Origin	:	Japan, Brazil, France	
F.	Source	:	Rwanda	

Discussion

Section 636(i) of the Foreign Assistance Act of 1961, as amended, prohibits AID from purchasing motor vehicles unless such vehicles are manufactured in the United States. Section 636(i) does provide, however, that "..... where special circumstances exist, the President is authorized to waive the provision of this act in order to carry out the purpose of this act." That authority has been delegated to you.

Experience with U.S.-manufactured vehicles in Rwanda (a few in the possession of the U.S. Embassy in Kigali) indicates that frequent breakdowns can prevent operation of a U.S.-manufactured vehicle for weeks on end while spare parts are ordered from the United States. Even if the full range of spare parts required to maintain the vehicles were available, competent repair facilities outside the U.S. Embassy are non-existent. The situation is exacerbated as vehicles age and are subjected to poor maintenance. On the other hand, certain European and Japanese vehicle dealerships and many country garages carry spare parts and maintain acceptable repair facilities for European and Japanese model trucks and cars. In the case of motorcycles, only Japanese dealerships and repair facilities for Japanese products are available in Rwanda. Most of the European and Japanese model dealerships have competent mechanics who have been trained in the factories of the respective manufacturers.

Primary Justification

The vehicles and motorcycles covered by this waiver request, which can be serviced and repaired locally, are essential to the effective implementation of the Fish Culture Project. The trucks will be used by the technical assistants in the course of their work, and one for use by the Kigembe Fish Station. The latter will be replaced in the last year of the project. The

small vehicle will be used by the Rwandan on-going evaluation team. The motorcycles will be used as transport for the ten Prefectural Fish Station Managers and one will be purchased for the Kigembe Training Center and will be replaced in the last year of the project. As indicated previously, service capabilities and spare parts are not available for U.S.-manufactured vehicles.

Recommendation

Based on the foregoing, it is recommended that (1) you conclude that special circumstances exist which justify the waiver of the requirement of procurement of U.S.-manufactured vehicles and motorcycles under the FAA Section 636(i), and (2) you certify that exclusion of procurement from the sources requested herein would seriously impede attainment of United States foreign policy objectives and objectives of the Foreign Assistance Program.

Justification for a Waiver of the Requirement of Section 110(a) of the FAA of a Host Country Contribution of at least 25% of Project Costs

A. Cooperating Country : Rwanda

B. Project : Fish Culture (696-0112)

C. Nature of Funding : Grant

Discussion

Section 110(a) of the Foreign Assistance Act of 1961, as amended ("FAA"), provides that: "No assistance shall be furnished by the United States Government to a country under Section 103 through 106 of this Act until the country provides assurances to the President, and the President is satisfied, that such country will provide at least 25% of the costs of the entire program, project, or activity with respect to which such assistance is to be furnished, except that such costs borne by such country may be provided on an 'in-kind' basis."

FAA Section 124(d) authorizes a waiver, on a case-by-case basis, on the requirement of FAA Section 110(a) for financial or "in-kind" contributions in the case of programs, projects or activities in relatively least developed countries. Rwanda is on the UNCTAD list of relatively least developed countries. A.I.D. regulations implementing FAA Sections 110(a) and 124(d) are set forth in A.I.D. Handbook 3, Chapter 3, Appendix 3D. With respect to the exercise of the waiver authority, Appendix 3D, Section B2 provides that it is reasonable to conclude that granting of a waiver is permissible whenever the initiation and execution of an otherwise desirable project is handicapped primarily by the 25% contribution requirement. Appendix 3D sets forth general considerations which should be taken into account in determining when a waiver of FAA Section 110(a) would be appropriate. These considerations relate to financial constraints, country commitment, nature of the project, phased contribution and other factors. These considerations, as they relate to Rwanda, are set forth hereafter.

Financial Constraints: Since Rwanda is on the UN's list of least developed countries and is reported by the World Bank to be one of the six poorest countries in the world, special consideration is merited with respect to the required level of GOR support. The GOR's contribution amounts to 19% of total project costs. Much of this contribution represents human rather than financial resources. The value of this human resource contribution is understated because of the relatively low salary scales for professional and skilled workers prevailing in Rwanda. Rwanda's fiscal situation will not permit a greater financial contribution to the project.

Country Commitment: There is strong presidential and party support for the project and its objectives. This high level of commitment on the part of the GOR is underscored by the government's willingness to provide a generous amount of very scarce trained human resources to the project.

Recommendation

That you approve the waiver of the FAA Section 110(a) requirement that Rwanda contribute 25% or more of the project costs for the Rwanda Fish Culture Project (696-0112).

UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D C 20523

PROJECT AUTHORIZATION

Country: Rwanda

Project Title: Rwanda Fish Culture Project

Project No.: 696-0112

1. Pursuant to Section 103 of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Rwanda Fish Culture Project for Rwanda involving planned obligations of not to exceed $2,470,000 in grant funds over a three year period from the date of authorization, subject to the availability of funds in accordance with the AID OYB/allotment process, to help in financing foreign exchange and local currency costs for the project.

2. The purpose of the Rwanda Fish Culture Project is to develop a fisheries extension service in Rwanda that can provide the assistance and advice required by Rwandan farm families to bring back into production and effectively manage at least 80% of the 3000 fish ponds which already exist in the country. The project will provide assistance in two areas. First, it will provide training and supervision for 12 acquaculture supervisors and 50 fish monitors who will form the extension link with the local farmers. Second, it will provide for the renovation of the National Fisheries Training Center at Kigembe and of the ten prefectural fish stations scattered throughout the country. These facilities will be used for training, demonstration, fingerling production, and research.

3. The Project Agreement, which may be negotiated and executed by the officer to whom such authority is delegated in accordance with AID regulations and Delegations of Authority, shall be subject the following essential terms and covenants and major conditions, together with such other terms and conditions as AID may deem appropriate.

4a. Source and Origin of Goods and Services.

Goods and services, except for ocean shipping, financed by AID under the project shall have their source and origin in the Cooperating Country or in countries included in AID Geographic Code 941, except as AID may otherwise agree in writing. Ocean shipping financed by AID under the project shall, except as AID may otherwise agree in writing, be financed only on flag vessels of the United States or the Cooperating Country.

b. Waivers

(1) Notwithstanding paragraph a. above, the following waivers are hereby approved:

A nationality waiver from Geographic Code 941 to Code 935 and a single source, non-competitive procurement waiver, based upon the justification set forth in Appendix A, attached hereto, to permit the procurement of services with an approximate value of $1,000,000 from the Food and Agricultural Organization of the United Nations (F.A.O.). It is hereby determined that the interests of the United States are best served by permitting the procurement of these services from Free World countries other than the Cooperating Country and countries included in Code 941. This waiver is to be exercised only if no satisfactory Code 941 firms can be located after a reasonable search has been made.

A vehicle procurement source/origin waiver from Geographic Code 000 to Geographic Code 935 and a waiver of Section 636(i) of the Foreign Assistance Act of 1961, as amended, for the purchase of project vehicles, motorcycles, and spare parts with an approximate value of $95,000, based on the justification set forth in Appendix B, attached hereto. It is hereby determined that exclusion of the procurement of the subject vehicles from Free World countries other than the Cooperating Country and countries included in Code 941 would seriously impede attainment of U.S. foreign policy objectives and the objectives of the Foreign Assistance program.

(2) A waiver of the requirement of Section 110(a) of the Foreign Assistance Act of 1961, as amended, that the Cooperating Country contribute at least 25% of the total costs of the project is hereby approved, based on the justification set forth in Appendix C, attached hereto.

c. Conditions Precedent

The following conditions precedent will be included in substance in the Project Agreement:

(1) Prior to any disbursement under the Grant, or the issuance of any commitment documents with respect thereto, the Government of Rwanda (GOR) shall furnish, except as the parties may otherwise agree in writing, in form and substance satisfactory to A.I.D., evidence of the existence of adequate accounting procedures for tracking local currency expenditures.

(2) Prior to any disbursement under the Grant to finance any item other than technical assistance during the first year of the Project, or the issuance of any commitment documents with respect thereto, the GOR shall furnish, except as the parties may otherwise agree in writing, in form and substance satisfactory to A.I.D., the first annual work plan and a detailed budget setting out expenditures required to carry out the work plan.

(3) Prior to any disbursement under the Grant to finance any item other than technical assistance during each year of the Project subsequent to the first, or the issuance of any commitment documents with respect thereto, the GOR shall furnish, except as A.I.D. may otherwise agree in writing, in form and substance satisfactory to A.I.D., the work plan for that year and a detailed budget setting out expenditures required to carry out the work plan.

d. Covenants

The following covenants will be included in substance in the Project Agreement:

(1) The GOR agrees that suitable candidates for project-financed training will be made available on timely basis.

(2) The GOR agrees that persons trained under the Project subsequently will be assigned or retained in positions with the Ministry of Agriculture commensurate with the nature and level of training received or in such other positions as the parties to the Agreement may agree in writing.

(3) The GOR agrees that payment of salaries to staff of the Division of Fisheries and Fish Culture of the Ministry of Agriculture and Animal Husbandry and to prefectural agronomes will commence according to the schedule indicated in the budget section of the Project Agreement.

Date: Sept 16, 1981

M. Peter McPherson
Administrator

Clearances:
GC:JRBolton
PPC:LSmucker
AA/AFR:FSRuddy

PROJECT PAPER

RWANDA FISH CULTURE

Project 696-0112

January 1981

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PROJECT PAPER

RWANDA FISH CULTURE

Project 696-0112

I. Background*

Possibly the single most serious problem facing Rwanda over the next 15-20 years will be to maintain levels of food production increases which keep pace with the projected population growth rate. All indications are that the population growth rate is in the 4 percentile and that the present population of approximately 5 million people will double in 10-15 years. In fact, production increases for both food and industrial crops has been around 3%, not adequate to meet needs. Every effort is being made by the government to increase food production and, at the same time, to introduce and encourage the production of more nutritious crops. It is estimated by the Food and Agriculture Organization that the average Rwandan gets less than 80% of minimum calorie requirements.

Production increases in the recent past have been achieved by putting new land into cultivation, much of it marginally productive land. The government and the donors are optimistic that a coordinated and concerted effort in research, extension and improved cultural techniques can realize significant increases in yields per hectare (yields have, in fact, been decreasing), whereas the relatively good soils and the two rainy seasons already provide the advantage of two or three crops a year and has allowed Rwanda to remain largely food self-sufficient. With the rapidly increasing population, however, this food requirement/availability equilibrium cannot continue, hence the concern and the urgency of programs to increase food production.

Among a series of steps being taken by the government to improve rural production (the reader is again referred to the Rwanda CDSS, particularly the sections on Progress and Commitment and Host Country Development Plan) is a country-wide program to increase fish production in the many lakes which dot Rwanda and in small family or group ponds which are found, and can be created, in the extensive valley system. It is this latter effort, fish culture at the family and cooperative level, which the Government of Rwanda has asked AID to finance.

In the course of preparing this Project Paper, the following studies were completed.

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*The development setting for the proposed Rwanda Fish Culture project is contained in the Rwanda CDSS and is not repeated here.

1. "Inventaire des Problèmes Liés à la Production Piscicole au Rwanda" (a sociocultural study of the possibility of fish culture in rural Rwanda), by NDENGEJEHO Pascal Baylon, IPNR, May 1980. (Available in AFR/DR and REDSO/EA).
2. "The Technical, Economic, Financial and Social Feasibility of Small-scale Rural Fish Culture Development in Rwanda," by U.W. Schmidt and M.M.J. Vincke, FAO, December 1980. (Annex E).
3. Environmental Assessment of Rwanda Fish Culture Project. Jerry Hall, Professional Analysts, Inc., November 1980. (Annex F).
4. Technical feasibility analysis. John Grover and Peter Galbreath, Auburn University, June 1980. (Incorporated into the PP).
5. Engineering analysis. (A) Glen Anders, AID/Rwanda. (B) Robert Adams, REDSO/EA. (C) AIDR, under contract to AID/Rwanda. (Incorporated into the PP).

History of Fish Production in Rwanda

One can trace the promotion of fish production back to 1935 when the Mandate Administration began a program to stock several lakes with Tilapia negra brought from Lake Bunyone in Uganda and Tilapia nilotica from Lake Kivu. Records indicate that in 1945, 300 tons of fish were pulled from Lake Muhazi alone, and the level reached 460 tons in 1949. Today, lake fish production country-wide is approximately 700 tons/year, indicating that little progress has been made since those early days.

After the Second World War, when Rwanda came under the protectorship of the United Nations, a renewed effort at development of the rural economy included reinforcement of the lake fish production efforts and, for the first time, encouragement of upland fish culture. The Kigembe Center, which will play a major role in the AID project, was established in 1954, and a large number of small ponds were also created throughout the country. This program was largely unsuccessful and, for the most part, the ponds were abandoned in the early 1960's, but not for long. With independence, a new effort was launched which included putting the Kigembe Center back into production and distributing fingerlings to 270 ponds. The Kigembe Center and the ponds which remain in working condition form the basis for present-day efforts to reestablish viable on-farm fishponds.

A number of reasons are ascribed to the failure of previous efforts at fish culture--from the fact that, in pre-independence, fish culture was decreed rather than voluntary, to the fact that the state of the art was not sufficiently advanced and that what was known was not adequately transmitted to the rural participating population. The 1970's has seen a rebirth in attempts at fish culture. The fact that over 3,000 individual and group ponds are presently being farmed, even with very low yields, supports the findings contained in the Ndengejeho study, "Inventaire des Problèmes Liés à la Production Piscicole," that the anti-colonialist feeling, at least as it

pertains to fish culture, is no longer a constraint and that the lack of an effective extension system is the most important constraint to upland fish culture. Fish culture production in 1978 is estimated at 15 tons.

Recent donor financial support for fish production in Rwanda has been rather meager but is on the increase. The most important programs have been a combined FAO-IDRC effort at developing the fishing potential at Lake Kivu.* This project is training and equipping groups of fishermen who will be working on the lake. At the same time, the project is evaluating existing lake stock in order to determine the off-take limitations.

More important from the point of view of AID, the project is evaluating native species for fish culture. This component of the project has renovated the National Center for Fish at Kigembe and provides a Director to the Center. The IDRC Assistant Director for Fisheries, W.H.L. Allsopp, has indicated IDRC's desire to have AID or some other donor build on the foundation that IDRC assistance has helped initiate. IDRC thinks that further capital development is needed at the Kigembe station as well as a meaningful program for use of the facilities in fish culture training and outreach. Future IDRC support will be limited to research.

II. Project Description

The objectives of the project will be accomplished by support of an extension program to give farmers the necessary skills and fish seed stock to achieve production results based on adoption of technology already demonstrated in other African countries.

A. Project Goal. Increase the availability of nutritious food in general, and the incomes of participating families.

B. Project Purpose. Develop the capacity of Rwandan farm families to build and maintain productive on-farm fishponds.

Maximizing the use of its limited land resources is absolutely essential if Rwanda is to avoid massive food assistance and the social and political upheavals which inevitably accompany a potential famine situation. Alternatives to agriculture simply do not exist for Rwanda. And, while increases in staple grain and tuber crops are very possible, increasing the availability of essential animal fats to the diet is not nearly as encouraging. Livestock production is limited and is not likely to increase, given the scarcity of cultivatable and range land. The average farmer, with less than one hectare, can support, at best, a few goats or sheep.

Fish culture, then, can present a real and attractive opportunity to provide nutritious food while using relatively little land. Nutrition is a major problem in Rwanda and is directly related to the large population vis-à-vis limited agricultural production. Rwandans only receive 70-80%

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*IDRC. International Development Research Centre, Vancouver, Canada.

of their basic caloric requirement--less than 2,000 calories of which 3 grams are of animal protein. Further study would very likely show the trend to be down. Nutrition problems are concentrated in the young. The high under 5 mortality rate and a high maternal child-bearing death rate are partially attributable to weak physical condition and low resistance brought on by mal- and under-nutrition.

Fish, on the other hand, are an important source of both protein and calories. It is estimated that, within the Rwandan context, adding fish to the diet three times per week (50 grams/week) one fish each time for a family of five, will provide roughly 15% of the family's protein requirements. Fish are equivalent nutritionally to meat as a source of protein and are high in essential minerals--calcium, phosphorus and iron, as well as a source of niacin.

The Rwanda CDSS establishes that one of the principal factors contributing to rural poverty is the lack of access to adequate productive land. This project cannot overcome that constraint. What the project can do is to offer the possibility for participating farmers to increase their income. This will not happen immediately, obviously. It is expected that for the first years of the project, virtually all fish harvested will be consumed on the farm or used as an article of barter for other kinds of food and for labor.

The Ndengejeho study indicated that virtually all families who are presently engaged in fish culture choose to sell a portion of their harvest in order to purchase other necessities. While this may, in fact, be a barter transaction, it is not clear from the report.

As production reaches a certain level (toward the end of the project or even into a second phase) both on the farm and in the commune, and as the indigenous marketing system adjusts itself to absorb fish as a regular commodity, cash flow will begin to materialize. (See Economic Analysis, Part III, C. of the PP). Obviously those directing the project will have to keep a close watch on production and demand to determine if an external intervention is necessary. The feasibility of drying and smoking excess production, for example, should be assessed as and if the need arises, as should the possibility of encouraging cooperative marketing of fish.

Social soundness studies completed for this project confirm that there is a strong demand for fish throughout the countryside. Ndengejeho states that the general demand for fish is much higher than the supply and that the requirement for preservation of fish has not yet arisen. He also states that there is general knowledge of sun drying, salting and smoking techniques.

As the project proceeds through its phases, the nature and extent of the demand will be retested and as increasing demand is felt, it can be met. If, on the other hand, increased demand does not materialize, the

phasing of the project offers an opportunity to slow down, to re-trench, or to phase out altogether.

C. The AID Project Elements and Related Inputs

The most important constraint being addressed by the project is the lack of effective farmer training in the techniques of fish culture. The project seeks to provide that training in several ways.

First, the extension service will be strengthened. This will involve some additional personnel, training of fish extension agents of all levels, and giving them the mobility to get out to farmers. Second, there will be strong emphasis on group production. There are already a number of pre-cooperatives who operate fishponds. This concept will be fostered among other potential groups and particularly among women's groups, youth, in schools and other institutions, etc. The opportunity will exist for a representative of each group to receive training at the Kigembe center or at one of the regional centers.

Third, assistance will be given to agricultural and rural training institutions to incorporate fish culture training into their programs. Specifically, the Agricultural School for Women at Nyagahanga, the only school in the country which trains women A-2 level extension agents, will be able to put in a fishpond, with necessary equipment, to allow practical application of fish culture techniques already a part of classroom work. The same will be done for the Agriculture School at Butare which trains male A-2's.

The Rwandan Scout Association has an impressive and well-organized training center at Butare where they offer 6-month training for scout leaders and weekend training for scouts. The Scout Center already has an established outreach program and offers an excellent opportunity for training and for group organizations to grow fish.

Fourth, AID, under another project, is financing the construction of 30 Rural Training Centers and is providing technical assistance to the Ministry of National Education to develop a rural-oriented curricula for the schools. Where appropriate, fishponds can be built close to the schools and fish culture taught as part of the curriculum.

Finally, there are other youth training centers operated by the Ministry of Youth, there are correctional institutions for young offenders, and there are numerous mission schools, etc., which offer similar opportunities to train young men and women in fish culture.

The key to success of the project will be the ability of the Fisheries and Fish Culture Service to provide training to its own agents, to train farmers and to provide adequate and timely follow-up to the farm. To strengthen the Service in this job, the Ministry of Agriculture and Livestock has agreed to provide ten A-2 level agronomes who will be given

long-term training in fish culture techniques and, over the life of the project, 50 fish culture monitors who will also be trained, but in-country. AID will provide the following:

1. Construction and Renovation of Fish Stations

(A) Kigembe National Fish Station and Training Center. The project will begin with the renovation and supplemental construction, and equipping, of the National Fish Center at Kigembe. This Center, already a recipient of Canadian aid, will become a national training center in fish culture. The first phase of the project will also begin working with three of the ten prefectural fish stations—Butare, Gikongoro, and Gitarama. The ten prefectural stations, of 1-2 hectares each, are to serve as fingerling and fish production ponds, as demonstration centers and as sites for training of fish monitors and farmers themselves. The extension outreach program will be directed from these centers. Renovation, equipping and establishing training and outreach programs at the remaining seven prefectural centers will be carried out in phases over the life of the project. The three prefectures which border Lake Kivu, Gisenyi, Kibuye and Cyangugu enjoy the last priority for development of fish culture in view of the possibilities for capture fishing from the lake. The analysis of this PP, particularly the Economic Analysis, limits itself to the seven inland prefectures. From the prefectural stations, the prefectural fish culture extension programs will be directed by A-2 level* fish specialists trained in fish culture, whose sole job will be fish culture in his/her prefecture.

The Kigembe Center will serve as the main site for training of fish monitors (3 months), representatives of farmer groups and farmers themselves (1-5 days), and will provide country specific training to the A-2 fish specialists (2 weeks). The Center will also prepare training and extension materials to be used by the prefectural stations and the extension agents. The Center will assist, where necessary and where it can, in developing and assisting in training programs for appropriate education institutions, youth training centers, etc.

The Kigembe Center, which was constructed in 1954, is still in good condition. Repairs are necessary and, if the Center is to expand to be used for fish culture training, additional buildings and repairs to existing buildings will be required. A complete description of the Center, the construction/renovation necessary, the equipment which the project will purchase and the personnel to be provided to operate the Center are provided in the Engineering Analysis, Part III, D.

(B) Prefectural Fish Stations. These exist in all 10 prefectures but are in varying degrees of operability. Site visits were made to five of the fish stations where it was determined that a minimum amount of work will be needed to bring them up to an acceptable standard. The

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*A-2 level agents are graduates of an agricultural school. A-3 level agents are primary school graduates with special training.

description of the five sites visited, the construction and renovation requirements, the equipment needed at the stations, and the personnel needed to operate them are contained in the Engineering Analysis, Part III, D.

(C) Other Institutions. Small pond construction will be required at those ancillary training institutions which will offer training in fish culture and which are suitably located and with the expertise to do so. In particular, the Women's Agricultural School at Nyagahanga and the Scout Center at Butare have requested such help. While neither of these or other institutions are at a stage where their exact requirements can be determined, a small amount of funding is provided for this purpose, to be released upon approval of AID.

2. Training

(A) Prefecture level station managers-supervisors. Eight Rwandans have been trained at the Centre de Formation Piscicole at Bouake, Ivory Coast, of whom three are already assigned to prefectural fishponds and will be incorporated into the AID project. Two additional A-2 agronomes are scheduled to be trained at Bouake beginning in September 1981, financed under the AMDP project as part of pre-project implementation. The project will fund the training of an additional seven agronomes at Bouake or at another appropriate training center, providing in all, 12 fish culture specialists to staff the 10 prefectural fishponds, the Kigembe Center, and to provide training specialists and supervisors to the institutional training program described above.

In addition to their duties as managers of the Prefectural Fish Stations, the A-2 fish culture specialists will have the responsibility of supervising the field level extension agents (fish monitors), providing demonstration and training opportunities to farmers and collecting data on fish production within the prefecture.

These A-2 agents will participate in an in-country training program of short duration which will orient them to the special situation which Rwanda presents. The objectives of this training, to be held at the Kigembe Center, will be:

(1) a review of basic fish culture techniques

(2) practical exercises in the culture of Tilapia nilotica, the culture species of choice in this project

(3) training in extension work theory and methodology

(4) acquaintance with the organization and methods of the extension program in which they will be working

(5) acquaintance with the stations, personnel and extension programs in the other prefectures

(B) Fish Culture Monitors. The monitors are low-level government agents who have direct contact with the farmer. Fifty monitors will be working on the project. Each will be assigned to provide extension services to a certain number of farmers in a commune where fish culture potential exists. The qualifications for these agents are that they have a primary school education and have attended several years of intermediate vocational training at the Rural Training Centers. They are literate in Kinyarwanda and may know some French.

Special training in fish culture technology and extension work methods will be provided to the monitors at the Kigembe Fish Station. The training will be directed by the Center Director with the help of U.S. technical assistance. The training will take approximately three months and will be held for groups of up to ten persons. An outline of the subject matter to be covered in both the theoretical and practical training sessions is contained in Annex J.

At the completion of the training, each monitor will be provided a kit of basic tools and a bicycle. The basic tools will consist of a handbook containing reference material and forms for recording and reporting activities, a backpack, fish measuring board, spring scale and small bucket, thermometer, and simple tools to maintain his bicycle.

The monitors will be supervised on a continuing basis by the Prefectural level Fish Station Manager.

(C) Farmer Training Programs and Demonstrations. Training of individual farmers, nominated members of farmer groups, youth groups, etc., will take place both at the Kigembe Center and at the Prefectural fishponds. Training programs of two or three days will be arranged at the Kigembe Center where there will be dormitory and eating facilities. Training at the prefectural centers will generally be on a daily basis and serve the needs of the farmers within walking distance of the prefectural ponds. Demonstrations will be arranged by the Kigembe Center and by the Prefectural Station Managers. These programs can be presented in a variety of formats--lectures, method demonstrations, slide shows, short courses with theoretical and practical exercises, etc. The formulation and scheduling of this type of training will be the responsibility of the Kigembe Center and the Prefectural Fish Station Managers.

(D) Other Training Opportunities. Specialists at the Kigembe Center and at the Prefectural Fish Stations will be available to assist other education institutions (Ag schools, CERAI's. Scouts, etc.) in establishing training courses and to advise on fishpond construction and operation. Training will also be available for fish culture instructors in the training institutions mentioned above (CERAI's, Scout Center, Youth Centers).

3. Technical Assistance

AID will provide two U.S. experts to the project, a Training Advisor/Team Leader and a Fish Culture Extension Specialist. They will be with the

project over the life of the project--four years. In addition, ten months of short-term consultancies are provided, in such fields as rural engineering, marketing, social analysis, etc. The exact nature of the short-term technical assistance will be determined as the project progresses and the need arises. The short-term consultancies will include two months of assistance in the monitoring of the ponds to determine the presence of schistosome snails, as recommended in the Environmental Assessment (Annex F), and two months for project evaluations to be conducted two years into the project and at the end of the project. Funds for a contract with a Rwandan sociologist and economist to conduct ongoing project evaluations are also included (See Part III, G, Evaluation Plan).

The IDRC has provided a Togolese Director for the Center. It is not yet certain if the IDRC will be in a position to continue this assistance after its present project ends in 1981. In the event that they are necessary, funds have been provided in the project to continue the Togolese Director for an additional two years beyond the end of his present contract. Should it materialize that these funds are not necessary, they will be re-budgeted into the training component of the project.

4. Commodities

Three small pickup trucks will be required at the beginning of the project, one for use by each of the technical assistants in the course of his work, and one for use by the Kigembe Fish Station. The Kigembe Center truck will be replaced in the fourth year of the project. Motorcycles will be the mode of transport provided by the project for the ten Prefectural Fish Station Managers, and one will be purchased for the Kigembe Training Center. Each will be replaced during the fourth year of the project. The fish monitors will be provided bicycles, all of which will be replaced during the fourth year of the project. A small vehicle (VW) will be required for the two-person Rwandan team who will be conducting the on-going evaluation.

A certain amount of equipment will be required at the Kigembe Center and at each of the Prefectural Fish Stations. Dormitory furnishings and equipment for the kitchen at the Kigembe Center will be provided by the project, as will a small amount of office furniture. Training equipment will also be provided to the Center. The complete list of commodities to be purchased is provided in Annex G.

5. Local Support Costs

The project will fund the operation and maintenance of vehicles and motorcycles, including the purchase of spare parts over the life of the project. Certain local employees whose hire is necessitated by the presence of the U.S. technical assistance (chauffeurs, secretaries) will be paid by the project over the life of the project and will not be retained beyond that life. Other local employees of a non-professional

nature who will be required as essential to the project (laborers and guards primarily, but also some semi-skilled staff) will be initially paid by the project but will become a charge on the GOR budget as the project progresses. The formula worked out with the government is that the project will pay the personnel entirely for the first two years, fifty percent for the third year and twenty-five percent during the fourth year. A discussion of recurrent costs, and the possibility of using proceeds from fish production at the Kigembe Center and at the Prefectural Fish Stations to cover a portion of the GOR costs for local employees is contained in Part III, F of this PP.

D. Research

The technical analysis supporting this Project Paper clearly shows that the technology exists for fish farming under the environmental conditions of Rwanda. This technology has been tested under reasonably controlled conditions at the Kigembe National Fish Center, and under actual farmer conditions at ponds within the vicinity of Kigembe. More recently, field trials on isolated ponds were conducted, particularly to test the utilization of brewery wastes for fish culture, using the species tilapia nilotica. The test results indicate that, under present conditions, the utilization of brewery wastes for pond culture gives reasonable growth rates for this species. Nonetheless, an on-going technical research element, in the form of field trials and testing, is included in the project as a means of ascertaining the optimum package for the several ecological zones of the country, given the particular economic and social structure found here.

The field trials will be designed by the technical assistance provided to the project and will be carried out by the Rwandan fish extension service under the direction of the AID technical assistance. Technical data will be compiled and evaluated along with the socioeconomic data to be collected by the Rwanda evaluation team (see Part III, G. Evaluation Plan). The field trial effort will be particularly intensive during the first phase of the project, as fish culture is reintroduced to the first three prefectures.

E. Production Outputs

With an adequate number of well-trained extension workers, fully equipped to carry out their tasks, and with a regular supply of required fingerlings, the following results are expected one year after project implementation effectively begins.

(i) About 80 percent of the existing ponds in the three concerned prefectures will again be in production;

(ii) Average yield will be 500 kg fish per ha/year (5 kg/are/year);

(iii) The rate of construction of new ponds will be between three and five percent per twelve months;

(iv) The total production of the 1,061 ponds will be 20,095 kg of fish.

The inputs/outputs expected at the end of the first year of the program are given in the following table:

Table 1

Fish culture programme at the end of the first year of Project Implementation.

Prefecture	No. of existing ponds (1976)	Rehabilitated ponds a/ No.	Rehabilitated ponds a/ Surface (are)	Rate of construction of new ponds b/	Ponds and production end of the first year No.	Ponds and production end of the first year Area c/ (are)	Ponds and production end of the first year Production d/ (kg)	No. of fingerlings needed for stocking e/
Gifarana	326	500	1 065	+ 5%	525	1 575	7 875	315 000
Butare	541	433	1 353	+ 5%	455	2 047	10 235	409 000
Gikongoro	160	128	362	+ 4%	133	399	1 995	79 800
Total	1 327	1 061	3 280		1113	4 021	20 105	803 800

Notes:

a/ It is assumed that after the first year of the project 80% of the existing ponds in the three prefectures will have been rehabilitated, and stocked with fingerlings.

b/ Estimates, taking into account percentage of inhabitants, involved in fish farming in each prefecture, distribution of existing ponds (see Table 3) and number of extension workers assigned in each prefecture.

c/ Calculated as follows: average area of one pond is 3 ares in the prefectures of Gifarana and Gikongoro, and 4.5 ares in the Butare prefecture.

d/ Calculation based on an average yield of 5 kg fish/are/year (or 500 kg/ha/year).

e/ Calculation based on a stocking rate of Tilapia nilotica fingerlings per m^2, or 200 fingerlings/are.

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It can be anticipated that the annual increase of the number of ponds will be around 5 percent during the first years of the programme and will reach 10 percent in the fourth year. Also, with effective and dynamic extension work, it can be expected that the average pond area will increase slowly, year after year, to reach an average of 500 m^2 in the fourth year of the programme.

Under intensive management of fish ponds (adequate stocking, required fertilization of the pond and balanced feeding), yields from 30-50 kg are/year (or 3-5 tons of fish per ha/year) can be obtained in rural aquaculture. Experience obtained in other African countries, culturing T. nilotica, shows that:

(i) the average yield in rural fish farming is between 18 and 20 kg fish/are/year;

(ii) the average fishpond has a surface of 1.5 ares (150 m^2), but progressive fish farmers have ponds measuring up to 10 ares, and that

(iii) it is possible to divide fish farmers into three groups according to the level of fishpond management:

(a) Group I - Consists of owners of ponds who do not take care of their ponds and do not feed their fish. Depending on the region, between 40 and 56% of the farmers belong to this group, and the yields in their fishponds are below 15 kg/are/year, with an average of 7-8 kg/are/year.

(b) Group II - Between 31 and 46% of the farmers belong to this group with yields between 15 and 39 kg of fish/are/year. Average yield is 24 kg/are/year. Farmers take care of and maintain their ponds, they fertilize the ponds with compost and feed the fishes several times a week.

(c) Group III - Concerns about 10-12% of the farmers who produce 40 kg and more fish per are/year, with an average of 55 kg/are/year. The farmers belonging to this group are maintaining bigger ponds (8-10 ares), regularly apply compost and manure, and feed their fishes daily, using feedstuffs rich in protein such as oil cakes.

According to the above findings, it appears realistic to expect that during a 4-year aquaculture development programme, the average yields with typical management of fishponds will be as follows:

first year :	5 kg fish/are/year
second year:	7 kg fish/are/year
third year :	10 kg fish/are/year
fourth year:	15 kg fish/are/year

Table 2 shows the expected increase, during a 4-year extension programme, of the number of ponds, the required fingerlings for stocking, and the expected production.

Table 2

Expected Increase during a 4-year intervention period

Prefectures	End of first year[a/]				End of year			
	No. of ponds	Surface (are)[b/]	Fingerling requirements	Expected production (kg/year)[c/]	No. of ponds[a/]	Surface (are)[b/]	Fingerling requirements	Expected production (kg/year)[c/]
Gitarama	525	1 575	315 000	7 875	551	1 653	330 600	11 571
Butare	455	2 047	409 400	10 235	476	2 141	430 200	13 657
Gikongoro	133	399	79 800	1 995	140	420	84 000	2 940
Cyangugu	–	–	–	–	61	183	45 000	1 761
Kibuye	–	–	–	–	133	399	159 000	5 565
Gisenyi	–	–	–	–	35	105	21 000	735
Total	1 113	4 021	803 200	20 105	1 434	5 302	1 073 400	37 569

Notes:

a/ It is assumed that after the first year of the project 50% of the existing ponds will have been rehabilitated, stocked and begin in production.

b/ The surface is estimated as follows: average area of one pond is 3 ares in the prefectures of Ruhengeri, Gitarama, Gikongoro, Cyangugu and Kibuye; 4.5 ares in the Butare prefecture, and 5 ares in the prefecture of Gisenyi (see Table 3).

c/ Production levels are as follows: first year, 5 kg fish per are/year; second year, 7 kg fish per are/year; third year, 10 kg fish per are/year; fourth year, 15 kg fish per are/year (see section 2.4...).

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Table 2 (page 2)

Prefectures	Third Year				Fourth Year			
	No. of ponds[d]	Surface (are)[e]	Fingerling requirements	Expected production (kg/year)[c]	No. of ponds[d]	Surface (are)[e]	Fingerling requirements	Expected production (kg/year)[c]
Kigali	664	2 415	483 200	24 150	664	3 320	664 000	49 800
Gitarama	579	2 027	405 400	20 270	637	2 185	637 000	47 775
Butare	502	2 510	502 000	25 100	552	2 760	552 000	41 400
Gikongoro	147	515	103 000	5 150	162	810	162 000	12 150
Kibuye	85	255	51 000	2 550	94	470	94 000	7 050
Gisenyi	167	835	167 000	8 350	184	920	184 000	13 800
Ruhengeri	37	111	22 200	1 110	41	205	41 000	3 075
Total	2 121	8 669	1 733 800	86 690	2 334	11 670	2 334 000	175 050

Notes:

a/ Annual increase is assumed to be 5%.

b/ Average area of one pond is 3 ares in the Ruhengeri and Kibuye préfectures; 3.5 ares in the Gitarama and Gikongoro préfectures; 4 ares in the Kigali préfecture, and 5 ares in the Butare and Cyangugu préfectures.

c/ Annual increase is assumed to be 10%.

d/ It is assumed that the surface of all the ponds is 5 ares (= 500 m^2).

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The dimensions of the potential impact of the project on the rural population is discussed in the Beneficiary Analysis, Part III, A.

III. Project Analyses

A. Social Soundness and Beneficiary Analysis

The social structure of a rural society is to be seen, basically, as the organizational reflection of the production structure under which the goods and material values necessary for the subsistence of the producers are generated. Any change in the production structure of a social entity will change its social organization, while social change may alter the organization of production. To estimate the quality and quantity of socio-economic change into which the introduction of improved fish culture techniques may result, the existing social, cultural and economic organization must be examined, in order to assess the possible impact of the intervention.

1. Present land ownership patterns. In 1975, a total of about 830,000 farms with a statistical mean land holding of about 1 ha (0.91 in 1979) existed in Rwanda.

A study undertaken in the Byumba Prefecture in 1973 (IBRD, 1977) identified three strata of farm sizes:

(i) 36% of the farms have less than 80 ares (half the average);

(ii) 35% of the farms have between 80 and 160 ares (between half the average and the average);

(iii) 29% of the farms have more than 160 ares (the average) and the largest are five times the size of the average.

The study also showed a fragmentation of the farm into an average of five fields, some of which were within 15 to 30 minutes walking distance from the homestead.

Farmers have a habitual rather than a legally-defined right to land use. Legally, all land belongs to the government, and transfers of land use rights or allocation of newly-cultivated land have to be approved by the burgomaster of the respective commune. In some areas, a trend to buy land-use rights has been reported in recent years. Financially better-off farmers, usually the ones who grow cash crops, thus gain control of seven or more hectares and employ the former cultivators on a full-time wage labor basis.

With respect to fish culture development, the present land ownership structure is not expected to be altered nor does it need to be. On a long-term basis and if fish culture generates a large cash surplus for some industrious farmers, the trend of land alienation could be affected.

2. Organizational structures. Agricultural production traditionally has been and still is based on the nuclear family. The nuclear family comprises the farmer, his wife (or wives, for the once widespread, but lately diminishing practice of polygamy), and their unmarried children. It may also include unmarried brothers or sisters and the old. The nuclear family produces for subsistence and the market, forming an ideally self-sufficient and independent production unit. Inheritance is patrilinear, i.e., the father will pass on house, land, tools, etc. to his sons. In the case that the land is not sufficient, he has to claim new land for them by bringing it under cultivation. The role of larger kinship organizations/patrilineages which formerly had a strong influence in land allocation, has been increasingly taken over by the administration (commune), which now has to approve any land transfer.

Kinship and neighborhood ties within a locality, based on mutual assistance and communal organization of public works and social functions, have remained relatively intact. Within the family, the farm labor is divided along sex lines, with banana cultivation, cash crop production and animal husbandry, as well as tasks requiring physical strength being done by the men and foodcrop production being done by the women.

A proportion of working hours, which may be substantial on some farms, is set aside for non-agricultural activities like handicrafts and trading.

On the basis of the existing information on the production structures, it appears that the present socio-economic organization of the family farm and its setting into kinship and administration structures will not be affected significantly by the innovation or reactivation of fish culture in the rural milieu. The social organization of the family does not have to be altered in order to include fish farming in the production pattern. Only the structure of labor inputs will be changed to a limited extent, as time has to be allocated to construct and operate the fishpond. Pond construction and management can be integrated into the existing system of division of labor, with the men doing the earth work, which requires a large amount of physical effort, and the women doing daily maintenance work, composting, feeding, etc. Harvest and post-harvest activities will probably be carried out by both men and women, as it is presently done for other crops.

For the collective undertaking of fish farming, within the framework of the government settlement schemes (paysannats), for example, considerable organizational efforts will be required. Although mutual aid is common among farmers and one day per week is usually spent doing communal work, collectively planned, implemented and operated fish culture production represents a new concept of production. The priorities the local administration attaches to it, the qualities of the extension service and, above all, the innovation potential of the farmers will determine whether such an approach can be carried through successfully. However, in order to promote a self-supporting organizational context of aquaculture development, the formation of groups or collectives should be encouraged.

3. Land use pattern, leadership and decision-making. The present land use pattern in rural Rwanda is, apart from ecological parameters (soil quality, altitude, rainfall, etc.), determined by a number of socio-economically and socio-culturally based variables, as:

(A) Diversification of production. To cultivate a variety of food crops and to achieve self-sufficiency is seen as a risk-minimizing strategy by the farmer. In case one crop fails, the subsistence of the family can be maintained by other crops with similar nutritive value.

(B) Traditional influence from superstructural power groups. Formerly a feudal elite, the cattle-herding Tutsi, ruled, for example, that bottom land was not to be cultivated so that it could be used as grazing grounds for cattle. At present, the government exercises some direct influence on farmers to increase cash crop production.

(C) Status. As an inheritance from feudal times, the possession of cattle is still regarded as the highest status symbol. Although cattle yields little economic return, cattle is used as dowry, giving status to both donor and recipient, when exchanged. Banana and sorghum beer also serve as an exchange equivalent within social relationships; it is also used to compensate ex-farm labor inputs. By expanding his banana plantation, a farmer increases his social status. According to its high exchange value, rural people grossly overestimate the nutritional value of beer, as shown by Ndengejeho (1980).

(D) Tradition. Traditionally farming people, the majority of the farmers are reluctant to adapt production concepts alien to agriculture. Production orientated animal husbandry, for example, plays only a very minor role in rural production, because regular feeding of livestock was never practised on the traditional farm. A considerable number of Ndengejeho's respondents believed that fish, kept in a pond, do not need feeding, or subsist on soil or water. Another example is the practice of confining chickens to a cage during the sorghum harvest to keep them from feeding on the grain. Being given no other food, many chickens starve to death.

(E) Leadership and decision-making. No pronounced internal leadership pattern exists in the rural society on a meta-family level. Patrilinearly-organized kinship groups had, and to a lesser degree, still have, influence only on land allocation and were the taxable entity during the feudal times. At present, and in line with the atomistic settlement structure, only one external authority, the Government, and its administrative bodies, exercise leadership above the family level. Within the family, the farm head, usually the (male) farmer is formally in command, followed by his son. His wife, however, is rather autonomous in the spheres dominated by her, e.g., food crop production and the household. A farmer would have to ask his wife's permission before taking food from the household storage. In the absence of detailed studies on the present decision-making process, it may be assumed, therefore, that the farmer decides on farm affairs, but that the wife influences his decision considerably.

With respect to the development of fish farming, the aspects described above permit the following conclusions:

(A) Fish farming may be regarded positively as a further diversification of production by the farmer. Also, Ndengejeho indicates a high degree of interest in fish farming among his respondents;

(B) Initially, at least, fish farming should be actively promoted by the local governmental authorities;

(C) Fish may acquire an acknowledged non-monetary exchange value, with a crop from one family pond being partly distributed among neighbors, and the reverse;

(D) Farm management practice should be promoted, at least initially, with emphasis on fertilization rather than on feeding, keeping close to known farming practices;

(E) Promotion of fish farming and extension work should be directed toward both the farmer and his wife.

4. Motivation and mobility. The basis of a farmer's decision to engage the family in fish farming may be formed by primary and secoudary motivations. The primary motivation may include the expectation that fish farming will diversify production further; that the family achieves a higher degree of self-sufficiency; that the nutritional standard of the family achieves a higher degree of self-sufficiency; that the nutritional standard of the family is raised; that monetary income is raised; and that the family's social status is heightened if the farmer can give fish to the neighbors, etc. The intensity of primary motivation to produce fish will be determined by the value which is commonly attached to fish as a produce. In the survey conducted by Ndengejeho in four communes, his respondents gave as the principal reason for their interest in fish culture the nutritive value of fish, i.e., they were interested in growing fish for home consumption. Income creation, by selling fish, was rated as secondary. Fish was, according to the survey, thought of as having about the same nutritive value as red meat. The principal reasons for not eating fish were stated as non-availability and high prices.

The same survey indicated the possible secondary motivation of farmers to culture fish. After the nutritive value, i.e., their interest in auto-consumption and income creation, they stated that they would undertake fish farming as a result of promotional efforts and extension work expecting in return a positive sanction in the form of extension service and assistance in management and procurement of inputs from the promoting agency.

Ndengejeho's survey indicated a considerable degree of occupational mobility among his respondents with regard to fish farming. His sample was, however, geographically limited. To what extent the innovative potential and the occupational mobility of farmers in other areas can be

reinforced and directed toward fish farming will depend upon the performance of fish culture extension and support from Government bodies. Initially successful on-the-spot demonstration in the field and on selected fish farms will be crucial for its diffusion within rural Rwanda.

5. Determination of the beneficiary impact of fish culture development. During the initial phase of fish culture development, only a small group of farmers will be affected because infrastructural support will be limited at that stage. The initial 'target group' of farmers, their selection and the approach employed to extend assistance to them, will determine the future impact of the development effort.

The identification of the individual farmer to be approached should involve the following criteria:

- whether the environmental conditions necessary for fish culture exist on the land he cultivates;

- whether the farmer's personal drive and interest is sufficient to cause him/her to commit himself, the family and, for pond construction, relatives and neighbors, in taking up fish culture successfully;

- whether the geographical position and social status justifies the aspiration that the fishpond can serve as an on-the-spot demonstration, convincing as many people as possible of the worthiness of fish farming.

A carefully selected target group in the initial phase of development will be the most relevant premise for further diffusion of the technological concept, as initial and demonstrated success of such 'progressive key farmers' in the rural milieu will be the best means to convince others of the worthiness of fish farming. Other measures can be product promotion by government bodies, extension agents and media, media coverage in general, inclusion of fish culture related courses in the curricula of educational institutions, etc. The degree of success to which such strategies can be employed will determine the extent of the impact of fish culture development in Rwanda.

The quality, socially and culturally, of change which can be expected as a result of the development can be assessed here only in the broadest sense. Being closer to farming than to animal husbandry, fish culture will not bring forward a considerable difference in the existing behaviour and value patterns. Neither will it require a significant change of organizational and production structures. Depending on the extent to which they participate and receive extension services, it will better the role and status of rural women in the country. If not extended to a sufficient number of farmers, it may, however, alter the structure of income distribution of the rural milieu by increasing considerably the income and monetary potential of the farmers engaging in it successfully.

6. Beneficiary incidence. Based on the projections made during the project analysis, fish culture development can have a direct effect on existing production structure in the following dimensions:

(A) Provision of fish for human consumption - After four years yearly yield of about 180 tons of fish will provide sufficient animal protein for around 2,400 rural families (a twenty-fold increase of present average per capita consumption will still leave 40% of the fish to be marketed—around 80 tons).

(B) Income - 2,400 families engaged in fish culture would increase their cash income by 2,000 to 2,500 RwF by selling about 40% of their fish production. The estimated combined additional income of 5,000 families of about RwF six million will strengthen the internal market of the country.

(C) Employment - The labor potential of around 2,400 families will be used more productively; cooperative production may create self-employment in government settlement schemes or other rural centres.

(D) Diversification of production - The overall agricultural production structure will be diversified by fishpond production, eliminating partly the potential need for animal protein imports.

(E) Transfer of technology - Extension, development support and technical assistance to around 2,400 families, enabling them to operate fishponds with mainly indigenous resources, can be expected to root fish culture in the rural milieu of Rwanda.

Taking into consideration that the assumed extension program is of small magnitude, and yields have been estimated conservatively, the increase in quantity and nutritive value of aquaculture production will have a significant impact on the overall protein supply.

The outlined magnitude of production does not consider the probable spread effect (or multiplier effect) of successfully operating fish culture units which may induce more than the number of farmers or cooperatives estimated to take up fish culture. However, taking into account only the above number of production units, the achieved production will, by the fourth year, have already increased the present yearly supply of fish in Rwanda considerably—adding an annual value of almost 11 million to the GDP. An annual growth rate of rural fish farming can be expected to be around 10%, as long as no presently unpredictable constraints limit expansion.

B. Economic Feasibility

1. Macro-economic aspects. Fish play only a small part in the daily diet of Rwandans. Total fish catch in 1979 did not exceed 725 tons. Based on studies of fish consumption carried out in those areas where fish are more

readily available, it is conservatively estimated that countrywide demand is 100,000 tons. Although capture fisheries can be expanded to meet some of this need, it will not be possible to meet total demand. Fish culture is one of the promising ways to bridge the gap between supply and demand. Dispersing production into the interior of the country, away from the lakes, also substantiallv reduces the commercialization and distribution problems which reliauce solely on lake fisheries would pose.

(A) Marketing. Even with 100% of the cash and industrial crop production marketed, less than one-half of total agricultural production enters into the commercialization system. The large majority of food crops are consumed on the farm or are bartered. This is a function of low purchasing power of the rural population and transport/storage difficulties, but primarily because of lack of excess production to be marketed. A similar situation will prevail with fishpond production. Local demand for fish will not begin to be met for a number of years. Fish will be largely consumed on the farm or bartered for work or other agricultural products. Although pond fish culture may result in a higher percentage of market production because of output peaks over the year, no difficulties are foreseen with respect to commercializing a marketable surplus. What marketing there is to be done will be largely carried out by the producers, as the dispersed location of production units will not encourage marketing by intermediaries or traders until and if production reaches a level where there is a marketable excess.

Conversely, unless fish culture is introduced into the countryside, there will be little opportunity for the majority of Rwandans to avail themselves of this nutritious food. Planning for increased fish production with the aim of curbing the deficit of animal protein in the rural diet will have to focus on small, family-based units which provide fish for home consumption, barter and, only on a limited scale, the market. Lake production will have to increase 100-fold before there is any effect outside of the immediate catch area or the several urban areas to which the lake catch is shipped. With several projects to increase lake fish production, the government cooperative store has opened a counter for fish sales. With a central location for sale, demand has been generated among a Rwandan clientele that did not look for fish heretofore. While supply is increasing slowly, demand is increasing at a much faster rate.

(B) Development infrastructure. Because of the dispersed settlement patterns in Rwanda, a decentralized infrastructural system to support small-scale fish culture will be put into place. Material inputs which are not available on the farm are fingerlings and, to some extent, feed. Feed for the prefectural centers is not available at firsthand, and feed procurement will have to be planned for timely availability and transport. During the initial development phase, producers will require advice and technical assistance in the form of extension agents. Fingerlings can be produced centrally, initially, but with the growing geographic coverage of the program, fingerling production and distribution will have to be organized on the prefectural level. The present transport and communication system in rural Rwanda constitutes, in general, no constraint to the

extension support as most settlements can be reached on earthen roads which are passable most of the year.

An effective extension service, trained and with the means to reach their client farmers with the necessary inputs, will be the key to success of the program.

2. Financial Analysis. The farm level financial analysis does not predict major constraints with respect to basic resources and operational inputs used for fish culture production in Rwanda. Whereas land suitable for aquaculture can be assumed to be available and raw materials for compost preparation can be found readily, labor and feed inputs can be considered potential bottlenecks. The labor requirements for fish culture per hectare and per year are lower than for most cash crops and are within the range of requirements for potatoes, sweet potatoes and rice, but, except in the case of cinchona, the returns from fish culture are higher than for these crops. A 500 m^2 family pond will require only about five percent of the labor usually available in an average rural family. Also, as much of the day-to-day labor inputs can be provided by children and the aged, the limited family labor capacity is not considered to be a serious obstacle to small-scale rural fish culture.

Suitable base materials for fish feeds, although seemingly available, may be limited in some areas, and little is known about their present alternative use, as no tradition of semi-intensive or intensive animal husbandry exists in rural Rwanda. The availability and accessibility of suitable foodstuffs will have to be investigated for each concrete case where a medium-scale production unit is planned and feeding is envisaged.

The input, which is at present not available to many farmers who could eventually start fish farming, is stocking material, i.e., fingerlings. The development of rural fish culture will depend on the production and distribution of fingerlings to the farmers, at prices within their financial possibilities.

Assessing its profitability, fish culture can be predicted to yield a net return to the farmer's family if a production of 1.2 tons/ha/year can be achieved. This theoretical break-even point was estimated from the input/output analysis which valued all operational inputs at their opportunity costs. In reality, however, the only cash inputs are the fingerlings for initial stocking and for the larger production units.

In order to arrive at a realistic appraisal of the worthiness of raising fish in the rural areas, present land and labor use and what it produces in cash and kind for the farmer's family is compared to the returns resulting from projected fish culture operations. For this purpose, present marshland agriculture was compared with projected fish culture operations in the same environment. In the case of fish culture, all operational inputs were valued according to their projected or opportunity costs and

depreciation of pond construction costs were added; the outputs were estimated conservatively and valued at presently realized prices. In the case of marshland agriculture, only labor was considered on the cost side, and the produce was valued at 1980 prices.

In spite of this bias, which favored agricultural production, fish culture, projected and calculated for two models (a 500 m^2 family pond with compost fertilization and a 5,000 m^2 pond with feeding), showed incremental gross returns of 137% and 216% and incremental gross returns per man/day of labor of 90% and 123% respectively.

When compared with other food and cash crops presently grown in Rwanda, only banana cultivation yielded a higher return per person/day; only cinchona production resulted in a higher gross return.

When compared to all the different types of crops which are presently grown on marshland (including tea and rice), projected fish culture showed a higher gross return and higher cash return, assuming only 40% of the production being commercialized (against 80% of rice and 100% of tea marketed). A 500 m^2 family pond would generate a cash income of RwF 2,250/year if 40% of the fish were sold; 40% of the production marketed would still leave 45 kgs for home consumption, which would represent a 20-fold increase of fish consumption per family member as compared to the present average *per capita* consumption of less than 0.5 kg per year.

C. Summary of Technical Findings

No major technical or biological constraints to fish farming exist in rural Rwanda. The climate, the soils, and the general availability of water constitute a sufficient natural resource base for fish culture. Basic materials (agricultural wastes, agro-industrial byproducts) to introduce feeding of fish and fertilization of ponds are, in general, available. Farmers in Rwanda are not trained in fish farming, though the immediate target group is actively involved in attempting to grow fish. If fish culture is to be established in the rural milieu, substantial improvement of the extension service will be required and ready availability of fingerlings assured.

A technical, social and economic "Review of Aquaculture Development Activities Central and West Africa" was completed for AID by Auburn University's International Center for Aquaculture in 1979. (Contract AID/DSAN-C-0053). Many of the observations of that report are appropriate to Rwanda. The report suggests that the culture of *Tilapia nilotica* using natural fish food production stimulated by pond enrichment with locally available organic wastes or crude feed materials offers the best choice of production systems appropriate for small farmer application. This system has the potential for farmer control of inputs rather than creating an elaborate governmental support structure and is in keeping with the limited financial resources of both the farmers and the government. *Tilapia nilotica* culture is also a very versatile system that can easily be adapted to more intensive feeding, should materials be available, or to combined stocking with complementary fish species.

Adoption of fish culture prior to about 1960 in Rwanda, as well as elsewhere in Africa, was hampered by a poor understanding of pond ecology that resulted in low fish yields. Ponds were usually stocked with herbivorous fish that required feeding with large quantities of specially grown vegetation if the fish were to grow. Fish yields were seldom worth the effort to grow the feed. Ponds were also frequently set up with deep flow-through water systems that diluted and washed out what little fertility might accumulate in the ponds. Wild predatory fish also frequently invaded ponds and decimated more productive fish populations, or prolific fish reproduction filled ponds with fish too small to be of much value.

More is known about fish culture and technology transfer now that should make it possible to overcome many of these earlier problems. There are several budding fish culture projects in countries such as Zaire, Cameroon, and Central African Republic that have potential for lasting impact and serve as models upon which the design of this project has been built. Fish yields and outreach capacity as used in this Project Paper are generally commensurate with what has been reported for these other projects. No short cuts have been found to basic farmer extension contacts using result-demonstration techniques and user group involvement.

Some factors which have hindered fish culture extension in other African countries do not seem to be a problem in Rwanda. For example, there is not a strong alienation between the government and the people. Governmental extension workers are welcome on farms and would not be expected to use their office to exploit the farm family. Fast efforts to introduce new technology, though rather modest, have met with relative success. The current setup with selected "lead farmers" and regular citizens' meetings in the communes seems like an ideal structure in which to extend fish culture technology. Furthermore, there has been relative stability in government office.

The Auburn review of fish culture efforts in Africa noted that there is not a strong tradition of animal care in Africa. Cows, goats, and chickens are generally expected to forage their own food. Farmers are not accustomed to providing feed and regular care for their animals. Cultured fish, although somewhat forgiving when cultured in an extensive method as proposed, do need some minimal care such as maintenance of water levels and addition of organic enrichment to ponds. Farmers will have to learn that there is more to fish culture than dumping fish into a pool of water and returning a few months later to a glorious harvest. To the extent that farmers are willing to learn and provide the needed care, they can beneficially produce fish.

1. Species recommendations. The main cultural species in Rwanda are *Tilapia melanopleura* (or *T. rendalli*) and *T. macrochir*. *T. nilotica* and common carp are also raised in ponds but on a very small scale. Neither *T. macrochir* nor *T. rendalli* is a fast-growing species, and growth rates, even with pond fertilization, are generally only 0.5/g/day and never exceed 1 g/day. *T. nilotica* will be the recommended species to be raised

in association with a malacophageous species for biological control of snails. Chinese carp can be raised if they prove well acclimatized to Rwanda and if adequate fingerlings can be obtained.

2. Fingerling requirements. Breeding ponds (at Kigembe and at the prefectural ponds) are to be stocked with T. nilotica at a density of 200 fingerlings/are. Fingerlings are now available at the Ruganwa Fish Station near Kigali and can be transported to any of the other production ponds without difficulty. The number of fingerlings needed during the first year of the project is noted in Table 1.

The fingerlings of other species required for polyculture will be produced in each prefecture according to the needs of the farmers.

T. nilotica broodfish will be stocked in spawning ponds of 1 to 4/ares at a density of 14 females and 6 males/are. The spawning ponds will be fertilized with manure or compost. When harvesting, the spawning ponds will be drained after three months and thereafter every one or two months, though not during the cold season. The small fingerlings will be stocked in fertilized growing ponds for about two months to reach the right size for stocking in the production ponds. They will be fed available foodstuffs.

3. Supplemental feed availability. Feeding fish is beneficial to growth as it supplements the natural food present in the ponds. The feasibility of supplementary fish feeding in Africa and especially in Rwanda depends, however, on the availability of cheap foodstuffs and agricultural byproducts with a sufficiently high food conversion rate (CR). Throughout Rwanda, crop residue is in plentiful supply, but many of the waste and byproducts potentially suitable as feed are grown and processed in the vicinity of towns such as Gisenyi, Ruhengeri, Kigali, and Butare--far away from most villages. High protein feed ingredients are in short supply, although small quantities of oilseed cake are available and only a small percentage of the slaughterhouse byproducts are now recovered.

For fish farming in Rwanda, using Tilapia species, common carp or Clarias spp., animal protein in diets is not necessarily required and only vegetable protein can be used. In Rwanda, diets for fish can be prepared using only locally available foodstuffs which can be fed by surface broadcasting. Larger fish farms should, however, be equipped with grinders in preparing foodstuffs such as maize, cotton seed, etc., for diets for fish.

According to available information, the following agro-industrial byproducts are actually available in Rwanda.

- Draff (beer waste). The present production at the brewery in Gisenyi is 1,400 tons/year, and it can be obtained free of charge. A new brewery will soon be established in Kigali. The conversion rate (CR) of draff is 12:1 (12 kg draff is needed to obtain 1 kg fish growth). T. nilotica

stocked at a rate of two fingerlings/m^2 and fed only with wet draff supplied bi-weekly at a rate of 2.3 of estimated weight of fish population in the pond will yield an average production of 3,500 to 4,000 kg/fish/ha/year.

- Brewer's yeast is an excellent source of protein of high nutritive value and digestibility. The brewery at Gisenyi produces 200,000 litres of yeast (slurry) per year, available free of charge. The total production is presently discharged into Lake Kivu.

- Draff from banana and sorghum beer. About 87,000 tons of banana draff and 20,000 tons of sorghum draff are available annually with a CR of 10:1.

- Slaughterhouse wastes. Sheep, goats and cattle are slaughtered in three large abattoirs, in 28 smaller slaughterhouses, and in 276 small killing pens throughout the country. Most of the waste (blood, stomach contents, and bones) is discharged into rivers and can be transformed into fish food on a semi-commercial basis.

- Byproducts of rice milling. In Rwanda only rice bran and rice polishing remain after milling. Approximately 2,500 tons of paddy are produced, giving about 75 tons of bran. Rice bran yields a CR of 4:5, and up to 20% can be used in fish feeds at a cost of 2,000 RwF ('23) per ton. About 150 tons of rice polishing are available at the same price. The CR of rice polishings is 3 - 3.5, and up to 35% can be used in fish feeds.

- Byproducts of wheat milling. Both wheat bran (193 tons) and remouldings (262 tons) are available in Ruhengeri and are excellent for use in fish feed composition.

- Sugar-cane wastes. About 14,000 tons of sugar cane are produced annually with bagasse, molasses, and filter presse mud as wastes available for fish feed.

- Coffee byproducts. Large quantities of coffee pulp (about 10,000 tons/year) are available free of charge. Coffee hulls (3,000 T/yr) are also available free.

Household scraps such as pot scrapings, vegetable and fruit wastes, cassava offal, etc. are available and can be collected as fish feed. Wastes from markets, restaurants, hospitals, and boarding schools are now used as fish feed at the Kigembe fish farm, and the opportunity exists to use them elsewhere as well.

Table 7, page 47, Annex E, indicates the foodstuffs for use in fish culture that are available in Rwanda most of the year, and quantities are available in almost all villages. Their appropriate and productive use will require adequate planning and organization, as well as advice and assistance by extension personnel. A detailed inventory of existing agro-industrial byproducts or wastes suitable as feed for fish will be necessary for each

of the prefectures where fish farming is planned. Such inventory will have to consider the kind of products, location, quantities available, period of availability, competitive use, price and transport costs.

4. Pond fertilization. To obtain high yields of T. nilotica, T. machoir, and common carp, fertilization of ponds has to be carried out regularly. Either organic or inorganic fertilizers may be used, but recent increases in the price of chemical fertilizers and the cost of their transport to Rwanda virtually preclude that they be used in Rwanda. Relatively high production can be obtained, however, by combining organic fertilization of the ponds with appropriate fish feeding programs. Cow manure is the most accessible, though the manure is used virtually exclusively as a crop fertilizer. Other kinds of manure are less readily available, but the promotion of the raising of small ruminants and the raising of pigs and chickens in conjunction with fish holds promise that more will become available in the countryside.

When manures are not steadily available, compost is a viable alternative for the fertilization of fishponds. Experience in the Central African Republic indicates that the proper preparation and application of compost can have very good results.

Composting is the method of fertilization recommended for individual farmer ponds. Fodder and common grasses are both suitable for making compost. If only grasses are available, artificial fertilizer made by adding a chemical nitrogen fertilizer can be used.

5. Extension services. An effective extension and information program for fish farmers and their families is essential to the success of the project. The program for training of extension agents and for the delivery of technical inputs which will be created by the project will meet this requirement. Through the program, farmers will be made fully aware of the benefits of careful management of their ponds and will receive full support from the project staff. It is noted that those farmers who already are working their ponds, though with little success, will be the first recipients of the extension services. There will be little or no encouragement of new farmers to take up fish farming. Success on existing ponds will serve as demonstration and impetus for new farmers to devote a part of their land to fish farmers.

Fish service extension and supervisory personnel are to be trained. U.S.-financed technical support will assist in the administration and implementation of the program and will assist in both formal and on-the-job training. The inputs financed by AID are primarily aimed at strengthening the extension service.

D. Engineering Analysis

1. Requirements. The project proposes to refurbish and expand the existing fish center operation at Kigembe to produce fingerling stock for distribution and to produce mature fish for market. Renovation of

existing housing and construction of new facilities for training and administration are required there. A dormitory for 20 students, a multipurpose hall and a kitchen/store are the major elements of new construction. In addition, renovation of existing fishponds is required as well as realignment of water supply canals to provide improved water service.

In addition to work at the Kigembe center, the project will improve facilities at the 10 existing prefectural level fish centers. At these centers, ponds and water supply canals will be improved and small warehouses will be constructed for the storage of equipment and supplies.

All project facilities at Kigembe and the prefectural centers are owned by the Government of Rwanda. Existing facilities at both Kigembe and the prefectures are sound and space is available at Kigembe for the construction of dormitory and training facilities for a group of 20 students.

The engineering component of the proposed project, therefore, consists of (1) the renovation of the existing fishery center at Kigembe as well as the expansion of facilities already existing at the prefectural level (2) the construction of new facilities necessary at Kigembe and in the prefectures, and, (3) the technical means necessary to realize and maintain the facilities. Since water retention and distribution will be necessary, pedalogical, hydrological and parasitological factors will have to be examined closely.

(A) <u>The Kigembe Center</u>

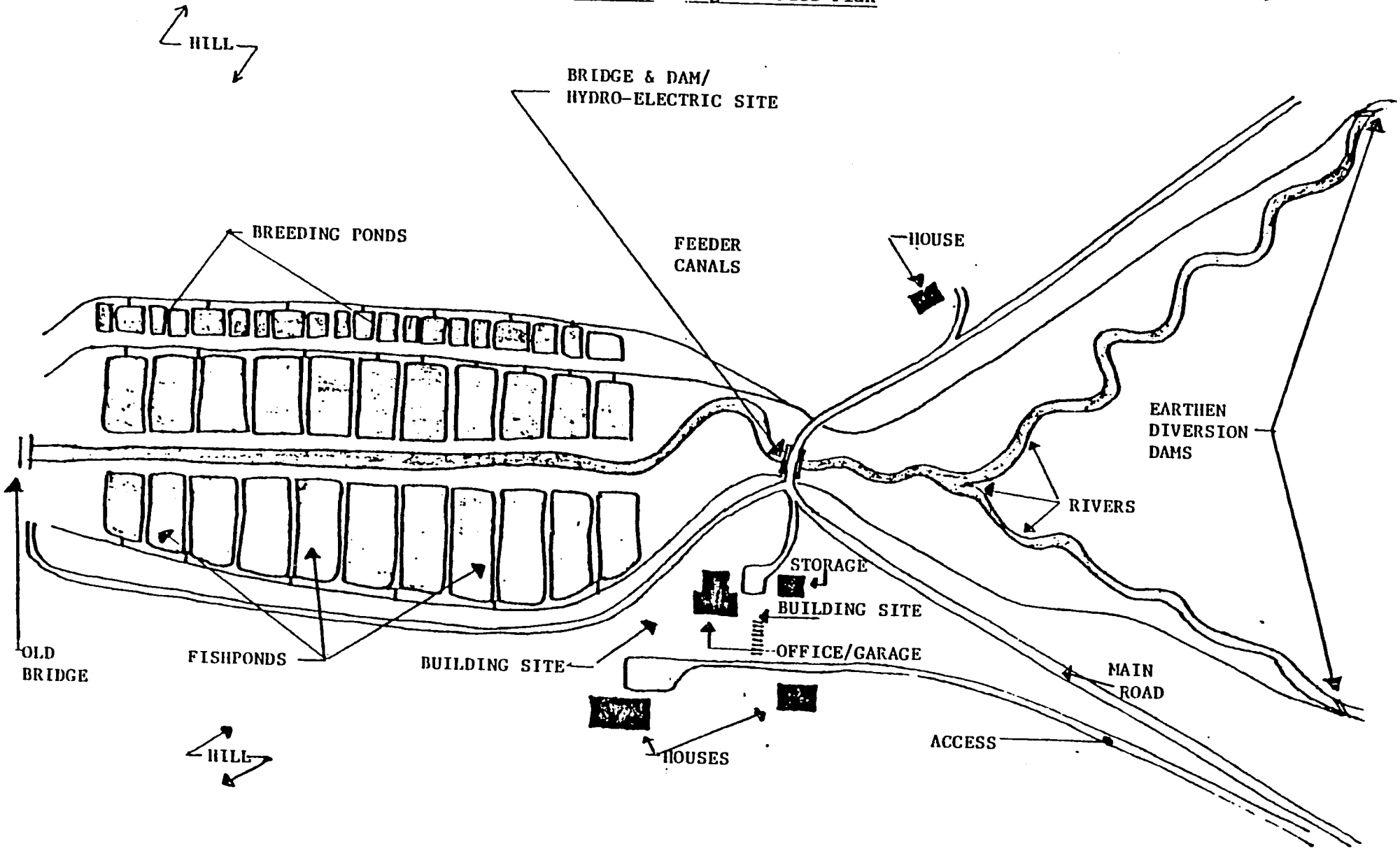
This facility is located in the southern central highlands in a narrow but shallow river valley of the Migina River, a tributary of the Akanyaru, several hundred meters downstream from the confluence of two smaller tributaries. The center occupies approximately 30 ha and presently consists of an office/garage/storage complex, several houses and 10 ha of fishponds with attendant distribution canals bisected by the river itself (see Site Plan, Table 3). The center was constructed in 1954 and, although in good structural condition, must be upgraded and expanded to fulfill the envisioned training and production functions.

Both buildings for the office, storerooms, workshop and garage are in good condition, requiring only minor repairs. The 35 sq. mt. semi-enclosed garage which is abandoned and adjoins the office will be easily converted into additional office space for the center's expanded activities.

The three houses at the center of the site are in need of varying degrees of repair. Plumbing, roofing, painting, doors and windows will all, to some extent, be necessary. The pipe which supplies the center with potable water from a spring above has deteriorated and must be entirely replaced.

A dormitory with sanitary block, a multipurpose hall, and kitchen will have to be constructed to accommodate the 20 trainees expected at the

Table 3 - Kigembe Site Plan



KIGEMBE FISHERY CENTER

center. The buildings will be situated next to the office and constructed of readily available materials--brick, mortar, timber, metal roofing, etc., with local craftsmen. The multi-purpose hall will serve for dining, classwork and other group activities, and the building layout will conform to the narrow site topography.

The fishponds and interior distribution canals are in good condition. Necessary repairs stem from the lack of maintenance over the years (e.g., broken entrance pipes, leaking drainage monks, cave-ins, reed growth, and seepage) and can be easily corrected with a well-directed works team on staff at the center.

The water needs (evaporation plus seepage) of these 10 ha of ponds can be estimated at 2000 m^3/day which is presently supplied by upstream supply canals which take water from the river by means of small cross channel diversion dams. This system will require fundamental modification. The dams are of flimsy wickerwork which must be reconstructed after each flood flow. The supply canals parallel the unstable, meandering riverbank for several hundred meters and transversing and sometimes inundating pasture and crop lands and must be re-excavated, shored-up and/or cleaned out frequently. The distance (600 and 900 m, respectively), present land use pattern, and nature of the soils (an argrillic horizon resting on a heavy sand base) make the present configuration difficult to maintain. The desired alternative is to provide a weir considerably further downstream towards the center. As shown on the site plan, the rivers providing the water pass beneath a masonry bridge situated on a rock out-cropping. At this point, within a hundred meters of the pond complex, the river level could be raised by means of a weir (1.50m above present levels, based on recent survey at the site) with take-off pipes or canals to supply the ponds. The project proposes to fund the final design and construction of this weir. Care should be taken to assure adequate overflow during flood flows and for periodic flushing of abrasive sediments. Upstream flooding by the weir will be limited to the actual river channel and will not displace agricultural land. If the weir design proves impractical, the existing diversion weirs will be improved and alignment of existing canals also improved.

Rudimentary on-site measurement yielded a rainy season flow of approximately 1.76 m^3/sec, of which 0.023 m^3/sec or 1.3% is required for pond maintenance. A hydrological station is situated at the bridge and past flow maxima and minima and river slope (estimated at 0.02-.03) must be verified before detailed design.to determine amount of ponds that can be serviced.

Supply canals will be lined both to minimize scour and seepage losses and to prevent reed growth. All canals should be designed with sufficient water velocities and sideslopes to minimize snail habitat. Drying cycles should be employed, as necessary, as further assurance against parasite proliferation.

The topography and hydrology of the river above the center are suitable for hydroelectric power production. Raising the upstream river level as

proposed above for better water supply makes conditions ideal for the installation of a small station (pelton wheel or similar) at the bridge site where the water will fall about 4 meters. The present net head is estimated at 2.5 m and would be increased to 4.0 with the weir. This could produce approximately 3-7 kw of electric power, or enough for center lighting and small appliance use. In collaboration with the nearby AID-funded Alternative Energy Project (CEAER), a more precise study of the site and hydrological data would be made before the final choice and design of a system. Funding for a mini-hydroelectric unit is not included in the project. Should it prove feasible, funding would be requested at a later time or would come from the AID alternate energy project.

(B) The Prefectural Stations

The project will construct, expand and renovate existing fish farming centers in each prefecture. Each center consists of approximately 1 ha of fishponds and a small $50m^2$ warehouse for storage of tools, nets, etc., and a guard. Existing pond complexes in all prefectures can be readily utilized for the demonstration and production activities proposed by the project. In these cases, modification to ponds and canals will be made to assure optimal and replicable design, with special emphasis on public health safeguards. (Pollution, reed growth, sanitation, etc.).

Special consideration should be given to seepage and soil permeability and the costly, but effective, possibility of stabilization with lime, clay or other admixture treatments. Renovation and maintenance of ponds and canals must ensure the optimal use of water supplied and minimum snail and mosquito habitats. Linings, side slopes, water velocities, drying cycles and adequate fish stocks are important design and operational elements.

Small $60m^2$ warehouses of simple brick, mortar, wood and roofing sheet construction will be built for storage adjoining each site. Design should include skylighting, ventilation and security. All design work will be accomplished by a firm in Rwanda. All construction and major renovation will be done by contract. Inspection will be performed by the TA team and a representative of the GOR. Minor renovation will be done by the maintenance crews over a period of time. REDSO engineers will review design work and make regular inspections to monitor construction.

2. Personnel and Equipment. The proposed design and construction involves no techniques more sophisticated than standard rural engineering practices. However, as the deteriorating capital investment at the Kigembe Center illustrates, a well-directed and budgeted maintenance team is a basic component in the operation of existing facilities. Therefore, no capital improvements will be financed without firm guarantees of the recruitment and payment of a competent works chief and team by the GOR. The GOR will organize and train such a team to properly maintain existing new facilities under the counsel of the project-funded technical assistance team. In light of the environmental consequences of poor maintenance of

systems involving water retention, the technical assistance package will include engineering services to organize and direct the maintenance team. Equipment for the renovation and maintenance team proposed would consist of one 1-ton flatbed truck and one set of basic excavation and construction tools (shovels, picks, wheelbarrows, etc.) for each of the 11 centers.

3. Proposed Construction and Renovation (See Table 4).

E. Environmental Concerns

An Initial Environmental Examination was conducted at the time of the PID preparation and recommended that a more complete assessment of the environmental impact of the project be carried out, particularly to determine the potentially significant impact on the health status of farmers and fish service personnel working in fishponds. The Environmental Assessment was completed in November 1980, and is attached as Annex F to this Project Paper.

The conclusions of the EA are that no significant environmental problems will result if the recommendations of the EA are followed. To meet potential health problems which could result from fish culture (increases in the incidence of schistosomiasis and malaria) the EA recommends the following:

1. Elimination of vegetation extending into the pond which would provide breeding ground for schistosome-bearing snails.

2. Inclusion of a snail-eating species of fish in the ponds in polyculture fish production.

3. A program of monitoring of the ponds to assure that snail and mosquito larvae populations remain low.

F. Administrative Analysis

1. Organizational Setting. Rwandan fish culture activities are directed by the Division of Fisheries and Fish Culture in the Ministry of Agriculture and Animal Husbandry (MINAGRI). An organigram illustrating the division of responsibilities within the MINAGRI is shown on Table 5. Field activities of the Service are primarily concerned with the monitoring of the fish harvest from the numerous lakes in the country, the management of government fish stations, the training of fishermen, the creation of fisher cooperatives, the direction of the extension services to fisher cooperatives and farmers, and participation in donor-funded projects for fish production. The Service is seriously understaffed and undertrained and, as a result, their input into donor-funded projects has been minimal.

The number of agents in the Service totalled 51 in 1979, and included one A-1 technician (a graduate of the University of Toulouse, France, with a degree in fisheries) who is Chief of the ELADEP Project. There are nine

Table 4

Proposed Construction and Renovation

ITEM	SIZE	WORK	UNIT COST	TOTAL COST
KIGEMBE				
house n° 1	$200m^2$	plumbing and misc. repairs	-	$1,200
house n° 2	$80m^2$	renovation of kitchen, bathroom, plumbing and misc. repairs	-	2,000
Office/storage/garage	$85m^2$	enclosed garage and add door and windows	-	850
water supp. pipe	$600m^2$	replace and cover	4/m	2,400
house n°3	$70m^2$	complete renovation	$80/m^2$	5,600
dorm/sanitary block	$100m^2$	construct	$400/m^2$	40,000
multipurpose hall	$80m^2$	construct	$350/m^2$	28,000
kitchen/store	$40m^2$	construct	$350/m^2$	14,000
ponds	n/a	add pipes and repair leaks at monks		2,500
main canals	$200m^2$	excavate and line with brick or stone	3/m	6,000
weir	$60m^3$	construct	$12.50/m^3$	7,500
erosion constrol	n/a	bamboo planting on river	-	300
drying pads	$200m^2$	construct	$10/m^2$	2,000
PREFECTURAL CENTERS				
ponds canals		10 1 ha, expand and/or renovate (5 prefectures)	500 ha	5,000
hangars		10 50m, construct (10 of 10 prefectures)	$300/m^2$	150,000
		Sub-total		267,350
		Engineering services (10%)		26,750
		Contingency (15%)		294,100
				44,100
		Total		338,200

Table 4 (page 2)

EQUIPMENT

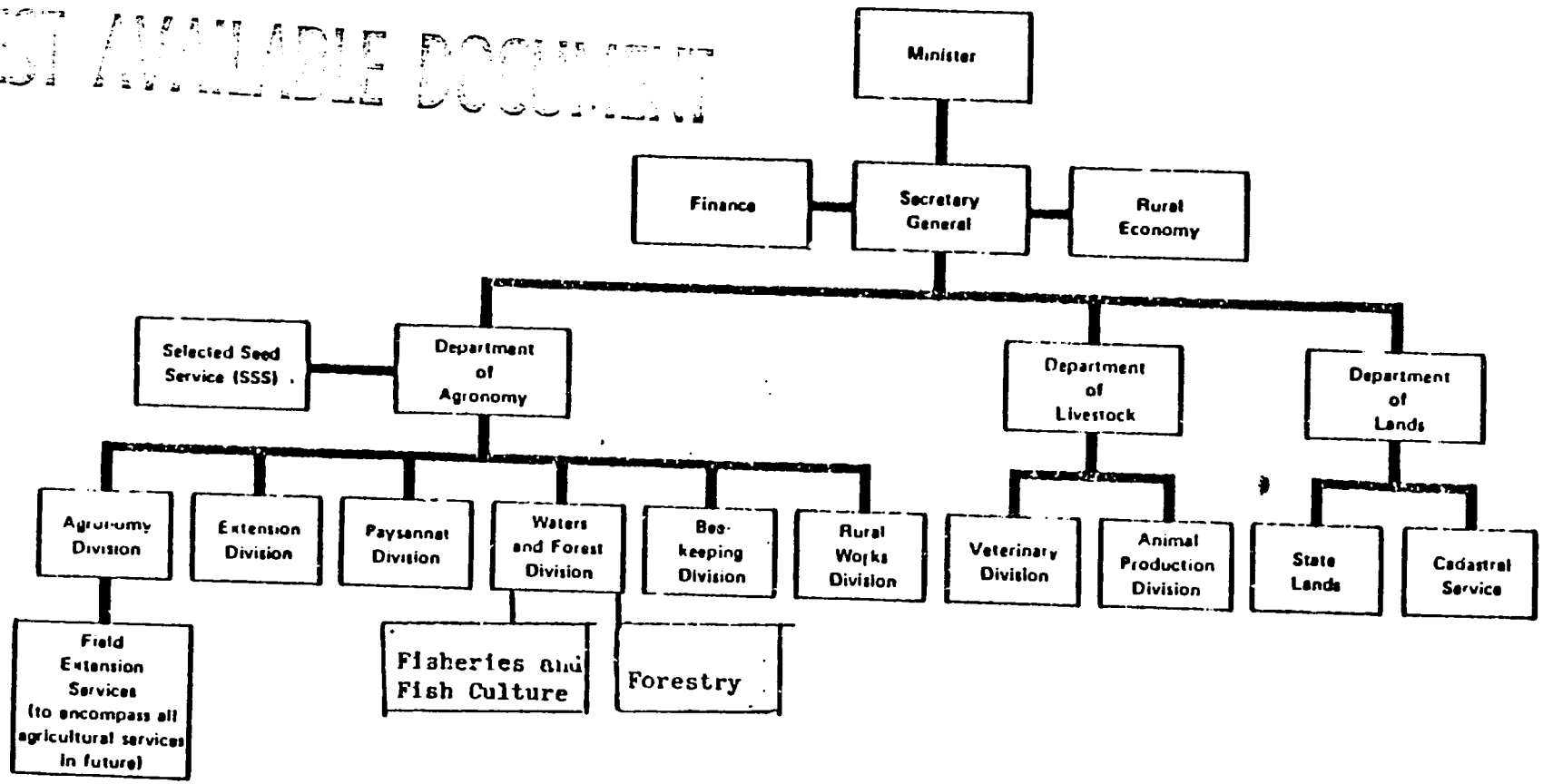
truck	1 ton	purchase with spares	-	(15,000)
tools	11 sets	purchase	100/set	(11,000)

Table 5

RWANDA

MINISTRY OF AGRICULTURE AND LIVESTOCK

BEST AVAILABLE DOCUMENT



November 5, 1975

A-2 level agronomes, graduates of secondary school and of the Agricultural School at Butare; three of these A-2 agronomes have been trained at the National Fisheries Center at Bouake, Ivory Coast. The 23 fish monitors, field-level fish extension agents, comprise the most numerous level of Fish Service agents. They have completed the six years of primary school and two-three years at the post-primary centers for Rural and Artisanal Training. None of them has yet had special training in fish culture, but all will be trained at the Kigembe Center. Remaining personnel are guards at the fish stations and helpers on lake harvests.

The majority of Fisheries Service resources, financial and personnel, have been directed toward lake fisheries activities. There is every indication, however, that fish culture is being given increased emphasis and resources. The government has directed personnel and financing to the ELADEP project, which includes research in fish culture and training of fish monitors. The government has also agreed to put additional personnel into fish culture, and, in fact, has already begun to do so on the basis of the AID agreement, in principle, to finance a major fish culture program. Positions have been reserved for ten A-2 agronomes, trained in fish culture, to work exclusively on the AID project. AID has already received the names of five candidates for training at the Bouake Center, and three are scheduled to depart in October as part of pre-project financing. In addition, the government has agreed to take on 50 fish monitors to work on the AID project.

Rwanda is divided into 10 political subdivisions called prefectures. Each prefecture is further subdivided into an average of 14 communes, the communes into an average of 13 sectors, and the sectors into numerous "collines," or hillside community groups. The planning teams for the proposed AID fish culture project have identified three prefectures--Butare, Gikongoro, and Gitarama--as being the target areas for the initial phase of the project. Three more prefectures--Byumba, Kibungo, and Ruhengeri--have been chosen for the second phase. During the planned training of the moniteurs for each phase, priority communes within the given prefectures will be identified as posts of assignment for the monitors. The priority of the different prefectures and communes chosen as target areas for the extension program has been/will be based on the following criteria:

- number of functioning or abandoned private fishponds
- number and area of sites amenable to fishpond construction
- proximity of ponds and sites to prefectural fish stations and road systems
- amount of interest in fish culture expressed by local government officials and farmers
- relative need for animal protein--scarcity of fish produced from the lakes

Each of the chosen prefectures will be assigned an A-2 Specialized DFF agent and five monitors. The A-2 agent will be responsible for managing the prefectural fish station and supervising the extension efforts of the five monitors. Each monitor will concentrate his efforts in a single commune, with the option to expand his work into neighboring communes as the case may warrant.

The commune structure in Rwanda is one that lends itself very well to extension work. Meetings for all adults in the commune are held on a monthly basis at the communal center. Similar meetings for each sector are held every two weeks. The meetings are chaired by the burgomaster, the governmental head of the commune.

The GOR relies heavily on the communes for promotion of development efforts within the country, and the community meetings thus provide a forum to communicate and discuss governmental policy decisions in these matters. The meetings also provide the opportunity for the commune's various social and agricultural extension workers to communicate information and make short presentations. A fish culture extension agent could in turn use these gatherings for the similar purpose of information presentation as well as to organize and announce special meetings and visits of extension personnel to particular sectors of collines.

Demands on the fish service budget will obviously increase by implementation of this project, particularly following the project's termination. The number of A-2 Specialized agents will increase. Maintenance of vehicles, of facilities at the various stations, and of continued special training and extension activities by service personnel will also require additional funds. These increases, however, will not be extreme. In light of the well-documented increase in fish production that should result from this project, the MINAGRI should be convinced of the importance of this production and of the need to increase the fish service budget as required to maintain the extension program.

2. Financial Plan. Total AID contribution to this project will be $2,470,000 in grant funds over the four-year life of the project. This includes a 10% contingency factor, as well as inflation allowance of 15% per annum, compounded. The Government of Rwanda will be expected to contribute the equivalent of about $589,000 in salaries of Rwandan staff and in the value of infrastructure being made available to the project. The GOR's share is equal to 19% of the total project cost of $3,059,000. The Project Budget is shown in Annex D.

Waiver of Section 110 (a) - Since the expected GOR contribution of approximately 20% of total project costs falls below the 25% level required by Section 110(a) of the FAA, a Waiver will be required and is hereby requested. As a nation near the bottom of the UN's list of least developed countries, Rwanda is eligible for this special consideration. The GOR is actually making a major contribution to this project in terms of human

resources (7 ASAU professional staff and 5 clericals; 10 prefectural supervisors; and 143 commune agronomes, one-third to one-sixth time). Even with the relatively low salary scale in Rwanda as compared to international standards, the GOR contribution still amounts to 19% of the total project cost, a more than respectable showing for a least developed country.

3. Recurrent Cost Implications for the GOR. The total operating budget for the MINAGRI in 1979 was the equivalent of $4.1 million. This represents an increase of 27% over the 1978 budget and 40% over the 1977 budget. It is not clear how much of that increase represents inflation, so in order to project a real increase for 1980, an enumerative figure of 5% has been used, which means that at 1979 prices the 1980 budget would be on the order of $4.3 million equivalent. The costs to the Government of Rwanda required to continue the project in the state in which AID expects to leave it four years hence will be as follows:

(A) The cost of personnel will be		
A-2 fish specialists	12 x $2,000/yr	$ 24,000
Fish monitors	50 x $600/yr	50,000
Guards/chauffeur	50 x $300/yr	15,000
Sub-total cost of personnel		89,000
(B) Replacement of equipment amortized over an average 5-year life (not including vehicles and motorcycles)		
Prefectural stations ($1,000 x 10)		2,000
Kigembe center - fish-handling equipment (6,800)		567
- training equipment (8,200)		683
- hand tools, etc. (3,000)		250
Fish monitors (bicycles, scale, etc.) $210 x 50		2,100
Sub-total equipment		5,600
(C) Training Costs - In-country (Estimated at $2,000/yr for transportation and per diem of trainees)		2,000
Sub-total training		2,000
(D) Amortization of Kigembe Center and Prefectural Stations over 25 years		
Kigembe center ($141,000)		5,600
Prefectural stations ($100,000)		4,000
Sub-total structures		9,600
(E) Amortization over 4-year life		
vehicles (12,000 x 2)		6,000
motorcycles (1,200 x 10)		3,000
Sub-total		9,000
(F) Miscellaneous and Administrative		4,000
Total recurrent costs		$119,500

This total represents the maximum recurrent costs to the project, including amortization of buildings and vehicles and is approximately 29% of the MINAGRI budget.

This figure does not represent entirely new costs to the GOR necessitated by the AID project. Approximately one-third of the personnel required in the project are already on-board and included in the present MINAGRI budget. This is also true for the maintenance of the Kigembe Center and the prefectural fish stations.

It is likely, however, that recurrent costs would not reach even these levels. Rwanda is one of the poorest countries in the world. It can be expected to receive assistance for a number of years. In all likelihood, the costs of building and pond renovation, and the purchase of replacement vehicles and motorcycles, will be covered by financing either from a second phase of the AID project (if evaluation and need determine that it is justified) or from other donor sources.

More important, however, is the distinct possibility that the Kigembe Center and the prefectural stations can become virtually self-sustaining through the sale of fish produced at these stations and through the sale of fingerlings. It is estimated that the sale of fingerlings and of production can realize approximately $15,000/yr to Kigembe and the fish stations to help cover the costs of guards, minor renovations of the center and operating expenses for the station supervisor and for the monitors operating in the prefecture. These costs are estimated to be $40,000 and $2,400 respectively.

Future possibilities for decreasing recurrent costs to the central government are to shift the salaries of fish monitors to the communes in which they work. This will be feasible only where there are numerous farmers in the commune who are engaged in fish culture and where production has reached the stage where the excess is marketed. The decision to pay field technicians is one that communes can make, and one which has been made in the past. Communes hire their own health workers, etc.

4. Summary Financial Plan ($000's)

Category	FX	LC	Total
Technical Assistance	1077	27	$1,104
Construction	-	338	338
Commodities	25	163	188
Training	70	27	97
Local Support Costs	-	157	157
Sub-total	1172	712	1,884
Contingency	117	71	188
Inflation	266	132	398
Total	1555	915	$2,470

GOR Contributions over Life of Project ($000's):

Personnel

Headquarters Staff (3, 1/4 time)	10
Kigembe Center (2 A-2 agents, $3,000 x 4 yr x 2)	24
Prefecture Stations (10 A-2 agents, 3,000 x 4 yr x 10)	120
Fish Monitors and Support Staff	35

Installations

Kigembe Center (est. value)	200
Prefecture Stations (est. value)	200
	589

5. Procurement Plan. The control of goods and services financed under this project will be the responsibility of the Water and Forest Service of the Ministry of Agriculture and Animal Husbandry. All commodity procurement in the U.S. will be accomplished through a Procurement Supply Agent authorized by the MINAGRI. Afro-American Purchasing Center is currently acting as PSA for projects funded through AID/Rwanda and can be contracted to provide purchasing agent services for this project. AID/Rwanda has established a Project Support Unit under the direction of the mission Management Officer, which will assist the Water and Forest Service in preparation of documents for overseas procurementin in local procurement, and in maintaining property and financial records.

Three small pick-up trucks will be required for the U.S. technical assistance and for the Kigembe Center. Motorcycles will be required for the 10 prefectural fish stations and one for the Kigembe Center. One of the pick-up trucks and all of the motorcycles will be replaced during the last year of the project. Bicycles will be purchased for the 50 fish monitors, and these too will be replaced in the fourth year of the project. Because of the lack of maintenance facilities and spare parts for U.S. vehicles and motorcycles in Rwanda, a waiver request is submitted as an annex to this paper to permit local procurement of vehicles of Code 935 origin (Western Europe or Japan). POL and spare parts for all of the vehicles and motorcycles, estimated at $8,000/year, will be purchased locally. The remaining equipment, totalling an estimated $102,000, will be purchased in Rwanda, either as local source and origin, or under the shelf-item procurement provision.

6. Financial Procedures. Financial procedures will be detailed in Project Implementation Letters to be issued by AID/Rwanda. The procedure which has been approved by both the GOR and AID on other projects is to provide an advance sufficient for approximately one month, to be replenished upon receipt from the MINAGRI of a report on the use of funds already advanced, and a request detailing expenditures to be covered by the replenishment.

7. Contracting for Technical Assistance. AID will finance two long-term technicians for the four-year life-of-project and ten months of short-term consultancies, two months of which will be for monitoring and surveillance of the environmental (health) factors surrounding the ponds and one month for project evaluation.

In line with recent initiatives by AID to establish more formal working arrangements with the Food and Agriculture Organization (FAO) of the U.N., as reported in 80 Rome 26758 and 80 Rome 27941, Annex K includes a request for waiver to permit a host country contract with the FAO to provide the required technical assistance, both long-term and short-term, directly related to fish production. An arrangement with the FAO is recommended for the following reasons:

(A) Difficulty in locating technicians with experience and with French language capability who are prepared to live in rural Rwanda for four years. AID success in recruiting technicians to live in the Capital or in semi-urban areas has been dismal. Kigembe offers more of an obstacle since it is located one hour from Butare (in the south of the country) and is without electricity and other basic comforts. Should the technicians live in Butare, the lack of English-speaking schools limits the field of recruitment to single technicians or childless couples.

The FAO, on the other hand, has a wide field for recruitment which includes French speakers. The FAO has fish culture specialists in many other countries of the third world, including Africa, and has a pool of well-qualified experienced technicians from which to draw, technicians who will not find the foreign atmosphere, the isolation, and the different culture an impediment to accepting a long assignment in Rwanda.

(B) Administrative support requirements. The AID Mission in Rwanda is small and is likely to remain so. Every attempt has to be made to allow the use of the limited USDH personnel as effectively as possible, including the reduction in the amount of attention given to administrative support of contractors. For AID to support a contract team based in Kigembe, even a contract team of two people, will be time-consuming and difficult. With FAO technicians, administrative actions will be substantially reduced. They will find their own housing, purchase furniture and appliances, clear customs, pack and ship their effects, arrange air travel, use international mail and generally live off of the economy.

G. Evaluation Plan

1. Continuing project evaluation will be carried out by a Rwandan sociologist and an economist from the National University at Butare. The Rwandan team will work with the U.S. technical assistance team and the fish extension service to evaluate whether the recommendations of the extension service are being accepted by farmers and the benefits which are accruing to farmers because of the project. The Rwandan team will be able

to 'feed back' their findings to the project management team to permit modifications in the extension program, and in the project, to be made as necessary. REDSO will be requested to assist in preparing the terms of reference for the Rwandan evaluation team and will assist in monitoring the evaluation process and the findings and evaluations of the team.

2. The Project is phased, i.e. the first year of the project will concentrate on establishing an extension service in three prefectures. The technical assistance team, working with the Rwandan sociologist and economist, will determine at which stage project activities should be expanded to the second three prefectures, and later, to the remaining prefectures, and present their recommendations to AID/Rwanda. AID/Rwanda, consulting with REDSO, will determine whether the project should be expanded to other regions.

3. At the beginning of the third year of project activity, an assessment of the project will be made by an outside review team consisting of a representative of the GOR and two AID consultants. The team will visit various project sites and interview individuals related to project activities. The team will assess the overall progress being made to achieve project objectives and will be able to suggest changes in project objectives and operations which their evaluation deems necessary. It is expected that the AID consultants will spend 7-10 days in country. At least one of them should have fisheries extension experience from a third world country.

4. Near the end of the project, a major evaluation will take place. This evaluation will assist AID in determining whether a second phase project is necessary and justified.

H. Status of Negotiations, Conditions and Covenants

The possibility of AID financing a fish culture project in Rwanda has been under discussion since early 1977 (See Section A, of the PID). The present PP is the result of close and frequent collaboration with the Ministry for Agriculture and Livestock, particularly the Division of Fisheries and Fish Culture. It is the opinion of the design team that the GOR is committed to a program to increase nutrition levels in rural Rwanda through a fish culture program, and that the required counterpart resources will be forthcoming from the Government. Government commitment can be assessed at the beginning of each phase of the project and subsequent phases delayed or modified if Government contributions are not forthcoming.

There are no special host country actions which must be taken prior to execution of the Project Agreement. There are no proposed conditions precedent to disbursement. The following covenants will be included in the Project Agreement:

1. A-2-level agricultural agents, training in fish culture, will be assigned to each of the prefectural fish stations included in the project.

2. The GOR will progressively assume the cost of fish monitors according to the formula worked out in the course of project design.

[illegible] major implementation actions [illegible] project.

[illegible]	Contract/ [illegible]	Pre-final [illegible]	Construction	Training	Procurement
[illegible]					
[illegible]					
Apr. [illegible] project author- [illegible]			Design work for conv./ renov. of Aquaculture Center and 3 freshwater fish stations negotiated with engineering firm		
[illegible]31		Contract for TA negotiated with [illegible]			
[illegible]	[illegible] project agreement signed and IL [illegible] [illegible]		Design work for Aquaculture Center and 3 freshwater fish stations contracted		
[illegible]31		TA contract signed			Local procurement of equipment for fish stations and Aquaculture center
[illegible]31		Contract with [illegible] evaluation team negotiated/signed			
[illegible]		Long-term TA arrives	Design work and bid documents completed	3 [illegible]-2 agronomists depart for training in Ivory Coast	Vehicles purchased
[illegible]31		On-going evaluation work begins			
[illegible] [illegible]31			Contracts let on Aquaculture and fish station work	20 monitors begin 3 months training	

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Date	Organization/ Evaluation	Construction	Training
Jun 3			3 A-2 agronomes return from training in Ivory Coast and [illegible] to fish stations
Aug 3		Fish stations construction completed	
Sept 3	Evaluation team to move on to next 3 Prefectures		3 A-2 agronomes depart for Ivory Coast training
Dec 3		Kipemba construction completed. Design and bid documents for 2nd 3 prefectures completed	20 monitors begin 3 mos. training
1981			
May 31	First project evaluation		
Jul 31		Const/renov of 2nd 3 prefectural fish stations completed	
Oct 31	Evaluation team to move to training prefectures		

BEST AVAILABLE DOCUMENT

Annex A

BEST AVAILABLE DOCUMENT

AID No. 1011-72

PROJECT DESIGN SUMMARY
LOGICAL FRAMEWORK

Life of Project: From FY 1981 to FY 1985
Total U.S. Funding $2,338,000
Date Prepared: 18 June 1981

Project Title & Number: Rwanda Fish Culture (696-0112)

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Program or Sector Goal: The broader objective to which this project contributes: Increase the availability of nutritious food for rural families in Rwanda - and increase incomes of participating families	Measures of Goal Achievement: 1.) Incidence of malnutrition declines. 2.) Farm family incomes increase	1. Nutrition Survey 2. Household budget survey	Assumptions for achieving goal targets: 1.) No decline in existing food production and availability. 2.) Continued GOR commitment to increasing food production. 3.) No significant resistance to eating fish.
Project Purpose: Assist in the development of a Fisheries Extension Service that can provide the advice & assistance required by Rwandan farm families to: 1) bring back into production and effectively manage at least 80% of the existing fish ponds in Rwanda; and 2) establish 50-100 new ponds per year.	Conditions that will indicate purpose has been achieved: End of project status. 1.) 2300 fish ponds being adequately managed & harvested throughout the country (average pond yield: 15 kg/are/year). 2.) At least 50 new fish ponds established during final year of project. 3.) 10 Prefectural fisheries stations are operational (i.e. fully staffed by trained personnel, producing 1.3 million fingerlings per year, providing training for local farmers). 4. GOR providing budget adequate to support 12 professional and 50 paraprofessional fisheries staff members.	1) MINAGRI Records & statistics/AID evaluations 2) MINAGRI Records & statistics/AID 2) MINAGRI Records & statistics/AID evaluation 3) Observation/AID evaluations 4) MINAGRI records	Assumptions for achieving purpose: 1) Farmers will follow recommendations of extension workers if properly & consistently presented. 2) Reasonable success in locating & making available low or no-cost fish feed. 3) Extension services will work diligently & effectively
Outputs: 1) A-2 level supervisors at long-term specialized fish culture course. 2) Fisheries extension workers (monitors) trained and hired. 3) Prefectural fish stations rehabilitated & equipped. 4) Kigembe Fisheries Training & Research Station rehabilitated & equipped	/trained MAGNITUDE OF OUTPUTS: 1) 12 supervisors trained by 1985 2) 50 fisheries extension workers 3) 10 stations by 1985 4) completed by Dec. 1982.	1) MINAGRI Records/AID Records 2) MINAGRI Records/AID Records 3) Observation 4) Observation	Assumptions for achieving outputs: 1) Personnel turnover & attrition within usual bounds. 2) Continued GOR commitment to expansion of fish culture.
Inputs: See Project Budget (Annex D)	Implementation Target (Type and Quantity)		Assumptions for providing inputs: AID & GOR funds will be made available as planned.

Annex B. Statutory Checklist

5C(1) - COUNTRY CHECKLIST

Listed below are, first, statutory criteria applicable generally to FAA funds, and then criteria applicable to individual fund sources: Development Asistance and Economic Support Fund.

A. GENERAL CRITERIA FOR COUNTRY ELIGIBILITY

1. FAA Sec. 116. Can it be demonstrated that contemplated assistance will directly benefit the needy? If not, has the Department of State determined that this government has engaged in a consistent pattern of gross violations of internationally recognized human rights?	The Social Soundness and Economic Analyses demonstrate that the direct beneficiaries of the project will be the rural poor.
2. FAA Sec. 481. Has it been determined that the government of recipient country has failed to take adequate steps to prevent narcotics drugs and other controlled substances (as defined by the Comprehensive Drug Abuse Prevention and Control Act of 1970) produced or processed, in whole or in part, in such country, or transported through such country, from being sold illegally within the jurisdiction of such country to U.S. Government personnel or their dependents, or from entering the United States unlawfully?	No narcotic drugs or other controlled substances are shipped from Rwanda to the U.S. It has not been determined that Rwanda has failed to take the necessary steps to prevent such shipment in the future..
3. FAA Sec. 620(b). If assistance is to a government, has the Secretary of State determined that it is not controlled by the international Communist movement?	The Secretary of State has so determined.
4. FAA Sec. 620(c). If assistance is to government, is the government liable as debtor or unconditional guarantor on any debt to a U.S. citizen for goods or services furnished or ordered where (a) such citizen has exhausted available legal remedies and (b) debt is not denied or contested by such government?	No.
5. FAA Sec. 620(e)(1). If assistance is to a government, has it (including government agencies or subdivisions) taken any action which has the effect of nationalizing, expropriating, or otherwise seizing ownership or control of property of U.S. citizens or entities beneficially owned by them without taking steps to discharge its obligations toward such citizens or entities?	No.

A.

6. FAA Sec. 620(a), 620(f); FY 79 App. Act, Sec. 108, 114 and 606. Is recipient country a Communist country? Will assistance be provided to the Socialist Republic of Vietnam, Cambodia, Laos, Cuba, Uganda, Mozambique, or Angola?	No.
7. FAA Sec. 620(i). Is recipient country in any way involved in (a) subversion of, or military aggression against, the United States or any country receiving U.S. assistance, or (b) the planning of such subversion or aggression?	No.
8. FAA Sec. 620 (j). Has the country permitted, or failed to take adequate measures to prevent, the damage or destruction, by mob action, of U.S. property?	No.
9. FAA Sec. 620(l). If the country has failed to institute the investment guaranty program for the specific risks of expropriation, inconvertibility or confiscation, has the AID Administrator within the past year considered denying assistance to such government for this reason?	Not applicable.
10. FAA Sec. 620(o); Fishermen's Protective Act of 1967, as amended, Sec. 5. If country has seized, or imposed any penalty or sanction against, any U.S. fishing activities in international waters: a. has any deduction required by the Fishermen's Protective Act been made? b. has complete denial of assistance been considered by AID Administrator?	Not applicable.
11. FAA Sec. 620; FY 79 App. Act, Sec. 603. (a) Is the government of the recipient country in default for more than 6 months on interest or principal of any AID loan to the country? (b) Is country in default exceeding one year on interest or principal on U.S. loan under program for which App. Act appropriates funds?	Not applicable.
12. FAA Sec. 620(s). If contemplated assistance is development loan or from Economic Support Fund, has the Administrator taken into account the percentage of the country's budget which is for military expenditures, the amount of foreign exchange spent on military equipment and the	Not applicable.

amount spent for the purchase of sophisticated weapons systems? (An affirmative answer may refer to the record of the annual "Taking Into Consideration" memo: "Yes, as reported in annual report on implementation of Sec. 620(s)." This report is prepared at time of approval by the Administrator of the Operational Year Budget and can be the basis for an affirmative answer during the fiscal year unless significant changes in circumstances occur.)

13. FAA Sec. 620(t). Has the country severed diplomatic relations with the United States? If so, have they been resumed and have new bilateral assistance agreements been negotiated and entered into since such resumption?

No.

14. FAA Sec. 620(u). What is the payment status of the country's U.N. obligations? If the country is in arrears, were such arrearages taken into account by the AID Administrator in determining the current AID Operational Year Budget?

There is no chronic arrearage situation though Rwanda has, from time to time, been slow in meeting its U.N. obligations.

15. FAA Sec. 620A, FY 79 App. Act, Sec. 607. Has the country granted sanctuary from prosecution to any individual or group which has committed an act of international terrorism?

No.

16. FAA Sec. 666. Does the country object, on basis of race, religion, national origin or sex, to the presence of any officer or employee of the U.S. there to carry out economic development program under FAA?

No.

17. FAA Sec. 669, 670. Has the country, after August 3, 1977, delivered or received nuclear enrichment or reprocessing equipment, materials, or technology, without specified arrangements or safeguards? Has it detonated a nuclear device after August 3, 1977, although not a "nuclear-weapon State" under the nonproliferation treaty?

No.

B. FUNDING CRITERIA FOR COUNTRY ELIGIBILITY

1. Development Assistance Country Criteria

a. FAA Sec. 102(b)(4). Have criteria been established and taken into account to assess commitment progress of country in effectively involving the poor in development, on such indexes as: (1) increase in agricultural productivity through small-farm labor intensive agriculture, (2) reduced infant mortality, (3) control of population growth, (4) equality of income distribution, (5) reduction of unemployment, and (6) increased literacy?

Criteria on commitment to involving the poor in development have been established and it has been determined that Rwanda's commitment in this regard meets AID standards. See Rwanda CDSS.

b. FAA Sec. 104(d)(1). If appropriate, is this development (including Sahel) activity designed to build motivation for smaller families through modification of economic and social conditions supportive of the desire for large families in programs such as education in and out of school, nutrition, disease control, maternal and child health services, agricultural production, rural development, and assistance to urban poor? — Not applicable.

2. Economic Support Fund Country Criteria

a. FAA Sec. 502B. Has the country engaged in a consistent pattern of gross violations of internationally recognized human rights? — Not applicable.

b. FAA Sec. 533(b). Will assistance under the Southern Africa program be provided to Mozambique, Angola, Tanzania, or Zambia? If so, has President determined (and reported to the Congress) that such assistance will further U.S. foreign policy interests? — Not applicable.

c. FAA Sec. 609. If commodities are to be granted so that sale proceeds will accrue to the recipient country, have Special Account (counterpart) arrangements been made? — Not applicable.

d. FY 79 App. Act, Sec. 113. Will assistance be provided for the purpose of aiding directly the efforts of the government of such country to repress the legitimate rights of the population of such country contrary to the Universal Declaration of Human Rights? — Not applicable.

e. FAA Sec. 620B. Will security supporting assistance be furnished to Argentina after September 30, 1978? — Not applicable.

5C(2) - PROJECT CHECKLIST

Listed below are statutory criteria applicable generally to projects with FAA funds and project criteria applicable to individual fund sources: Development Assistance (with a subcategory for criteria applicable only to loans); and Economic Support Fund.

CROSS REFERENCES: IS COUNTRY CHECKLIST UP TO DATE?
HAS STANDARD ITEM CHECKLIST BEEN REVIEWED FOR THIS PRODUCT?

A. GENERAL CRITERIA FOR PROJECT

1. FY 79 App. Act Unnumbered; FAA Sec. 653 (b); Sec. 634A. (a) Describe how Committees on Appropriations of Senate and House have been or will be notified concerning the project; (b) is assistance within (Operational Year Budget) country or international organization allocation reported to Congress (or not more than $1 million over that figure)?	The Project has been included in the FY 1981 and 1982 Congressional Presentations.
2. FAA Sec. 611(a)(1). Prior to obligation in excess of $100,000, will there be (a) engineering, financial, and other plans necessary to carry out the assistance and (b) a reasonably firm estimate of the cost to the U.S. of the assistance?	The required plans have been completed and are discussed in this PP.
3. FAA Sec. 611(a)(2). If further legislative action is required within recipient country, what is basis for reasonable expectation that such action will be completed in time to permit orderly accomplishment of purpose of the assistance?	No further legislative action is required.
4. FAA Sec. 611(b); FY 79 App. Act Sec. 101. If for water or water-related land resource construction, has project met the standards and criteria as per the Principles and Standards for Planning Water and Related Land Resources dated October 25, 1973?	Not applicable.
5. FAA Sec. 611(e). If project is capital assistance (e.g., construction), and all U.S. assistance for it will exceed $1 million, has Mission Director certified and Regional Assistant Administrator taken into consideration the country's capability effectively to maintain and utilize the project?	Yes. Certification is included in this PP.
6. FAA Sec. 209. Is project susceptible of execution as part of regional or multilateral project? If so why is project not so executed? Information and conclusion whether assistance will encourage regional development programs.	The project is not susceptible of execution as a regional or multi-lateral project. However, experience gained under this project will have applicability for future, similar projects in neighboring countries.

A.

7. FAA Sec. 601(a). Information and conclusions whether project will encourage efforts of the country to: (a) increase the flow of international trade; (b) foster private initiative and competition; (c) encourage development and use of cooperatives, credit unions, and savings and loan associations; (d) discourage monopolistic practices; (e) improve technical efficiency of industry, agriculture and commerce; and (f) strengthen free labor unions.

The project will encourage the development of fish production cooperatives though this is not a primary project objective. Other factors are not applicable.

8. FAA Sec. 601(b). Information and conclusion on how project will encourage U.S. private trade and investment abroad and encourage private U.S. participation in foreign assistance programs (including use of private trade channels and the services of U.S. private enterprise).

Not applicable.

9. FAA Sec. 612(b); Sec. 636(h). Describe steps taken to assure that, to the maximum extent possible, the country is contributing local currencies to meet the cost of contractual and other services, and foreign currencies owned by the U.S. are utilized to meet the cost of contractual and other services.

Not applicable.

10. FAA Sec. 612(d). Does the U.S. own excess foreign currency of the country and, if so, what arrangements have been made for its release?

Not applicable.

11. FAA Sec. 601(e). Will the project utilize competitive selection procedures for the awarding of contracts, except where applicable procurement rules allow otherwise?

A waiver for sole source contracting with the FAO for technical assistance is being requested. Competitive procurement procedures will be applied in all other applicable cases.

12. FY 79 App. Act Sec. 608. If assistance is for the production of any commodity for export, is the commodity likely to be in surplus on world markets at the time the resulting productive capacity becomes operative, and is such assistance likely to cause substantial injury to U.S. producers of the same, similar, or competing commodity?

Not applicable.

B. FUNDING CRITERIA FOR PROJECT

1. Development Assistance Project Criteria

a. FAA Sec. 102(b); 111; 113; 281a. Extent to which activity will (a) effectively involve the poor in development, by extending access to economy at local level, increasing labor-intensive production and the use of appropriate technology, spreading investment out from cities to small towns and rural areas, and insuring wide participation of the poor in the benefits of development on a sustained

Poor rural farmers are the primary beneficiaries of the extension services to be aided by the project. Appropriate technology for fish culture will be transmitted to interested farmers. Successful fish ponds will enable farmers to improve the nutritional levels of thei families and, over time, increase their incomes. Major investment is not require of farmers other than labor. Self-help efforts are reinforced both at farm and national levels by increasing total

basis, using the appropriate U.S. institutions; (b) help develop cooperatives, especially by technical assistance, to assist rural and urban poor to help themselves toward better life, and otherwise encourage democratic private and local governmental institutions; (c) support the self-help efforts of developing countries; (d) promote the participation of women in the national economies of developing countries and the improvement of women's status; and (e) utilize and encourage regional cooperation by developing countries?

food supply and reducing import requirements. As the member of the family who will control the care and use of the fish, women will be prime targets of extension services, and will be hired as extension agents.

b. FAA Sec. 103, 103A, 104, 105, 106, 107. Is assistance being made available: (include only applicable paragraph which corresponds to source of funds used. If more than one fund source is used for project, include relevant paragraph for each fund source.)

(1) [103] for agriculture, rural development or nutrition; if so, extent to which activity is specifically designed to increase productivity and income of rural poor; [103A] if for agricultural research, is full account taken of needs of small farmers;

(103)The project is specifically designed to reinforce an extension service to provide technical advise and needed inputs (fingerlings) to rural farmers. The project design has considered alternative ways to reach the farmer and has determined that the assistance described in the PP is the most appropriate and has the best chance for success and replication.

(2) [104] for population planning under sec. 104(b) or health under sec. 104(c); if so, extent to which activity emphasizes low-cost, integrated delivery systems for health, nutrition and family planning for the poorest people, with particular attention to the needs of mothers and young children, using paramedical and auxiliary medical personnel, clinics and health posts, commercial distribution systems and other modes of community research.

(3) [105] for education, public administration, or human resources development; if so, extent to which activity strengthens nonformal education, makes formal education more relevent, especially for rural families and urban poor, or strengthens management capability of institutions enabling the poor to participate in development;

(4) [106] for technical assistance, energy, research, reconstruction, and selected development problems; if so, extent activity is:

(i) technical cooperation and development, especially with U.S. private and voluntary, or regional and international development, organizations;

(ii) to help alleviate energy problems;

(iii) research into, and evaluation of, economic development processes and techniques;

(iv) reconstruction after natural or manmade disaster;

(v) for special development problem, and to enable proper utilization of earlier U.S. infrastructure, etc., assistance;

(vi) for programs of urban development, especially small labor-intensive enterprises, marketing systems, and financial or other institutions to help urban poor participate in economic and social development.

c. [107] Is appropriate effort placed on use of appropriate technology?

d. FAA Sec. 110(a). Will the recipient country provide at least 25% of the costs of the program, project, or activity with respect to which the assistance is to be furnished (or has the latter cost-sharing requirement been waived for a "relatively least-developed" country)?

Rwanda will contribute approximately 25% of the cost of the project. Rwanda is a "relatively least developed" country and a waiver from this Section of the FAA has been requested.

e. FAA Sec. 110(b). Will grant capital assistance be disbursed for project over more than 3 years? If so, has justification satisfactory to the Congress been made, and efforts for other financing, or is the recipient country "relatively least developed"?

Rwanda is a "relatively least developed" country.

f. FAA Sec. 281(b). Describe extent to which program recognizes the particular needs, desires, and capacities of the people of the country; utilizes the country's intellectual resources to encourage institutional development; and supports civil education and training in skills required for effective participation in governmental and political processes essential to self-government.

Farmers have been trying to raise fish for the last 20 years without success. Studies carried out in conjunction with the PP design have determined that farmers want advise on the right way to raise fish and want access to fingerlings. The project will provide that. The project has a large training component for fish culture specialists and for low-level extension workers who will work directly with the farmers.

g. FAA Sec. 122(b). Does the activity give reasonable promise of contributing to the development of economic resources, or to the increase or productive capacities and self-sustaining economic growth?

Yes.

2. Development Assistance Project Criteria (Loans Only)

a. FAA Sec. 122(b). Information and conclusion on capacity of the country to repay the loan, including reasonableness of repayment prospects.

Not applicable.

b. FAA Sec. 620(d). If assistance is for any productive enterprise which will compete in the U.S. with U.S. enterprise, is there an agreement by the recipient country to prevent export to the U.S. of more than 20% of the enterprise's annual production during the life of the loan?

Not applicable.

3. Project Criteria Solely for Economic Support Fund

a. FAA Sec. 531(a). Will this assistance support promote economic or political stability? To the extent possible, does it reflect the policy directions of section 102?

Not applicable.

b. FAA Sec. 533. Will assistance under this chapter be used for military, or paramilitary activities?

No.

ANNEX C

Responses to REDSO/EA and AID/W PID Review Cables

The PID was reviewed by REDSO/EA on January 24, 1980, and the Review Committee comments forwarded to AID/Rwanda by 80 Nairobi 2028. The AID/W PID review was conducted on February 20 and reported to the field in 80 State 07]483. Copies of both cables are attached. The Project Paper has addressed the comments/recommendations of both reviews. Below is presented a brief summary of these responses.

1. 80 Nairobi 2028 (REDSO/EA)

A. The economics of small farmer fish culture.

(I) Cost to the small farmer of building and maintaining small ponds. The AID project will involve little if any new pond construction. There are approximately 3,000 ponds already in existence and being worked, but with very little yield. These ponds will be the focal point of extension services. New ponds to be constructed will be at farmer initiative but only after farmers have been shown that a viable return is possible from fish culture.

Maintenance of ponds is a labor cost to be incurred by the farmers. While some labor is already allotted to the ponds, more will be required, particularly maintaining the ponds free of weeds at the edges. This is labor which will be given to the young members of the family since it is not strenuous, only time consuming.

Supplemental feed availability is discussed in the FAO report. Feed is available and the technical assistance team will have to establish a mechanism for systematically assuring that it is reserved for fish culture and is delivered.

(2) Cost to the GOR. The recurrent cost burden of the entire project is $120,000/yr., including the cost of amortizing the government-owned installations and for personnel. It should be noted, however, that all of the A-2 technicians are already on board and assigned to the prefectural fish stations and that 20 fish monitors are already on government rolls, as are a number of laborers. The project will result in an estimated increase in personnel of approximately 50, including 30 fish monitors and 20 laborers and guardians. Possibilities for self-financing, at least of the day-to-day costs at Kigembe and at the fish stations, will be examined, particularly that of using proceeds from the sale of fingerlings to cover some costs. Other options include putting the fish monitors at the charge of the communes and, ultimately, the farmers who benefit from their services. These options will be examined over the life of the project.

(3) Marketing costs. The project analyses have determined that marketing of fish will not enter into the equation during the first three years of the project--that fish grown will be consumed at home and/or will be bartered for other goods and services. What little may enter into the commercial system will be marketed to neighbors. Should production reach the level where personnel needs are exceeded, the marketing system being developed for the lake fisheries program can be brought into play. The technical assistance team will be responsible for making recommendations for future assistance in marketing, should the need arise.

(4) Cost to AID. The project costs have been determined by the design team and are presented in the PP.

B. Land allocation. The project will work with ponds already in existence. The question of allocating new land for ponds will not arise over the near term.

C. Update on existing pond situation. The PP analyses have determined that production is not maximized due principally to a total lack of extension services to participating farmers. The IDRC research project has concerned itself entirely with lake fisheries. Very little of their experience is transferable to the fish culture project.

D. Possibility of joint project with Burundi. This possibility was explored and rejected. The Rwanda program is ahead of the proposed Burundi project. Certainly, the experience in Rwanda will prove extremely valuable for Burundi and the possibility of coordination and collaboration in the future should be retained.

2. <u>80 State 071483</u>

A. Self-financing. See remarks para A (2) above.

B. Comparative returns from use of manure. According to the Auburn team, studies on comparative returns from manure for fishponds versus use of manure on food crops have never been carried out.

C. Costs and returns from using chemical fertilizer. The PP design team determined that the use of chemical fertilizer was not possible.

D. The use of formal or informal credit. The design team saw no instance where the use of credit would be required either by individual farmers or by groups of farmers. The scale of production will be too small. Should groups of farmers reach the scale of production where credit for the purchase of feed or fertilizer becomes possible, the Banques Populaires (People's Banks) are available and ready to extend credit.

E. Fish grown in rotation with rice. It has been determined that, because of the limited rice production in Rwanda, the project would not

consider this possibility. The only rice projects are Chinese financed, and a fish/rice program would probably involve co-mingling of funds. Further, chemical fertilizer and pesticides are used on the rice paddies. Since we are unaware of the kinds being used, environmental issues cannot be easily addressed. Finally, it was determined advantageous to concentrate the project on the types of fish culture with which farmers are familiar.

F. Alternative crops and effective land use. New pond construction will not be the target of the project. The extension services will concentrate on farmers who already have ponds but are getting little or no yield from them. If new land is brought into fish production, it will be the farmers' decision based on his perception of what is being achieved on other ponds. The construction of new ponds is not likely to occur until substantial production increases are felt on existing ponds.

ACTION: AID-2 INFO AMB DCM CHRON

1- [illegible]
2-TB-ES-C

C/4

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ZNR UUUUU ZZH
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Action Taken: NAW
Date: 2/6/80
Sign: [illegible]

AIDAC

FROM REDSO/EA

E.O. 12065:N/A
SUBJ: RWANDA FISH CULTURE (696-0112) - PID SUBMISION

REF NAIROBI 1153

1. REDSO/EA COMMITTEE REVIEW OF SUBJECT PID WAS HELD JANUARY 24: PID WAS WELL-RECEIVED, ALTHOUGH SOME POINTS WERE RAISED DURING THE DISCUSSION WHICH WE FEEL (A) WILL PROBABLY ALSO BE RAISED IN THE AID/W REVIEW PROCESS AND (B) MAY JUSTIFY REVISION OF SOME SECTIONS OF THE PID PRIOR SUBMISSION TO AID/W. THESE POINTS ARE HIGHLIGHTED BELOW:

2. THE ECONOMICS OF SMALL FARMER FISH CULTURE. THIS QUESTION MUST BE EXAMINED ON FOUR LEVELS: (A) COST TO THE SMALL FARMER OF BUILDING AND MAINTAINING 1-2 SMALL PONDS. EIGHTY MAN-DAYS OF LABOR TO BUILD EACH POND REPRESENTS A CONSIDERABLE LEVEL OF EFFORT TO BE EITHER HIRED (FINANCIAL COST) OR PERFORMED BY THE SMALL FARMER (COST OF EFFORT). TO THIS INITIAL COST MUST BE ADDED THE COST OF FEEDING THE FISH AND MAINTENANCE. SOURCE AND COST OF FEED AND ITS TRANSPORT TO PONDS WAS A MAJOR QUESTION RAISED BY AUBURN TEAM IN BURUNDI. SINCE THE QUESTION OF FEED WILL DIRECTLY IMPACT ON YIELD (AND PREFITABILITY), BELIEVE THIS DESERVES PARTICIULAR ATTENTION. COPY OF AUBURN REPORT WAS POUCHED TO AAO LAST WEEK. (B) COST TO THE GOR. GOR PERSONNEL COSTS SEEM UNDERESTIMATED AND REPRESENT A SIZEABLE RECURRENT COST BURDEN. THE COST OF FINGERLINGS ALSO REPRESENTS A RECURRENT COST BURDEN. WILL THE COST BE SUSIDIZED BY THE GOR? IF SO, ESTIMATED COST SHOULD BE INCLUDED IN GOR CONTRIBUTION TO THE PROJECT. (C) MARKETING COSTS. IF PONDS ARE HARVESTED 1-2 TIMES PER YEAR, YIELD IS LIKELY TO REQUIRE SOME MARKETING. (IS IT FEASIBLE FOR SUBSISTANCE FARMERS TO STOCK PONDS MONTHLY SO THAT MATURE FISH CAN BE HARVESTED THROUGHOUT EACH MONTH TO AVOID MARKETING?) PID IMPLIES THAT MARKETING-RELATED QUESTIONS (CAN FARMERS AFFORD TO BUY FISH? ARE THERE LOCAL MARKETS? WHAT ARE IMPLICATIONS OF TRANSPORTING FISH TO NEIGHBORING OR URBAN MARKETS?) WILL BE ADDRESSED DURING PP DESIGN. AT MINIMUM, BELIEVE QUESTIONS SHOULD BE RAISED IN PID AND EXTENT OF OUR KNOWLEDGE OF ANSWERS ACKNOWLEDGED, INCLUDING IDEA THAT SOCIAL SCIENTIST WILL EXAMINE UNANSWERED QUESTIONS PRIOR TO PP DESIGN EFFORT. (D) COST TO AID. COST OF CONSTRUCTION OF TRAINING CENTER AND DORMITORY SEEMS UNDER ESTIMATED IN VIEW OUR PREVIOUS EXPERIENCE IN RWANDA, AT LEAST WITHOUT EXPLANATION OF WHY IT IS SO INEXPENSIVE.

3. LAND ALLOCATION, THERE ARE TWO ASPECTS OF THIS QUESTINON: (A) ALLOCATION OF LAND FOR FISH PONDS, WHICH IS BEING ADDRESSED IN PDS STUDY, AND (B) ALTERNATIVE USES FOR LAND BASED ON PRODUCTION REVENUE. CRITERIA MUST BE ESTABLISHED ON BASIS OF WHICH FARMER CAN BE ADVISED ON MOST PROFITABLE USE OF AVAILABLE LAND. THIS ASPECT OF LAND ALLOCATION SHOULD PERHAPS ALSO BE ACKNOWLEDGED IN PID WITTH STATEMENT THAT I WILL BE ADDRESSED FULLY IN PP DESIGN EFFORT. C/5

4.UPDATE ON EXISTING POND SITUATION. OBVIOUS QUESTION IS WHY ARE FARMERS NOT MAXIMIZING PRODUCTION FROM EXISTING PONDS? IS IT ONLY BASED ON A LACK OF TECHNICAL KNOW-HOW? PERHPAS MORE FUNDAMENTAL PROBLEM IS COST AND SOURCE OF SUPPLEMENTAL FEED FOR FISH WHICH, AGAIN, AUBURN RAISED IN BURUNDI SITUATION. IT WOULD ALSO BE HELPFUL TO HAVE MORE OF A DESCRIPTION OF IDRC RESEARCH PROJECT AT BUTARE. ARE THERE RESULTS AND EXPERIENCES WHICH ARE APPLICABLE TO THIS PROJECT?

5. POSSIBILITY OF JOINT PROJECT WITH BURUNDI, REDSO/EA COMMITTEE RAISED QUESTION OF WHY AUBURN TEAM (GROVER AND PALM) DID NOT RAISE/ACKNOWLEDGE SAME TECHNICAL AND ECONOMIC PROBLEMS WHICH GROVER RAISED IN BURUNDI. ASSUMING AUBURN IS ALSO SELECTED FOR RWANDA PROJECT, IT SEEMS REASONABLE TO IMPLENT THE PROJECT IN CONCERT WITH BURUNDI PROJECT - THAT IS, AUBURN WILL UNDERTAKE RESEARCH ON ISE CULTURE IN BURUNDI WHICH WOULD COMPLEMENT ON-FARM PRODUCTION EFFORT INRWANDA.

6. ALSO, REDSO/EA WOULD APPRECIATE RECEIVING A COPY OF AUBURN'S STATE OF THE ART STUDY OF FISH CULTURE IN WEST AND ANCENTRAL AFRICA.

7. REDSO/EA APPRECIATES AAO'S DESIRE TO FORWARD PID ASAP TO AID/W AND INABILITY TO ANSWER MUST OF QUESTIONS RAISED ABOVE WITHOUT TECHNICAL TEAM TO BE FIELDED FOR PP DESIGN. ONE THE OTHER HAND, QUESTINS ON ECONOMICS OF FISH CULTURE SEEM SERIOUS ENOUGH TO REQUIRE ANALYSIS PRIOR TO PP DESIGN EFFORT. SHOULD FISH CULTURE PROVE AN UNECONOMIC VENTURE FOR THE SMALL FARMER, IT IS UNFW T TT BOTH GOR AND AID TO PROCEED TO PP STAGE AT WHICH POINT BOTH PARTIES FEEL COMMITTED TO PROJECT AND EXA PECTATIONS ARE HIGH. WE ARE WILLING TO CHECK OUT POSSIBILITY OF CONTRACTING WITH LOCALLY-BASED ECONOMIST TO CONDUCT, IN EFFECT, A FEASIBILITY SUTDY OF SMALL POND ECONOMICS, IF YOU ARE IN AGREEMENT. IF AAO WISHES TO DISCUSS REDSO/EA'S CONCERNS IN GREATER DETAIL AND/R HAVE ASSISTANCE IN REWORKING PID, BLANE AVAILABLE FOR TDY NEXT WEEK OR IN NEAR FUTURE . ALTERNATIVELY, REDSO/EA CAN POUCH COLLETIVE COMMENTS TO AAO IMMEDIATELY. REQUEST AAO COMMENTS AND PROPOSED NEXT STEPS.

8. FYI. REDSO/EA IS OBTAINING INFORMATION FROM PEACE CORPS/ KENYA ON FISH CULTURE PROGRAM (6 PCVS) IN NYANZA PROVINCE. ALSO, REDSO/EA ECONOMIST IS STUDYING BOTH PID AND AUBURN REPORT ON BURUNDI IN GREATER DETAIL IN ORDER OFFER COMMENTS MORE SUBSTANTIVE THAN THOSE OUTLINED PARA. 2 ABVE.LOVE PLANS TO TELEPHONE GROVER FROM AID/W TO DISCUSS POINTS RAISED PARA 5 ABOVE. END FYI.LE MELLE
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TAGS:
SUBJECT: RWANDA FISH CULTURE PID REVIEW (696-0112)

1. REVIEW COMMITTEE (WITH AAO CHIVIAROLLI ATTENDING) MET ON 20 FEBRAURY AND APPROVED PID.

2. FOLLOWING RECOMMENDATIONS WERE MADE FOR DESIGN AND PP PREPARATION:

A. DESIGN TEAM SHOULD EXAMINE POSSIBLE SELF-FINANCING METHODS TO COVER RECURRENT COSTS IN PROJECT;

B. COMPARATIVE RETURNS FROM USE OF MANURE FOR FISH PONDS VERSUS CROP USE SHOULD BE CONSIDERED;

C. ESTIMATED COSTS AND RETURNS FROM USING CHEMICAL FERTILIZER IN PONDS SHOULD BE DETERMINED..IF THIS IS FOUND TO BE FINANCIALLY ATTRACTIVE, THE ENVIRONMENTAL ASSESSMENT WOULD ALSO NEED TO CONSIDER POSSIBLE NEGATIVE EFFECTS.

D. THE USE OF FORMAL OR INFORMAL CREDIT BY FARMERS OR COOPERATIVES IN FISH PRODCUTION SHOULD BE CONSIDERED;

E. THE FEASIBILITY OF GROWING FISH IN RICE PADDIES OR IN ROTATION WITH RICE SHOULD BE EXAMINED;

F. QUESTION OF ALTERNATIVE CROPS, MORE EFFECTIVE LAND USE, AND THE COMPARATIVE ECONOMIC RETURNS SHOULD BE CONSIDERED.

3. ACTION ON THE IEE HAS BEEN DEFERRED UNTIL AFTER THE PP HAS BEEN PREPARED. THE PP TEAM MUST INCLUDE AN ENVIRONMENTALIST WHO WILL EXAMINE THE ENVIRONMENTAL ISSUES, DETERMINE WHAT CAN BE HANDLED BY MITIGATING MEANS, AND OTHERWISE DO NECESSARY PRELIMINARY WORK. WHEN THIS INFORMATION IS REVIEWED AS PART OF THE PP REVIEW, IT WILL BE DECIDED WHETHER AN ENVIRONMENTAL ASSESSMENT IS NECESSARY.

4. A 611A REPORT SHOULD BE SUBMITTED WITH THE PP.MATERIALS DEVELOPED FOR PP SHOULD BE COMPILED IN MANNER TO SATISFY REQUIREMENTS FOR 611A.

5. IT WAS DECIDED THAT, IF THE PP IS APPROVED, THE CHOICE OF AN IMPLEMENTING CONTRACTOR SHOULD BE MADE THROUGH OPEN COMPETITION, SO THAT THE WIDEST RANGE OF QUALIFIED ORGANIZATIONS CAN BE SOLICITED FOR TECHNICAL PROPOSALS.

. THE COMMITTEE FELT THAT THE COSTS GIVEN IN THE PID WERE PROBABLY LOW AND SUGGESTED THAT THEY BE CAREFULLY REEXAMINED DURING PP PREPARATION.

C/7

7. THE DESIGN TEAM SHOULD BE MADE UP OF REDSO/EA PERSONNEL, IQC PERSONNEL, AND AUBURN UNIVERSITY PERSONNEL UNDER PRESENTLY EXISTING CENTRALLY FUNDED PROJECT. DS/N ADVISES THAT AG ECONOMIST COULD BE MADE AVAILABLE UNDER RSSA FROM USDA NUTRITION ECONOMICS GROUP. PP DESIGN TENTATIVELY SCHEDULED FOR END MAY/JUNE. AAO WILL CABLE CONFIRMATION FOR DESIGN TIMING. DESIGN TEAM SHOULD ALSO INCLUDE AAO AG ENGINEER. PROCUREMENT PLAN FOR COMMODITIES EQUIPMENT AND SERVICES SHOULD BE VERIFIED BY REDSO/EA SUPPLY MANAGEMENT ADVISOR. IT MUST INCLUDE A DETAILED LIST OF PROCUREMENT ITEMS AND ESTIMATED CIF COSTS.

8. NECESSARY WAIVER REQUESTS(VEHICLES, SERVICES, COMMODITIES CONSTRUCTION, ETC.) SHOULD BE INCLUDED IN THE PP. POUCHING ADDITIONAL SUGGESTIONS FROM AFR/DR/ENGR.

9. APPROVAL AUTHORITY IS RETAINED BY AID/W, IN VIEW OF THE PROJECT SIZE, THE AMOUNT OF WAIVERS REQUIRED, AND THE ENVIRONMENTAL IMPLICATIONS. VANCE

Annex D

Project Budget, ($000)

	YR 1	YR 2	YR 3	YR 4	TOTAL
Technical Assistance	285	305	252	262	1.104
Long-term (2,4 years ea)	220	220	120	220	800
Short-term Technical consultants (8 mos)	20	20	20	20	80
Environmentary monitoring (2 mos)	5	5	5	5	20
Evaluation (2 mos)		10		10	20
Local contract for evaluation		10	7	7	24
Kigembe Center Director (2 years)	40	40			80
Construction	178	95	44	21	338
Kigembe Center	93	36			129
Prefectural fish stations	70	51	40	17	178
Engineering services	15	8	4	4	31
Commodity Procurement	103	55	2	28	188
1 ton vehicles (4 at $11.000)	33			11	44
VW (1)		8			8
Motorcycles (22 - $1550)	17			17	34
Bicycles (50 - $120)	3	3			6
Maintenance equipment for Kigembe and fish stations (11 - $1,000)	11				11

	YR 1	YR 2	YR 3	YR4	TOTAL
Equipment for fish monitors (50 -$100)	2	2	1		5
Fish culture equipment for Kigembe and fish stations (11 - $400)	2	2	1		5
Dormitory and Kitchen equipment at Kigembe		40			40
Training equipment	35				35
Training	26	38	28	5	97
long-term, 3d country (7 persons, 9 mos. each)at $10.000	20	30	20		70
In service (12 A-2 agents for 2 weeks twice)		2			2
(50 monitors for 3 months)	6	6	6	5	23
(cooperative members, farmers, etc 100 for 2 days)			1		1
(one day training at fish station)			1		1
Local support costs	38	58	38	23	157
Vehicle/motorcycle spare parts, repairs, maintenance and operation	8	8	8	8	32
Personnel costs (fish monitors, secretary, chauffeurs, guards etc.)	20	20	10	5	55
Kigembe center	(12)	(12)	(6)	(3)	
Fish stations	(4)	(4)	(2)	(1)	
Fish monitors	(4)	(4)	(2)	(1)	
Assistance to other training institutions	10	30	20	10	70
Sub-total	630	551	364	339	1 884

	YR 1	YR 2	YR 3	YR 4	TOTAL
Contingency (10%)	62	55	37	34	188
Sub-total	692	606	401	373	2 072
Inflation (15% compounded)	-	85	139	174	398
	692	691	540	547	2 470

ANNEX E

The Technical, Economic, Financial and Social Feasibility of Small-Scale Rural Fish Culture Development in Rwanda

by

U.W. Schmidt and M.M.J. Vincke

Aquaculture Development and

Coordination Programme

Fisheries Department

FAO, Rome

Note: This document is not an official FAO document and is not to be quoted as such.

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INTRODUCTION

Fish culture was introduced in Rwanda by the Belgian colonial administration in 1948, and by 1960 a considerable number of family-size ponds existed in the country. During the post-colonial years, most of these ponds have been abandoned, however, and it is only in recent years that the people and the Government of Rwanda have again become interested in reactivating and expanding fish farming in the country.

Responding to this revived interest, USAID Rwanda proposed a fish culture project to the Government of Rwanda, with major emphasis on extension training and technical assistance.

To undertake some of the necessary background studies, USAID Rwanda requested FAO assistance. The request was forwarded to the FAO/UNDP interregional Aquaculture Development and Coordination Programme, (ADCP), which, after a respective agreement between USAID and FAO had been reached with regard to financing the assistance, sent an aquaculture socio-economist, Mr. U.W. Schmidt to Rwanda in June 1980. A second mission, comprising Mr M.M.J. Vincke, Senior Aquaculturist of the ADCP and Mr U.W. Schmidt, was fielded in September 1980.

The following report is a result of these visits and assesses the technical, economic, financial and social feasibility of rural fish culture development in Rwanda.

The authors express their gratitude for the active cooperation and valuable assistance of Mr. E. Chiavaroli and Mr. T. Barker of the Rwanda USAID Bureau. Valuable information was obtained in discussions with Dr.G.Mahy and Mr.Pascal Bayor of the National University of Rwanda in Butare and Mr. M. Monnon, at that time member of a UNDP/ADB Mission to Rwanda.

1. FINDINGS AND RECOMMENDATIONS

1.1 Summary of Findings

The present stagnant situation of fish culture in Rwanda is a result of the almost complete lack of extension of fish farming technology. Not receiving technical-assistance, fingerlings, motivational support, etc., farmers have abandoned many ponds and others have not been harvested for years.

In spite of the present situation, interest in fish culture has remained high among rural people. However, reactivating and upgrading fish pond production will require promotion of fish farming, as farmers have become reluctant to invest labour and time, due to disappointing yields during the last two decades.

The mission found no major technical and biological constraints to fish farming in rural Rwanda. The climate, the available soils and the general availability of water constitute a sufficient natural resource base for fish culture. Basic material (agricultural wastes, agro-industrial by-products) to introduce feeding of fish and fertilization of ponds are in general available, although their feasable use will have to be evaluated in particular for every production unit.

To establish fish culture in the rural milieu will require substantial effort to strengthen the development infrastructure, i.e., research, training and extension.

With respect to the national economy, fish farming can be expected to yield a significant and positive impact, as it will provide much-needed protein for human consumption, increase incomes and employment opportunities, diversify production, and strengthen and diversify the internal market.

Based on the assumption of a hypothetical development support project providing about 2 400 rural families with technical assistance and advice in operating fish ponds, a yearly production of about 180 tons of fish is estimated, which should add a value of about 11 million Rw.F to the overall agricultural production. This estimate assumes, however, only low yields and does not consider the probable spread effect of successfully operating fish culture units.

On the farm-level fish farming is more profitable to the farmer than most other agricultural undertakings.

A 500 m^2 family pond is expected, when properly managed, to yield a minimum gross return of Rw.F 6 000 per year, with a considerable potential for increase. Using, except for fingerlings to initially stock the ponds, available resources (mainly family labour and agricultural wastes), a rural family can derive a minimum cash income of Rw.F 2 250 per year from a 500 m^2 pond, while still consuming 45 kg of fish per year (a 20 percent fold increase over the present average per caput (consumption).

Rural fish culture development will not alter the socio-economic ownership and production structures. Fish culture is technologically within the reach of the farming population; as a technology it can be expected to be assimilated more readily as, for example, animal husbandry, because it ressembles farming more closely. There is already a significant interest in taking up fish farming among rural people.

Socially and culturally, fish farming will not disrupt existing social structures and behaviour or value patterns, and can be integrated into the existing rural life.

Considering the predicted technical feasibility of fish culture in Rwanda, the probable positive and significant economic impact, the projected profitability for farming families and the apparent absence of major socially or culturally based constraints, the provision of the necessary development infrastructure and support to upgrade or innovate fish culture in Rwanda appears to be thus both justified and desirable.

1.2 Recommendations

On the basis of the above findings the following is recommended:

(i) to establish a development support structure to facilitate the reactivation and expansion of fish culture, as a family venture or a group undertaking, in the rural areas of Rwanda. The major elements of such support should be: training of national staff, extension work and fingerling production;

(ii) to organize the development support through one national centre (for training, research, initial fingerling production, etc.), and prefectural centres (as basis for extension work and fingerling production and distribution). At the initial stage of fish culture development (approximately four years) expatriate expertise should be considered necessary;

(iii) To carry out limited applied research in order to adapt established fish culture practices to local conditions. Special emphasis should be on the rational use of existing materials as feeds and fertilizers, in order to reach a high degree of self-reliance in fish farming;

(iv) to monitor the performance of rural fish culture on the farm level, to establish feed-back mechanisms between fish farmers and the development support structure, and to evaluate the overall impact of the development effort, periodically;

(v) to provide motivational support to farmers to induce them to take up or intensify fish culture, to propagate the consumption of fish among the population, and to include fish farming in the curriculae of schools, youth training centres, etc.

(vi) to desing the development support activities and the direct assistance to farmers with the objectives of making fish farming an integral element of rural production, taking available means and aspiration of the rural people into account.

2. TECHNICAL FEASIBILITY ANALYSIS

2.1 INTRODUCTION

In Rwanda, as in most of the developing countries, there is an acute shortage of animal protein in the population's diet.

The regular sources of animal protein are animal husbandry, fish (cattle, caprines, ovines, porcines and poultry), dairy products, fish (from inland fisheries or from aquaculture), and to a limited extent, game. According to Morris (1979), consumption of animal protein-rich foods in Rwanda is as follows: meat, between 0.5 and 18.9 kg *per caput* per year; fish, between 0.0 and 5.6 kg *per caput* per year; milk, between 0.8 and 17.8 l *per caput* per year.

In general the daily protein requirements are taken to be as follows:

- for light work: 90 g proteins/day, including 30 g of animal protein;
- for medium hard work: 100 g protein/day, including 33 g to 35 g of animal protein;
- for heavy work: 125 g protein/day including 40 to 45 g of animal protein.

Given that 100 g of fresh meat (beef, pork) contains between 16 and 21 g of protein (average 18 g) and that 100 g of fresh fish contains between 14 and 20 g of protein (average 17 g) it is obvious that the ration which is consumed daily in Rwanda is insufficient, as shown in Table 1.

Table 1: Meat and fish production in Rwanda (1977)

Item	Production (tons)	Average Annual Consumption (kg/capita/yr)	Average Daily Consumption (gm/capita/yr)
Meat	14 000	3.365	9
Fish			
Capture Fisheries	710		
Aquaculture	19		
	729	0.175	0.46

As it is very difficult, for several reasons (especially lack of adequate and sufficient pasture land), to improve the meat production in the country, the government of Rwanda has given fish production a high priority, with the aim of overcoming the scarcity of animal protein in the population's diet.

There are two ways to improve fish production: development of the capture fisheries in the country's lakes, rivers and marshes and development of aquaculture.

2.1.1 Situation of the capture fisheries in Rwanda

The total production for 1977 was estimated at 1 4 55 tons and the total potential of the lakes at 16 857 tons/year (Many, 1979). According to the Ministry of Agriculture and Animal Husbandry (Rapport Annuel 1978), the production of the capture fisheries in 1978 was only 709 T.

The fisheries lake outputs can certainly be increased but it will require large investment and will take many years. Even if the production

could reach the substainable potential of 16 857 tons/year, the gap between demand and supply would still be about 70 000 tons/year, considering a total demand of 87 000 tons/year. Part of this gap could be filled by fish farming, particularly in the préfectures with no or little potential for capture fisheries, and in regions with a particularly high animal protein deficit. These are, according to Reizer (1975) the following seven préfectures, in order of priority: Byumba, Butare, Gikongoro, Kigali, Ruhengeri, Gitarama and Kibungo.

2.1.2 Situation of Fish Farming in Rwanda

Fish farming started in Rwanda at the end of the fourties, under the Belgian colonical administration. At the end of the fifties the total pond area under production was about 450 ha (Aubray, 1976). The total production from these ponds was 180 tons/year approximately, with an average yield of about 400 kg/ha/year.

Two main fingerling and production centres were constructed during this period; the fish farm at l'Ecole des Assistants Agricoles at Butare in 1952, and the Kigembe Station in 1954.

During the years 1960-65, most of the rural ponds were completely abandoned and fish culture in Rwanda came to a standstill. The main reasons for this were the lack of a government initiative to continue support to rural fish farming and a consequent inadequacy of government support activities (extension service, fingerling production, training, etc.).

In 1966, it was estimated that 448 ponds still existed in Rwanda, with a total surface of 84 ha approximately (Meschkat, 1967), but eventually these ponds were also abandoned.

Due to the inability of natural fisheries to fill the widening gap between supply and demand for fish, the Rwandan Government rivived its interest in small-scale fish farming during the years 1967-73. During the same years two UNDP/FAO Projects were implemented with the aim of reactivating the Kigembe Centre and of carrying out trials o culture of common carp, T. macrochir, T. rendalli and Clarias carsonii. Tilapia fingerlings were produced and several ponds in rural areas have been stocked again.

In 1975, FAO assisted the Government in preparing an overall development plan for fisheries and aquaculture.

The number of ponds, surface area and production for 1978 are given in table 2. According to those figures, the yields are approximately 196 kg fish per ha/year. The average surface of the ponds is 2.92 ares.

Table 2

Census of Fish Ponds (1978)

Préfectures	No. of ponds	Total surface (ha)	Average pond area (ares)	Production (kg)	Average yield (kg/ha/year)
Kigali	653	12.91	1.97	1 500	116.2
Gitarama	626	12.57	2.00	690	54.9
Butare	541	23.16	4.28	9 696	41.8
Gikongoro	160	4.54	2.83	1 105 (a)	243.3
Cyangugu	32	0.94	2.93	229 (a)	243.3
Kibuye	151	2.03	1.34	604	297.5
Gisenyi	183	9.96	5.44	42	4.2
Ruhengeri	93	2.16	2.32	2 745	1 270.8
Byumba	183	8.31	4.54	2 022 (a)	243.3
Kibungo	40	1.06	2.65	258 (a)	243.3
TOTAL	2 662	77.64	-	18 891	-

Source: Ministère de l'Agriculture et de l'Elevage - Rapport Annuel 1978

(a) Production figures not quoted, but calculated by the Mission on the average yield obtained in the ponds in the other préfectures (243.3 kg fish/ha/year). The annual estimated production is thus 18 891 kg instead of 15 277 kg

On 5 April 1970 an agreement between the Ministère de l'Agriculture et de l'Elevage and CRDI (Centre de Recherches pour le Developpement International, Ottawa, Canada) was signed to impiement the ELADEP Project ('Epoisonnement des lacs du Pays et Développement de la Pêche'). The headquarters of this project are at the Ruganwa Fish Station at Kigali. According to ELADEP's programme, this project should be only involved in inland fisheries (stocking of the lakes and development of lake fisheries), but in fact, ELADEP's main activities are growing experiments of different species in aquaria and ponds at the Ruganwa Fish Station and the Kigembe Centre and the training of extension workers (Moniteurs piscicoles) at Kigembe. ELADEP has also activities at the Rusumo Fish Station (Karangwa, 1979). All personnel who has been trained in fish farming and fisheries at the 'Centre de Formation' in Bouaké, Ivory Coast, has been assigned to this project up to now.

At present only two species are commonly cultured: Tilapia melanopleura (it may be T. rendalli and not the true T. melanopleura) and T. macrochir. T. nilotica is also raised, but only in Kigali.

Occassionally one can find in some ponds Clarias carsonii, C. mossambica, Serranochromis Macrocephala and Cyprinus carpio (carpe commune).

Fingerlings of grass carp (Ctenopharyngodon idella) and maybe other chinese carps, such as silver carp (Hypophthalmichthys molitrix) were introduced in December 1979 at the Ruganwa Fish Station in Kigali by a North Korean Mission. The plan of the mission is to let the carp mature and try to spawn them for fingerling production. Trials on induced spawning will start in December 1980. The average weight of the grass carps was around 2 kg in September 1980.

2.1.3 Present plans for future development

According to Mahy (1979), Reizer (1975), Dunn (1974), De Vries (1971) and Huet (1957), average yields in fish pond in Rwanda are low, between 200 kg and 2 000 kg/ha/year. The latter yield was obtained with T. nilotica.

In 1979 the Ministère de l'Agriculture et de l'Elevage prepared a programme for aquaculture development to be carried out in each of the préfectures and communes of the country.

Rwanda is divided in ten préfectures. Each préfecture is sub-divided in sous-préfectures and communes. The programme of the Ministry of Agriculture and Livestock consists in (Minagri, 1979):

- building of one prefectoral fish breeding station composed of 16 ponds of 15 ares each, total - 240 ares, in each of the ten préfectures;
- building of one communnal fish breeding station in 100 communes.

Each centre will consist of 12 ponds of 10 ares each, total - 120 ares per every centre/communes'.

The total area of these stations will be:

		ares	ha
Préfectures	10 stations x 240 ares	2 400	24
Communes	100 stations x 120 ares	12 000	120
	TOTALS	14 400	144

Estimated cost of construction (included excavation works, construction materials, etc.) is estimated to be Rw.F 2 000 000 (U.S.$ 21 978) per ha. Total cost for 144 ha would be Rw.F 288 million (U.S.$ 3 169 230). As no detailed cost estimates were available, the mission could not assess the validity of those figures.

According to the Annual Report (1978) of the Ministry of Agriculture and Livestock, seven prefectoral fish breeding stations have already been constructed:

Gitarama: Rugeramigozi swamp near Kabgayi (commune Gitarama)

Gikongoro: Nkungu

Cyangugu: Ntendezi (commune Kagano)

Kibuye: Rehabilitation of the Fisheries Station at Nyamishaba

Gisenyi: Kazabe

Kibungo: Rusumo

Ruhengeri: Rehabilitation of the Fisheries Station at Muko

Due to lack of time the Mission could not visit these stations.

For the purpose of breeding mostly T. nilotica fingerlings, it seems not realistic to build ponds as big as 10 and 15 ares in the prefectoral and communal breeding stations. The programme proposed by the Ministry should be adapted to the required standards for T. nilotica breeding (see section 2.5).

Basic information concerning the situation of fish farming in the seven préfectures where development of aquaculture has to be considered as a priority is given in Table 3.

Table 3

Basic Information on Aquaculture in the Seven Prefectures where Development of Aquaculture is Considered as a Priority

Prefecture	Inhabitants (1974)	Density of population (inhabitants/km^2)	Situation of existing ponds (1978)					Inhabitants involved in fish farming (%)
			Number	Total area (ares)	Total production (kg)	Average production (kg/are/year)	Average area of ponds (are)	
Kigali	445 425	137	653	1 291	1 500	1.162	1.97	0.14
Gitarama	532 599	237.7	626	1 257	690	0.549	2.00	0.12
Butare	606 589	331.5	541	2 316	9 696	4.180	4.28	0.09
Gikongoro	367 886	167.8	160	454	1 105	2.433	2.83	0.044
Ruhengeri	517 171	293.5	93	216	2 745	12.700	2.32	0.010
Byumba	411 858	82.6	183	831	2 022	2.433	4.54	0.04
Kibungu	279 641	67.6	40	106	258	2.433	2.65	0.015
TOTALS	3 161 169	-	2 296	6 471	18 016	-	-	-

2.2 Summary and Conclusions

Rural fish farming can be undertaken almost anywhere in rwanda, because:

(i) climatic conditions (air and water temperature) are suitable for rearing of Tilapia and other associated species;

(ii) land with suitable soils and adequate water supply is available. Most of the existing ponds have been built in marshland and peaty soils. It is foreseen that almost all the new ponds will be established in the same sites where acid waters are predominant. Complete surveys of the sites where ponds will be constructed have to be carried out (soil and water analysis) to allow correct evaluation of the needs for liming and fertilization of the fish ponds;

(iii) Agro-industrial by-products are available, mostly all year round, and they can be used as fertilizers for the ponds and as feeds for fishes. Their appropriate and productive use will require adequate planning and organizatio as well as advice and assistance by extension personnel. A detailed inventory of existing agro-industrial by-products or wastes suitable as fertilizer for ponds (composting) and as feed for fish is necessary, not only for each of the préfectures where fish farming is planned, but also for each group of farmers involved in fish culture. Such inventory has to consider the kind of products, location available quantities, period of availability, competitive use, nutritional value, price and transport costs.

Farmers in Rwanda are not yet trained and not well accustomed to fish farming. To develop fish farming in the country, an adequate extension service for fish farming has to be established. Therefore, the training of technicians (A-2 level) and extensio workers in aquaculture (moniteurs piscicoles) is indispensable. This training can be carried out at the Kigembe Centre.

One of the bottlenecks in aquaculture development in Rwanda is the non-availability of fingerlings of suitables species all year round, It is very important to reactivate the existing fish culture stations in the concerned préfectures, and to establish the new stations already planned. This stations have to produce the fingerlings of the recommended species and make them available to the farmers.

2.3 PRINCIPAL ENVIRONMENTAL PARAMETERS FOR SMALL-SCALE RURAL FISH CULTURE

Rural, small-scale fish farming can be undertaken anywhere in Rwanda if:-

- land with suitable soils and adequate water supply is available
- climatic conditions are not harmful to cultivated fish species
- the farmer (and his family) can spend the necessary time to operate the pond.

More intensive, commercially oriented fish farming is also possible, but can only be undertaken, with success, if enough and suitable agro-industrial by-products are locally available (in radius of about 50 km from the fish farm). This seems now only possible around Kigali, Butare, Ruhengeri and Gisenyi.

In order to determine the possibilities of raising fish and to choose the suitable species it is necessary to study the climatic conditions (air and water temperature), the rainfall, the physico-chemical conditions of soils and water and also the water supply.

2.3.1 Climatic conditions

According to Morris (1979), there are two major types of climate in Rwanda and they are closely associated with elevation:

(a) a dry season tropical climate, which covers the land ranging between 1 300 and 1 900m in altitude (mostly 1 500 to 1 900m), with an average annual rainfall of 1 000 - 1 100 mm and an average annual temperature of 20°C. There are two rainy seasons.

(b) an isothermal climate, tempered by altitude, located along the Zaire-Nile ridge and the Volcanic slopes above 1 900m and reaching to 2 500 m or more. Rainfall is around 1 200-1 400 mm a year and even higher on the volcanic slopes, and the average annual temperature is 16°C. The lower part of this area has a 2-3 month dry season, but the higher part has no dry season.

The eastern fringe of the country and the southeast have an altitude below 1 000m with a rainfall dropping to below 800 mm in the southeast.

Following those facts we can distinguish between four agricultural zones:-

- the low lying land to the east and southeast (Buyumba, Kibungo and Kigali);
- the Central Plateau (Byumba, Kibungo, Kigali, Gitarama and Butare where more than half of the population lives;
- the high lands (Gikongoro, Kibuye and Cyangugu);
- the western plateau (Gisenyi, Kibuye and Cyangugu).

No complete data is available concerning the water temperatures. The extreme air temperatures and average air temperature for some of the areas are shown in Table 4.

Table 4

Extreme Air Temperature and Average Annual Air Temperature (°C)

Locality	Tx	Tn	TM	TA	Ta
Kigali-Aëro	26.3	15.5	20.8	30.7	10.8
Kigembe	26.3	15.5	20.8	30.7	10.8
Butare - Aëro	25.1	14.0	19.7	29.7	11.4
Gikongoro	23.0	13.8	18.4	26.3	11.2
Ruhengeri - Aëro	23.7	11.1	17.5	27.1	7.5

Tx = average maximum temperature

Tn = average minimum temperature

TM = average temperature

TA = absolute maximum

Ta = absolute minimum

Source : Bulletin Climatologique du Rwanda - Année 1977

Minimum air temperatures around 1.2°C are recorded at Ruhengeri and Kigembe. These low temperatures may occasionaly provoke the death of fishes in the Cichlid family i.e. Tilapia rendalli, T. mossambica and also T. nilotica in regions where water temperature drops below 10-12°C for a long time. This seems not to be the case in the areas visited by the mission since no mortalities due to low water temperatures had been reported

Because of the climatic conditions prevailing in some areas of the country, spawning of different species of tilapia will not occur in the cold season, when water temperature is below 17-18°C (generally June, July and August). Fingerlings can be produced only during the warm season (9 months per year). The growing season will also be about nine months (from September to the end of May), as growth is poor during the cold season.

2.3.2 Rainfall and water supply

According to the information detailed in Table 4 we can consider that with rainfall between 1 000 and 1 400 mm and taking into account the average volume of water in the rivers, evaporation and seepage, there will be enough water all year round to meet the water requirements of fish pond culture in the valleys and marshlands.

2.3.3 Physico-chemical conditions of soils and water

Soils in Rwanda are generally poor and mostly acid especially in the marshlands, where almost all existing ponds have been constructed. The pH of the soils is generally between 4.8 and 6.5.

As in most of the tropical countries, the soils of Rwanda are lacking phosphorus and nitrogen and, as they are generally acid, there is also a lack of calcium. As the waters in contact with these soils are generally also lacking the same nutrients, it will be absolutely necessary to compensate this lack of nutrients by fertilizing the fish ponds.

Most of the existing ponds have been constructed in valleys. In Rwanda, organic soils occupy numerous large valleys with very slight slopes, topographic conditions which are suitable for pond construction. But the soils of these valleys are generally swampy and peaty (turf-moor), with acid soils and acid water.

As it can be foreseen, most of the new ponds will have to be constructed in marshlands where peaty soils are prevailing. According to Morris (1979) there are 48 000 ha of marshland in Rwanda.

The development of the 48 000 ha in marshland has been considered for a long time and studies on the development of 3/4 of this land have been undertaken, (Table 5). Clearly, this represents a valuable resource for Rwandan agriculture but the costs of development per ha are relatively high. Recently, there has been experience of rapid acidification of drained soils in one of the marsh areas, caused by draining marshes high in sulphates. So marshland development must be approached with care (Morris, 1979), because oxidation of the sulphates causes production of more aggressive sulphur compounds (S_2 as end product).

Table 5

Marsh Land and Development Studies

Name	Marsh area (ha)	Year study finished	Activities proposed
Rugenzi, Kamizanzovo	7 000	1970	Tea, milk production
NDongozi	5 700	1972	Tea
Isumo	2 000	1974	Milk production, oil seeds
Migina	1 900	1973	Oil seeds, export crops
Kagitumba, Muvumbu	8 900 b/	1971	
Mukunguri	350 a/	1960 1968	Rice, vegetables
Nyubugogo	750 a/	1969	Rice, sugar cane
Nyaborongo	7 700	1961	Livestock
Mivongo	619 a/		
Buganya	a/		
Gasyata	a/		
Rwasave	a/		
Small valleys in Gitarama	900	1973	Various
TOTAL	35 811		

Source: Morris (1979)

a/ In operation

b/ Development funded

The fringes of many marshes are already being used by farmers as a valuable complement to their rain-fed farm land on the colline. In this way, the farming system has a better use of labour in the dry seasons at a very low investment cost (Morris, 1979).

2.3.3.1 Peaty soils

Peat consists of organic black deposits composed of the remaining parts of plants, partially decomposed, and accumulated due to bad drainage conditions which completely stop their decomposition. Hydrophile plants develop on peat. The value of peat as a combustible is about 4 200 calories because peat contains about 55 percent carbon (Lozet, 1956).

Meyer, quoted by Van Wambeke (1961), has studied the problems concerning the reclamation of peaty soils as a whole. His main conclusions are as follows:-

(i) In the large marshes, where peat up to several metres, sometimes even more than 10 m is present, the main problems are of a technical, hydrologic and economic nature. The hydrologic problems are complicated by the irreversible settling (compression) which occurs during drying.

Except for peaty soils enriched locally by volcanic ashes in North Rwanda, peat is an inert, organic matter, of poor quality and with a very low mineralisation capacity. As such, peat is of no interest in agronomy and fish farming, both because of its very low mineral content, and for the organic material with a C/N ratio of between 20 and 30. This is especially true for the swamps situated at high and medium high altitudes.

(ii) With regard to the swamps with a peaty layer, which is limited to a depth of 1 to 2 m, or where settling has occured anteriorely, the problems are very different according to the natural regions:

(a) In the high altitude swamps, surrounded by very desaturated and poor grasslands, the only actual economic technique which assures the rapid mineralisation of peat is the "veenbrandkultuur", or calcination of peat.

1/ Mineralisation: the change from the organic state to the mineral state is, for example, the case in the nitrogen cycle, when nitrogenous organic material is transformed into ammonia

Fertilizing with manure gives good results and liming has irregular effects. Those marshlands have a double disadvantage: the soils are cold (11 to 15°C) and very poor. They are generally covered by a vegetation composed of Miscanthidium violaceum.

(b) In the swamps of medium altitude, incineration seems not necessary. However, the yields decrease rapidly 18 months after clearing. Trials have shown positive results witht the use of manure.

(c) As for regions of low altitude, trials carried out in the Lugoma Swamp have clearly demonstrated that with a well regulated water level, a strong incineration of all aeral vegetation and rhizomes and good cultural practices, these organic soils (depth of peat between 70 and 80 cm; loss after calcination of 50 to 65%) can be productive.

(d) The histosoils (or organic and peat soils) of the volcanic zones are more fertile and regulating the water level is until now the main problem. One admits generally a depth of 60 cm for perennial plants and about 30 cm for annual plants.

Different types of peat can be distinguished according to the degree of decomposition of their organic matters. They are also different depending on the type of vegetation at the origin of the peat.

Three groups of peats can be distinguished:

(i) Coarse peat. Dark maroon coloured materials, formed by the accumulation of vegetal wastes, not or slightly decomposed, fibrous or spongy, with numerous alive roots, gorged with water (80 to 90%) and fluent. Total organic matter content: 85 to 98%. Coarse peat is acid and the pH is between 3.5 and 5 (SCET COOP, 1970). The coarse peat is generally sub-divided in two sub-groups:

(a) Fibrous peat consisting of reeds or of cyperaceae: Formed of a felting of fragments of reeds or cyperaceae, slightly alterated, is found generally in the axial part of the swamps, where water depth is over 3-4 m. Sometimes a floating mat is developing at the surface.

After drainage, settling of these kind of peat will be the more important as the peat is rich in rough vegetable fibres and by consequence will not be easily recuperated for agriculture. This peat is acid, with pH between 4 and 5.

(b) Peat consisting of sphagnum. Is a very porous tissue, stuffed with water, forming a thick vegetal carpet, continuous and flexible. This peat has a high acidity and its pH is between 3.4 and 4.

The peat consisting of sphagnum can be recovered for culture after drainage, without excessive settling, but if the drains are not regularly cleaned, the water table will rise again and the vegetal mat will grow again.

(ii) Semi-coarse peat. Dark maroon coloured material formed by a mixture of coarse vegetal wastes and between a third to a half part of adulterated peat. It is a very humid material, stuffed up to 80-90% with water, fluent to soft in the 10-12 first meters, and more and more compact and with a low water content between 10 and 20 m. Total organic matter content of semi-coarse peat is between 60 and 85%, with a pH between 4 and 5.

This kind of peat is better for agriculture than coarse peat. Semi-coarse peat is recoverable for culture after lowering the water table (maximum 1 m). The reclamation is very superficial and affects only the 5-10 first centimeters.

Semi-coarse peat is cultivated in ridges ('billons'), generally on the edges of the valleys where water table has been lowered between 0.40 and 0.80 m and no noticeable settling is observed.

(iii) Adulterated peat. Black material form by vegetal wastes almost completely decomposed, oily on the touch and very soft, stuffed to 70-80% with water. Total organic matter is between 40 and 60%.

Adulterated peat is acid (pH 4.5 to 5) and contains a fraction of organic matter partly humificated, formed by black humic acids having a strong reduction capacity. This type of peat is frequently cultivated when found on the surface, but most of the time adulterated peat is situated in the depth and not accessible.

2.3.3.2 Consequences of reclamation of peaty soils

Reclamation of peaty soils and swamps can only be undertaken after draining of the land and controlled evacuation of a part of the waters of the peat-bog. One has to study the consequences of eventual reclamation on the evolution of peat. Drainage of peaty soils modifies deeply the nature of the material; physically, chemically and biologically.

(a) Modification of the physical state of peat

The modifications are due to desiccation and settling:

(i) Desiccation - is a result of rapid lowering of the water table, provoking the production of not moistable products (resins, waxes, fatty acids) around the radicles and the organic wastes. The capilarity of the radicle felting is so suppressed that the water does not penetrate anymore and the plants die by lack of it.

Thus, a too rapid and excessive drainage transforms the peat in a hydrophobic material and the desiccation is considered as irreversible. Peat is considered dry when it contains only 30% of its weight.

(ii) Settling (compression or 'tassement'): after dehydration the volume of peat diminishes very much and the peat becomes a hydrophobe material with low water retention capacity. Settling is all the more important as the volume of peat increases; as the peat is less decomposed and rich in coarse vegetable fibres and as the depth of drainage increases.

With fibrous peat after drying, incineration and rehydratation conserves only 14% of its inital volume. The combustion of 50 cm of fibrous peat leaves about 15 cm of fine ash.

In drained peat a relative enrichment of the mineral fraction occurs, as well as a diminuition of water reserve and original excessive permeability.

The content of organic elements in the ashes are still good but the microbian activities are reduced. The fire increases the pH and produces an enrichment in exchangeable bases.

(b) Modifications of the chemical properties of peat during drainage

The two main modifications are an increase of the pH in the superficial layers and partially humidification of the organic matters. Excessive acidity of peat restrains the nitrification. Nitrogen in the soil is then only partially utilized and nitrogen deficit occurs.

When drainage and aeration are sufficient, the fibrous organic matters are decomposed (microflora) and become humus (humification).

(c) Modifications of the biological properties

Peat is biologically inactive because of the asphyxiating conditions of the environment. The drainage of peaty soils leads to a progressive increase of the activities of micro-organisms favouring the nitrification in the surface layers of the peat. Peat changes from the particularly inactive fibrous phase to the semi-fibrous stage which facilitates a greater microbian activity.

2.3.3.3 Recommendations concerning reclamation of peaty soils for aquaculture

When peaty soils have to be reclaimed for fish farming, the drainage has to bedone slowly and progressively in roder to avoid problems. The water talbe may not be lowered more than 0.80 to 1.00 m below ground surface.

When fibrous peat occurs, the incineration of the superficial layers is recommended before or during drainage. These fibrous materials will be transformed in ash, and when mixed with the other layers the acidity will be slightly reduced.

The correction of excessive acidity of peat by liming facilitates the humification of the organic matters and the nitrification. Application of assimilable nitrogen fertilizers can correct nitrogen deficit in peaty soils.

The ideal solution would be to lime the fish ponds constructed in peaty soils and to apply a nitrogenous fertilizer, but due to the high costs given in Rwanda, it is not certain that such action would be financially viable. These problems will be dealt with in more detail in Section 2.5.3.

Before planning aquaculture in peaty soils, it is absolutely necessary to carry out a complete soil survey, including soil and water analysis, to allow correct evaluation of the needs for liming and fertilization of the fish ponds.

One should avoid fish farming in coarse peat (fibrous peat of reeds or of cyperacae) as much as possible.

2.4 Culture Techniques Suitable for Rural Fish Culture

In Rwanda fish culture can be based on the following culture techniques: monoculture of T. nilotica (at least at the initial stage of rehabilitation of the existing ponds); (ii) polyculture with T. nilotica as the main species, and with various other Tilapia and with Clarias and snail eating fishes (Haplochromis mellandi, and Astatoreochromis alluaudi) as secondary species; and, (iii) associated animal husbandry. Rice-cum-fishculture and cage culture should also be carried out, but only on an experimental scale.

2.4.1 Monoculture

At the initial stage of rehabilitation of the existing ponds, and as farmers are not yet trained and not well accustomed to fish farming, it is foreseen that farmers will raise T. nilotica in monoculture, going progressively over to polyculture and integration of fish farming and animal husbandy (pig-cum-fish culture).

2.4.2 Polyculture

Natural food in ponds (increased by fertilization) and supplemental feeds are not completely consumed if only one species is cultured in the pond and better yields are obtained with polyculture. Actually T. rendalli (T. melanopleura) (herbivor), and T. macrochir (plancton eater and browser) are generally cultured together in the same pond.

The technique to be adopted for rural fish culture should be polyculture with T. nilotica as main species, and T. rendalli and T. macrochir as secondary species.

Common carp, silver carp and grass carp can also be used if fingerlings of these species are available in adequate quantities.

The following combination in polyculture are recommended:

(i) T. nilotica (phytoplancton feeder), 2 fingerlings/m^2 (200 fingerlings/are + 1 fingerling/m^2 (100/are) of T. rendalli (herbivor) + 1 fingerling/m^2 (100/are) of T. macrochir (plancton eater and browser).

(ii) T. nilotica: 200 fingerlings/are + Clarias lazera (predator) or C. mossambica = 100 fingerlings/are;

(iii) T. nilotica: 200 fingerlings/are + T. rendalli: 100 fingerlings/are.

To all these combinations, one should add about 10 Haplochromis mellandi or Astatoreochromis alluaudi fingerlings/are.

The Production targets in polyculture during the proposed 4-year extension programme are as follows:

Year	Typical management of fish ponds (kg/ha/year)	Advanced management of fish ponds (kg/ha/year)
First	500	1 500
Second	700	2 000
Third	1 000	2 500
Fourth	1 500	3 000

According to the local conditions and with an efficient extension service, these production targets seem very realistic and are not above the capacity of the farmers.

2.4.3 Integration of fish farming and animal husbandry

Associated animal husbandry has proven to be the most practical and economical system for commercial and economical fish production. The raising of pigs, ducks or chickens in pens beside or over fish ponds provides a source of continuous organic fertilization. It works very well, not only in polyculture of T. nilotica and common carp, but also in other combinations. This practice increases the efficiency and rentability of both animal farming and fish culture through the profitable utilization of animal and feed wastes and has given some of the highest fish yields in Africa (Vincke, 1976).

Fish-cum-pig culture: Pigs are reared in pens built over the ponds on piles at a density of 100 pigs/ha (1 pig/are). Normally one sow produces three broods of 6 to 8 piglets each in two years. Thus, one can sell an average of 8 to 10 pigs/year/sow in reproduction. The piglets are weaned at two months (weight between 12 and 15 kg) and are ready for fattening. Castration has to be done at one month. With proper feeding the average weight of market pigs is 70 to 72 kg after six months and 85 kg at seven months.

In ponds stocked with *T. nilotica* at a rate of two fingerlings/m^2, the average production of fish can reach between 8 000 and 10 000 kg/ha/year and 6 000 to 9 000 kg of pigs (on the hoof) per ha/year (Vincke, 1976).

Fish-cum-duck culture: Ducks are reared in pens over the ponds at a density of 1 000-5 000 ducklings/ha (10-50/are). Peking and Moscovy ducks are generally cultured in Africa. The shelter where ducks are fed and spend the night is built over the pond on poles. The floor is made of lattice work to permit droppings and feed wastes to fall into the water. Under good conditions ducks reach 2 kg after 8-9 weeks.

Ponds are stocked with fish at the usual rate of 2-3 fingerlings/m^2 and production can reach 2 500 to 4 500 kg fish/ha/year and 1 500 kg of duck per ha/year.

For large-scale fish-cum-duck culture, a well-operated breeding and duckling distribution centre is needed. The production of ducklings is, of course, dependent upon the maintenance of an adequate brood stock (one male to 4-6 females) of a selected strain. During one laying season and under good conditions a Peking duck will lay 120-160 eggs. During peak production, two eggs are laid every three days. One female duck will produce 70-80 one-day-old duckling during a laying period of eight months under suitable conditions of brood keeping and hatching (Woynarovich, 1979).

Fish-cum-chicken culture: Chickens are reared in pens over the ponds in roughly the same conditions as ducks, at a density of 10 to 30 chickens per 100 m^2 of ponds (1 000 to 3 000 chickens/ha). After a rearing period of 4 to 5 months, the production of fish can be between 3 500 and 5 000 kg/ha/year. At each harvest of the ponds the chicken yield can reach between 6 000 and 8 000 kg/ha/year (Vincke, 1976). In some regions egg production can provide supplementary income.

As associated animal husbandry has not yet been practised in Rwanda, it would be very interesting to implement some trials at the Kigembe Centre as demonstration to the fish farmers.

2.5 Technical Considerations Concerning Production Inputs

The natural productivity of waters in Rwanda is between 100 and 300 kg fish per ha/year. To increase the natural production in ponds the suitable species of fishes have to be selected; fingerlings of those species have to be made available in sufficient quantities to the farmers, fishes should be ~~either~~ fed artificially and on ponds should be fertilized. These different means of increasing production are explained below.

2.5.1 Choice of species to be cultivated and fingerling production

At present, the main cultured species in Rwanda are: Tilapia melanopleura (or T. rendalli) and T. macrochir. T. nilotica and common carp are also raised in ponds, but on a very small-scale. T. macrochir and T. rendalli are not fast-growing species and growth rate increments, even with fertilization of the ponds and artificial feeding, are generally only 0.5 g/day and never exceed 1 g/day.

These tilapia can only be considered suitable for farming in polyculture with fast-growing species such as T. nilotica, common carp (Cyprinus carpio), Clarias mossambica, C. lazera. Eventually, grass carp (Ctenopharyngodon idella) and silver carp (Hypophtalmichthys molitrix) can be raised if these Chinese carp are well acclimatized in Rwanda, and if adequate quatities of fingerlings can be obtaine

without problems. Clarias mossambica can be used as predator, but if, for different reasons, natural spawning does not occur in ponds or if induced spawning is not successful, one could utilize Clarias lazera which has been cultured successfully, as predator, in the Central African Republic and in Ivory Coast.

C. carsonii occurs sometimes in ponds, but it is a relatively slow growing omnivorous growing species which never reaches more than 20 cm.

Growth rate increments, under good conditions (fertilization of the ponds and artificial feeding) are between 1 and 2 g/day for T. nilotica; 2-4 g/day for C. lazera; 8-14g/day for common carp; and, 6-8 g/day for silver and grass carp.

As bilharzia (schistosomiasis) is a common disease in Rwanda, a snail eating fish should be raised in the ponds, for biological control of snails and to avoid further spread of bilharzia. In the case of co-production of irrigated rice and fish, farmers spend considerable time in water where they are in close contact with snails or molluscs, the intermediate host of bilharzia (Schistosomia mansonii and S. haematobium).

A survey carried out in Liberia by Dr. Noamesi, Biologist of WHO, showed a high infection rate amongst workers of all ages working in rice fields. Dr. Noamesi recommended strongly that all fish ponds, dams, rice fields and swamps should be stocked with the malacophageous species Astatoreochromis alluaudi and Haplochromis mellandi (Vincke, 1972).

Trials carried out in 1970-71 in Madagascar and Ivory Coast have proven that other species, which are not snail eaters, but selective plancton eaters or feeding only on periphyton (biota growing on stems and leaves of submerged aquatic weeds) are also very efficient in reducing the number of snails because they destroy the eggs of snails which often adhere on the stems of submerged plants, such as

Potamogeton, Myriophyllum and Ceratophylhum, on the lower face of the floating leaves of Nymphea, Azolla, Pistia stratiotes or Salvinia natans, or on the roots and leaves of the water hyacinth (Eichornia crassipes). Species feeding on periphyton are T. nilotica, T. mossambica and T. zilii. Herbivours as T. rendalli and grass carp destroy also a lot of eggs when they eat aquatic plants.

2.5.1.1 Fingerling requirements for stocking the rural ponds

One of the main bottlenecks in development of aquaculture in Rwanda is the all year round availability of fingerlings of suitable species (fast growing and aceepting artificial feeds) for pond culture. At present only few fingerlings of T. rendalli and T. macrochir are available at the Kigembe Centre.

As T. nilotica is recommended to be the main species, breeding ponds should be stocked, in monoculture, at a density of 2 fingerlings/m^2 (or 200 fingerlings/are). The number of T. nilotica fingerlings required during the first year of a project to develop fish culture are given in Table 6.

The fingerlings of the other species, required for polyculture, will have to be produced in each préfecture, according to the needs of the farmers.

Table 6

Requirement for Fingerlings and Corresponding Pond Area

Prefecture	No. of fingerlings needed (end of the 1st year) (a)	Broodstock needed		No. of fingerlings produced/year (d)	Surface of required:	
		Females (b)	Males (c)		Breeding ponds (are)	Fry rearing ponds (are)
Kigali	328 800	183	79	329 400	14	150
Gitamara	315 000	176	76	316 800	13	145
Butare	409 400	228	98	410 400	17	185
Gikongoro	79 800	45	19	81 000	4	37
Ruhengeri	46 200	26	11	46 800	2	21
Byumba	151 000	84	36	151 200	6	70
Kibungo	19 800	11	5	19 800	1	9
TOTALS	1 350 000	753	329	1 355 400	57	617

Notes:

(a) Fingerling requirements: calculations based on a stocking rate of 2 *T. nilotica* fingerlings/m^2

(b) Number of *T. nilotica* females needed to produce the required fingerlings

(c) Number of *T. nilotica* males according to a ratio of 1 male for 2 females

(d) Number of fingerlings calculated as follows: from each female one obtain annually 2 000 fry. With a 10% mortaiity rate during a two-months rearing period, about 1 800 fingerlings per female will be available for stocking purposes

2.5.1.2 Fingerling production

Fingerlings of the following species should be produced in the breeding stations and made available to the farmers: T. nilotica, T. rendalli (or so named T. melanopleura), T. macrochir, Clarias lazera. C. mossambica, Haplochromis mellandi, Astatoreochromis alluaudi and, eventually, common carp, grass carp and silver carp.

Fingerlings of the different species will be produced using small ponds (100 to 400 m^2 ponds) which can be drained quickly and easily.

(a) T. nilotica

Fingerling production of T. nilotica (natural spawning in ponds) is relatively easy and can be carried out in all breeding stations in the country.

T. nilotica fingerlings are now only available at the Ruganwa Fish Station near Kigali. Unfortunately no fingerlings of this species have transferred to other stations in the country. According to Mr. Body-Lawson, RCID Conselor, T. nilotica fingerlings will be transported to the Kigembe Fish Station in October 1980.

It is now extremely urgent to transfer, from Kigali, stocks of T. nilotica fingerlings to all the prefectoral fish stations. These fingerlings have to be cultivated at a stocking rate of 2 fingerlings/m^2, to become the broodstock for fingerling production in the different prefectoral fish stations,

Under Rwandese conditions each T. nilotica female will spawn about 5 times a year with an average of 400 fry per spawn. Each female will thus produce about 2 000 fry/year Assuming a mortality rate of 10% during a two-month rearing period, fingerling production of one female will be 1 800 one-month old fingerlings per female and per year.

T. nilotica broodfishes will be stocked in spawning ponds of 1 to 4 ares (= 100-400 m^2) at a density of 14 females and 6 males /are, or 20 broodfishes per 100 m^2. Average individual weight of females will be around 150 g and for the males between 150 and 200 g.

Spawning ponds will be fertilized using manure (3-5 kg/are every two weeks) or well decomposed compost (20-30 kg/are/month).

When harvesting the fingerlings, the spawning ponds will be drained the first time after three months and every one or two months afterwards, but not during the cold season.

The small fingerlings should be stocked in fertilized growing ponds to reach the right size for stocking in the production ponds (8 - 10 g). The following fertilization can be applied:

- manure: 5 kg/are every two weeks, or
- compost: 20-30 kg/are/month.

If inorganic (chemical) fertilizers are available at competitive prices, one could apply the following, monthly: superphosphate 0.400 kg/are + ammonia sulphate: 0.200 to 0.400 kg/are or urea: 0.100 to 0.200 kg/are + agricultural lime: 1 kg/are.

Stocking densities in growing ponds will be 500 fingerlings/are (or 5 fingerlings per m^2). Fingerlings will stay about 2 months in the growing ponds and will be fed daily using available feed stuff. Some diets are described in Section 2.5.2.

(b) T. macrochir and T. rendalli (T. melanopleura)

Reproduction of these two species has to be done in the same way as for T. nilotica.

T. macrochir will spawn 4-5 times a year with an average of 500 fry per spawn. T. rendalli is more prolific than the microphagous and planctonophagous T. macrochir and T. nilotica, and will spawn 5-7 times a year with an average of 2 000 fingerlings/spawn.

(c) Clarias lazera and C. mossambica

If the various species of clarias do not spawn naturally in ponds, induced spawning should be tried using hypophysis and Doca (desoxycorticosterone acetate).

(d) Haplochromis mellandi and Astatoreochromis alluaudi

For reproduction, these species have to be kept in separate spawning ponds to avoid cannibalism. Stocking rates for genitors of these species are around 20 adults (10 males and 10 females) per are.

2.5.2 Supplementary feeding

2.5.2.1 General

Feeding fish at any level is beneficial to growth as it supplements the natural food present in the ponds. The feasibility of supplementary fish feeding in Africa and especially in Rwanda depends, however, on the availability of cheap foodstuffs and agricultural by-products with a sufficiently high food conversion rate (or CR).

Throughout Rwanda, crop residue are in plentiful supply but many of the waste and by-products potentially suitable as feed are grown and processed in the vicinity of towns such as Gisenyi, Ruhengeri, Kigali and Butare, far away from most villages.

High protein feed ingredients are in short supply, although small quantities of oilseed cake are available and only a small percentage of the slaughterhouse by-products are now recovered.

For fish farming in Rwanda, using Tilapia species, common carp or Clarias spp., animal protein in diets is not necessarilly required and only vegetable protein can be used. During trials carried out in the Central African Republic with Tilapia nilotica and Clarias lazera, using two different rations of 30 percent protein - one with only vegetable protein sources and the other with one quarter of the protein from animal sources - greater production was obtained in feeding the vegetable protein diet (7 167 kg/ha/year with vegetable protein and 4 718 kg/ha/year with animal protein) (Hastings, 1973; Miller and Maletoungou, 1976). Similar growth of 8.4 g/day/fish was obtained with common carp (Cyprinus carpio) feeding pellets containing 30 percent vegetable protein (Vincke, 1975). Animal protein feed inputs will be necessary only for pigs and ducks in combined animal husbandry and fish farming.

For storing, transporting and dispensing fish feed in automatic feeders and self-feeders, many fish feeds are prepared in pellet form, which also prevents sorting and selection of ingredients by the fish, resulting in many particles settling at the bottom of the pond where they remain uneaten (Hastings, 1979). It was

demonstrated by Swingle (1968) that there was significant benefit to feed conversion for channel catfish (Ictalurus punctatus) and common carp (Cyprinus carpio) when feed stuffs were pelleted. This, however, is not the case for T. nilotica, as shown by Miller (1977), (and for T. aurea, as demonstrated by Allison et al., (1976)).

In Rwanda diets for fish can be prepared using only locally available feed stuffs, which can be fed by surface braodcasting. Fish farms should however be equipped with grinders to allow the grinding of feed stuffs such as maize, cotton seed, etc. for preparing practical diets for fish.

2.5.2.2 Availability and use of wastes and by-products

According to available information the following agro-industrial by-products are actually available in Rwanda: draff (brewery waste), brewery yeast, draff from banana beer and sorghum beer, slaughter waste (blood, stomach contents and bones), rice brans and rice polishings, wheat brans and regrindings, sugar cane waste and molasses, household scraps, cassava waste, soyabean cake, maize (grains, meal and bran) and coffee pulp.

- Draff (beer waste): is produced as a by-product in the brewerey industry in Gisenyi. The present production is 1 4 00 tons/year approx, and draff can be obtained free of charge. A new brewery will be established soon at Kigali, and future available quantities of draff have to be assessed. The conversion rate (CR) of draff is 12:1 (12 kg draff is needed to obtain 1 kg fish). Up to 20 percent of draff can be used in fish feed, and up to 15 percent can be fed to pigs and ducks if associated animal husbandries and fish farming is envisaged. T. nilotica stocked at a rate of 2 fingerlings/m^2 and fed only with wet draff supplied bi-weekly at a rate of 2/3 of estimated weight of fish population in the pond will yield an average production of 3 5 00 to 4 000 kg fish/ha/year.

- Brewer's yeast: is an excellent source of protein of high nutritive value and digestibility. In poultry and pig rations it is generally included at levels of 2-5 percent (Gohl, 1975). Usually available as slurry it has to be dried or cooked to de-activate the yeast cells. The brewery at Gisenyi produces 200 000 litres approximately of yeast (slurry) per annum, available free of charge. The total production is presently discharged in lake Kivu.

- Draff from banana beer: According to Morris (1979), the total banana production of Rwanda was 1 896 253 tons in 1978, at an average price of Rw.F 7 00/kg. Between 36 and 100 percent (average 76.9 percent) of the banana production is utilized for the preparation of banana beer (The average consumption of banana beer is 281 kg per caput/year (Morris, 1979). One needs 2.5 to 3 kg of bananas to obtain 1 litre of beer. Banana beer is prepared in almost all villages, all the year round. About 987 000 000 tons of banana draff is available annually in the country, with a CR of 10:1 (10 kg of draff needed to produce 1 kg of fish). A 200 litre-petrol drum, containing about 180 kg draff of locally made beer (banana or sorghum beer) is bought in Butare for Rw.F 300, and in Kigembe for Rw.F 400 (between Rw.F 1.67 and 2.22/kg draff).

- Draff from sorghum beer: The sorghum production reached 163 776 tons in 1977 (Morris, 1979). When preparing beer 84.7 percent of the harvest is used. (1 kg sorghum = 2 litres beer). The annual production of sorghum beer draff is about 20 800 tons, with a CR of 10:1. Draff of sorghum beer and banana beer is available, all the year round, in almost all villages at little or no charge.

- Slaughterhouse wastes: Sheep, goats and cattle are presently commercialised in 60 traditional markets. They are slaughtered in 3 abbatoirs (Kigali, Butare and Rusumo), 28 slaughter house and 276 slaughter places (Morris, 1979). Most of the waste is rarely collected and seldomly used to feed animals, but discharged into rivers. Slaughterhouse by-products or wastes can be animals that have died from diseases, carcasses, or parts of carcasses that do not pass the meat inspection, fresh blood, inedible parts of the digestive tract, reproductive organs and bones and other trimmings not suitable as feed for aesthetic reasons. In some developing

countries slaughterhouse by-products are not easily obtainable if, for example, all the slaughtered animal is eaten except the blood, some bones, skin, hooves and stomach content. In most of the African countries, and also in Rwanda, only blood, stomach contents and bones are available.

It is possible to utilize offals from slaughterhouses and slaughter places to feed fishes, pigs and poultry. In diets based on cereal grains and other plant -- products, it is difficult to avoid a deficiency in essential amino acids and in some vitamins. Slaughterhouse waste can supply these amino acids and vitamins. Even when used in small amounts, they vastly improve the nutritive value of the entire fish feed diet (Gohl, 1975).

(a) Blood meal: contains only small amounts of minerals but is very rich in protein which. However, it is of a rather inferior amino acid composition The digestibility of raw blood is very high.

Approximately 390 000 kg of raw blood is available annually in Rwanda. This quantity, if recovered, could be used as food for fishes, pigs and poultry.

Modern methods of prodcuing blood meal are not yet applied in Rwanda. But blood meal can easily be produced on a semi-commercial scale. The blood is collected at the abattoir and boiled very slowly in a large pot over an open fire until the blood has coagulated and the water has evaporated. Continuous stirring is necessary. When coagulated, the blood is then spread on a concrete floor or on galvanized sheets, dried in the sun and then cooled off and dried completely in a well-ventilated shed. When completely dry, the blood meal is scrapped off with a shovel and milled to obtain a black meal. According to Gohl (1975), 1 000 kg of liveweight carcass yields about 6 kg of blood meal.

Another way to utilize blood is to absorb it on wheat middlings, rice bran or citrus meal and then spread it out on trays heated from below or dried in the sun. In this way, the low protein vegetable matter is enriched with protein. The process may be repeated several times.

Blood can also be coagulated by the addition of 1 percent of unslaked or 3 percent of slaked lime and the coagulate then dried. Many minerals and 10-15 percent of the dry matter are lost if the coagulate is used rather than the whole blood for production of blood meal. Blood meal made from whole blood will contain more isoleucine, one of the essential amino acids (Gohl, 1975).

Raw blood can be preserved by the addition of 0.7 percent firmic acid or sulphuric acid. Blood treated in this way may be stored for about one week. If 0.5 percent potassium metabisulphite is added to sulphuric acid treated blood, it may be kept for a few months before feeding (Gohl, 1975).

Fresh blood can be used to feed fishes (weekly application of 5 to 10 litres/are) but it is generally mixed with stomach contents or with brans.

Feeding trials carried out by FAO in Central African Republic have shown the viability of using locally produced blood meal, e.g. in diets for T. nilotica and Clarias lazera. Using a ration composed of 15 percent draff, 20 percent wheat bran, 15 percent rice bran, 30 percent cotton seed cake, 7.7 percent sesame cake, 5 percent fish meal, 5 percent blood meal , 2 percent bone meal and 0.25 percent vitamin mix, with T. nilotica at a stocking density of 20 000 fingerlings/ha, the net production was 6 180 kg/ha/year, with a CR of 1.63 (Miller, 1976). Protein content of the feed was 35.72 percent. A wet combination of cow stomach contents, coarse-ground cotton seed meal and fresh blood in a proportion of 2:1.5:1, yielded a mean net production of 4 309 kg/ha/year with T. nilotica stocked at 20 000 fingerlings/ha. The costs per kg were CFA.F 37.6 (= U.S.$ 0.16/kg) and a mean feed conversion of 9.4 was achieved in ponds ranging from 31 to 48 ares in area (Miller, 1976).

(b) Stomach contents: are composed of undigested feeds present in the rumen of cattle at slaughter. Rumen contents, about 20 to 22 kg for a 240 kg animal starved normally before slaughter, presents a large disposal problem for abattoirs. This material, which can be used as a feed for fishes, pigs, poultry and cattle, is usually washed into rivers or piled and allowed to decompose thus causing concern to more than just the abbattoir. Rumen content contains not only the vitamins present in the feed

ingested before slaughter, but is enriched with B vitamins from the rumen flora (Gohl, 1975). The composition of fresh rumen contents is as follows:- carbohydrates 36.2 percent; fats 1.0 percent; total protein 11.6 percent and fibre 37.8 percent (Miller, 1976).

About 800 tons of stomach contents are annually available in Rwanda and this material, yet not utilized, can be collected and used as feed for fishes, at almost next to nothing for the farmer, except transport costs (45 Rw.F per ton/km). Stomach contents can also be used to prepare compost, mixed with grasses and farm wastes

The rumen contents can be preserved by addition of sulphuric acid to reach a pH 3.0 by ensiling together with molasses; or by drying, either in the sun or on trays heated from underneath. If used for feeding, it is important that the material is dried immediately. Rumen content silage is palatable to pigs and they can consume up to 0.5 kg per day when they have become accustomed to it. It has also been used mixed with blood in poultry diets (Gohl, 1975).

In fish farming, stomach contents can be mixed with rice bran, wheat bran, draff, blood etc.

(c) Bone meal: is used as a source of phosphorous and calcium in fish diets. It also provides trace elements. There are different types of bone meal, according to their processing: green bone meal, steamed bone meal, raw bone meal, calcinated bone meal, etc. With simple equipment, bones can be processed either into raw bone meal or calcinated bone meal; steamed bone meal requires more expensive equipment.

Raw bone meal is made by boiling fresh bones in open kettles until all adhering material is freed. The bones are then dried in the sun and ground.

Calcinated bone meal or bone ash is made by piling the bones on a metal frame and burning them. Burning sterilizes the bones and deprives them of all organic matter. This is the only recommendable method of utilizing bones. The charcoal-like bone ash is friable and can easily be pulverized (Gohl, 1975).

Raw bone meal contains between 15 and 20 percent crude protein, calcinated bone meal is rich in calcium (34 percent Ca of dry matter) and phosphorous (16 percent P of dry matter). (Gohl, 1975). Bone meal is added up to 5 percent in diets for fishes. Bones are in plentiful supply in Rwanda, in the abattoirs and slaughterhouses, generally free of charge.

- By-products of rice-milling

Threshed rice or paddy, or rough rice has to be processed. This is done to free the paddy from the hull, germ and bran. In many countries this process is carried out in a one-stage mill. The by-product from these mills is a mixture of hulls and bran. In large-scale mills the paddy passes through several processes in the mill, viz. cleaning, parboiling, hulling, pearling, polishing and grading. (Gohl, 1975). In Rwanda, only rice bran and rice polishings are available.

(a) Rice bran: represents between 2 and 4 percent of the weight of paddy. In 1975, 2 480 tons of paddy were produced in Rwanda, giving about 74 tons of rice bran. Irrigated rice is produced in Rwanda in Kabuyé (10 km from Kigali) and in the Préfectures Cyangugu, Butare and Gitarama. Rice is harvested in August/September and February/March. Husking is done in Butare and Kigali in September and March. Rice bran yields a CR of 4.5 and up to 20 percent can be used in fish feeds at a cost of 2 000 Rwf per ton. For pigs, rice bran should not exceed 30 to 40 percent of the total ration to avoid soft pork. Up to 25 percent can be included in rations for poultry and double that amount has successfully been used in experiments (Gohl, 1975)

(b) Rice polishings ("farine basse"): represent about 6% of the paddy weight. About 149 t of rice polishings were available in Rwanda in 1975, at a cost of Rwf 2 000 per ton. The CR of rice polishings is between 3 and 3.5 and up to 35% can be used in fish feeds.

- By-products of wheat milling

The wheat grain (or endosperm) is covered with two kinds of fibrous coatings: the coarsest outer one is called bran and under this one is a less fibrous aleurone layer (albumen of cereals). During milling, the starchy endosperm is separated from the other part of the grain.

Whole wheat, after milling yields between 70 and 80 percent white flour and 20 to 30 percent offal consisting of coarse bran, fine bran (aleurone) and germ. The offal consists generally of 2.5% of coarse bran, 40% of fine bran and 57.5% remouldings or regrindings ('remoulages').

In the Ruhengeri area 2 300 tons of wheat were produced in 1975, leaving about 460 tons of sharps ('issues de blé'), of which 193 tons are bran and 262 t are remouldings.

(a) Wheat bran: is excellent for fishes as well as for pigs and poultry. There is no sharp difference between fine bran and coarse bran and these two by-products are generally mixed. The bran fractions contain most of the vitamins and protein of the wheat grain. The Protein content of bran is between 14.5 (Hastings, 1973), and 16.9% (Gohl, 1975). Up to 35 percent of wheat bran can be used in fish diets; up to 30 percent in pig diets and up to 15 percent in poultry diets. Wheat bran costs Rwf 2 000 per ton in Ruhengeri.

(b) Remouldings: are the most common by-product from the flour mills, and up to 45 percent can be used for fattening up pigs. Up to 10 percent can be used for poultry and up to 20 percent can be utilized in fish feeds. Remouldings contain between 15 and 19 percent protein. The cost per ton in Ruhengeri is Rw.F 2 000 - 2 500

- Sugar-cane wastes

About 14 000t sugar cane was produced in 1975 in the Kabuye area. The by-products of the sugar-cane industry are bagasse, molasses and filter-press mud.

(a) Bagasse : is the cane waste after it has passed through the crusher where sugar sap is extracted. It represents about 15 percent of the whole sugar-cane plant. An average of 60 percent of bagasse produced is generally used as fuel in the sugar mills

There are two kinds of bagasse fibres:- (a) fine, strong and flexible fibres that are suitable for the manufacture of high grade pulp and paper, and (b) short fibres or pithy material (bagasse pulp), which are used as animal feed.

The bagasse production in Rwanda is about 2 100 tons/year. Bagasse or portions of bagasse can be used as roughage for pigs and cattle, or as a carrier for molasses.

Bagasse and bagasse pith are good carriers of molasses (four parts bagasse pith and 10 parts of molasses cane). Bagasse can also be used for compost.

(b) Molasse : is a liquid by-product (80 percent dry matter) containing sugar and non-protein nitrogen. There are many kinds of molasses. Final molasses is the by-product of the sugar industry from which a maximum amount of sugar has been extracted. Molasses represents about 2.5% of the whole sugar-cane plant. About 350 tons of molasses are presently available in Rwanda. There are different ways in which molasses can be utilized (Gohl, 1975):-

(i) in dry feeds:- molasses have to be absorbed to simplify their transport and handling. Used as a binding product, molasses can replace other more expensive carbohydrates in feeds. Percentages of molasses absorbed by some feed ingredients are as follows: wheat middlings - 19%; maize meal - 15%; draff - 9%. Up to 15% of molasses can be fed to pigs, and to poultry, and 10-15% can be included in fish diets. The maximum amount of molasses used is often determined by the absorbability of molasses by the other ingredients in the diet.

Trials undertaken in the Ivory Coast, with 30 gm fingerlings of T. nilotica (stocking density: $1.3/m^2$), feeding a mixture of 60% molasses and 40% rice bran have given the following results: yield: 3 649 kg fish/ha/year; average daily growth increment: 0.78 gm per fish/day; CR = 8 (Lazard, 1980).

(ii) in silage making:- molasses is quickly fermented and is, at a 5% level sometimes added to grass during the ensiling process to act as a preservative on the nutrient value and palatability factor is a bonus.

(c) Filter press mud: (or scum, 'tourteaux de filtration', 'ecumesde défécation') represents about 2.5% of the whole of the sugar cane (as it stands before harvesting) This product is obtained when the chopped cane is pressed and the sugar is extracted with water. Filter press mud contains many of the impurities of the sugar cane juice and includes organic compounds mainly calcium sulphate and calcium phosphate. The protein content is between 10 and 15% (Gohl, 1975).

Filter press mud is generally used as a fertilizer for sugar-cane cultivation but it can also be used as a fertilizer in ponds, and to feed fish when mixed with bran or draff.

Maize and by-products

77 166 tons of maize was produced in Rwanda in 1977 (Morris, 1979).

(a) Maize (grain): is a staplefood for the population and its possible use as a fish feed is questionnable from the socio-economic point of view. The majority of the maize milling capacity is concentrated in centres and the cost of transport to remote areas is high. If used, and to avoid prohibitive costs, maize should be milled at the fish farms, using a commercial hammer-mill. Maize (grains) cost Rw.F 10 000 per ton.

(b) Maize meal: is available in almost all the prefectures and costs about Rw.F 17 000 per ton. Maize meal levels of 15 to 30% are used in fish feeds and 15 to 70 percent in pig and duck feeds. In fish culture the CR of maize meal is 3.5 - 3.9%.

(c) Maize bran: is available in some villages, but in small quantities. The optimum level in pig rations is between 20 to 25 percent and about 30 percent in fish diets. Maize bran costs Rw.F 2 000 per ton and the CR is between 4.5 and 5.5.

Groundnuts: between 12 and 14 000 tons (in hulls) were produced in 1975, mainly in the Cyangugu, Kibuye, Gisenyi, Gitarama, and Kigali préfectures, as well as in the Eastern plateau and the eastern savanna. According to Morris (1979), some peanuts, perhaps 50 percent of the supply, are available for oil extraction.

Groundnut cakes are available in only very small quantities and prices fluctuate from year to year. Shelled weight of peanuts is 70 percent of the weight in the shell. Oil is 50 percent of the shelled weight and the other 50 percent is cake (Morris, 1979). The groundnut cake content may be 30 to 45 percent in fish feed, 23 to 27 percent in pig feed and 5 to 7 percent in duck feed. Groundnut cake contains 53.5 percent protein.

- Soya bean: the production for 1975 was 2 700 tons, mainly produced for human consumption in the Kibuye (Gitesi), Cyangugu (Bugarema) and Kibrungo (Kayonza) préfectures. Soya is mainly grown between 1 400 and 1 800 m of altitude.

Soya beans are the richest by far in protein of all the common seeds used in feeds. Soya seeds have a low oil content (maximum 20 percent). Beans are 72 percent of the pod weight. When pressed, the oil cake represents about 80 to 82 percent of the seeds and 18 to 20 percent is oil.

Locally produced soya beans sell at Rw.F 25 000 per ton and imported soya is processed in Kigali. 15 300 tons of soya bean were pressed in 1975, producing about 10 000 t of soya oil cake.

- Coffee by-products

The coffee production ("café marchand") in Rwanda was 24 385 t in 1975. The by-products of coffee are pulp and coffee hulls.

(a) Coffee pulp: represents about 26% of the whole coffee fruit ("cherry" or "cerise de café"). The coffee fruit can be processed either by the simple dry method or by the more advanced wet method, to liberate the seeds ("coffee beans"), from the fleshy wet pulp. Large quantities of coffee pulp (about 10 000 tons/year) are available in Rwanda, free of charge. Coffee pulp can be used as a roughage for cattle and for pigs and also as fish feed, after drying. Wet pulp should be dried immediately (in the sun, as described for brewery's yeast), as it spoils very quickly. Coffee pulp contains between 7 and 9 percent protein (Mongodin, 1977).

Up to 16% dehydrated coffee pulp can be included in pig rations (Gohl, 1975), and up to 25% in fish diets.

(b) Coffee hulls: ("parches de café"): are obtained during the decortication process of the coffee beans, and they represent 15% of the "café parche". About 3 000 t coffee hulls are available in Rwanda, free of charge. The protein content of coffee hulls is between 6 and 12%. Coffee hulls have to be mixed in diets and can be used up to 20%. If used as a single feed, CR of coffee hulls is 40 (Lazard, 1980).

Cassava offals: In 1977, 414 326 tons of cassava were produced in Rwanda, at a value (market price) of Rw.F 8 000 per ton. The average consumption of manioc (Préfecture Cyangugu) is about 113.2 kg/capita/year (Morris, 1979).

Cassava tubers or roots have a poor protein content (about 3.6%), but protein content in the peel is relatively high, as in the external parts of the root too. By retting cassava, a necessary practice to liberate the cyanhydric acid of the tubers, some of the nutrients are dissolved in the water.

Peeled cassava ("manioc pelé"), after retting, represents about 68% of the fresh tubers. Offals are about 32% of the fresh roots. "Cossettes" are 33% and flour 31% of the fresh root weight (Morris, 1979).

Cyanhydric acid can cause fish mortality, if too much cassava is retted in a small water area. According to FAO trials set up in the Central African Republic (CTFT, 1972), the fish mortality (T. nilotica) is as follows:-

- peelings of 10 kg raw cassava tubers in 100 l water: total fish mortality occurs after 24 hours (density not precised).
- peelings of 5 kg raw cassava tubers in 100 l water: high mortality occurs after 48 hours.
- peelings of 1 and 2 kg raw cassava tubers in 100 l water: no mortality occurs.

Trials on cassava retting in fish ponds were undertaken in Gabon with the following results (CTFT, 1972):

Retting of:	Yield (T. nilotica):
10 kg raw cassava tubers per are /week	2 400 kg Fish per ha/year
100 kg	4 280 kg
200 kg	4 000 kg

One should note that large quantities of cassava tubers which are to be retted to obtain only a few kilogrammes of fish can still be economical. Since retting bitter cassava is absolutely necessary before consumption, it is generally done in brooks and rivers instead of ponds.

As cassava is a staplefood in almost the whole country, retting cassava tubers

is carried out in many villages. It can also be carried out in fishponds, using approx 100 kg tubers/week per are. With this method, the average yield can reach between 3 000 and 4 000 kg fish per ha/year.

Household scraps: are very nutritious, but are not always collected and utilized as fish feeds. Pot scrapings, vegetable wastes and fruits (mango, papaya, etc), cassava offal, rice, maize, etc are availabel daily in all families and can be collected as fish feed. Depending upon the composition of the scraps, CR is between 8 and 20.

Wastes from markets, restaurants, hospitals and boarding-schools: are now used as fish feed at the Kigembe fish farm. They are collected, free of charge, mostly in Butare, and transported (19 km) to the station, when the pick-up and petrol are available.

The cost of these ingredients rendered at Kigembe is about Rw.F 0.85 per kg. The conversion rate (CR), of these wastes is between 6 and 25 (6 to 25 kg wastes, depending on their nature and average composition, needed to produce 1 kg fish).

Wastes from markets, because of their nature (leaves, stalks, bunches of bananas, spoiled fruits, sweepings, etc.), are sometimes better for composting than for direct feeding in ponds.

A summary of available wastes and by-products is presented in Table 7.

Table 7

Availability of Agro-Industrial By-Products

:o-industrial ·products	Localities	Availability (tons/year)	Period of availability	Cost (Rwf)
ıff (wet)	Gisenyi (a)	1 400	all year	free of charge
:r yeast	" (a)	200 000 litres	"	idem
ıff from banana beer	all country	87 000	idem	2 per kg
ıff from sorghym beer	idem	20 800	"	"
ɔod meal	(b)	390	idem	free of charge
ɔmach contents	(b)	800	"	idem
ıe meal	(b)	(c)	"	"
:e brans	Kigali	74	Sept-Oct & March	2 000 per ton
:e polishings	Kigali	149	idem	2 000 per ton
ɜat brans	Ruhengeri (d)	193	all year	2 000 per ton
nouldings (wheat)	" "	262	idem	2 000-2 500/ton
gasse	Kabuye	2 100	all year	free of charge
ıasses	"	350	"	to be assessed
ıter press mud (cane)	"	(c)	"	idem
ıze bran	all country	(e)	"	2 000 per ton
ɔundnut cake	(f)	(c)	"	to be assessed
·a oil cake	Kigali	10 000	"	to be assessed
ffee pulp	all country	100 000	"	to be assessed
ffee hulls	idem	3 000	"	idem
ssava offals	idem	(c)	"	idem
ıaehold scraps	idem	(c)	"	idem
ıer wastes	idem	(c)	"	idem

tes: (a) A new brewery will be established presently in Kigali

(b) Available in the three abattoirs (Kigali, Butare and Rusumu), 28 slaughterhouses and 276 unimproved slaughter places

(c) Figure not available.: Quantities should be assessed

(d) A new wheat mill will be installed soon at Adikongoro

(e) Available in almost every village, but in small quantities

(f) Available in Cyangugu, Kibuye, Gisenyi, Gitarama and Kigali prefectures

The above data show that various ingredients and feedstuffs for use in fish culture are available in Rwanda, mostly all the year round and quantities are available in almost all villages. Their appropriate and productive use will require adequate planning and organization, as well as advice and assistance by extesion personnel. A detailed inventory of existing agro-industrial by-products or wastes suitable as feed for fish will be necessary for each of the prefectures where fish farming is planned. Such inventory will have to consider the kind of products, location, quantities available, period of availability, competitive use, price and transport costs.

2.5.2.3 Diet formula

Suitable diet formula, using locally available ingredients, are given in Annex I. Diets with 25 percent protein will be used for fingerlings and spawners as high protein ingredients are expensive and not always readily available. The 30 percent protein diets should be used only for fry.

2.5.3 Fertilization of the Ponds

To obtain high yields with T. nilotica (micro-planctonophageous), T. macrochir (micro-plancton eater and browser), and common carp (C. carpio, omnivorous), fertilization of the ponds has to be carried out regularly. Either organic or inorganic fertilizers may be used, but recent increases in the price of chemical fertilizers may greatly limit their use in Rwanda, taking also into account local transport problems, especially in remote areas.

2.5.3.1 Chemical fertilizers

When using chemical (inorganic) fertilizers, such as superphosphate, triple superphosphate, ammonium and urea, it is recommended to apply these fertilizers every two weeks. It has been proven that applications of phosphates and nitrogen, in tropical waters, had effects lasting for only two or three weeks (Miller, 1976).

While awaiting the results of new trials to be undertaken at the Kigembe Centre, the following rates of application of inorganic fertilizers are recommended:

- Superphosphate (18% P_2O_5): 0.300-0.400 kg/are, fortnight
- Triple superphosphate (45% P_2O_5): 0.150 kg/are, fortnight
- Ammonium sulfate (20% N): 0.200-0.300 kg/are, fortnight
- Urea (46% N): 0.100-0.200 kg/are, fortnight

Using only superphosphate and ammonium sulfate at the above rates, the cost of fertilization, including application, will be about Rw.F 980 per are/year or Rw.F 98 000 per ha/year.

2.5.3.2 Calcareous fertilizers

Liming is indispensable when the pH of the water is too low (below 6.0-6.5). The best water for fish cultivation is that with a pH between 7.0 and 8.0. As already explained, marshy and peaty water with weak alcalinity have an acid pH.

The nitrification of ammonium compounds into nitrites and nitrates demands the presence of sufficient quantities of lime.

The principal fertilizers containing lime to be used for liming the ponds are: powdered limestone, marl, quicklime, caustic lime and calcium cyanamide. At present, only powdered limestone is available at Rubona and costs Rw.F 16/kg.

For the purpose of controlling the acidity of the water, one can use powdered limestone at the following rates of application:

- In new ponds with acid water (pH between 4.0 and 6.5): 15-20 kg/are (1 500-2 000 kg/ha) on the bottom when the pond is dry. After spreading out, powdered limestone has to be lightly worked in and the pond can be filled. The cost of such application is estimated to be Rw.F 240-300 per application and per are.

- Other ponds: monthly application of 1.5 to 2 kg/are, at a cost of Rw.F 288-384 per are/year (Rw.F 28 800-38 400 per ha/year)

2.5.3.3 Manures

Relatively high production can be obtained combining organic fertilization of the ponds and supplying supplemental feed. The following is a brief summary of the availability and application of various manures:

- Cow manure. Is relatively easy to obtain in the country. One cow produces annually about 16 tons of manure, which can be used to fertilize a 1-ha pond at a rate of 300 kg manure/ha/week (or 3 kg/are/week).

- Horse manure. May also be used, but is often not available in large quantities. Recommended application rate: 20 to 30 kg/are, monthly.
- Pig manure. Raising of pigs in pens and beside or over fish ponds, permits continual organic fertilization of the ponds and appears to work very well with T. nilotica as well as other tilapia species, and common carp. This culture system (associated animal husbandry) is recommended in the different areas visited.
- Poultry manure. In Central East Africa, Maar et al., (1966) recommended the use of poultry manures at a weekly application rate of 120-220 kg/ha (6.240-11.440 kg/ha/year). The manure obtained per year by 100 chickens is about 1 900 kg. In tilapia culture (T. nilotica, two fingerlings/m^2) with artificial feeding, the application of poultry manure at an initial rate of 2 500 kg/ha, followed by montly applications of 1 000 kg/ha (12 000 kg/year) gives an additional production of about 1.5 t tilapia/ha/year. This manure can only be used if there are poultry farms near the ponds.

The composition of some manures is presented in Table 8.

Table 8

Composition of Various Manures

	N (%)	P_2O_5 (%)	K_2O (%)	CaO (%)
Cow manure	0.3	0.15	0.10	0.45
Horse manure	0.45	0.35	0.35	0.15
Pig manure	0.6	0.40	0.25	0.10
Poultry manure	1.7	1.7	0.85	2.40

2.5.3.4 Compost

When manures are not steadily available one can utilize compost for the fertilization of the ponds, as it is practised in rural ponds in the Central African Republic. Natural productivity in ponds in Central Africa is around 200 kg fish per ha/year. In monoculture of T. nilotica stocked with two fingerlings/m^2, the average production from ponds where compost is used is 1 500 kg fish/ha/year. The compost is stacked underwater in a 1 m^2 pile in the corner of the filled pond, with weekly doses of 9-10 kg organic matter (grasses, spoiled fruits, wastes from soaking cassava and some cattle or chicken manure) then being added to the pile. To collect, transport and pile the organic matter for composting a 100 m^2 pond, the farmer may spend and average of 28 hours a year.

With aerobic prepared compost, production can reach 3 000 kg of fish/ha/year an application rate of 20-30 tons compost per ha/year (C.T.F.T., 1972).

The fertility of compost depends broadly on the mineral content of the used grasses and organic matters to prepare the compost, and the method of preparation (aerobic or anaerobic methods). Organic matters, stacked underwater in piles scattered around the edges of filled ponds generally produce relatively low fertility, because decomposition is anaerobic and slow. Decomposition (rotting) of organic matters in compost piles (aerobic conditions) is more rapid and more complete, giving a richer fertilizer than the anaerobic prepared compost.

Preparation of compost under aerobic conditions is easy. A trench of about 1.20 m wide and 0.50 m deep is dug. The length of the trench depends on the quantity of compost needed. A trench of 1.20 x 0.50 x 5 m is needed to prepare a pile of 9 m^3 compost. To obtain good fermentation, it is necessary to apply alternatively a layer of fresh fodder, rich in nitrogen and then a layer of dried organic matter. Fresh fodder can be composed of all kinds of organic wastes (spoiled fruits, vegetable wastes, garbage, household refuse, sweepings, etc.).

The dried organic matter is made from grass and is arranged in piles of 20-30 cm thick layers in the trench to a height of 1.50 m. The layers should be compressed slightly and, if available, some manure or ash (rich in minerals) can be added between the layers. Coarse materials should be chopped before piling.

Between 5 and 7 tons of organic matter is needed to prepare a 9 m^3 compost pile. One of the best composts is prepared with a mixture of green fodder and household refuse, garbage from towns and night soil. When the pile is made up, water has to be sprayed on it to initiate the fermentation process (about 30 l water/day is needed for a 9 m^3 pile, except during the rainy season). Approximately one month after completing the pile it is necessary to mix and turn over the compost and then place it in another trench. Only during the dry season should watering be continued. Decomposition is complete about two months after the turning over of the pile. Thus, compost can be prepared every three months, giving each time about 2 800 kg compost for a 9 m^3 pile. Preparation of such compost is estimated at Rw.F 400/ton. At doses of 20-30 tons/ha/year, compost ponds cost between Rw.F 8 000 and 12 000 per ha/year.

The best fodders are made from leguminous plants rich in protein and minerals, such as aerial portions of peanut (Arachis hypogaea), Calapogonium muconoides, Crotalaria mucronata, Dolichos lablab, Soya, Leucaena glauca, Pueraria thunberziana (Kudzu), Mucuna utilis (Velvet bean), Stylosantes sp., Vicia sativa and Voandzeia subterranea.

Grass has to be cut from natural (or artificial) grasslands around the fish farm if the cuttings from grasses on the dikes of the ponds are not sufficient to make up the compost piles. Common grasses, such as Brachiaria ruziziensis, Chloris gayana, Cynodon dactylon, Hyparrhenia rufa, Imperata cylindrica, Loudetia arundinacea, Paspalum spp., Pennisetum glaucum and P. purpureum are very suitable for making compost. Also aquatic grasses growing along rivers, in

swamps and in ponds are suitable, such as Echinochloa pyramidalis, E. staginina and Leersia hexandra, containing between 5.8 and 11 percent crude protein (CP) and between 8.6 and 16 percent ash (Göhl, 1975).

2.5.3.5 Artificial manure

If only grasses and a few organic matters are available, artificial manure can be used to fertilize the ponds. The preparation of artificial manure is roughly the same as that for compost, but chemical nitrogen fertilizer (generally urea) is added to the grasses and organic matter during the preparation of the manure. Artificial manure of good quality is as rich as farmyard manure and one ton contains approximately 150-180 kg organic matter, 4.5-5.4 kg nitrogen, 2.0-2.5 kg phosphoric acid, 6-7 kg potassium and 4-5 kg of calcium, depending on the mineral content of the grasses and organic matter used to prepare the artificial manure, the fertilizers used and the methods of preparation.

The following method of preparation of artificial manure was suggested during 1972-73 at the Agriculture Section of the Institut Technique Agricole du Burundi (ITAB) (De Valck, person.commun., 1978).

In a trench of 4 x 4 m and 1.75 m deep (28 m^3) fresh chopped fooder is placed in 20-30 cm thick, not compressed, layers. Between each layer urea should be sprayed (46 percent N). To fill the 28 m^3 trench, about 17 tons of green organic matter is needed, together with 8 kg of urea. The pit, after filling, has to be covered by earth and water and sprayed (about 60-70 l/day), except during the rainy season). After one month the trench has to be emptied for aeration of the manure. The manure has to be turned over and replaced in the same pit for one more month. Generally after two months, 9 tons of manure is ready for use. Application rate of artificial manure in ponds is between 20 and 30 tons/ha/year at a cost of Rw.F 7 500-11 300/ha/year.

3. MACRO-ECONOMIC ASPECTS

3.1 Introduction

The Rwandese economy is based on agricultural production, which creates more than half of the Gross Domestic Product and generates 75 percent of export revenues. Because of limited land resources the Government has given priority to development programmes which aim at the intensification and diversification of both food and export crop production in order to meet the nutritional demands of the increasing population, to raise rural incomes, and to generate rural employment.

The development of small scale rural fish culture would be in line with these objectives, but the implementation of such development requires infrastructural support and assistance in the field of extension, training and research.

The following part of the report assesses the present situation of the local infrastructure, and the existing development support services, and identifies further requirements. In addition the demand and supply situation with respect to fish production is outlined and the future demand estimated.

The last chapter attempts, on the basis of an assumed fish culture development and support project, to predict the economic input/output dynamics of such development assistance and project the possible impact on the national socio-economy.

3.2 Summary and Conclusions

From examining the Rwandan fish supply situation, it is apparent that at present fish plays only a minor role in the local diet. Assessing the potential future demand for fish, i.e. more than 100 000 tons, it becomes evident that a tremendous gap between supply and demand exists.

Fish culture development is one of the most promising ways of bridging this gap, and it is only possible with the help of an adequate [illegible]
The emphasis of the respective development assistance will have to be mainly on training low and medium level extension workers as well as on the manpower and financial provisons necessary for an adequate extension service.

An appropriate extension service and other development support activities are estimated to promote small-scale fish culture in the country to the extent that approx. 2 400 families could be operating a fish pond after 4 years. Apart from raising family incomes and improving the overall animal protein supply such development would add approx. 10 million Rwf to the Gross Domestic Product annually.

Because of the dispersed location of fish culture production units, there are no forseen difficulties with regard to marketing. Because of the low purchasing power of the rural people, which will in itself limit the fish sales, it is recommended that family size ponds are aimed at, so promoting home consumption of fish, and leaving only part of the harvest to be marketed.

3.3 Demand and Supply

The Ministry of Agriculture and Livestock, in their 1978 Annual Report[1/], estimated the output of lake fisheries during that year at 709 256 kg. The existing 2 662 fish ponds (see Table 9) produced an additional 15 277 kg during that year.

1/ Ministère de l'Agriculture et de l'Elévage. Rapport annuel 1978, Kigali, République Rwandaise, 1979

Table 9

Number of Fish Ponds, Surface and Yields, by Prefectures
(1978)

Prefecture	No. of fish ponds	Total Surface (ha)	Production (kg)
Kigali	653	12.91	1 500
Gitarama	626	12.57	690
Butare	541	23.16	9 696
Gikongoro	160	4.54	- a/
Cyangugu	32	0.94	- a/
Kibuye	151	2.03	604
Gisenyi	183	9.96	42
Ruhengeri	93	2.16	2 745
Byumba	183	8.31	- a/
Kibungo	40	1.06	- a/
Total	2 662	77.64	15 277

a/ Production figures were not given in the report, an extrapolation of theses figures as attempted by the mission is given in Table NO.2, Section 2.1.2

Source: Rapport annuel, 1978

These production figures, to which riverine fisheries and imports may indicate an extremely low per caput consumption - mostly estimated to be below 3 g per caput and per day (Aubray, 1976), the overall protein consumption being 46.8 g per caput and per day in 1978, according to the 1978 annual report of the Ministère de l'Agriculture et de l'Elevage.

This significant lack of animal protein indicates a substantial potential demand for fish in Rwanda, in spite of the fact that fish is not part of the traditional local diet in the country (see section 5.3.4). Reizer (1975) observed a daily per caput fish consumption of 50 g in a government settlement scheme (paysannat) close to Lake Kirimbi and used this figure as the basis for the potential fish consumption in Rwanda. He estimated the potential demand at four levels, at 63 g/day (his estimate of the optimal intake level to compensate for the overall protein deficiency) at 50 g per day, at 100 g/week (to allow two meals comprising fish), and at 50 g/week (to allow one meal with fish). His demand projections are summarized below:

Table 10

Potential Demand for Fish according to differen
Consumption Levels and by Prefecture
(in metric tons)

Year	Prefecture	Inhabitants	Individual Demand			
			63g/day	50 g/day	100 g/week	50 g/week
1973	Butare	594 836	13 700	10 700	3 000	1 500
	Gitarama	524 830	12 100	9 400	2 800	1 400
	Ruhengeri	505 806	11 600	9 100	2 600	1 300
	Kigali	460 281	10 600	8 300	2 400	1 200
	Gisenyi	406 710	9 400	7 300	2 200	1 100
	Byumba	405 075	9 300	7 300	2 200	1 100
	Gikongoro	344 480	7 900	6 200	1 800	900
	Cyangugu	295 038	6 800	5 300	1 600	800
	Kibungo	271 068	6 200	4 900	1 400	700
	Kibuye	250 476	5 800	4 500	1 400	700
	Rwanda	4 058 600	93 400	73 000	21 400	10 700
1980	Butare	721 687	16 600	13 000	3 800	1 900
	Gitarama	636 752	14 600	11 500	3 400	1 700
	Ruhengeri	613 671	14 100	11 000	3 200	1 600
	Kigali	558 438	12 800	10 100	3 000	1 500
	Gisenyi	493 443	11 300	8 900	2 600	1 300
	Byumba	491 459	11 300	8 800	2 600	1 300
	Gikongoro	417 942	9 600	7 300	2 200	1 100
	Cyangugu	357 956	8 200	6 400	1 800	900
	Kibungo	328 874	7 600	5 900	1 800	900
	Kibuye	303 891	7 000	5 500	1 600	800
	Rwanda	4 924 113	113 100	88 600	26 000	13 000

Source: Reizer, 1975

Although a part of the total potential future demand for fish could be satisfied by the expansion and intensification of capture fisheries, the possible contribution of the lake fisheries is considered finite, according to various studies (Reizer, 1975; Aubray, 1976). Therefore a saturation of the potential market for fish, as shown in the table, cannot be expected in the foresseable future.

A serious constraint to an increased *per caput* consumption of fish - the low purchasing power of the rural population - remains, however. The commercialisation of fish in rural markets, via monetary exchange, will be limited in the near future, as rural incomes cannot be expected to increase dramatically. Therefore planning for fish culture development with the aim of curbing the deficit of animal proteins in the rural diet will have to aim at small, family based units, which provide fish for home consumption, barter and, only on a limited scale, the market. Any marketable surplus, will, at least in the near future, be readily absorbed by the urban markets and rural centres. The urban population was an estimated 217 000 in 1979 (Rwanda, 1980), with more than double the monetary income of the rural population. Assuming a consumption level of 5 kg *per caput* per annum (as compared to national averages of 4-5 kg for Burundi, 15 kg for Uganda and 13 kg for Tanzania), the urban population alone would create an annual demand of over 1 000 tons.

3.4 Marketing and Prices

Based mainly on subsistence agriculture, only 41.9 percent of the total rural production is estimated to be marketed in Rwanda. The following table gives an overview of the scale of marketing according to the sectors of the economy.

Table 11

Scale of Marketing

Sector	Percentage marketed
Foodcrop production	30.8
Industrial and export crops	100.0
Livestock	35.1
Forest products	59.5
Fish	19.4
Total rural production	41.9
Mines and industries	87.2
Tertiary activities	100.0
Total GNP	69.5

Source: Ministère du Plan, année 1976, Projections, In: IBRD (1977)

There are 275 permanent markets in Rwanda, frequented daily by about 60 000 people (Aubray, 1976). The accessibility of markets is illustrated in the following table:

Table 12

Time to Reach Nearest Market[1/]

Travel time (hours)	Families No.	Families %
less than half	169	14
1/2 - 1 1/2	617	51
1 1/2 - 2 1/2	282	23
2 1/2 - 3 1/2	130	11
3 1/2 - 4 1/2	6	
over 4 1/2	4	1
	1 208	100

1/ Sample survey by Leurquin (1960) quoted in Morris (1979)

Source: Morris, 1978

Considering the degree to which farm produce may be consumed on the farm (although pond fish culture may result in a higher percentage of market production because of output peaks two or three times a year) and the relatively developed accessibility of rural markets, no difficulties can be foreseen at the moment with respect to commercializing a marketable surplus accruing to the farmer after harvesting his fish pond.

Bulk harvests achieved in larger scale cooperatively undertaken pond culture operations may acquire the organization of transport to urban markets.

Fish is consumed fresh, dried and smoked ~~and~~ fresh fish yields the highest price. The Workd Bank reported a controlled price for fresh fish of Rw.F 55/kg in 1975 (IBRD, 1977). At present the price of fish to the consumer fluctuates between Rw.F 60-140/kg. For the financial analysis (next chapter) a medium price of Rw.F 75/kg of fish was assumed, a very conservative estimate considering a price increase for food items of up to 18.5 percent in 1979[1/]

For both family based and cooperatively organized production, commercialization of the marketable surplus will be, at least in the near future, carried out by the producers, as the magnitude of production, as well as the dispersed locations of production units, will probably not encourage marketing by intermediates or traders.

At present an average of 1.2 percent of all economic activities of a family is allocated to marketing, with men and women equally involved (IBRD, 1977).

3.5 Development Infrastructure

3.5.1 Physical infrastructure

Because of the dispersed settlement structure in Rwanda, it will not be feasible to organize a centralized infrastructural development support for the development of small-scale rural fish culture with respect to operational inputs. Material inputs which are not available on the farm comprise feed and fingerling. Feed procurement, where planned, will have to be organized, for timely availability and transport, by the respective production units, and during the initial development phase, producers will require advice and technical assistance form extension agents. Fingerlings can be initially produced centrally, but with a growing geographical coverage of a programme to develop fish culture, fingerling production and distribution will have to be organize

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1/ Consumer price increase for medium level government officials, December 1978 to

on the prefectural level. The present transport and communication system in rural Rwanda constitutes, in general, no constraint to the physical infrastructural support, as most settlements can be reached by earthen roads which are passable most of the year.

3.3.2 Extension

Administratively, Rwanda is organized in prefectures, communes, sectors and collines.

Table 13
Administrative Organization

Unit	Approximate size (persons)	Number in country	Administrative Head
Prefecture (Province)	400 000	10	Prefect (appointed)
Commune (District)	30 000	143	Burgomaster (appointed)
Sector	3 000	1 600	Chairman (elected)
Colline	300	16 000	Chef de Colline (elected)

Source: USAID, 1978

Agricultural extension is organized in the same way, with prefectural and communal extension workers (Agronomists, A2), sectoral extension workers (Agronomists, A3) and extension workers who act on the colline level (moniteurs).[1/]

Extension personnel officially working for fisheries and fish culture comprised, in 1978, four specialized A2 agronomists (working mainly in lake fisheries), two other A2 agronomists, four A3 agronomists and 23 extension staff without special training. A prefectural breakdown is given as follows:

1/ A2 agronomists have usually graduated from the Agricultural University, A3 Agronomists from agricultural colleges; moniteurs have little or no educational background above that of basic schooling

Table 14
Fisheries Extension Personnel,1978

Prefectures	Agronomist A2	Agriculturist A2	Assistant Agriculturist	Vulgarisation	Moniteurs Pisc.	Agents Pisc.	Gardes pêche
Kigali	1	-	-	-	-	4	4
Gitarama	-	-	-	1	-	-	-
Butare	-	1	-	-	2	-	-
Gikongoro	-	-	-	-	-	-	1
Cyargugu	-	-	1	-	-	-	1
Kibuye	-	1	1	-	-	-	-
Gisenyi	1	-	1	-	-	-	1
Ruhengeri	1	-	-	-	-	-	2
Byumbe	-	-	-	-	-	-	1
Kibungo	1	-	1	-	-	1	5
Total	4	2	4	1	2	5	15

Source: Rapport annuel, 1978, Rwanda (1979)

The scarcity of extension personnel, trained at different levels, constitutes one of the major constraints to fish culture development in Rwanda.

An adequately staffed, trained and equipped fish culture extension service has to be considered a pre-requisite with respect to reaching a take-off phase of self-reliant, rurally based,production of fish in ponds.

3.5.3 Training and research

There are four institutions in Rwanda which could carry out training and research in fish culture:

- the 'Institut des Sciences Agronomique' at Rubono/Kigali;
- the 'Institut National de la Recherche Scientifique at Butaré;
- the 'Université National de la Recherche Scientifique'at Butaré;
- the 'Institut National de Pedagogie' at Butaré.

At present, however, training and research efforts by these institutions are insignificant, the National University at Butaré being the only one which offers specialized courses in Fisheries Biology and Fish Culture; in 1980 only four students received a degree in this discipline.

External training and research facilities, as the FAO/UNDP Regional Aquaculture Centre in Nigeria or the Fisheries School in Ivory Coast, have been and can be expected to be frequented by Rwandans with adequate qualifications. However, this will result in an output of only a limited number of highly trained specialists. specialists.

The major constraint to the development of rural fish culture - sufficient numbers of extension personnel with medium-level and practical training - will remain. To overcome this constraint a centralized in-country training will be most feasible, because resource limitations will not allow dispersed installations. Centralized research facilities, capable of supporting applied research in order to adapt established fish culture technologies to local conditions, will be the most feasible for the same reason.

The existing fish culture centre in Kigembe near Butaré, seems to be potentially suitable for the purpose of establishing a national centre for fish culture training and applied research.

3.6 Requirements and Economic Impact of Fish Culture Development

Economic and social costs and benefits accruing to the Rwandan national econoy through the development of rural fish culture cannot be assessed here comprehensively, as in the form of an economic feasibility analysis. The necessary data are in part unavailable and many indirect effects are difficult to quantify.

A project to initiate and support such development is still in the formulation phase, which makes it difficult to project it's inputs and outputs. To outline the already predictable direct and indirect effects of a future development effort to reactivate and innovate rural fish culture in the country we shall attempt, however, to estimate possible input/output dynamics and indirect effects.

3.6.1 Direct Development Support

For viable fish culture development in Rwanda, the training of technicians and extension workers in aquaculture is indispensable. An extension service for fish farming has to bestablished. The necessary transport and equipment for the extension workers to carry out their job must be made available. And finally, some form of applied research programme must be developed.

3.6.2 Training

Countepart personnel will play a key-role in the implementation of a project to develop fish culture. These nationals have to be well trained technicians. There are now three Rwandans in the Bureau of Fisheries and Fish Culture of the Ministry of Agriculture and Livestock who have been trained (one year) in fish culture and fisheries at the CFP (Centre de Formation Piscicole) in Bouaké, Ivory Coast. They are now assigned to the ELADEP Project and are thus not available for other assignments.

For the implementation of a project to develop fish culture the following personnel is required:

(a) Nine Agronomes (A-2 level): two at the Kigembe Station, (one as an instructor and one as chief of the station) and seven will be responsible for the management of one préfectoral fish farming station, and the technical supervision of the extension workers (Moniteurs) assigned in the préfecture.

The nine agronomes have to be trained during 5-6 months at the Kigembe Station. The training should start at the beginning of the project and should be as practical as possible, and adapted to the local conditions.

(b) Sixty extension workers (moniteurs piscicoles): they have to be selected before their acceptance to follow a 4-month special training in fish culture and extension. Monitors are low level government agents who have direct contacts with the farmer. These agents will have a primary school education and have attended several years of intermediate vocational training at Rural Training Centres. They are literate in Kinyarwanda and may know some French. The training of the moniteurs will be provided at the Kigembe Fish Station. The training will be held in groups of 15 to 20 people.

The already existing facilities at the Kigembe Centre must be upgraded and expanded to accommodate 20 trainees. A dormitory with sanitary block (100 m^2), a multi-purpose hall (80 m^2) and a kitchen (40 m^2) will have to be constructed. The multi-purpose hall will serve for classwork, eating and other group activities.

3.6.3 Extension

The existing extension service has to be strengthened and established at the Kigembe Centre. Sixty extension workers have to be trained during the 4 years of the project, to overcome the lack of effective farmer training in the techniques of fish culture.

At the completion of the training, each moniteur has to be provided a kit of basic tools[1/] and means of transport (bycicle or motorbike) to visit the farmers.

The basic tools will consist of: one 20 m-survey tape (to measure and to peg the ponds), one 10-litre bucket, one spring scale (10 kg), note books, pencils, etc., one scoope net, one beach seine (10 m long) or a cast net, one rope (100 m) for pegging the ponds, one masone's level, boots and audio-visual aids.

The audio-visual aids will consist of: one slide projector, one screen, series of slides, one small power plant, one booklet, one fanellograph and posters. The audio-visual equipment will be used under the direct supervision of the extension expert and his counterpart.

The moniteurs will be supervised on a continuing basis by the Prefectural Level Fish Station Manager.

3.6.4 Research

It will be necessary to carry out non-sophisticated applied research concerning the following aquaculture techniques: (i) polyculture in ponds of T. nilotica, T. rendalli, T. melanopleura and T. macrochir at different densities with artificial feeds and fertilization of ponds; (ii) polyculture in ponds of T. nilotica + T. rendalli + T. macrochir + Clarias mossambicus as predator with artificial feeds and fertilization of the ponds; (iii) trials, in polyculture, of application of lime at different rates; (iv) trials, in polyculture, of application of compost; (v) trials, in polyculture, of application of inorganic fertilizers such as triple superphosphate, ammonium sulfate and urea; (vi) trials concerning associated animal husbandry (fish-cum-pig culture, fish-cum-duck culture and fish-cum-chicken culture).

The results of these investigations whould be applied on the rural level to improve the production of the fish farmers, if conditions permit.

3.6.5 Extrapolation of Potentially Obtainable Production

With an adequate number of well-trained extension workers, fully equipped to carry out their tasks, and with a regular supply of required fingerlings, the following situation is expected at the end of the first year:

(i) About 80 percent of the existing ponds in the seven concerned préfectures will again be in production;

(ii) Average yield will be 500 kg fish per ha/year (5 kg/are/year);

(iii) The rate of construction of new ponds will be between 3 and 5 percent per 12 months;

(iv) The average surface of the ponds will be 3.5 ares;

(v) The total production of the 1 922 ponds will be 33 750 kg of fish.

The inputs/outputs expected at the end of the first year of the programme is given in the following table:

Table 15

Fish Culture Programme at the End of the First Year

Préfecture	No. of existing ponds (1978)	Rehabilitated ponds a/		Rate of construction of new ponds b/	Ponds and production, end of the first year			No. of fingerlings needed for stocking e/
		No.	Surface (are)		No.	Area c/ (are)	Production d/ (kg)	
Kigali	653	522	1 028	+ 5%	548	1 644	8 220	328 800
Gitarama	626	500	1 005	+ 5%	525	1 575	7 875	315 000
Butare	541	433	1 853	+ 5%	455	2 047	10 235	409 000
Gikongoro	160	128	362	+ 4%	133	399	1 995	79 800
Ruhengeri	93	74	162	+ 3%	77	231	1 155	46 200
Byumba	183	146	663	+ 4%	151	755	3 775	151 000
Kibungo	40	32	85	+ 3%	33	99	495	19 800
TOTALS	2 296	1 835	5 158	-	1 922	6 750	33 750	1 350 000

Notes:

a/ It is assumed that after the first year of the project 80% of the existing ponds will have been rehabilitated, and stocked with fingerlings.

b/ Estimates, taking into account percentage of inhabitants, involved in fish farming in each préfecture, situation of existing ponds (see Table 3) and number of extension workers assigned in each préfecture.

c/ Estimated as follows: average area of one pond is 3 ares in the préfectures of Kigali, Gitarama, Gikongoro, Ruhengeri and Kibungo; 4.5 ares in the Butare Préfecture and 5 ares in the Préfectue of Byumba.

d/ Production based on an average yield of 5 kg fish/are/year (or 500 kg/ha/year).

e/ Calculation based on a stocking rate of 2 *Tilapia nilotica* fingerlings per m^2, or 200 fingerlings/are.

It can be anticipated that the annual increase of the number of ponds will be around 5 percent during the first years of the programme and will reach 10 percent in the fourth year.

With effective and dynamic extension work, it can be expected that the average pond area will increase slowly, year after year, to reach an average of 500 m^2 in the fourth year of the programme

Under intensive management of fish ponds (adequate stocking, required fertilization of the pond and balanced feeding), yields from 30-50 kg are/year (or 3-5 tons of fish per ha/year) can be obtained in rural aquaculture. Experience obtained in other African countries, culturing T. nilotica, shows that:

(i) the average yield in rural fish farming is between 18 and 20 kg fish/are/year;

(ii) the average fish pond has a surface of 1.5 ares (150 m^2), but progressive fish farmers have ponds measuring up to 10 ares, and that,

(iii) it is possible to divide fish farmers into three groups according to the level of fish pond management:

(a) Group I - Consists of owners of ponds who do not take care of their ponds and do not feed their fish. Depending on the region, between 40 and 56% of the farmers belong to this group and the yields in their fish ponds are below 15 kg/are/year, with an average of 7-8 kg/are/year.

(b) Group II - Between 31 and 46% of the farmers belong to this group with yields between 15 and 39 kg of fish/are/year. Average yield is 24 kg/are/year. Farmers take care and maintain their ponds, they fertilize the ponds with compost and feed the fishes several times a week.

(c) Group III - Concerns about 10-12% of the farmers who produces 40 kg and more fish per are/year, with an average of 55 kg/are/year. The farmers belonging to this group are maintaining bigger ponds (8-10 ares), regularly apply compost and manure, and they feed their fishes daily, using protein feedstuffs rich in protein such as oil cakes.

According to the above findings, it appears realistic to expect that during a 4-year aquaculture development programme, the average yields with typical management of fish ponds will be as follows:

first year:	5 kg fish/are/year
second year:	7 kg fish/are/year
Third year:	10 kg fish/are/year
fourth year:	15 kg fish/are/year

Table 16 shows the expected increase, during a 4-year extension programme, of the number of ponds, the required fingerlings for stocking, and the expected prdouction.

Table 16

Expected Increase during a 4-year Extension Programme

Préfectures	End of First Year a/				Second Year			
	No. of ponds	Surface (are) b/	Fingerling requirements	Expected production (kg/year) c/	No. of ponds d/	Surface (are) b/	Fingerling requirements	Expected production (kg/year) c/
Kigali	548	1 644	328 800	8 220	575	1 725	345 000	12 075
Gitarama	525	1 575	315 000	7 875	551	1 653	330 600	11 571
Butare	455	2 047	409 400	10 235	478	2 151	430 200	15 057
Gikongoro	133	399	79 800	1 995	140	420	84 000	2 940
Ruhengeri	77	231	46 200	1 155	81	243	48 600	1 701
Byumba	151	755	151 000	3 775	159	795	159 000	5 565
Kibungo	33	99	19 800	495	35	105	21 000	735
TOTALS	1 922	6 750	1 350 000	33 750	2 019	7 092	1 418 400	49 644

Notes:

a/ It is assumed that after the first year of the project 80% of the existing ponds will have been rehabilitated, stocked and again in production.

b/ The surface is estimated as follows: average area of one ponds is 3 ares in the préfectures of Kigali, Gitarama, Gikongoro, Rhengeri and Kibungo; 4.5 ares in the Butara Préfecture, and 5 ares in the Préfecture of Byumba (see Table 3).

c/ Production targets are as follows: first year, 5 kg fish per are/year; second year, 7 kg fish per are/year; third year, 10 kg fish per are/year; fourth year, 15 kg fish per are/year (see section 2.4.2).

Table 16 (continued)

Préfectures	Third Year				Fourth Year			
	No. of ponds d/	Surface (are) e/	Fingerling requirements	Expected production (kg/year) c/	No. of ponds f/	Surface (are) g/	Fingerling requirements	Expected production (kg/year) c/
Kigali	604	2 416	483 200	24 160	664	3 320	664 000	49 800
Gitarama	579	2 027	405 400	20 270	637	3 185	637 000	47 775
Butare	502	2 510	502 000	25 100	552	2 760	552 000	41 400
Gikongoro	147	515	103 000	5 150	162	810	162 000	12 150
Ruhengeri	85	255	51 000	2 550	94	470	94 000	7 050
Byumba	167	835	167 000	8 350	184	920	184 000	13 800
Kibungo	37	111	22 200	1 110	41	205	41 000	3 075
TOTALS	2 121	8 669	1 733 800	86 690	2 334	11 670	2 334 000	175 050

Notes: (continued)

d/ Annual increase is assumed to be 5%.

e/ Average area of one pond is 3 ares in the Ruhengeri and Kibungo Préfectures; 3.5 ares in the Gitarama and Gikongoro Préfectures; 4 ares in the Kigali Préfecture, and 5 ares in the Butare and Byumba Préfectures.

f/ Annual increase is assumed to be 10%.

g/ It is assumed that the surface of all the ponds is 5 ares (= 500 m^2).

3.7 Impact of the Development Effort

Based on the projections which have been very roughly estimated above, fish culture development would have a direct effect on existing production structure of the following dimensions:

(i) Provision of fish for human consumption - After four years yearly yield of about 180 tons of fish will provide sufficient animal protein for around 2 400 rural families (a 20 fold increase of present average per caput consumption will still leave 40% of the fish to be marketed (around 80.0 tons)

(ii) Income - 2 400 families engaged in fish culture would increase their cash income by 2 000 to 2 500 Rw.F, by selling about 40% of their fish production. The estimated combined additional income of 5 000 families of about Rw.F 6 million will strengthen the internal market of the country.

(iii) Employment - The labour potential of around 2 400 families will be used more productively, cooperative production may create self employment in government settlement schemes or other rural centres.

(iv) Diversification of production - The overall agricultural production structure will be diversified by fish pond production eliminating partly the potential need for animal protein imports.

(v) Transfer of technology - Extension, development support and technical assistance to around 2 400 families, enabling them to operate fish ponds with mainly indigeneous resources can be expected to root fish culture in the rural milieu of Rwanda.

Considering that the assumed extension programme is of small magnitude, and yields have been estimated conservatively, the increase in quantity and nutritive value of aquaculture production will already have a significant impact on the overall protein supply.

The outlined magnitude of production does not consider the probable spread effect (or multiplier effect) of successfully operating fishculture units, which may induce more than the number of farmers or cooperatives estimated to take up fishculture. However, taking into account only the above number of production units, the achieved production will, by the fourth year, have already increased the present yearly supply of fish in Rwanda considerably, adding an annual value of almost 11 million to the GDP. An annual growth rate of rural fish farming can be expected to be around 10%, as long as no presently unpredictable constraints limit expansion.

4. FARM LEVEL FINANCIAL ANALYSIS

4.1 Introduction

Aquaculture, unlike capture fisheries, allows the relating of operational inputs to expected outputs with a reasonable probability. Assessing the financial feasibility of aquaculture development on a micro, i.e., farm level, the production factors have to be analyzed. The factor analysis assesses the general and seasonal availability and costs of the projected inputs. In order to analyse the financial implications of fish culture operations, input-output dynamics and expenditures versus revenues are projected. Projected revenues are compared to benefits which could be derived from alternative farm operations in order to arrive at the qualitative and quantitative appraisal of aquaculture production.

An ex-ante financial appraisal of fish culture must necessarily be reduced to the evaluation of assumed production, a rather abstract exercise. Nevertheless it will predict, if the assumptions used are realistic, whether or not it will be beneficial for the farmer to undertake fish farming.

The decision to culture fish, as well as its consequences, has however, to be borne by the farmer and his family, and their value pattern is usually different from that of an economic analyst. This should be taken into account while planning for a technological innovation.

While it is still useful to discuss fish culture development on a micro-economic level, one should be aware of the non-empirical nature of the data presented in the following. For the success of such a development in the concrete case of Rwanda, the socio-economic and socio-cultural variables, which will be discussed later in this report, will be of at least equal importance.

Summary and Conclusions

The farm level financial analysis does not predict major constraints with respect to basic resources and operational inputs used for fish culture production in Rwanda. Whereas land suitable for aquaculture can be assumed to be available with regard to the 20-30 000 ha of marshlands, and raw materials for compost preparation can be found readily, labour and feed inputs can be considered potential bottlenecks. The labour requirements for fish culture per hectare and per year are lower than for most cash crops and are within the same range as for potatoes, sweet potatoes and rice; but the returns from fish culture are higher than for these crops (except in the case of cinchona). A 500 m^2 family pond will require only about 5 percent of the labour usually available in an average rural family. Also, as much of the day-to-day labour inputs can be provided by children and the aged, the limited family labour capacity is not considered to be a serious obstacle to small-scale rural fish culture.

Suitable base-materials for fish feeds, although assumingly available, may be limited in some areas, and little is known about their present alternative use, as no tradition of semi-intensive or intensive animal husbandry exists in rural Rwanda. The availability and accessibility of suitable feedstuffs will have to be investigated for each concrete case where a medium-scale production unit is planned and feeding is envisaged.

The input which is at present not available to many farmers who could eventually start fish farming, is stocking material, i.e. fingerlings. The development of rural fish culture will depend on the production and distribution of fingerlings to the farmers, at prices within their financial possibilities.

Assessing its profitability, fish culture can be predicted to yield a net return to the farmer's family if a production of 1.2 tons/ha/year can be achieved. This theoretical break-even point was estimated from the input/output analysis which valued all operational inputs at their opportunity costs. In reality, however, the only cash inputs are the fingerlings for initial stocking and, for the larger production units,

In order to arrive at a realistic appraisal of the worthiness of raising fish in the rural areas, present land and labour use and what it produces in cash and kind for the farmer's family, as compared to the returns resulting from projected fish culture operations. For this purpose, present marshland agriculture was compared with projected fish culture operations in the same environment. In the case of fish culture, all operational inputs were valued according to their projected or opportunity costs and depreciation of pond construction costs were added; the outputs were estimated conservatively and valued at presently realized price. In the case of marshland agriculture, only labour was considered on the cost side and the produce was valued at 1980 prices.

In spite of this bias, which favoured agricultural production, fish culture, projected and calculated for two models (a 500 m^2 family pond with compost fertilization and a 5 000 m^2 pond with feeding) showed incremental gross returns of + 137 percent and + 216 percent and incremental gross returns per man/day of labour of + 90 percent and + 123 percent respectively.

When compared with other food and cash-crops presently grown in Rwanda, only banana cultivation yielded a higher return per man/day; only cinchona production resulted in a higher gross return.

When compared to all the different types of crops which are presently grown on marshland (including tea and rice), projected fish culture showed a higher gross return and higher cash return, assuming only 40 percent of the production being commercialized (against 80 percent of rice and 100 percent of tea marketed). A 500 m^2 family pond would generate a cash income of Rw.F. 2 250/year, if 40 percent of the fish were sold; 40 percent of the production marketed would still leave 45 kg for home consumption, which would represent a 20-fold increase of fish consumption per family member as compared to the present average <u>per caput</u> consumption of less than 0.5 kg per year.

4.3 Factor Analysis

4.3.1 Land and water

In the case of fish culture, land and water are the material basis of production which will determine, for each individual case, whether and to what extent fish culture is possible. For a general assessment, one has to evaluate the availability in quality and quantity and the opportunity costs (revenues generated if used alternatively), as it is not assumed that farmers buy or lease additional land to construct fish ponds.

- Availability (quantity)

For the scope of this report, it is not necessary to evaluate in detail the potentially available land and water for fish culture on a national basis, as decisions on land-use will be made by the farmers on an individual basis. To have a rough idea of land resources the following figures may be useful:

- Of 1 250 000 ha of potential farm land (Delepierre and Prefol, 1972), 102 000 ha were not cultivated in 1974 (IBRD, 1976). As agricultural land use increased by 3.5 percent annually (IBRD, 1976), this potential should have decreased accordingly by now.
- Land unsuitable for agriculture was estimated at 525 000 ha (Delepierre and Prefol, 1972).
- The land surface occupied by marshes was estimated at 84 000 ha (IBRD, 1976), of which 20 to 30 000 ha (Monnon, personal communication 1980) could potentially be used for fish culture.

Rainfall can be used as an indicator for water availability (see Table 17). However, water availability should be assessed individually for each envisaged operation.[1]

- Quality of land and water

No overall statement on the quality of available land and water can be made here. For each envisaged fish pond topography, soil and water quality and accessibility have to be studied. Decisive factors are usually PH value, mineral contents and the capability of the soil to hold water. Particularly the available marshland, as an obvious potential for pond culture, will have to be examined carefully in this respect (acidity).

1/ As a general rule, pond culture of fish required a water inflow of 9 l/sec for a pond of 1 ha with an average depth of 1 m.

Table 17 allows a general overview of soil qualities in Rwanda:

Table 17
Agricultural Regions of Rwanda (after Delepierre)
in Morris (1979)

REGION	AVER. ELEVATION M	AVER. RAINFALL	SOIL	POP %	LAND %	PRINCIPAL CROPS	QUALITY
Imbo	1100	1200	alluvial	.5	.7	Banana, manioc bean, peanut, sweet potato, cotton, rice, sugarcane, citrus	excellent
Impara	1700	1400	heavy red basaltic	3.6	6.8	banana, beans, maize, sorghum, sweet potato, manioc, peanuts, coffee, tea, quinchona	good
Boros of Lake Kiva	1600	1200	shallow silty-clay	3.9	2.7	banana; beans, maize, sorghum, sweet potato, manioc, peanuts, coffee	good to - excellent
J va area	2200	1500	volcanic	4.1	3.5	banana, beans, maize, sweet potato, sorghum, peas, potato, pyrethrum, tobacco	excellent
Congo-Nile ridge	2100	1600	acid organic	14.2	17.0	peas, maize, potato, eleusine, wheat, tea, sun-flower, wood	average
Buberuka	2000	1200	laterised	9.2	7.0	banana, bean, sorghum, sweet potato, maize, potato, peas, wheat, barley	good
Central plateau	1700	1200	organic various	21.5	13.2	beans, sorghum, maize, sweet potato, banana, taro, yam, coffee, soybean	good
Dorsale granitic	1500	1100	light, gravely	15.4	6.8	banana, beans, sorghum, maize, sweet potato, yams, taro, peanuts. manioc, coffee. livestock	average
Mayaga	1450	1050	clay from schists	13.3	14.1	coffee, beans, sorghum, maize, banana. sweet potato, manioc, pea-nuts, soybean	very good

..esera	1400	900	strongly altered clays	1.9	5.3	beans, sorghum, maize, bananas, sweet potato, manioc, peanuts, livestock	poor
Eastern plateau	1500	950	later-ised	9.1	13.4	beans, sorghum, maize, bananas, sweet potato, manioc, peanuts, coffee	average N good S
Eastern savanna	1400	850	old soils variable texture	3.4	19.6	manioc, peanuts beans, sorghum, maize, sweet potato, livestock, National Park	very good

Source: Morris, 1979

- Opportunity costs of land

No general assessment of opportunity cost of land used for fish culture can be attempted for Rwanda. Froam an economic, as well as from a financial point of view, it would be ideal to use land which is not or less suitable for agriculture as no or little opportunity costs arise in such cases. For reason implied before (soil quality, water availability) fish culture will often have to compete with agriculture for land, however.

The specific opportunity cost of a land area considered for pond construction have to take the alternative possible and probable land use under the prevailing production structure into account. Swampy marshlands (marais) for example, will have the opportunity cost of the gross value of crops presentl grown minus inputs, for the respective land area and over a given time.

The "marais" are typically farmed under the following production pattern (for one ha/year)

Table 18
Structure, Output and Value of Present Marshland Production

	Area (M²)	%	Production (kg)	Price Kg (RwF)	Value (RwF)
Sweet potatoes	6000	60	2700	13	35,100
Beans, interplanted			270	30	8,100
with maize	3000	30	300	10	3,000
Green fodder	1000	10	600	2	1,200
Total					47,400

Inputs to be deducted from the total value created by marshlands cultivated in the way shown above are almost inclusively farm labour. Farm labour is difficult to value for rural subsistence production, ranging from zero (when no alternative production is possible) to the monetary return on labour for an alternative activity, which can be as high as Rw.F. 528/man/day (IBRD, 1977) in the case of bananas.

For the opportunity cost of marshlands considered for fish culture, the labour input which has to be subtracted from the total value of production should be calculated according to the key used for the estimate of the farm value of production (per ha/year).

Table 19

Labour requirements of present marshland production

	Area (m^2)	% of area	Labour input (m/d/y)	Returns (per m/d) Rw.F.	Total (Rw.F.)
Sweet potatoes	6 000	60	180	103	18 540
Bean, interplanted with maize	3 000	30	35	97	4 000
Green fodder	1 000	10	20	40	800
Total			235		23 340

Source: own estimates, IBRD 1977

Assuming these premises, the opportunity cost of marshlands can be roughly estimated at Rw.F. 24 000/ha/year (total production - labour inputs).

4.3.2 Labour

Next to the availability of land and water, labour is a crucial factor for aquaculture development. For an assessment of the labour available for fish culture in Rwanda one has to evaluate the present structure of labour inputs in agriculture, i.e., labour potential, seasonality, labour inputs, division of labour, and opportunity costs of labour.

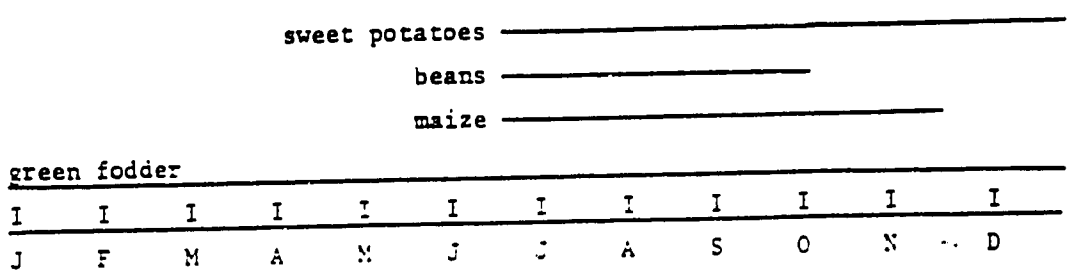
- Labour potential

The dominant agricultural production unit is the nucleus family (parents, children) with additional inputs from the aged and the unmarried brothers or sisters. Average family size is about five persons (4.71 in 1970, 4.97 in 1973); an average of economically active persons per family constitute a total labour potential per family per year of about 4 000 hours or 660 man-woman/days/year 1/ (Delepierre et al., 1978).

- Seasonality of farm labour inputs

Because of the variety of food and cash crops cultivated simultaneously by the average Rwandan family, labour inputs are spread relatively evenly throughout the year (see Table 20). Occasional labour peaks occur, however, but usually neighbourhood and kinship help are available in such cases.

For marshland cultivation the key used in calculating opportunity costs of land would produce the following seasonality diagram:



1/ Delepierre et al., 1978

Fish culture operations will have to be timed in order to avoid coinciding labour peaks. This implies planning for major labour inputs in fish culture during the months January to May, and, to a lesser extent, October and November, in order to prevent labour peaks coinciding with present 'marais' cultivation patterns. An indication of the seasonality of labour inputs for the overall farm production pattern is given, for one region, in the table presented below.

Table 20

Annual Calendar of Farm Work at Butare

September	Sowing of beans and gourds. Cultivation of the hillsides
October	Further sowings of beans, planting of potatoes and sweet potatoes, harvesting of beans and sweet potatoes grown in the marshes
November	Weeding work in the banana groves, harvesting the leaves of beans and pulses, planting of banana trees
December	Harvesting the first potatoes and the first green beans
January	Bean harvest; preparation of the mixed crops of sorghum, beans, maize, and sweet potatoes under the banana trees and of the fields of peas, beans, and sorghum in the open air
February	Potato harvesting. Continuation of the sowing of beans, peanuts and sorghum, etc. Planting of sweet potatoes and pulses, harvest of gourds
March	Planting of potatoes and sweet potatoes
April	Green beans harvest
May	Bean and maize harvest
June	Preparation of the marshes for the planting of sweet potatoes, the beginning of the sorghum and coffee harvest
July	Harvesting of peas, potatoes, coffee. Storage of sorghum, threshing of dried beans, mulching of coffee trees
August	Reconstruction of huts, brewing, marriages
All year around	Care of banana groves, preparation of banana beer and harvest of fruits, harvest and preparation of manioc, harvest of sweet potatoes, care of animals

Source: Leurquin, 1960

- Division of Labour

As for the qualitative division of labour between the sexes the men usually perform the heavy works such as land preparation, they are also dominant in animal husbandry and take care of cash crops like coffee and (except for composting) banana cultivation. Women are mainly responsible for the daily labour for food crop production and the household. Harvesting and post-harvest activities are generally shared between the sexes. A quantitative breakdown of total weekly labour inputs is given below.

Table 21

Average Hours Worked/Week

	Farm and associated	Off-Farm paid	Off-Farm not paid	Household	Total/Week
Household head	35.2	10.2	3.3	2.6	51.3
Wife	38.1	1.4	1.0	16.7	54.8
Son	25.4	11.4	2.1	5.6	44.5
Daughter	29.4	3.6	1.7	17.5	52.2

Source: Delepierre et al., 1978

For fish culture operations these data suggest labour inputs in pond construction and pond maintenance (earth work) for the male family members and feeding/fertilizing by the women. Stocking, harvesting and post-harvest activities will probably be shared between the men and women.

- Opportunity cost of labour

The family labour inputs of 4 000 men/hours/year/family indicate a high degree of utilization of overall available labour.[1/] It appears to be advisable, therefore, to attach a value to labour input projections for fish culture.

From the calculation of opportunity costs for marshlands, as shown in the former chapter one can deduct a return on labour per day of about Rw.F. 100 for marshland cultivation and this figure will be assumed for the micro-economic analysis presented here.

1/ H. Brand (1979) estimates an African average of 900-1 100 men/hours per economically active person in agriculture per year.

For cases where labour earmarked for fishculture may compete with the alternative production of other agricultural commodities, the following table presents estimated returns on labour.

Table 22

Returns to Labour/Man/Day (in [illegible] F.) of Different Crops in Rwanda

Crop	Returns/man/day undiscounted
Bananas	528
Peas	107
Groundnuts	168
Soybeans	91
Sorghum	117
Millet	n.d.
Rice	[illegible]
Potatoes	144
Cassava	113
Squash	123
Coffee	79
Tea	96
Pyrethrum	57
Cinchona	363
Cotton	[illegible]

Source: IBRD, 1977

4.3.3 Capital

For small-scale family based pond culture little or no capital investment is required. Pond construction will be done by manual labour provided by the family, relatives or neighbours, in which case no monetary compensation is usually given. No concrete is usually used in pond construction at present. Operational inputs as labour, compost and green manure will, in most cases, come from internal sources without monetary exchange. Only fingerlings and, in the case of integrated production, livestock will possible have to be purchased, but expenditure will be minimal (at present a nominal price of 1 Rw.F per fingerling is considered justified by the Departement des Eaux et Forêts). For larger production units, managed by groups and cooperatives, locally produced bricks and clay pipes can be used and only little concrete is needed. Eventually purchased operational inputs will be discussed in the next chapter. Infrastructural capital costs are not envisaged to be extended to farmers and groups.

4.3.4 Operational Inputs

Inputs, other than the already discussed in the factor-analysis, will consist mainly of feeds (for larger production units) and fertilizers, for which availability and costs have to be discussed.

- Feeds

  Family based small-scale fish culture will in most cases use feeds available on the farm, i.e., kitchen scraps, food crop and cash crop, draff from banana and sorghum beer. non edible parts of farm grown vegetables, etc., with no costs to the farmer. The procurement of purchased feed inputs

should be considered only for large-scale fish culture operations because transport will be feasible only for large amounts and feedstuffs exist only to a limited extent in Rwanda. At present, mainly rice bran and slaughterhouse wastes are used in the few cases where fish are being fed. Alternative potentially suitable agro-industrial wastes and by-products are however obtainable. Little information on quantities, alternative uses, seasonality and prices is presently available, accordingly the possibilities to use feed in fish culture will have to be evaluated for each production unit.

Present available information indicate a cost price for the majority of brans of a maximum of 2 Rwf/kg, while slaughterhouse and other wastes can be obtained free of charge. Accordingly, fish feed based agro-industrial by-products and wastes, including transport, is assumed to have a cost price of about 2 Rwf/kg, if available within a radius of no more than 50 km.

Fertilizer

Chemical fertilizer is presently not, or only marginally, available in Rwanda. Therefore, green manure and compost will have to be used for fertilizing the fish ponds; the availability of livestock manure will have to be assessed for each individual site.

For green manure, i.e., grasses, vegetable residues, other plants, which are available on a normal farm in Rwanda, no specific costs are assumed. The labour necessary to collect and apply it is part of operational labour inputs. For compost, which requires considerable labour inputs to prepare but is also more productive, costs have to be applied. Such calculations can be based on the opportunity cost of the labour necessary for compost production. For fertilizing a 1-ha pond, 20 to 30 tons of compost are necessary and the preparation requires 120 m/day approximately. Assuming that the raw material for compost preparation, i.e., all kinds of organic matters , grasses and crop wastes, is available on the average farms at no extra cost, fertilization of 1-ha of pond for one year would cost about Rw.F. 12 000.

4.4 Expenditure-revenue Projections

The factor-analysis has, apart from discussing the general availability of the necessary production factors, assumed values (opportunity costs) for the different inputs. Relating projected inputs to estimated outputs will allow the assessment of the rentability of fish culture operations under local conditions. As the productivity of pond culture will vary from case to case, according to the expertise of the farmer, the efficiency of the extension service and the specific availability of inputs, different output levels have been taken into consideration.

All inputs/outputs are expressed in monetary terms, according to their assumed opportunity costs or present values, abstracting from the largely non-monetary nature of exchange in rural Rwanda. Although this reduces the complexity of agricultural production within the rural milieu to mere cost benefits, it will indicate whether, financially, fish culture is profitable to the small-scale farmer.

Expenditures and revenues are projected for two types of model operation: a 500 m^2 family run pond under fertilization with compost and a 5 000 m^2 collectively managed pond with feeding. *Tilapia nilotica* in polyculture with *T. macrochir* and *T. melanopleura*, stocked twice a year at a density of 2 fingerlings/m^2, is assumed to be cultured. Fertilizer and feed inputs are projected according to the factor analysis; for feed inputs a food conversion rate (C.R.) of 10:1 was assumed, i.e., 10 kg of feed would produce 1 kg of fish.

Expenditures arising from pond construction are not included in this calculation.

Table 23

Revenue-expenditure Projections for a 500 m^2 Family Pond

Production levels (ha/year)	I 1 000 kg	II 1 500 kg	III 2 000 kg
(a) Revenues			
- production per 500 m^2/year	50 kg	75 kg	100 kg
- value per 500 m^2 (Rw.F. 75/kg)	3 750	5 625	7 500

(b) Expenditures (Rw.F.)			
- opportunity costs of land	1 200	1 200	1 200
- opportunity costs of labour (stocking, maintenance, harvesting)	1 500	1 500	1 500
- fingerlings	1 000	1 000	1 000
- compost	600	600	600
total	4 300	4 300	4 300
(c) Net return	- 550	1 325	3 200

It should be noted that the only cash expenditures accruing to the family use are the cost of fingerlings. In the desirable case where the farmer can be given sufficient training to keep the necessary number of fingerlings from the previous harvest, this would arise only once for initial stocking. Under the assumed conditions, i.e., valuing all inputs according to their opportunity costs and purchasing fingerlings once a year, family fish farming of a 500 m^2 pond will break even at a production level of 57 kg/year (1 150 kg/ha/year).

For a 5 000 m^2 pond stocked with T. nilotica, with feeding of rice bran and slaughterhouse wastes, a higher productivity can be assumed.

Table 24

Revenue-expenditure Projections for a 500 m^2 collectively operated pond with feeding

Production levels (ha/year)	I 1 500 kg	II 2 000 kg	III 2 500 kg	IV 3 000 kg
(a) Revenues				
- production per 5 000 m^2/year	750 kg	1 000 kg	1 250 kg	1 500 kg
- value per 5 000 m^2 (Rw.F. 75/kg)	55 250	75 000	93 750	127 500
(b) Expenditures (Rw.F.)				
- opportunity costs of land	12 000	12 000	12 000	12 000
- opportunity costs of labour (stocking, maintenance, feeding, harvesting)	15 000	17 000	19 000	21 000
- fingerlings	10 000	10 000	10 000	10 000
- feeds (including transport, C.R. 1:10)	15 000	20 000	25 000	30 000
	52 000	59 000	66 000	73 000
(c) Net return	3 250	16 000	27 750	54 500

Under the assumed conditions, the break-even point would be at a production level of 690 kg (level I), 786 kg (level II), 888 kg (level III) and 973 kg (level IV), according to the increased inputs.

The calculation of projected operational costs and returns, which assumes values for all inputs, shows that also under these hypothetical conditions, which have been purposely biased toward the most unfavourable, fish farming will be profitable in itself if a production of about 1.2 t/year/ha can be achieved.

4.5 Comparison of Production from Marshland Cultivation with and without project

The comparison of marshland cultivation under the present production pattern and when used for fish culture allows a quantitative judgement on whether the latter offers a better return on land and labour to the farmer. For the 'with and without project' comparison, no opportunity cost for land is considered/ in either case, but depreciation of initial investment for pond construction over 25 years is included. Initial investment for pond construction is depreciated linearly but no interest is added as inputs are almost entirely non-monetary, i.e., manual labour is provided by the family or the cooperative members.

Table 25

Volume and value of marshland production
with and without project
(yearly cost/benefits for 500 m² with fertilization)

Without Project					With Project (at medium productivity, 1 500 kg/ha/year)				
Production	area (m²)	volume (kg)	unit price (Rw.F.)	value (Rw.F.)	Production	area (m²)	volume (kg)	unit price (Rw.F.)	value (Rw.F.)
sweet potatoes	300	135	13	1 755	fish	500	75	75	5 625
beans		13,5	30	405					
interplanted with maize	150	15	10	150					
green fodder	50	30	2	60					
total				2 370	total				5 625
Expenses	quantity of inputs		unit price (Rw.F.)	value (Rw.F.)	Expenses	quantity of inputs		unit price (Rw.F.)	value (Rw.F.)
seeds	-		-	-	seeds	1 000 fingerlings		1	1 000
fertilizer	-		-	-	fertilizer	1.5 tons		400	600
labour	12 m/d		100	1 200	labour	15 m/d		100	1 500
depreciation	-		-	-	depreciation	-		-	440
total				1 200	total				3 540

/Continued

Table 25 (continued)

Without Project	(Rw.F.)	With Project	(Rw.F.)
Gross return	2 370	Gross return	5 625
Net return	1 170	Net return	2 085
Gross return per m/d	197.5	Gross return per m/d	375
Net return per m/d	97.5	Net return per m/d	139
Rate of return	- 97%	Rate of return	- 59%
Gross return per ha	47 400	Gross return per ha	112 500
Net return per ha	23 400	Net return per ha	41 700

Table 26

Volume and value of marshland production
with and without project
(yearly cost/benefits for 5 000 m^2 with feeding)

Without Project					With Project (at medium productivity, 2 000 kg/ha/year)				
Production	area (m^2)	volume (kg)	unit price (Rw.F.)	value (Rw.F.)	Production	area (m^2)	Volume	unit price (Rw.F.)	value (Rw.F.)
sweet potatoes	3 000	1 350	13	17 550	fish	5 000	1 000	75	75 000
beans, interplanted with maize	150	135	30	4 050					
		150	10	1 500					
green fodder	500	300	2	600					
total				23 700	total				75 000
Expenses	quantity of inputs		unit price (Rw.F.)	value (Rw.F.)	Expenses	quantity of inputs		unit price (Rw.F.)	value (Rw.F.)
feeds	-		-	-	seeds	10 000 fingerlings		1	10 000
feed	-		-	-	feed	10 000 kg		2	20 000
labour	120 m/d		100	12 000	labour	170 m/d		100	17 000
depreciation	-		-	-	depreciation	-		-	4 400
total				12 000	total				51 400
gross return				23 700	gross return				75 000
net return				11 700	net return				23 600
gross return per m/d				197.5	gross return per m/d				441.2
net return per m/d				97.5	net return per m/d				138.8
rate of return				- 97%	rate of return				- 46%
gross return per ha				47 400	gross return per ha				150 000
net return per ha				23 400	net return per ha				47 200

Although these figures are self-explanatory, it should be noted that for the 'with project' calculations, all inputs have been valued according to their real or opportunity costs and only a moderate output is assumed. For the 'without project' only the operational labour inputs are inserted as costs. In spite of this purposely applied bias, projected fish culture compares favourably with present marshland production, namely by producing more value from, except for fingerlings and feeds, existing resources (land, water, labour,etc.), as demonstrated by the incremented values shown below.

Table 27

Incremental values produced by projected fish pond operations as compared to present marshland cultivation (Rw.F./h/y)

	gross return	net return	gross return m/d	net return m/d
family units	+ 65 100	+ 18 300	+ 177.5	+ 41.5
cooperative units	+ 102 600	+ 23 800	+ 243.7	+ 41.3

4.6 Additional parametric comparisons between agriculture and fish farming

As shown in the last chapters, under the present pattern, fish farming compares mostly favourably with production from marshlands. In the following table the projections of fish culture operation under local conditions will be compared with the average benefit-costs performance of food and cash crops presently grown in Rwanda. In the case of most of these crops, no competition for land use with fish culture will emerge. The relatively high grade of utilization of the labour potential of the family indicates, however, a possible conflict with respect to labour use. Therefore, comparing yields, returns, labour requirements and returns to labour, will allow to estimate whether, and to what extent, fish farming is beneficial to the farmer.

Table 28

Economic performance of different food and cash crops as compared to fish raised in a 500 m^2 family pond and in a 5 000 m^2 cooperative pond

	fish 500 m^2	fish 5 000 m^2	banana	beans	peas	cassava	potatoes	sweet potatoes	yams	sorghum	maize	millet	wheat	rice	cinchona	tea	coffee	cotton	pyrethrum
Gross production (kg/ha/y)	1 500	2 000	9 100	800	800	4 100	6 600	7 750	5 620	1 080	1 070	560	840	2 480	2 129	3 518	610	626	2 275
Gross return (Rw.F./ha/y)	112 500	150 000	58 130	16 000	16 000	28 700	46 200	31 000	39 340	19 850	8 560	5 600	12 600	42 160	248 417	31 670	39 676	9 390	27 300
Labour requirements (m/d)	300	340	110	150	150	250	320	300	320	170	100	100	130	400	684	323	501	130	479
Gross return to labour (m/d/Rw.F.)	375	441	528	107	107	115	144	103	123	117	86	56	97	105	363	98	79	72	57

Source: IBRD 1977 and own estimates

The table shows that only banana production would yield a better return per man per day than fish culture and that only cinchona production would result in gross returns superior to fish culture.

With respect to the income generating capacity of fish culture it is useful to compare net return and cash return (percentage of return commercialized) of sweet potatoes, cassava, maize and beans, which are presently grown in marshy land, with the corresponding figures estimated for fish culture. In addition, the following table shows the respective figures for rice and tea, cash crops which are to a very limited degree grown in the same environment at the moment and can be considered as possible alternatives to fish culture.

Table 29

Comparison of income generating performance of fish culture and alternative marshland crops (ha/y)

	net return	gross return	% commer-cialized	cash return	respective cash returns from 20 family ponds	respective cash returns from two cooperative ponds
fish culture	41 700	112 500	40	45 000	-	-
sweet potatoes	28 500*	58 500	10	5 850	11 250	15 000
cassava	3 700*	28 700	6	1 722	6 750	9 000
maize	- *	8 560	9	770.4	10 125	13 500
beans	1 000*	16 000	12	1 920	13 500	18 000
rice	2 160*	42 160	80	33 728	90 000	120 000
tea	- *	31 670	100	31 670	112 500	150 000

Source: IBRD 1977 and own estimates

* gross return minus labour inputs valued at Rw.F. 100/m/day

As inputs subtracted from the gross return in order to arrive at the net return are almost entirely non-wage labour, i.e. non-monetary inputs, net returns indicate mainly the profitability of the different operations. For an indication of the total potential income the gross return is significant; for an indication of the probable cash-income the value of the average percentage of the production marketed respectively projected:

to be marketed (for fish) should be consulted. What percentage of the yearly fish production will be marketed by the farmer or the cooperative is difficult to project, therefore different degrees of commercialization are assumed, corresponding with the respective percentage of the alternative crop.

By allowing the farmer's family to eat 50 g of fresh fish twice a week, the yearly consumption per family would be 26 kg, leaving about 65 percent of the assumed production from a 500 m^2 pond to be marketed. If each family member consumed 50 g of fresh fish (or its processed equivalent) five times a week (per caput yearly consumption of 13 kg/y), still 15 percent of the total production could be marketed. Assuming a medium degree of commercialization of 40 percent, a 500 m^2 pond, covering 5 percent of an average farm would yield a cash income of Rw.F. 2 250, using about 4 percent of the available labour.

4.7 Cash flow of the two assumed production units over 25 years

For the calculation of the cash flow the cost for pond construction can also be estimated, although the non-monetary nature of inputs and the only partly monetary nature of output limits its significance. Here again labour, which is the only significant input, will be valued according to its opportunity cost, i.e. Rw.F. 100/man/day. For a rough estimate of the labour effort needed for pond construction, 20 man/days to build 100 m^2 of pond with a medium depth of 1 m is assumed, plus 10 percent (2 man/days) for feeder canals. According to this estimate a hectare of fish pond would cost approximately Rw.F. 220 000 (Rw.F. 11 000/500 m^2, Rw.F. 110 000/5 000 m^2), which corresponds with pond construction costs in similar areas of Central Africa.

Table 30
Cash Flow of Rural Fish Culture Over 25 Years
(Rw.F)

	500 m^2 pond			5 000 m^2 pond		
	benefits	costs	cash flow	benefits	costs	cash flow
1st. year	2 812.5	12 550	- 9 737.5	37 500	133 500	- 96 000
2nd.-25th year	5 625	3 100	2 525	75 000	47 000	28 000

The cash flow analysis shows an Internal Rate of Return of 25.8% for a family unit and 29.1% for the 5 000 m^2 unit. The initial investment for pond construction would be recuperated within the fifth year of production.

5. SOCIAL FEASIBILITY ANALYSIS

5.1 Introduction

If, for the farm-level financial analysis, we have emphasized the abstract nature of projected cost-beneftis, assumed opportunity costs and the resulting conclusions, the following assessement of selected variables which determine the socio-economic and socio-cultural context into which fish culture is envisaged to be introduced, has to be considered similarly theoretical, as the author was not able to conduct a field level survey or an extensive socio-cultural study on rural Rwanda. The variables discussed here have been deducted from the few available studies and from personal communications with persons familiar with local rural dynamics. Before discussing selected variables which will be relevant to the development of fish culture in Rwanda, some general remarks on the present rural structure are useful.

The central constraint to a dynamic rural development is the discrepancy between an increasing population and finite land resources. The population growth rate over the last 10 years is estimated at 3.8 percent/annum, including immigration (0.4 percent). The total population in 1978 was 4.8 million, of which more than 95 percent live in the rural areas. The overall population density is 182 persons/km^2, making Rwanda the mos densely populated country in Africa. The total population is envisaged to have doubled by the end of the century (Rwanda, 1980). In 1970, 5 percent of the economically active population were engaged in wage labour. Between 1970 and 1976 the Ministry of Planning estimated 43 000 newly created jobs, while 258 000 new job seekers were believed to have entered the market (IBRD, 1977).

Against this population explosion the land resource base of 2 559 500 h is poor. Of the total surface, 50 percent were available, 30 percent unavailable and 20 percent unsuited for agriculture in 1970 (Delepierre and Prefol, 1972).

The absolute poverty level is estimated, per caput, at U.S.$ 65/year for the rural and U.S.$ 120/year for the urban population. An estimated 60 percent of the urban and 30 percent of the rural inhabitants receive an income below this level (IBRD, 1977).

Socio-culturally Rwanda is a relatively homogeneous conglomerate with about 90 percent of the people being of Bantu origin, about 9 percent Nilotic origin and less than 1 percent Pygmies, all speaking one language, Kiniarwanda.

5.2 Summary and Conclusions

On the basis of the background information used for this report, the innovation or upgrading of fish culture in Rwanda will not face any significant socio-economic and socio-cultural constraints. Rural fish culture, designed as an appropriate technology, using mainly local resources and operating on a technological level within reach of traditional farming populations, does not require major cognitive efforts. The existing socio-economy, i.e. land ownership pattern, social organization and the present mode of production, will not be altered. Fish culture can, socio-culturally, be integrated within the organization of production on the family level; socio-economically it does not require structural change on the farm level, except an insignificant shift in labour allocation.

Its impact will aim primarily at improving nutrition, incomes and general wellbeing of the families involved. It will not require nor promote structural change above the farm level unless, as a technological means to intensify production, it remains accessible only to a few farmers, thus polarizing income distribution. The degree diffusion of fish culture in the rural milieu will determine the quantity of its impact and the degree to which it can be assimilated into existing structure will determine the rôle it may take in the overall integrated development.

Although fish culture development will require considerable promotion and assistance from outside initially, in order to activate the innovative potential of farmers, their active participation and self-determination must be sought from the beginning in order to make fish farming an integral element of their productive and social organization. To focus innovative efforts on existing organizations (as the government induced settlements) or to encourage groups of farmers to form self-help orientated aquaculture interest groups is therefore desirable.

5.3 Socio-economic and Socio-cultural Aspects

The social structure of a rural society is to be seen, basically, as the organizational reflection of the production structure under which the goods and material values necessary for the subsistence of the producers are generated. Any change in the production structure of a social entity will change its social organization, while social change may alter the organization of production. To estimate the quality and quantity of socio-economic change into which the introduction of improved fish culture techniques may result, the existing social, cultural and economic organization must be examined, in order to assess the possible impact of the intervention.

5.3.1 Present land ownership patterns

In 1975, a total of about 830 000 farms with a statistical mean land holding of about 1 ha (0.91 ha in 1979) existed in Rwanda. Broken down by geographic locations, this statistical average converts into more differentiated land holding sizes:

Table.31
Areas of Family Farms by Prefecture

Prefecture	Family Farm (ares)	15% marginal error	
Butare	78.4	66.6	90.2
Byumba	83.8	71.2	96.4
Cyangugu	101.8	86.5	117.1
Gikongoro	99.3	84.4	114.2
Gisenyi	79.5	67.6	91.4
Gitarama	98.7	83.9	113.5
Kibungo	210.3	178.8	241.8
Kibuye	102.0	86.7	117.3
Kigali	135.0	114.8	155.3
Ruhengeri	115.0	97.8	132.3
Rwanda	103.6	88.1	119.1

Source: IBRD, 197[illegible]

A study undertaken in the Byumba Prefecture in 1973 (IBRD, 1977) identified three strata of farm sizes:

(i) 36% of the farms have less than 80 ares (half the average);

(ii) 35% of the farms have between 80 and 160 ares (between half the average and the average);

(iii) 29% of the farms have more than 160 ares (the average) and the largest are five times the size of the average.

The study also showed a fragmentation of the farm into an average of five fields, some of which were within 15 to 30 minutes walking distance from the homestead.

Farmers have a habitual rather than a legally defined right to land use. Legally all land belongs to the government and transfers of land use rights or allocation of newly cultivated land have to be approved by the Burgomaster of the respective commune. In some areas a trend to buy land-use rights has been reported in recent years. Mainly financially better-off farmers, usually the ones who grow mainly cash crops, thus gain control of seven or more hectares and employ the former cultivators on a full-time wage labour basis.

With respect to fish culture development, the present land ownership structure is not expected to be altered nor does it need to be. On a long-term basis and if fish culture generates a large cash surplus for some industrious farmers, this could, however, accelerate the above mentioned trend of land alienation.

5.3.2 Organizational structures

Agricultural production has been traditionally and still is based on the nucleus family. The nucleus family comprises the farmer, his wife (or wives, for the once widespread, but lately diminishing practice of polygamy), and their unmarried children. It may also include unmarried brothers or sisters and the old. The nucleus family produces for subsistence and the market, forming an ideally self-sufficient and independent production unit. Inheritance is patrilinear, i.e., the father will pass on house, land, tools, etc. to his sons. In the case that the land is not sufficient, he has to claim new land for them by bringing it under cultivation. The role of larger kinship organizations patrilineages which formerly had a strong influence in land allocation, has been increasingly taken over by the administration (communes), which now has to approve any land transfer.

Kinship and neighbourhood ties within a locality, based on mutual assistance and communal organization of public works and social functions, have remained relatively intact. Within the family the farm labour is divided along sex lines, with banana cultivation, cash crop production and animal husbandry, as well as tasks requiring physical strength being done by the men and foodcrop production being done by women. The World Bank quantified the system of division of labour as shown in the following table, stressing, however: 'that in practice there is no such thing as a homogeneous farm but merely a series of overlapping sub-systems (IBRD, 1977).

A case study on the division of labour in the Byumba Prefecture produced the following break-down.

Table 32

Division of Labour

	Relative importance (total %)	Division between men	women
a) Domestic activities	15.5	10	90
b) Processing activities	5.1	5	95
c) Marketing (markets)	1.2	51	49
d) Handicrafts	1.7	1	99
e) Animal husbandry	10.7	44	56
f) Food crops	34.5	21	79
g) Banana plantation	0.7	93	7
h) Coffee trees (some 200)	23.0	30	70
i) Outside work	7.6	66	34
Total (all work)	100.0	27	73
Sub total (f+g+h)	58.2	25	75

The Bank remarks further that:

'Even if the work force is provided primarily by the family, the extent to which outside labour is obtained in the traditional form of mutual aid or on a wage-paying basis is by no means negligible (at Byumba 33 percent of families avail themselves of outside workers, averaging 34 days per production unit per annum), especially at the time of the principal bottleneck in the agricultural year, i.e., at plowing time in the main growing season September-October. Mutual aid is practised both amongst relatives and amongst neighbours.

A proportion of working hours, which may be substantial on some farms, is set aside for non-agricultural activities like handicrafts and trading (IBRD, 1977).

Delepierre (1978) classified the activities of an average family as follows:

1. Non-productive activities:

   (i) regular or cyclic; eating meals, religious or administrative activities, rest, personal care, entertainment;

   (ii) chance events; illness and transport of the sick, voyages.

2. Housework:

   (i) kitchen work, fetching wood and water, care of children, making the fire, cleaning house;

   (ii) doing hair, repair or making of clothes.

3. Work that is supplementary to farming:

   (i) livestock production activities including beekeeping;

   (ii) anti-erosive measures, manure production, woodlot planting and maintenance;

   (iii) building and maintenance of housing.

4. Post-harvest work on farm crops:

   (i) marketing, buying and selling;

   (ii) beer making (banana and sorghum);

   (iii) milling manioc or sorghum.

5 Farm work by crop and activity

6. Off-farm work for pay
   Crafts, work on other farms, building work, etc.

7. Off-farm work unpaid
   Collaborative work for the commune (umuganda)

According to the same author, the following time (in hours) was allocated to the different activities per week:

Table 33
Allocation of time per week

	non-productive work	House-work	Annex to farm	Post harvest work	Exterior paid	Exterior not paid	Agric.	Total	Agriculture, house, and exterior
Household head	32.1	2.6	10.5	3.2	10.2	3.3	21.5	83.3	48.7
Wife of household head	26.8	16.7	1.7	4.2	1.4	1.0	31.5	83.2	54.8
Son	38.3	5.6	16.8	1.8	11.4	2.1	6.8	82.9	44.5
Daughter	31.0	17.5	2.3	3.3	3.6	1.7	23.8	83.2	52.2
	128.2	42.4	31.3	12.5	26.6	8.1	83.6	332.6	200.2

On the basis of the existing information on the production structures it appears that the present socio-economic organization of the family farm and its setting into kinship and administration structures will not be affected significantly by the innovation or reactivation of fish culture in the rural milieu. The social organization of the family does not have to be altered in order to include fish farming in the production pattern. Only the structure of labour inputs will be changed to a limited extent, as time has to be allocated to construct and operate the fish pond Pond construction and management can be integrated into the existing system of division of labour, with the men doing the earth work, which requires a large amount of physical effort, and the women doing daily maintenance work, composting, feeding, etc. Harvest and post-harvest activities will probably be carried out by both men and women, as it is presently done for other crops.

For the collective undertaking of fish farming, within the framework of the government settlement schemes (paysannats) for example considerable organizational efforts will be required. Although mutual aid is common among farmers and one day per week is usually spent doing communal work, collectively planned, implemented and operated fish culture production represents a new concept of production. The priorities of the local administration attaches to it, the qualities of the extension service and above all, the innovation potential of the farmers will determine whether such an approach can be carried through successfully. However, in order to promote a self-supporting organizational context of aquaculture development, the formation of groups or collectives should be encouraged.

5.3.3 Land use pattern, leadership and decision making

The present land use pattern in rural Rwanda is, apart from ecological parameters (soil quality, altitude, rainfall, etc.), determined by a number of socio-economically and socio-culturally based variables, as:

(i) Diversification of production

To cultivate a variety of food crops and to achieve self-sufficiency is seen as a risk-minimizing strategy by the farmer. In case one crop fails, the subsistence of the family can be maintained by other crops with similar nutritive value.

(ii) Traditional influence from superstructural power groups

Formerly a feudal elite, the cattle-herding Tutsi, ruled, for example, that bottom land was not to be cultivated so that it could be used as grazing grounds for cattle. At present the government exercises direct influence on farmers to increase cash crop production. In the government organized settlement schemes, farmers are obliged to produce a certain quota of cash crops, otherwise their land-use right is threatened.

(iii) Status

As an inheritage from feudal times, the possession of cattle is still regarded as the highest status symbol. Although cattle yields little economical return, it is used as dowry, giving status to both donor and recipient, when exchanged. Banana and sorghum beer also serve as an exchange equivalent within social relationships; it is also used to compensate ex-farm labour inputs. By expanding his banana plantation a farmer thus increases his social status. According to its high exchange value, rural people grossly overestimate the nutritional value of beer, as shown by Bayon (1980).

(iv) Tradition

Traditionally farming people, the majority of the farmers are reluctant to adapt production concepts alien to agriculture. Production orientated animal husbandry, for example, plays only a very minor role in rural production, because regular feeding of livestock was never practised on the traditional

farm. According to the survey of Bayon (1980) a considerable number of his respondents believed that fish, kept in a pond, do not need alimentation or subsist on soil or water. Another example is the practice of confining chickens to a cage during the sorghum harvest, to keep them from feeding on the grains. Being given no other food many chickens starve to death during this time.

(v) Leadeship and decision making

No pronounced internal leadership pattern exists in the rural society on a meta-family level. Patrilinearly organized kinship groups had, and to a lesser degree, still have, influence only on land allocation and were the taxable entity during the feudal times. At present, and in line with the atomistic settlement structure, only one external authority, the Government, and its administrative bodies, exercise leadership above the family level. Within the family the farm head, usually the (male) farmer is formally in command, followed by his son. His wife, however, is rather autonomous in the spheres dominated by her, e.g., food crop production and the household. A farmer would have to ask his wife's permission before taking food from the household storage. In the absence of detailed studies on the present decision-making process, it may be assumed, therefore, that the farmer decides on farm affairs, but that the wife influences his decision considerably.

With respect to the development of fish farming, the aspects described above allow the following assumptions:

- fish farming may be regarded postively as a further diversification of production by the farmer. Also the study of Bayon (1980) indicates a high degree of interest in fish farming among his respondents;
- initially, at least, fish farming should be actively promoted by the local governmental authorities;
- fish may acquire an acknowledged non-monetary exchange value, with a crop from one family pond being partly distributed among neighbours, and reverse;

- farm management practice should be promoted, at least initially, with emphasis on fertilization rather than on feeding, keeping close to known farming practices;

- promotion of fish farming and extension work should be directed toward both the farmer and his wife.

5.3.4 Motivation and mobility

The basis of a farmer's decision to engage himself and his family in fish farming may be formed by primary and secondary motivations. The primary motivation may include the expectation that fish farming will diversify his production further; that he achieves a higher degree of self-sufficiency; that the nutritional standard of his family is raised; that his monetary income is raised, and that his social status is heightened if he can give fish to his neighbours, etc. The intensity of primary motivation to produce fish will be determined by the value which is commonly attached to fish as a produce. In the survey conducted by Bayon (1980) in four communes, his respondents gave as the principal reason for their interest in fish culture the nutritive value of fish, i.e., they were interested to grow fish for home consumption. Income creation, by selling fish, was rated as secondary. Fish was, according to the survey, thought of as having about the same nutritive value as red meat. The principal reasons for not eating fish were stated as non-availability and high prices.

The same survey indicated the possible secondary motivation of farmers to culture fish. After the nutritive value, i.e. their interest in auto-consumption and income creation, they stated that they would undertake fish farming as a result of promotional efforts and extension work expecting, in return, a positive sanction in the form of extension service and assistance in management and procurement of inputs from the promoting agency.

Bayon's survey indicated a considerable degree of occupational mobility among his respondents with regard to fish farming. His sample was, however, geographically limited. To what extent the innovative potential and the occupational mobility of farmers in other areas can be reinforced and directed toward fish farming will depend upon the performance of fish culture extension and support from Government bodies. Initially successful on-the-spot demonstration in the field and on selecte selected fish farms will be crucial for its diffusion within rural Rwanda

5.3.5 Determination of the socio-economic impact of fish culture development

During the initial phase of fish culture development, only a small group of farmers will be affected, because infrastructural support will be limited at that stage, requiring time to be formed and developed. Nevertheless, the initial 'target group' of farmers, their selection and the approach employed to extend assistance to them, will determine the future impact of the development effort.

The identification of the individual farmer to be approached should involve the following criteria:

- whether the environmental conditions necessary for fish culture exist on the land he cultivates;
- whether his personal drive and interest is sufficient to engage himself, his family and, for pond construction, relatives and neighbors, in taking up fish culture successfully;
- whether his geographical position and social status justifies the aspiration that his fish pond can serve as an on-the-spot demonstration, convincing as many people as possible of the worthiness of fish farming.

A carefully selected target group in the initial phase of development will be the most relevant premises for further diffusion of the technological concept, as initial and demonstrated success of such 'progressive key farmers' in the rural milieu will be the best means to convince others of the worthiness of fish-farming. Other measures can be product promotion by Government bodies, extension agents and media, media coverage in general, inclusion of fish culture related courses in the curriculae of educational institutions, etc. The degree of success to which such strategies can be employed will determine the quantity of the impact of fish culture development in Rwanda.

The quality, socially and culturally, of change which can be expected as a result of the development, can be assessed here only in the broadest sense. Being closer to farming than to animal husbandry, fish culture will not bring forward a considerable difference in the existing behaviour and value patterns. Neither will it require a significant change of organizational and production structures. Depending on the extent to which they participate, it may better the rôle and status of rural women in the country. If not extended to a sufficient number of farmers, it may, however, alter the structure of income distribution by the rural milieu by increasing considerably the income and monetary potential of the farmers engaging in it successfully.

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ANNEX I

Diet Formula for Fish Farming in Rwanda

A. Diets with 25% Protein (quantity of ingredients in kg)

Ingredients	No. of Formula													
	25-1	25-10	25-10A	25-12	25-12A	25-13	25-13A	25-14	25-15	25-15A	25-16	25-16A	25-17	25-17A
Groundnut cake	48	30	30	80	-	20	20	-	-	-	-	-	-	-
Rice bran	50	40	40	18.5	80	60.5	60.5	-	-	-	-	-	-	-
Limestone	1.5	1.5	1.5	1	1	1	1	-	-	-	-	-	-	-
Vitamin premix[1/]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bewery waste, dry	-	28	-	-	-	9	-	-	-	-	9	-	20	-
Bewery waste, wet	-	-	80	-	-	-	37	-	-	-	-	36	-	81
Blood, fresh	-	-	-	-	83	-	40	-	-	86	-	40	-	-
Blood meal	-	-	-	-	-	9	-	-	19	-	9	-	-	-
Soyabean cake	-	-	-	-	-	-	-	46	-	-	20	20	38	38
Maize bran	-	-	-	-	-	-	-	52	79	79	60	60	40	40
Bone meal	-	-	-	-	-	-	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5

/CONTINUED

ANNEX I (continued)

Diet Formula for Fish Farming in Rwanda

B. Diets with 30% Protein (quantity of ingredients in kg)

Ingredients	No. of Formula													
	30-1	30-10	30-10A	30-11	30-11A	30-12	30-12A	30-13	30-14	30-14A	30-15	30-15A	30-16	30-16A
Groundnut cake	65	47.5	47.5	18	18	37.5	37.5	-	-	-	-	-	-	-
Rice bran	33	22.5	22.5	58	58	43	43	-	-	-	-	-	-	-
Limestone	1.5	1.5	1.5	1.5	1.5	1	1	-	-	-	-	-	-	-
Vitamin premix 1/	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Brewery waste, dry	-	28	-	-	-	9	-	-	-	-	9	-	20	-
Brewery waste, wet	-	-	80	-	-	-	37	-	-	-	-	36	-	61
Blood, fresh	-	-	-	-	81	-	40	-	-	86	-	40	-	-
Blood meal	-	-	-	18	-	9	-	-	19	-	9	-	-	-
Soyabean cake	-	-	-	-	-	-	-	62	17	17	36	36	54	54
Maize bran	-	-	-	-	-	-	-	36	62	62	44	44	24	24
Bone meal	-	-	-	-	-	-	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5

1/ It is doubtful wether the use of 'premix', a prefabricated mixture of vitamins, is feasable for rural fish farmers, it's use should, therefore, be considered optional

Source: K.W. Chow (personal communication, 1980)

Annex F

ENVIRONMENTAL ASSESSMENT

OF

RWANDA FISH CULTURE PROJECT 696 0112

Prepared for

UNITED STATES OF AMERICA
AGENCY FOR INTERNATIONAL DEVELOPMENT

by

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Indefinite Quantity Contract No. AID/SOD/PDC C 0232

Scope of the Environmental Assessment

Rwanda Fish Culture (696-0112)

Scoping Statement

The data for the proposed assessment will be collected from literature, by interviews with knowledgeable experts, field visits, and analysis of data collected during the field visits.

Great importance will be attached to the opinions of officials and experts working for the Government of Rwanda and medical institutions. Extensive visits will be made to the pond sites to collect data to be included in the assessment. Village chiefs, local people and officials will be consulted. Relevant data from ponds in operation will be used to help assess the environmental impacts of proposed project.

The EA will generally describe the present health conditions in operational ponds and will address and consider the following topics:

- any adverse environmental effects which cannot be avoided should the proposal be implemented.
- alternatives to the proposed action.
- the relationship between local short-term uses and the enhancement of long-term productivity.
- any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Specifically, the EA will focus on the environmental impacts listed below, which were considered to be the most significant and recommend actions for mitigation of their adverse effects.

It will identify more environmentally acceptable alternatives. Discussion of these and other topics will also ensure that present environmental and cultural values will be given appropriate consideration in decision-making along with economic and technical considerations.

1. Collect and organize detailed data on water-borne disease vectors and habitats. Of special importance are schistosomiasis, malaria dengue/hemorrhagic fever and other communicable diseases.

2. Assess potential health hazards associated with occasional drainage of the ponds and the use of animal manure or plant materials as fish food.

3. Assess GOR institutional capabilities in public health and communicable disease control.

4. Assess potential preventative measures to prevent or mitigate disease problems associated with local fish ponds.

5. Make recommendations on how any deleterious environmental effects of the project can be eliminated or mitigated.

Five to six weeks will be required to complete the EA. A general schedule is proposed as follows:

WEEK 1 : Field trips to collect ecological data from existing ponds and site inspections

WEEK 2 : Gathering of environmental data and review of existing data

WEEK 3-4: Field trips to gather medical information from completed laboratory analyses

WEEK 5 : Rough draft based on local environmental and medical information

WEEK 6 : Complete EA

No significant environmental problems are anticipated that cannot be prevented or minimized to acceptable levels. Fish are currently being cultured in various ponds in the country. The specific issues listed above are considered to represent the primary environmental problems. They will be studied in detail and practical alternatives will be considered.

Approved: Gene Chiavaroli

Gene Chiavaroli, AID Affairs Officer

ENVIRONMENTAL ASSESSMENT OF
RWANDA FISH CULTURE PROJECT 696-0112

SECTION I
Introduction and General Environmental Impacts

1.1 Introduction

The proposed action is a national fish culture program which has as its overall goal an increase in (a) the availability of nutritious food and (b) the income of farm families. It proposes to achieve this goal in a highly efficient way through the introduction and extension of small fishponds (approximately 20 m square and 1 m deep) which rural farm families can easily construct and manage in valleys throughout Rwanda. By the end of the project, (a) an estimated 1,200-1,600 fishponds will be producing approximately 36 metric tons of fish on 600 farms in Rwanda's ten prefectures, and (b) a national extension program will be established to support the development of on-farm fish production throughout Rwanda. The specific purpose of this project is to develop the capacity of Rwandan farmers to build and maintain productive on-farm fishponds. The project is more fully described in the Rwanda Fish Culture Project Implementation Document (PID).

The environment which this project will affect is bottomland with a year-round water supply, usually a small stream. This bottomland was traditionally preserved by pastoralists for grazing. Farmers often grow vegetables on this land by con-

structing long series of raised beds alternating with ditches, both to provide adequate drainage and to preserve moisture during the dry season. Much of it, however, consists of marsh or valley grasses.

The primary objective of this report is to evaluate the impact of the fish culture project on public health. The detailed impacts on human health are described in Section II which is entitled "Relationship of Fish Culture to Schistosomiasis and Malaria in Rwanda". The present section consists of an introduction and discussion of the general environmental impacts.

1.2 Impact on Plans for Land and Resource Use Policies and Controls

The proposed project should have no impact on plans for land and resource use policies and controls. This is because 2,000-3,000 small rural fishponds already exist in Rwanda but are not currently in production. Consequently, the project will involve construction of very few new ponds. Furthermore, land is owned by the government while individuals or families have the right to farm parcels of land. Farms have an average area of one hectare. Small fishponds easily fit within the farm. Additionally, land not farmed and which must be reclaimed from marsh or grassy bottomland, can be allocated to individuals or families by normal administrative processes.

1.3 Impact on Human Environment

The impact of the proposed project on the human environment

is adequately discussed in the Initial Environmental Evaluation (IEE) of the PID with a few exceptions. We have based the following assessments on the discussions in the IEE, but have made additions in several areas. The single outstanding deficiency in the IEE concerns the Public Health aspect of the human environment, and we have discussed this aspect fully in Section II.

1.3.1 Land Use

As described in the introduction, the land this project will use is primarily bottomland with a year-round water supply. Pastoralists traditionally preserved it for grazing, and much of it still consists of sedge marshes or lowland grasses. Since 2-3000 small rural fishponds already exist throughout Rwanda, very few new ponds will be constructed under this project. In those few cases, small units (100 ares) of the above-described land will be converted to ponds. Comparison of resulting fish production with traditional meat production from grazing of cattle, sheep, and goats is viewed as highly favorable for fish production (see study by U. W. Schmidt). Although the sedges from the marshes are used in basket-making, apparently a very small percentage of sedge marsh area is utilized for this activity, and the marsh area lost to fishponds will not affect basket-making. Conversion of marsh to properly managed fishponds may reduce mosquito habitat and hence the danger from malaria (see Section II).

No factors are involved in the project which will lead to any unusual increase in the population of people or animals in a particular area.

Pond sites are generally in bottomlands, often in narrow valleys between hills. In the construction of a few new fishponds, ground cover removed may consist of marsh or valley grasses or some cultivated land. Disturbance of the soil during construction might cause some loss of fertility, but, in turn, the accumulation of silt and residues from fish culture usually results in increased fertility. Feeding fish and fertilizing ponds will also increase soil fertility because many nutrients become bound up in the pond mud.

The training and technical services provided under the project will have no direct impacts on land use. Facilities for the ten fish production centers for the most part already exist. Any additional land required for renovation or construction will be designated by the GOR Ministry of Agriculture so as to avoid productive, inaccessible or unsuitable sites.

1.3.2 Water Quality

Impounding water and enriching it for fish production will probably result in reduced silt loads, but also in increased temperatures and nutrient levels. Downstream water flow patterns may also be altered slightly. Overall, the negative impact in terms of total runoff will be slight. Stream flows appear to be ample year-round; a reduced silt load will, if anything, improve

the water quality. Unless excessive (an unlikely event), increased temperatures and plant nutrient load will generally enhance fish productivity in receiving waters. Furthermore, many areas where ponds will be built are currently farmed in such a way as to retain the water and impede runoff (see 1.1 Introduction) so that any temperature or stream flow impact will be indistinguishable from the results of farms, and any increase in plant nutrients should be beneficial.

There is some danger that dams will wash out during heavy runoff, but the capacity of any one pond is small enough so that the normal drainage system should handle it. Proper construction, using mainstream diversion, should make the danger very low. The potential sites for pond construction are dispersed enough in the countryside so that no significant impact on groundwater tables is foreseen as a result of seepage.

1.3.3 Atmospheric

During the construction activities there will be short-term environmental impacts from dust and noise. Such impacts are unavoidable. As most of the construction has already been completed and because any additional construction and renovation will be very small-scale and labor-intensive over a short time frame, these impacts will be marginal.

1.3.4 Natural Resources

Although the use of ponds will involve some diversion of water, the amount of water required is minimal because a "closed

system" approach will be used. This means that, after initially filling a pond (which can be coordinated with water availability), water will be diverted to the pond only occasionally to replace water lost through evaporation and a small amount of seepage. This may not even be necessary during rainy periods.

Although presence of fishponds will not foreclose certain other agricultural uses, for example, it is a reversible process because pond areas can be returned to crop land.

Use of existing fishponds or construction of new ones may result in a change of wildlife habitat by clearing brush or slowing streamflow periodically, but generally the area of impact is so small that negligible losses or climatic alterations are involved. Since many ponds have been or will be constructed in cultivated land where wildlife habitat is changing, additional impact by ponds should be negligible. No rare species should be endangered as could happen with huge reservoir construction. Ponds do serve as new habitats for ducks and migratory water fowl and a variety of other small wildlife. The location of large game in Rwanda (elephants, lions, gorillas, buffalo) is restricted to the Kagera and Volcanos National Park.

Widespread development of fish farming will probably result in the moving of fish seed of different species around the country and the possible accidental seeding of natural waters. To the extent that the culture is with the native species, however, this should present little problem. In the case of fish

culture in Rwanda, it is proposed to farm with indigenous "cichlids" or with species, such as Serotherodon nilotica, already widely introduced in Rwandan waters.

1.3.5 Cultural and Socio-economic

A complete socio-economic and cultural analysis of the impact of the fish culture project in Rwanda has been completed by U. W. Schmidt of the Aquaculture Development and Coordination Programme, Fisheries Department, FAO, Rome. This report entitled "The Economic and Social Feasibility of Small-Scale Rural Fish Culture Development in Rwanda" was published by FAO in Rome. A copy is available from AID in Kigali, Rwanda.

1.3.6 Health

Water-related diseases include schistosomiasis (bilharzia malaria, Dengue/hemorrhagic fever, onchocerciasis, cholera, and typhoid. Control of cholera and typhoid is principally a question of sanitation and not particularly dependent on the presence or absence of ponds. Onchocerciasis is transmitted by simulid vectors whose larvae require rapidly flowing water. The disease is, therefore, not associated with fishponds. Dengue/hemorrhagic fever, fortunately, does not occur in Rwanda (personal communication from Dr. Molubu, Director of the Expanded Program for Vaccination, Ministry of Public Health, Rwanda). Furthermore, it is transmitted by culicid vectors which can be controlled in the same fashion as those of malaria.

Diseases which construction of fishponds may impact unfavorably are schistosomiasis and malaria. Section II, "Relationship of Fish Culture to Schistosomiasis and Malaria in Rwanda", discusses in detail the potential impacts and possible mitigation and alternative actions, and presents appropriate recommendations to decision-makers.

1.4. Alternatives to Proposed Action

Alternatives to the proposed action may be of two types. Alternative action in regard to fish culture, including the alternative of "no action", are adequately discussed in Section II. Alternative action to achieve the overall project goal, an increase in (a) the availability of nutritious food and (b) the incomes of farm families, could include such alternatives as poultry or rabbit production, introduction of improved crop varieties, or improvement of marketing procedures. However, consideration of such alternatives was taken up in earlier stages of project development and is not discussed here.

1.5. Unavoidable Adverse Environmental Impacts

The only significant adverse environmental impacts the proposed project presents are health-related and these impacts can be avoided. They are adequately discussed in Section II.

1.6. Trade-offs Between Short-term Environmental Gains and Long-term Losses

The proposed project presents no significant long-term environmental losses except those associated with the potential

impact on health and such impacts can be prevented, as discussed in Section II.

1.7. Irreversible or Irretrievable Commitment of Natural or Cultural Resources

The proposed action involves no irreversible or irretrievable commitment of natural or cultural resources. The fishponds can at any time be drained and filled and the land returned to agricultural or other uses. The training and technical services provided under the project will have no direct impacts on land use (see Section 1.3.1) or cultural resources (see sections 1.3.1 and 1.3.5).

1.8. Amelioration of Adverse Environmental Effect by Other USAID or LCD Activity

Health care activities of the GOR will offset any adverse effect on human health due to the Rwanda Fish Culture project, as discussed in Section II. Other USAID or LCD activities are likely to influence or be influenced by the fish culture project, but there are no significant adverse environmental effects other than those related to public health.

1.9. Recommendations

Recommendations to decision-makers resulting from this environmental assessment are presented in Section II.

SECTION II
Relationship of Fish Culture to Schistosomiasis and Malaria in Rwanda

1. Introduction

The purpose of this report is to assess the impact of a national fish culture program on the public health environment in Rwanda. The overall goal of the fish culture project is an increase in (a) the availability of nutritious food and (b) the income of farm families. Its specific purpose is to develop the capacity of Rwandan farmers to build and maintain productive on-farm fishponds. The project is more fully described in the accompanying environmental assessment and in the PID.

Water-related diseases include schistosomiasis (bilharzia), malaria, Dengue/hemorrhagic fever, onchocerciasis, cholera and typhoid. In addition, a variety of parasites have eggs or cysts which readily survive aquatic conditions. Control of such parasites and also of cholera and typhoid is principally a question of sanitation and not particularly dependent on the presence or absence of ponds. Onchocerciasis is transmitted by simulid vectors whose larvae require rapidly flowing water. The disease is, therefore, not associated with fishponds. Dengue/hemorrhagic fever is transmitted by culicid vectors which can be controlled in the same fashion as those of malaria. Fortunately, Dengue/hemorrhagic fever does not occur in Rwanda (personal communication from Dr. Moluba, Director of the Expanded Program for Vaccination, Ministry of Public Health, Rwanda; 1979 Annual Report of the Ministry of Public Health, Republic of Rwanda). The remaining two diseases, schistosomiasis and malaria, may receive impact from implementation of the fish culture project.

This report includes, in Part 2, a brief description of the life cycles of schistosome and malaria organisms as they relate to humans. It presents an

evaluation, in Part 3, of the influence of fish culture on incidence in human populations of these two diseases, and, in Part 4, an evaluation of Rwandan institutional capabilities to treat or prevent the same diseases. In Part 5, it discusses measures to prevent or ameliorate any fish culture influence on disease incidences presented in Part 3. Finally, in Part 5, it presents recommendations appropriate for decision makers regarding the influence of a national fish culture program on public health and includes consideration of the alternatives of (1) no changes in the fish culture project, (2) modifications in the project to prevent or reduce impacts, and (3) cancellation of the project.

2. Life Cycles

2.1. Schistosomiasis

Schistosomiasis is caused by a trematode parasite, a blood fluke, with a complex life cycle requiring both a definitive and an intermediate host. It matures in the definitive host, which may be man or a wide variety of other mammals, and eggs are passed in the feces or the urine. The eggs hatch in water as a free swimming cilliate larva called a miracidium. These miracidia must find an aquatic snail of appropriate species within about 32 hours, or they will die. Each penetrates its snail intermediate host and reproduces asexually to produce 100,000 to 200,000 cercariae, beginning in about 1 month and continuing for a period of several months. These cercariae escape their snail host as free swimming flagellate larvae. Cercariae approach suitable mammalian hosts in the water, attach by means of suckers and enter by dissolving a hole in host tissue with enzymes. They survive no more than 48 hours if they find no host. Each cercaria migrates through the blood system of its new host to the walls of the colon, of the urinary bladder or of the small intestine, depending on the schistosome species, where it matures and where

it must pair with another of opposite sex to produce viable eggs.

Because of the variety of mammalian species besides man which can also serve as definitive hosts, it is not usually possible to reduce the danger of this disease in an area by treating infected humans or by improved sanitation. It is also not usually possible to eliminate other mammalian hosts since these usually include domestic livestock. It is furthermore very difficult to restrict such wild animals as small rodents from bodies of water even with such controlled access as man-made fishponds. The most effective means of controlling a reservoir of schistosomiasis has been to eliminate the snail intermediate hosts.

2.2. Malaria

Malaria is caused by a sporozoan parasite of the genus Plasmodium, including 7 different species and a variety of strains. In this case, man is the intermediate host, in which only asexual reproduction occurs, and female mosquitoes, of the genus Anopheles, are the definitive hosts where sexual reproduction takes place. When a female mosquito bites an infected human, micro- and macro-gametocytes invade the mosquito, combine to form a zygote, then reproduce, forming sporozoites, which migrate to various tissues of the mosquito, including the salivary glands. The mosquito is infective 10 to 20 days after it has ingested human blood. When an infective mosquito bites a human, sporozoites from its salivary glands enter the human blood stream, invade liver and other similar cells and reproduce asexually, after which the cells rupture, releasing 10-20 tiny merozoites. These merozoites invade either additional liver-like cells or red blood cells. There then follow series of asexual reproductions, cells bursting, and reinvasions, often periodically and corresponding to periodic appearances of malarial symptoms. The human is infective to mosquitoes in 10-30 days. Malaria can be controlled in an area by drug

treatment of a large percentage of the human population or by a large-scale campaign to eliminate the mosquito vector, often by eliminating or altering its aquatic habitat. An integrated combination of both approaches is often most effective.

2.3. Epidemiology

With any parasite which requires two alternate hosts, it is possible to eliminate the disease by reducing or dispersing the populations of one host. It is not necessary to totally eliminate a vector host. If the vector organism has either a very low population or is very dispersed, then the probability that a human (or other mammal in the case of schistosomiasis) will be exposed to an infected vector is very low. The probability is also very low that a vector organism will be exposed to an infected human. But to maintain the parasitic cycle, a human who has been exposed to an infected vector must be the same human to whom another vector organism is later exposed. If both probabilities are very low, their joint probability becomes negligible. The parasitic cycle becomes broken and the disease incidence actually decreases as infected humans are treated or as infected vectors die. Thus, a potential health danger in the case of such parasites does not lie with the presence of vector organisms, but with concentrations of such organisms. Any attempt to control snail or mosquito populations need not be 100% effective in order to prevent schistosomiasis or malaria.

3. Influence of Fish Culture on Human Disease Incidence

3.1. Incidence in Human Populations

Table 1 indicates the number of cases of schistosomiasis and of malaria, and their incidences per 1,000 population, per prefecture throughout Rwanda in 1979 (from 1979 Annual Report, Ministry of Public Health, Republic of Rwanda). The data in parentheses for schistosomiasis in Ruhengeri and Byumba

prefectures, however, represent a new outbreak in 1980 (Mr. Jules Hanotiez, Head of Anti-bilharzia Mission of Rwanda, personal communication).

Table 1

Number of cases and incidence per 1,000 population per prefecture in Rwanda in 1979 (1980).

Prefecture	Schistosomiasis Cases	Schistosomiasis Incidence	Malaria Cases	Malaria Incidence
Kigali	0	0	14,805	20.6
Gitarama	0	0	19,997	32.3
Butare	0	0	31,092	50.3
Gikongoro	3	0.01	6,536	17.2
Cyangugu	165	0.48	15,040	44.2
Kibuye	0	0	11,167	32.2
Gisenyi	0	0	4,082	8.5
Ruhengeri	(300+)	(0.55+)	2,375	4.3
Byumba	(±100)	(±0.18)	7,198	13.2
Kibungo	0	0	24,755	66.7

3.1.1. Schistosomiasis

Although the incidence of schistosomiasis appears very low or zero throughout the nation, the number of cases in Ruhengeri prefecture increased from zero to over 300 during 1980 alone. Mr. Jules Hanotiez, a public health officer in Rwanda for 20 years, suggests (personal communication) that this sudden increase in schistosomiasis incidence in Ruhengeri is primarily due to two factors. The first factor is that farmers have begun draining and cultivating the papyrus swamps surrounding the two large lakes in Ruhengeri prefecture only recently, during the last two or three years. This activity may increase the farmers' exposure to the disease since a potential intermediate host, snails of the genus *Biomphalaria*, abound in the papyrus swamps.

The second factor is that public health clinicians in Ruhengeri prefecture apparently did not recognize schistosome eggs in routine fecal examinations before 1980. Rwandan and French medical doctors began to recognize symptoms of schistosomiasis in patients during early 1980, and subsequent careful fecal examinations, including supervision by Mr. Hanotiez, revealed the number of cases reported in Table 1. These facts suggest that the outbreak was not as sudden as the data in Table 1 indicate. The fact that symptoms were not recognized until early 1980, however, suggests that the outbreak is recent, probably corresponding with draining and cultivating of papyrus swamps. Hanotiez suggests that failure of clinicians to recognize schistosome eggs is not due to lack of training, but because such eggs so rarely occur in fecal examinations in Rwanda that they simply are not recognized. He also feels that clinician ability throughout the country to recognize schistosome eggs will be fully adequate within two years and probably within one year.

We may draw the following conclusions from the above discussion.

(1) The statistical evidence of schistosomiasis is slightly low except in the three foci reported in Table 1.

(2) The incidence of schistosomiasis throughout the country is likely to increase very slightly as clinician ability to detect schistosome eggs becomes fully adequate.

(3) The incidence of schistosomiasis is likely to increase markedly in additional foci around the country as farmers make more use of swampy areas, especially papyrus swamps, increasing their exposure.

3.1.2. Malaria

The incidence of malaria appears moderate but constant throughout the nation (see Table 1). It is highest in the prefectures containing lower elevations; Kibuye, Butare and Cyangugu, and lowest in prefectures with the highest elevations; Ruhengeri, Gisenyi and Byumba. Clinical diagnosis of malaria is an important part of clinician training in Rwanda (Dr. Moluba and

Dr. A. Mugobushaka, Director of Health Services, personal communications), and clinicians have frequent experience with it throughout the country. It is possible, however, that some rural people fail to recognize malarial symptoms and fail to report them. It is very probable that the malarial data reported in Table 1 closely parallel the true incidences in the Rwandan population, though they may slightly underestimate them. The incidence of malaria has increased steadily since 1974 (1979 Annual Report, Ministry of Public Health, Republic of Rwanda). This increase is apparently due, at least in part, to improved diagnosis and reporting of malaria during this period and also in part to increased awareness of the disease among rural people. It is probable that the incidences reported in Table 1 for malaria will continue to increase slightly in the near future.

3.2. Examination of Existing Fishponds

We examined existing fishponds in 8 of Rwanda's 10 prefectures. We captured snails and examined them for schistosome infections, and we searched for the presence of mosquito larvae. We recorded snail species and density, fish species and density when known, vegetation conditions and the results of snail examinations and mosquito searches. The results are summarized in Table 2.

Table 2

Results of examination of 8 sets of prefectural fishponds for snails (schistosoma) and mosquito larvae in Rwanda, 1980

Ponds Sampled Location	S	T	Vegetation Conditions Marginal	Aquatic	Fish Species	D	Snails Species	D	S	P/S	Schist.type	P/P	Mosquito larvae
Kigali	1		excessive	2		low	Biomphalaria	low	10	0/10	–	0/10	none observ.
							Bulinus 1	mod	6	0/6	–	1/6	
							Bulinus 2	high	9	0/9	–	2/9	
Gitarama	4	16	excessive	moderate 3 (algae water lilies)	T.mecrochir T.zillii	mod	Biomphalaria	mod	10	2/10	reptilian	8/10	none observed
							Lymnaea	low	8	0/8	–	8/8	
							Bulinus 1	mod	10	6/10	reptilian	10/10	
Gikongoro	4		excessive	2		mod	Biomphalaria	high	11	0/11	–	0/11	none observed
							Lymnaea	high	9	0/9	–	3/9	
Kigenbe (Butare)	4		excessive	1 none	T.nilotica T.zillii	high	Biomphalaria	mod	15	4/15	avian	14/15	none observed
							Lymnaea	mod	12	0/12	–	9/12	
Ruhengeri	3		very little	0 little algae	Tilapia	low	Lymnaea	v.low	3	0/3	–	1/3	none observed
Gisenyi	3	3	excessive	2 mod.algae	Tilapia mix	mod	Biomphalaria	low	17	0/17	–	0/17	none observed
							Lymnaea	mod	20	0/20	–	20/20	
							Bulinus 1	low	10	1/12	avian	8/10	
Gatsibo (Byumba)	4	8	excessive	moderate (emergent. carex) 3	none	–	Biophalaria	low	10	0/10	–	5/10	very abundant
							Lymnaea	high	5	0/5	–	1/5	
							Bulinus 1	low	5	0/5	–	0/5	
Rusumo (Kibungo)	5	15	excessive	excessive algae, some emergent	mixed Tilapia of Lac Nasho	low	Lymnaea	low	10	0/10	–	10/10	none observed
							Bulinus	low	10	0/10	–	10/10	

S = number sampled
T = total number
D = density

P/S = proportion of snails with schistosomes
P/P = proportion of snails with parasites

Addition of fish of almost any species can be expected to reduce mosquito larval populations greatly. We can expect addition of fish, combined with the removal of marginal and aquatic vegetation, to lower snail populations greatly and reduce mosquito larval populations to near zero. However, we must emphasize that during examination of sets of fishponds in 8 of Rwanda's 10 prefectures, in only one set of ponds was the vegetation along the pond margins carefully trimmed away.

Addition of compost and animal manures to increase the food supply for the fish should increase the biological productivity of a pond and, therefore, increase the growth rates of both snails and mosquitoes. With such increased growth rates, control of these disease vectors by adding fish and removing vegetation must be less effective. Although some such control of snails and mosquito larvae must remain, this degree of control may be offset by increased exposure of the farmers who manage the ponds to the two diseases. Furthermore, since domestic mammals can serve as determinant schistosome hosts, addition of animal manures to fishponds can result in the addition of schistosome eggs and miracidia, an increased infection rate of snail intermediate hosts, and an increased danger of schistosome infection to humans.

We draw the following conclusions regarding the impact of fish culture on human incidence of schistosomiasis and malaria in Rwanda.

(1) Although fishponds appear largely or entirely free of mammalian schistosomes at present, the recent outbreak in Ruhengeri prefecture suggests that similar outbreaks may occur in other parts of the country and fishponds can become infested with schistosomes in the future through exposure to infected humans.

(2) Since malaria is widespread and moderately common among humans in Rwanda, fishponds have the potential at any time of parti-

We point out the following observations from Table 2:

(1) Although we frequently found snails of the genrea Biomphalaria and Bulinus, both potential intermediate hosts for schistosome, and although we found some cases of reptilian and avian schistosomes, we found no schistosomes capable of infecting man.

(2) In the single set of ponds in which vegetation was kept carefully trimmed around pond peripheries and was carefully removed from the water itself, in the presence of fish, we found virtually no snails (only 1 found in 3 ponds of about 10 ares each).

(3) Snail density does not appear to be related in any way to fish density.

(4) In all ponds with fish, we observed no mosquito larvae, while in the single set of ponds without fish, mosquito larvae were very abundant.

An additional observation not reported in Table 2 is that in new ponds the proportion of snails with schistosomes and with parasites of any kind is very low or zero compared with ponds which have held water for one year or more.

We conclude, with respect to the specific ponds examined, that (1) eliminating marginal and aquatic vegetation is effective in controlling snails, and that (2) presence of fish, irrespective of species or density, is effective in controlling mosquito larvae.

3.3. Expected Impact Effect of Fish Culture on Snail and Mosquito Populations

In the absence of fish and without removal of marginal and aquatic vegetation, fishponds should provide ideal habitat for high population levels of both snails and mosquito larvae, and, therefore, excellent foci for both schistosomiasis and malaria in areas where these diseases already occur.

Table 3, we summarize, per prefecture, the number of hospitals and beds, the number of health centers and beds, and the number of dispensaries and beds. In addition, we indicate the mean human population served per bed of all types combined (from 1979 Annual Report, Ministry of Public Health, Republic of Rwanda). The national average population served per bed of all types is 615 persons.

In Table 4, we indicate, per prefecture, the number of medical doctors, the number of paramedics, the number of nurses of all types, and the number of other medical personnel. Finally, we indicate the mean population served by each medically trained person, including doctors, paramedics and nurses, but excluding "other personnel" (from 1979 Annual Report). The national average population served, per medically trained person, is 5,401 persons per person.

Personnel of dispensaries and health centers are given training in recognizing symptoms of schistosomiasis and malaria, and personnel of health centers are given training in the clinical diagnosis of these two diseases (Dr. Mugubushaka, personal communication). Please refer to section 3.1.1. and 3.1.2. for discussions of present and future clinician ability to detect these two diseases.

Every health center and every dispensary in the nation, as well as every hospital, has a supply of the medicines used in the drug treatment of both schistosomiasis and malaria (Dr. Mugubushaka, personal communication). These medicines are apparently kept up-to-date and the supply replenished when necessary.

We conclude that Rwandan institutional capability to treat schistosomiasis is, at least potentially, fully adequate for the incidences of the disease we discuss in section 3.1.1. Capability to treat malaria also

cipating in the malarial parasite cycle.

(3) The presence of fish in ponds and the removal of marginal and aquatic vegetation should provide sufficient protection against both schistosomiasis and malaria and may even decrease the danger from these diseases from existing ponds neglected many years.

(4) Farmers may or may not keep marginal vegetation adequately trimmed.

(5) Addition of compost and manures to fishponds to provide increased fish production may also produce a danger of infection to humans, especially of schistosomiasis, because of increased populations of snails and mosquito larvae.

4. Rwandan Institutional Capabilities to Treat or Prevent Diseases

4.1. Treatment

In terms of statistical reporting, the Rwandan Ministry of Public Health is organized in a hierarchial fashion (Dr. Moluba, personal communication). Local dispensaries and health centers each send reports of every public health action to the hospital in its particular region and to the Ministry headquarters office in Kigali. Each hospital also sends reports of all public health actions to Kigali. There are one to several hospitals in each prefecture and several health centers and several to many dispensaries in the region of each hospital. Health centers are essentially miniature hospitals with clinical diagnosis capability and maternity wards. There is usually a doctor or paramedic in residence, or one may visit regularly from a nearby hospital. A dispensary contains drugs for outpatient treatment and first aid and has capability of referral to a health center or hospital. In

Table 4

Prefecture	Population	Doctors	Paramedics	Nurses (all types)	Other Personnel	Average population served per med.personnel
Kigali	717,500	42	52	241	161	2,142
Gitarama	619,500	8	19	69	69	6,453
Butare	617,900	37	44	142	117	2,771
Gikongoro	380,200	3	7	26	29	10,561
Cyangugu	340,600	9	13	42	46	5,322
Kibuye	347,100	9	10	67	58	4,036
Gisenyi	481,900	9	31	50	31	5,354
Ruhengeri	543,400	11	27	53	45	5,971
Byumba	544,700	10	25	43	23	6,983
Kibungo	371,000	11	26	47	47	4,417

Table 3

Prefecture	Population	Hospitals (beds) public	Hospitals (beds) private	Centres de Sante (beds) public	Centres de Sante (beds) private	Dispensaries (beds) public	Dispensaries (beds) private	Average population served per bed (all types)
Kigali	717,500	1 (445)	1 (105)	8 (202)	7 (91)	21 (329)	13 (149)	543
Gitarama	619,500	0	2 (465)	10 (212)	3 (15)	17 (391)	9 (69)	538
Butare	617,900	2 (586)	0	5 (92)	10 (267)	17 (149)	15 (382)	419
Gikongoro	380,200	0	1 (156)	2 (16)	6 (209)	5 (49)	7 (237)	570
Cyangugu	340,600	1 (139)	2 (414)	1 (11)	4 (14)	11 (33)	6 (14)	545
Kibuye	347,100	1 (131)	2 (236)	0	6 (165)	3 (40)	11 (106)	512
Gisenyi	481,900	2 (250)	1 (101)	5 (118)	4 (183)	11 (143)	8 (232)	469
Ruhengeri	543,400	1 (322)	1 (96)	0	6 (26)	11 (126)	8 (125)	782
Byumba	544,700	1 (89)	1 (48)	2 (47)	1 (34)	18 (178)	6 (43)	1,241
Kibungo	371,000	2 (306)	2 (161)	2 (28)	2 (34)	12 (134)	4 (40)	528

appears adequate, yet incidence of malaria in Rwanda does not decrease. Apparently, awareness of the disease and the habit of reporting its symptoms to medical personnel lag several years behind the clinical capability to detect and treat it. Implementation of a fish culture program should not adversely affect Rwandan capabilities to detect and treat these two diseases.

4.2. Prevention

Prevention of schistosomiasis is best achieved by elimination of its snail intermediate host, while prevention of malaria is best accomplished by a combination of control of the mosquito vector and drug treatment of a large proportion of the exposed human population. At present, in Rwanda, there are no programs for either snail or mosquito control. Furthermore, administration of anti-malarial drugs is at the level of treatment of those cases detected and not at the epidemiological level needed to interrupt the vector/human transmission cycle.

It is very probable that programs for large-scale prevention of these diseases, especially malaria, will be initiated by the Rwandan Ministry of Public Health in the future. It is imperative that a national fish culture project be implemented in such a fashion that it will not interfere with any such prevention programs. Such precaution is best achieved by assuring that snail and mosquito populations are adequately controlled in the fishponds.

5. Mitigation Measures of Fish Culture Impact on Disease

Potential adverse health impacts of the fish culture project are participation of fishponds in human/vector parasite cycles of schistosomiasis and malaria. Large and concentrated populations of snail vectors of schistosomiasis and of mosquito vectors of malaria can result from allowing vege-

tation to grow untrimmed around and within ponds and addition of compost and manures. The problems to be solved become twofold: (1) removal of vegetation, and (2) removal of snails. If vegetation is removed, mosquito larvae will be removed adequately by the fish.

5.1. Removal of Vegetation

Removal of unwanted vegetation can be chemical, mechanical or biological. The objective is that no vasculor plants grow in or extend into the water. A variety of herbicides are available commercially for control of vegetation. Chemical control has two disadvantages in fish culture ponds, however. One is that toxic chemicals may transfer to either the fish in culture or the farmers or other humans who eat the fish, and may cause physiological harm. The second is that use of such chemicals may also destroy phytoplankton or other plants which the fish must use for food. We do not recommend the use of chemical control of vegetation in fish culture ponds.

Mechanical control of vegetation, in terms of small rural fishponds, means cutting it with a machete or other hand tool, or pulling it by hand. According to our observations of 8 sets of prefectural fishponds in Rwanda (refer to section 3.2.), this form of mechanical control can be fully adequate. The same observations also suggest that such control is rarely carried out in practice.

Biological control of the vegetation may involve herbivorous animals which eat the vegetation, diseases or parasites which weaken or destroy specific vegetational species, or other plant species which eliminate undesireable vegetation through some means of competition. The competition alternative would not eliminate all vascular plants, since the winning species would remain. The method is, therefore, not adequate for fish culture ponds.

The disease or parasite alternative would be very complex, may require a different control organism for each species of plant, and would almost certainly require extensive preliminary research. An example of the herbivorous animal alternative which has proven effective in fish culture is the inclusion in the pond of macrophytophagous fish which eat the vegetation and are cultured in the pond for human consumption as well. Table 5 is a list of macrophytophagous fish species which have been cultivated in ponds for human consumption.

Table 5

Some Macrophytophagous Fish Species Used in Fish Culture

Species	Endemic System	In Rwanda	Authority
Tilapia marial	Niger delta	no	Ruwet, et.al. 1976
Tilapia rendalli	Katanga-Zambia	no	"
Tilapia zillii	W.,N.,Cen.Africa	yes	"
Tilapia tholloni	Zaire	no	"
Tilapia guineensis	Ivory Coast	no	"
Ctenopharyngodon idellus	China	no	Bardach,et.al. 1972
Puntius javanicus	Indonesia	no	Coche, 1967

The productivity of most of the species listed in Table 5 is lower than that of some other fish species, notably those that feed on phytoplankton or tiny planktonic plants, the microphytophagous fish. However, many of them have been grown together with another or other species of fish in a polyculture. The result of such polyculture has been both control of vegetation and increased total fish production. In situations where fish farmers do not in practice adequately control the vegetation mechanically, or where they do not wish to do so, then use of macrophytophagous fish species is an

obvious advantage and is an adequate method to control the vegetation. A disadvantage of their use is that polyculture fish culture requires availability of fingerlings of all species included and hence more elaborate support facilities than for monoculture. If this disadvantage is unacceptable, then mechanical control of vegetation can be officially monitored in some fashion to assure its adequacy.

5.2. Removal of Snails

Removal of snails can also be chemical, mechanical or biological. The objective is to reduce snail numbers to such a low concentration that the parasite cycle is broken. At least a dozen different chemical products can be obtained commercially to control snails. Such chemical control has the disadvantage, with fish culture, that toxic chemicals may be transferred to either the fish in the culture or the farmers or other humans who eat the fish, and may cause physiological harm.

Mechanical removal of snails, in small rural fishponds, would entail collecting the snails by hand and disposing of them. The labor required for such collecting would be very time consuming, and the farmers simply might not spend time at such an activity. Furthermore, the snails involved would be very small, often less than one centimeter diameter, and a large percentage may escape detection. It is doubtful that snail numbers could be reduced by this method to concentration low enough to break the parasite cycle.

Biological control of snails may involve animals which eat the snails, diseases or parasites which reduce snail populations, other snail species or other animals which eliminate the snails through some means of competition, or species of plant which produce a substance toxic or repellant to the snails. The toxic or repellant plant alternative has been suggested in northeastern Africa. The competition alternative has proven effective in Puerto Rico, and

the disease or parasite alternative could be very specific to particular snail species without a broad ecological impact. All three alternatives appear promising and potentially effective, but they would all be very complicated for application in widely dispersed rural fishponds and would all require preliminary research. An example of the alternative of animals which eat the snails, that has been discussed by many authors and which has been applied successfully in some cases and not in others, is the inclusion in fishponds of fish species which eat the snails and that can also be consumed by humans. Characteristics which such fish must have include the following:

1. Snails must make up a significant proportion of its diet;
2. It must not exclusively eat snails, for it would starve once the snails in a delimited pond were decimated;
3. It must be cultivable in fishponds;
4. It must be acceptable for human consumption;
5. It must complement, or at least not compete with, other fish species if used in a polyculture;
6. It should be indigenous to or already occur in the watersheds of the region where it is to be cultured.

Table 6 is a list of fish species which may possess these characteristics. A few of these species have been successfully cultured in ponds, including H. mellandi and the three species of Clarias. The other species have not been tested. As with the macrophytophagous fish, these snail-eating fish contribute best in polyculture with at least one other more rapidly growing species. A disadvantage of their use is that polyculture fish culture requires availability of fingerlings of all species cultured, and hence more elaborate support facilities than for mococulture. However, their use should eliminate any increase in snail populations due to addition of compost and manures to increase fish food supply. The increased fish production result-

ing from addition of compost and manures to ponds is so great that it probably justifies the use of snail-eating fish in polyculture.

Table 6

Some snail-eating Fish Species

Species	Endemic System	in Rwanda	Authority
Haplochromis mellandi	Bangwelo-Luapulo	maybe	Coche, 1961
F sauvagei	Lake Victoria	no	Greenwood, 1957
H. prodromus	"	no	"
H. xenognathus	"	no	"
Astatoreochromis alluaudi	"	no	" 1959
Macropleurodus bicolor	"	no	" 1956
Hoplotilapia retrodens	"	no	"
Clarias senegalensis	Senegal-Gambia	maybe	Micha & Frank, 1976
C. massambicus	L.Victoria & Kivu	yes	Hulot, 1950
C. lazera	West Africa	no	Grover, et.al. 1979

6. Recommendations

We recommend that the national fish culture project of Rwanda include provision for eliminating marginal and aquatic vegetation that would otherwise extend into the water. We recommend this control be achieved either by mechanical removal of vegetation by the farmers themselves or by inclusion of a macrophytophagous fish species in polyculture with two other species, one exhibiting high productivity and one which eats snails.

We also recommend that a snail-eating fish species be included with at least one other species. This species should possess the characteristics described in Section 5.2. and may be one of the species listed in Table 6.

We further recommend on-going monitoring of farm ponds throughout the

nation to assure that snail and mosquito larvae populations remain low and that schistosomiasis is not detectable in snails. This monitoring activity should be carried out by person or persons with ability to assess snail and mosquito populations and to recognize and identify schistosome cercarviae from snails. This monitoring activity should be fully effective if it occurs twice a year.

Finally, if mechanical control of vegetation is chosen over biological control, we recommend on-going monitoring of the effectiveness of vegetation control in farm ponds throughout the nation. This monitoring activity could be carried out by such government operatives as extension agents. Such activity should occur at least approximately twice yearly.

These recommendations would require certain modifications in the project as described in the PID. These modifications are described in the following list.

(1) The use of polyculture instead of monoculture of fish. Plans have called for the culture only of Sarotherodon nilotica. We recommend inclusion of a snail-eating species and possibly a macrophytophagous species as well. This modification is not great because the Kigembe fish culture center and other fish culture centers are capable of rearing several species of fingerlings.

(2) The monitoring of snail and mosquito populations and schistosomiasis. This modification will require employment of an additional specialist not more than two months per year and will include the cost of travel, round trip to Rwanda, if the specialist comes from outside the country, and in-country travel and per diem.

(3) The monitoring of vegetation control, if macrophytophagous fish species are not included in a polyculture. This modification will require employment, possibly by the GOR, of appropriate technicians, and in-country travel and per diem.

We feel that the potential adverse impacts of the fish culture project on public health can be eliminated, and we do not recommend cancellation of the project.

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Annex G

Site Visit Notes. Auburn University Team

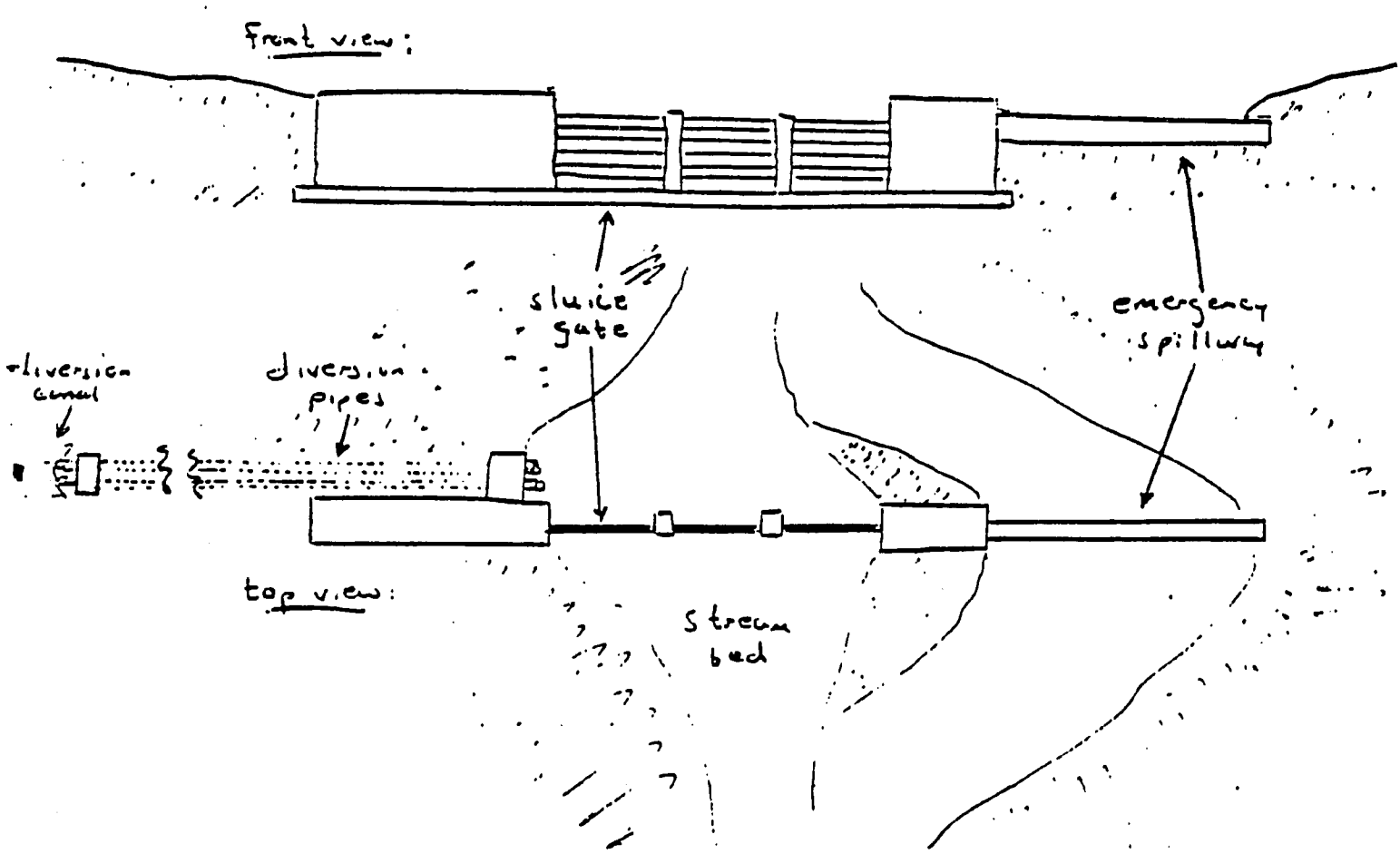
A. Kigembe National Fish Station

The Kigembe Fish Station is located 18 km. south of the city of Butare, in the south central highlands of Rwanda. The station consists of 77 ponds - 32 large porduction ponds and 45 small research and fingerling production ponds - with a total surface area of approximately 2.7 ha. The ponds are fed by two separate inlet canals, diverted from two separate small streams, and a central drainage stream. The ponds possess concrete or stone and mortor water inlet and drainage structures. Three pairs of holding tanks are also located on the station. The station was constructed in 1954, but is still in relatively good, functional condition.

Building facilities on the station consist of 3 residences, a storehouse and a combination office/garage/storeroom. The buildings are still structurally sound but need varying amounts of renovation, such as remortaring in places, repair or replacement of windows, doors or other fixtures, repainting, repair of plumbing, etc.

The proposed AID Fish Culture Extension Project would require renovation of the present station facilities, as well as addition of a few new buildings, in order to proerly use the Kigembe Station as a fingerling production and national fish culture training center. The needed renovation and construction activities are itemized below:

1. Diversion dam. Replace the present wood and earth dam with a stone and mortan structure, with water diverted initially through 50M of 2 10"-12" PVC or concrete pipes. Sluice gates would be incorporated into the dam in order to help regulate the water level. See illustration below.



2. Diversion canals. Clean out weeds and obstructions.

3. Dig out pond bottoms so as to reduce the slope.

4. Remortar monks, inlet structures, and holding tanks, as needed.

5. Repair erosion damage around canals and water inlet and drainage structures.

6. Renovate station buildings.

a. Residence No. 1. - plumbing and miscellaneous repairs
b. Residence No. 2. - renovation of hitchen, bathroom, plumbing and miscellaneous repairs
c. Residence no. 3. - complete renovation - guest house
d. Office/garage/storeroom -enclose the garage and add large garage door; renovate store room into extra office space; miscellaneous repairs
e. Storehouse. - new roof, doors and windows; remortar in places; miscellaneous repairs.

7. Construct new station facilities.

a. Dormitory. Sleeping capacity for 12, with sanitary facilities (see attached diagram).
b. Multipurpose hall. Classroom, dining room and laboratory. (see attached diagram).
c. Kitchen/storeroom.

8. Replace potable water line with new 1 1/2"-2" PVC pipe.

9. Drying floors/work hangar. Two 50m^2 floors, onw with sheet metal roofing, one without.

10. Supply all of the necessary furniture, cooking and eating utensils, office supplies, fish handling equipment, garage tools, construction and carpentry tools, classroom and laboratory materials, vehicle and motorcycle.

Note_ It is felt as unnecessarily expensive to line the canals with concrete, dam the stream at the proposed downstream site, near the bridge, or install a hydroelectric generator.

(These capital costs estimated from preliminary engineering analysis. Assumed that major construction tasks will be contracted out and that A and E expenses were included in the costs provided, and that the GOR will handle the management).

The number and salaries for the GOR supported personnel to operate the Kigembe Station, and the monitors to conduct the extension program in the prefecture will be the following: (100 RwF = $.91).

Description	Number	Rate/Yr	Total
A-1 agent. Chief of station	1	240,000	240,000
A-2 - specialized agent	1	180,000	180,000
Driver/mechanic	1	120,000	120,000
Clerk/typist	1	120,000	120,000

Rigembe Fish Station

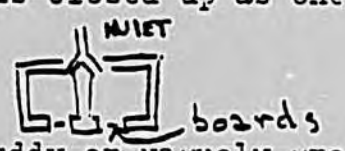
visited 8.7.80 by:
- R. Galbreath
- Adongojoho P.
- Mathias S

- Prefecture of Butare
- 16 km south of Butare
  25 minute drive

- a very large station - up to 10 ha
  32 large ponds (for production)
  45 small ponds - 5m x 15m 3m x 6m
  77 total 10 ha

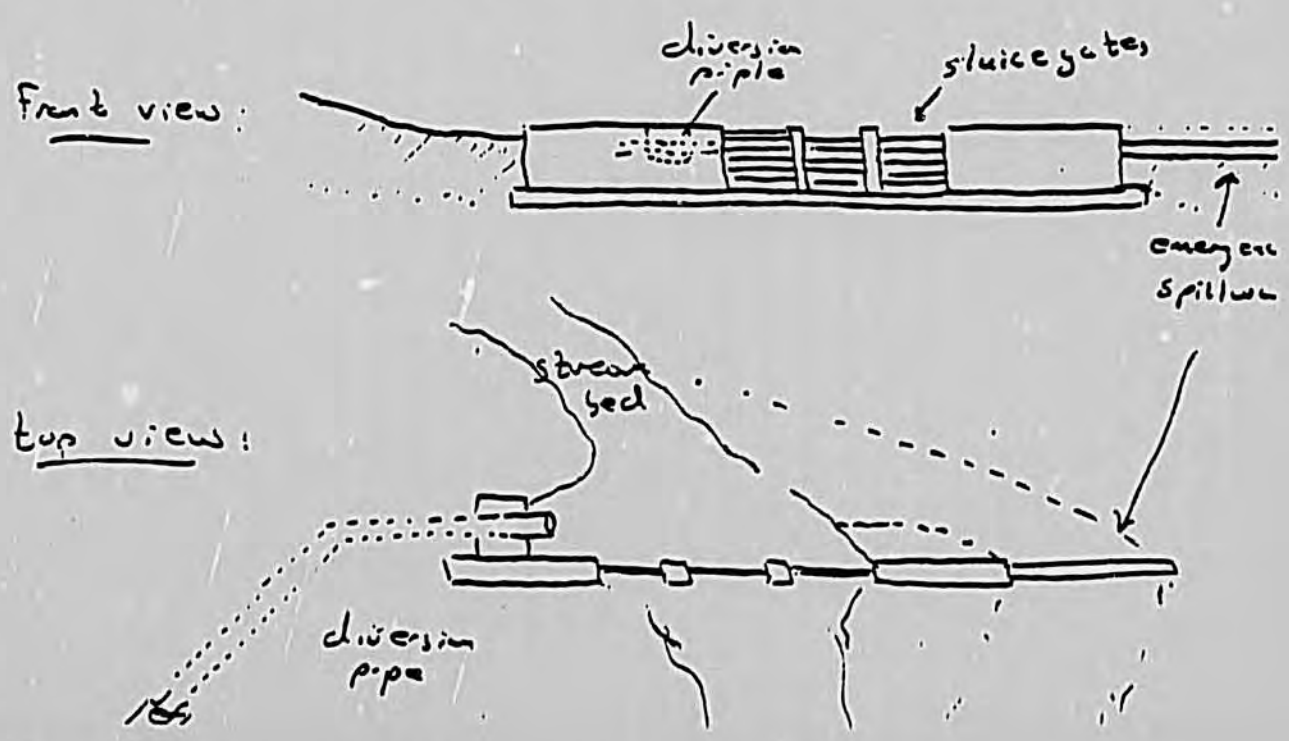
- water inlet structures = brick & mortar structures, with 8" drain pipes (large ponds) and catch bassins in front, and stone & mortar drain bassin behind - for the most part in fairly good repair

- holding tanks - 3 or 4 pair of tanks - 1m:2m:1m per tank; the drain side wall is open, and is closed up as one closes a monk - with flash boards:



- pond water has a clear to a muddy or vaguely green color, some will a reddish algal scum - productivity in the water appears limited

- water sources are diverted from streams about 1 & 0.6 km away - on both sides of the station - canals need cleaning out - also the major source (on the right, side as you look downstream of the central drainage stream) needs a new concrete dam at the point of diversion to replace the wood pole and earth dam that presently exists, but which must be rebuilt with each major dain; propose a stone and mortar dam with 2-3 sluice gates in the middle, and an emergency sillway on the side opposite the canal; the first 50 m of canal should be in cement or PVC pipels) - see illustration below



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- personnel:

  - station director - [illegible] Lawson
    - [illegible] supervisor
    - advisor to [illegible] project
      [illegible] as of Oct. 75 - will leave as of [illegible]
    - chief of station - [illegible] Lesi Mabimbure
      [illegible] agent
    - monitors:
      - [illegible] - [illegible] Greenwood Everiboo
      - [illegible] - [illegible] Mlopinos
    - sentinels - 2
    - laborers - up to 30, but normally only 15 due to non-payment of salaries as of 3-4 months

- water temp. pond surface - 71° - 75°C
  (1.5 km) inlet canals - 67°C

- fish species present
  1. macrochir
  2. melanopleura (rendalli)
  3. milli
  Cyprinus carpio

- Body has had some limited success with natural spawning of C. carpio

- Food stuff, available: (seasonally)
  - sorghum beer wastes - bought from farmers - 300 [illegible]/demi-[illegible] (2.5 [illegible])
  - skins of manioc, yavates, potatoes
  - rice bran - 2 locations - Gyili & [illegible] [illegible]/kg

- present station management is poor to poor; ponds need grass composting; need water level lowered, as well as pond shallow ends dug out; tilapia fry production is going on in small deep ponds - will not be very productive

- equipment & materials at the station are almost non-existent

- Renovation needs:
  - construct diversion dam
  - clean out canals
  - remorter as needed, monks, inlet structures and holding tanks
  - need full complement of tools, materials and equipment
  - renovation of station buildings & construction of new ones
  - need station vehicle - picking truck
  - replace potable water supply line (1.5 km)
  - need to construct a laboratory/classroom
  - need to construct a dormitory/dining hall/kitchen - or renovate [illegible] on to the 3rd residence.

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- [illegible] building :
  - 3 residences - in relatively good shape on regular, but with some minor renovation
  - storehouse - in poor condition - with asbestos roofing and new roofing possibly
  - office/ cafe/ restroom - also needs some renovation
  - one residence in [illegible] to be converted into a dormitory

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3. Prefectural Fish Stations

Small fish stations are located in all of the 10 prefectures in Rwanda. Of these 10, site visits were made to 5 of them - Nyagatare, Gitarama, Gikongoro, Kibungo and Kibuye.
In general, the pond layout at each station was relatively well designed, with the numbers of ponds ranging from 12 to 20, and total water surface area from 1 to 2 ha. Water inlet and drainage structures had been constructed (concrete, or stone and mortar in only 2 of the 5 stations. Holding tanks and a storehouse were each found at only 1 station.

The envisioned use of these prefectural stations as fingerling production and demonstration/training centers would require a moderate amount of renovation and new construction. The following is an itemized list of the activities and their estimated cost for materials (purchased & shipping)

		cost ($)
1.	Purchase of a set of tools, equipment and supplies (see attached list)	2000
2.	cleaning and renovation of water delivery canal system	-
3.	construction of water inlet and drainage structures	2000
4.	construction of a storage house/work area/holding tank facility (see attached diagram)	5000
5.	digging out of pond bottoms to provide less of a slope	-
	total	$9000

The number and salaries for the GoR supported personnel to operate these stations, and monitors to conduct the extension program in the prefecture will be the following: ($1=91.[illegible])

description	number	rate/year (RwF)	total (RwF)
- A-2 specialist	1	100,000	100,000
- monitors	5	48,000	240,000
- laborers	5	18,000	90,000
- guardians	2	18,000	36,000
			546,000 RwF

Operating costs for the station operation and extension work will be partially supplied through the GoR and partially through station receipts from fish sales. Feeds and fertilizers will be purchased from an account established through station receipts from fish sales. GoR will supply as a regular budget item, funds for the purchase of fuel, maintenance costs for the motorcycle, and bicycles, per diem costs for overnight travel and miscellaneous supplies. A breakdown of these costs is as follows:

activity	cost/yr. ($)
1. vehicle operation & maintenance	$[illegible]
2. per diem	$3[illegible]
3. supplies and equipment	$1[illegible]
	$[illegible]

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Prefectural Stations
Development Plan - Equipment List

Each station has its unique needs. Generally the pond layout is adequate but there maybe some need to level pond bottoms, construct drainage ponds, clean out supply or draining canals, etc. Each station should have funds for this work which can be accomplished by a maintenance crew as directed by the prefectural fish specialist using tools provide by the project. A prioritized list of tools follows. Each station also needs some sort of stockpile for these tools and a few holding tanks, depending on the order of the outlined above. It should be remembered that prefectural programs will be started in phases, three in the first year, three in the second year, and presumably an additional four over the next 2 years. Operating budget for station should include enough money to buy miscellaneous lumber, plastic, cement, sharpening stones, etc. A typical station would need about 5 maintenance crew plus security guards and the capacity to hire special casual laborers for major tasks. Sale of fish/fingerlings may be used to offset some of the recurring costs of station operation.

Suggested Equipment needed at each Prefectural Station

Number	Description
2	Wheel barrel, heavy duty 4 ft^3
3	Shovel, long handle pointed
2	Rakes, garden type
2	Hoes, grubbing type
4	Hoes, native style grubbing
3	machete, std.
3	machete, coup-coup curve type or other grass cutting blades
2	Hammer, carpenters curved claw
2	Saw, carpenters hand, 1 rip, 1 X-cut
25 yd^2	Netting, 1/4 " opening synthetic (for making holding nets)
1	Cord/thread, nylon spool (for sewing nets, etc 50 lb test)
2	Dipnets, large - see McGrary's catalogue
2	Dipnets, small aquarium type 3"
1	Scale, spring 20 kg capacity (meric)
3	Buckets, 5 gal heavy duty plastic
4	Washtubs, 4L (about 10 gal capacity)
1	Seine, bar 100 ft x 6 ft, 1/4"bar, Composite mud line
1	Seine, minnow 15ft,1/4"bar
1	Motorcycle, 125cc trail type (for each prefectural fish base-local purchase with payback scheme ?), rack, rider pedals should provide tool kit and tire repair stuff

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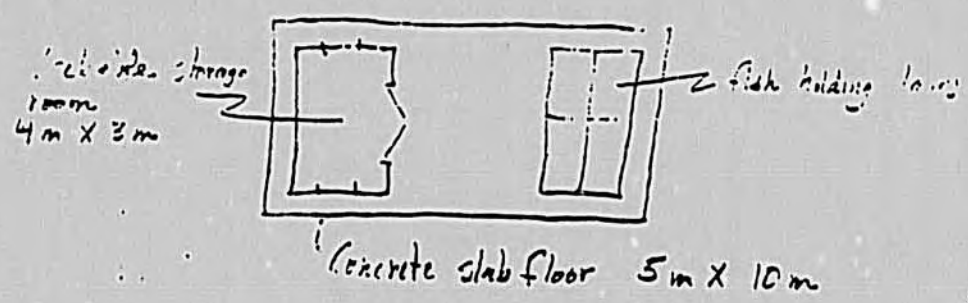
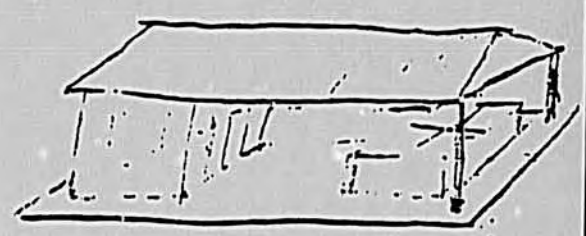
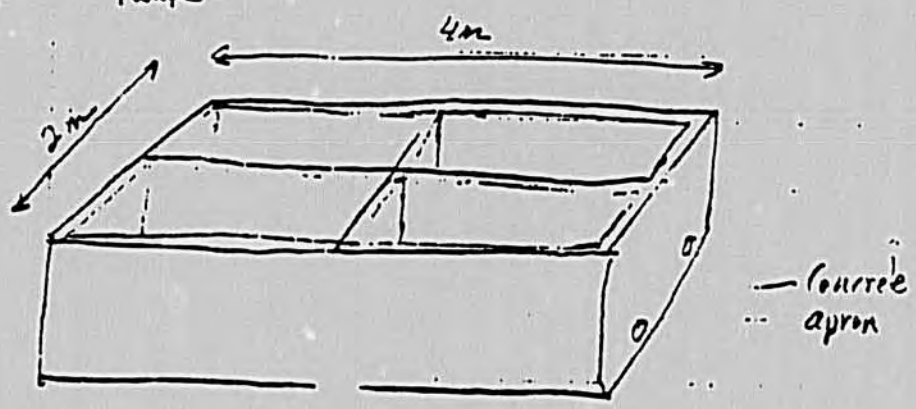
Utility shed/tanks for each prefectural station

Floor plan -

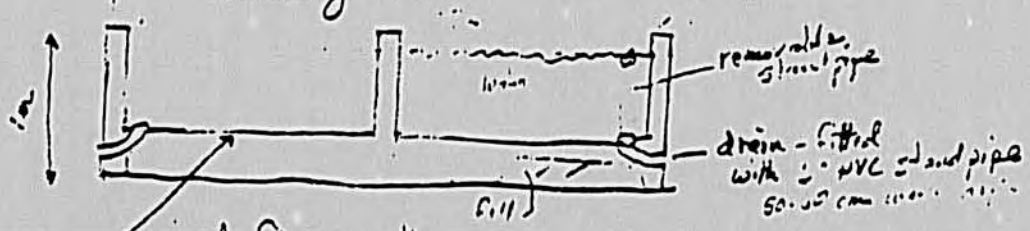




Tanks -



Cutaway view



raised floor with about 3cm slope to drain

(estimated cost $5000)

[illegible] station

- commune of [illegible]

- a simple series of [illegible] ponds
  10 large ponds = [illegible] series = 3 ares each
  [illegible] small ponds = [illegible] series = 1 are each
  total surface area = [illegible].5 ha

- ponds were recently renovated with funds from the [illegible] project
  - moats were constructed

- there is currently a team of [illegible] koreans who have stocked two ponds with grass carp (ctenopharyngodon idella), common carp (cyprinus carpio) and possibly other chinese carps - their plan is to let them mature and try to spawn them for fingerling production.

- a series of other fishes from lakes have also been stocked
  T. nilotica
  T. melanopleura
  T. macrochir
  others

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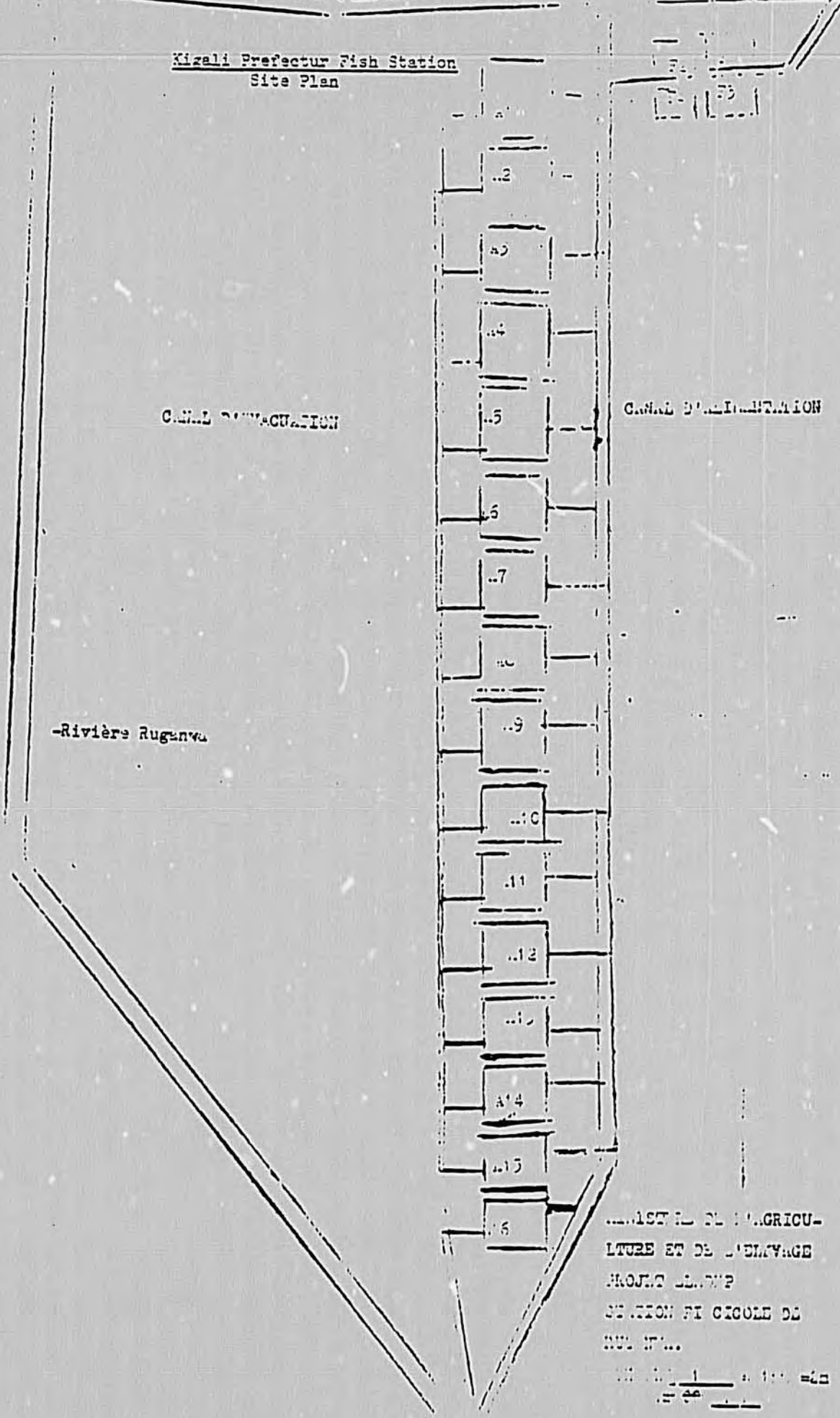
Kizali Prefectur Fish Station
Site Plan



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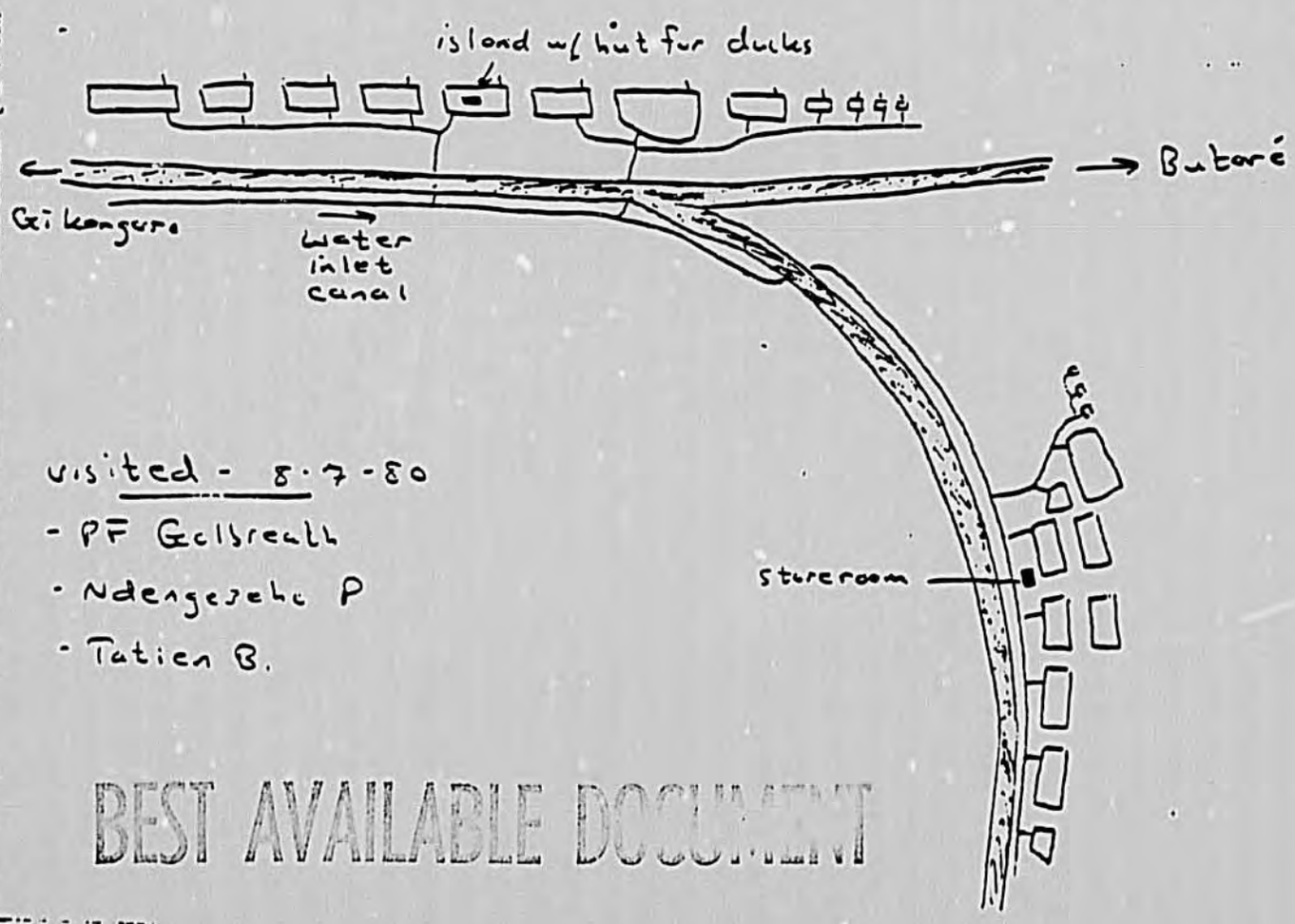
Gikongoro Prefecture Fish Station

- village of Nyamagabe - 5 km from Gikongoro on the road to Butare
- a recently built station (1977) consisting of 24 ponds = 1.9 ha
  large ponds = 17 = 10 - 30 ares each
  small ponds = 7 = 0.3 - 1.0 ares each
- personnel:
  - chef de station - M. Nkurunziza Antoine - A-2 spécialisé
  - sentinels - 2
  - laborers - 12 have not had recent payment problems
  - monitor - M. Malisa François (no special tr.)
- water supply - 2 diverted small streams 2 kms up a small valley
- there are no constructed water inlet or water drainage structures
- Fish species:
  - Tilapia nilotica (majority)
  - Tilapia melanopleura
  - Tilapia macrochir
  - Serranochromis sp.



visited - 8-7-80
- PF Goldsmith
- Ndengeseho P
- Tatien B.

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- <u>Water temp</u> - pond surface = 75° - 76°C
  3:00 pm, inlet canal = 72° C

- <u>Feeding regime</u>:
  - 1 bucket daily of leaves of colocasia and potatoes
  - coffee hulls - available free from waste pile of coffee factory nearby
  - rice bran - limited, seasonal supply

- pond depth = 1m

- pond water was generally a muddy green to light green color - indicating a mild plankton bloom

- management under the A-2 agent is relatively good; there is daily feeding with locally available leaves and organized stocking of some of the ponds

- production averaged 600 kg/ha from the last 3 pond drainings

- there is a small mud-stick storehouse

- the A-2 agent has a Honda 125 trail bike

- there has been a limited amount of extension work done

- <u>renovation needs</u>:
  - inlet and drainage structures
  - storeroom/office
  - holding tanks
  - complete set of tools

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Observations by Mounir Abi Saab

- command in [illegible] and [illegible]

- a recently built (1977) station of 15 ponds running in a double line with a central drainage stream and water inlet canals on either side

- surface area (total) = 0.04 ha
  ponds are [illegible] m x 30 m = 3 ares each

- observed up to 7" [illegible] in the ponds; no evidence of [illegible] mitotica mites

- pond depth = 0.5 -1.0 m

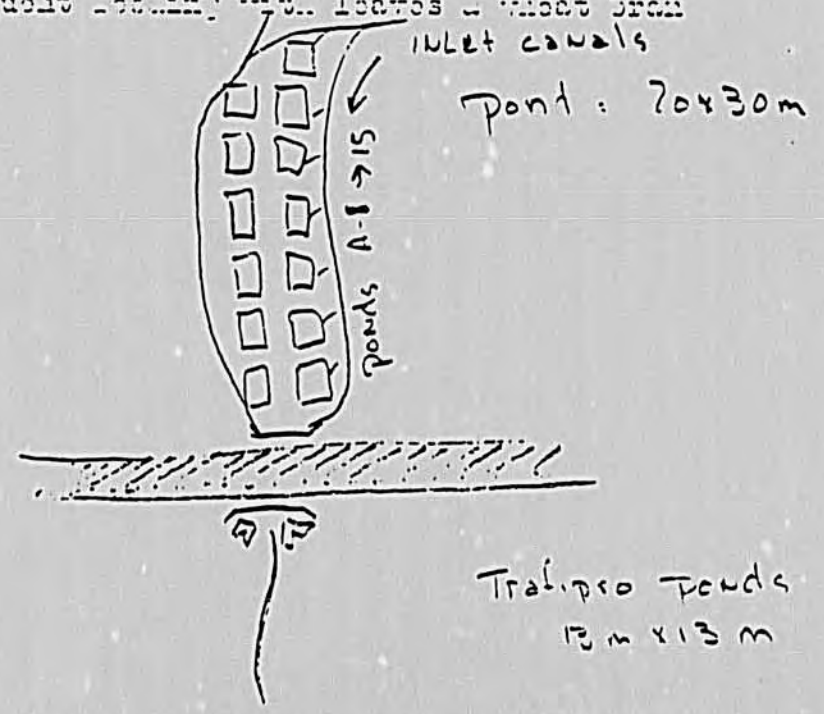
- water temp — ponds (surface) - 69-71°F
  (11 am) inlet canal - 70°F

- personnel
  - laborers - 1
  - responsible for the station = Professional [illegible]

- grass on dikes well cropped

- some water lily overgrowth in 1 pond

- infrequent feeding with leaves & wheat bran



- 3 ponds below station recently renovated by Trafipro - 13 m x 13 m - stocked with 3 buckets of fingerlings (1.[illegible]) from station

- up to 104 private ponds on record in the prefecture

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- [illegible] pond [illegible] in ponds A-15 and [illegible] ponds [illegible] 3

- [illegible] production from one pond of [illegible] average [illegible] pond, plus many [illegible]

<u>Renovation needs</u>:
- ameliorate water canal system
- build water inlet & drainage structures
- build holding ponds
- build tool [illegible]
- need full complement of tools

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Mahuma Fish Station

Visited 7-9-80 by:
- Wadsworth
- Brown
- Lanier
- Martin

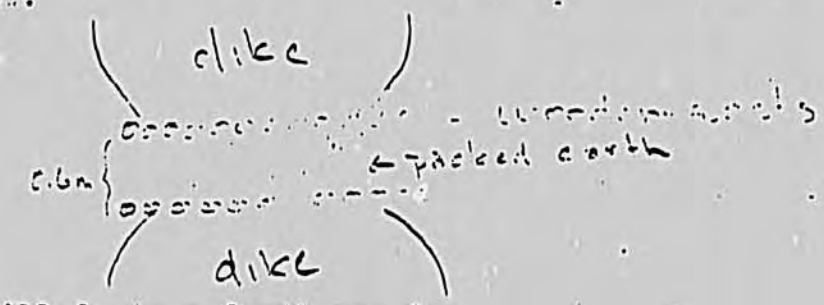
- Irrigation of Mibunjo

- a long, single series of ponds running down the middle of an open narrow valley

- water source is a spring, 50 m from the uppermost pond, that is diverted down one side of the valley by a long canal; the canal is normally 40 cm wide and 40 cm deep (see station plan, attached)

- drainage canal is the ill-defined stream bed; it is grown up in grasses.

- there are no constructed water inlet or drainage structures; water inlet is an open canal that is (un)blocked with dirt; drainage is accomplished by digging out the dike at the pond's low point - there are 2 walls of wooden posts between which the earth is packed in or dug out for filling and draining, as illustrated below:



- all ponds were filled, to a depth ranging from ½ to 1 m

- color of pond water ranged from rather clear to a light muddy color or a vague green; there generally seemed to be a very light plankton bloom

- surface water temp. in ponds = 73° - 78°F
  in inlet canal = 71°F

- ponds were stocked in March 1980 with a variety of lake caught fish:

Tilapia nilotica	Barbus sp
Labeo sp.	but also contains
Schilbedus sp	carassius auratus
	clarius sp.

- Tilapia & clarius were visible in ponds

- soils in the valley are a heavy silty clay - as evidenced by the brickmaking area close by the top pond

- one pond had extensive growth of an aquatic weed and 2 others small amounts

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-station personnel include
- 2 guardians
- 1 parts-gate 50 [illegible]/day
- up to 30 laborers 72 [illegible]/day
(but workers present at station numbered only about 6, due to lack of salary payment for the past 3-4 months)

-the provincial irrigation is responsible for management of the station, but visits very infrequently

-irrigation main:
- dams
- water inlet structures
- clean out drainage canal & inlet canal
- basic station equipment - tools, hoes, etc.
- holding tanks
- portable water basin
- holding cages
- personnel
  - payment of laborers
  - chief of station - A-2 agent

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MINISTERE [illegible] L'AGRICULTURE

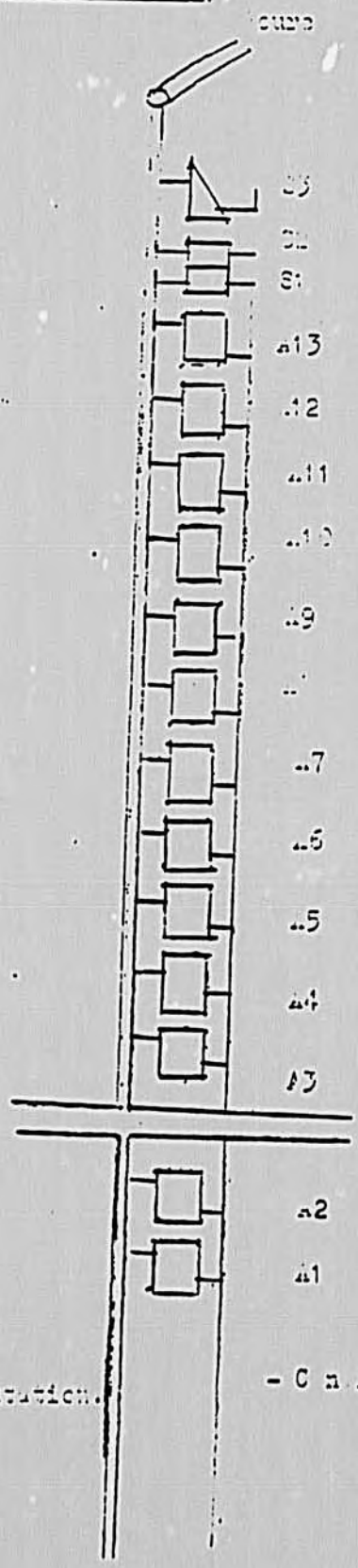
[illegible]

PROJET [illegible]

Projet [illegible] P

SOUS-PROJET PISCICULTURE

6-17



A [illegible] moyenne [illegible] m x 25 m [illegible]

total [illegible] arbres [illegible]

[illegible] 100 m

OHL : 1mm = [illegible] mètres

0 40 80 100 Mètres

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[illegible] [illegible] [illegible] [illegible]

- in the [illegible] of [illegible], 3 km from [illegible] on the road to [illegible] (south)

- the station was originally built in the 1960's, and recently renovated in the mid-1970's

- personnel:
  - [illegible] - [illegible] [illegible]
  - [illegible] - [illegible] [illegible]
    [illegible] specialist
    trained in [illegible] - 1977-78
    " [illegible] - 1978
  - monitors Tilapia
    [illegible] - 1 untrained in fish culture
    [illegible] - 1 " "
  - laborers - [illegible] (?)

- ponds are generally functioning, but in need of additional renovation

- water inlet structures - sluice gates or pipes - need cleaned out and eroded areas along the cement repaired with earth

- monks appear to function, but need to be remortared in placed

- ponds follow the same colonial pattern - very steep bottom slope, such that the very small ponds are almost 1 m deep, and large ponds up to 2 m deep

- the middle large pond was over rom [illegible] with aquatic vegetation

- holding tanks - 2 sets of 4 - the small set are only .4m x .4m but functional; the large set are 1m x 1m x .6m, but inlet pipe is broken - needs (pipe) replaced, and remortared

- inlet canal - small stream diversion [illegible] m above ponds; needs cleaned out, and erosion damage repaired

- no storeroom; a shelter (roof but no walls) has long since collapsed) - there is a coffee huller there, which is functional

- fish stock: T. nilotica
  T. macrochir

- Tilapia nilotica nests were observed in ponds

- fish are apparently present in only small quantities; lack of reproduction has been noted in recent pond breedings - it is suspected that low water temp is primarily responsible - possibly some predation also, by small clarias (?)

- water temp - inlet canal - 23°C ??
  pond outlet - 25°C
  pond shallows - up to 7[illegible]°C

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- pond water was [illegible] clear - [illegible] line = 1 m but [illegible] was being lost due to constant running of water through the ponds

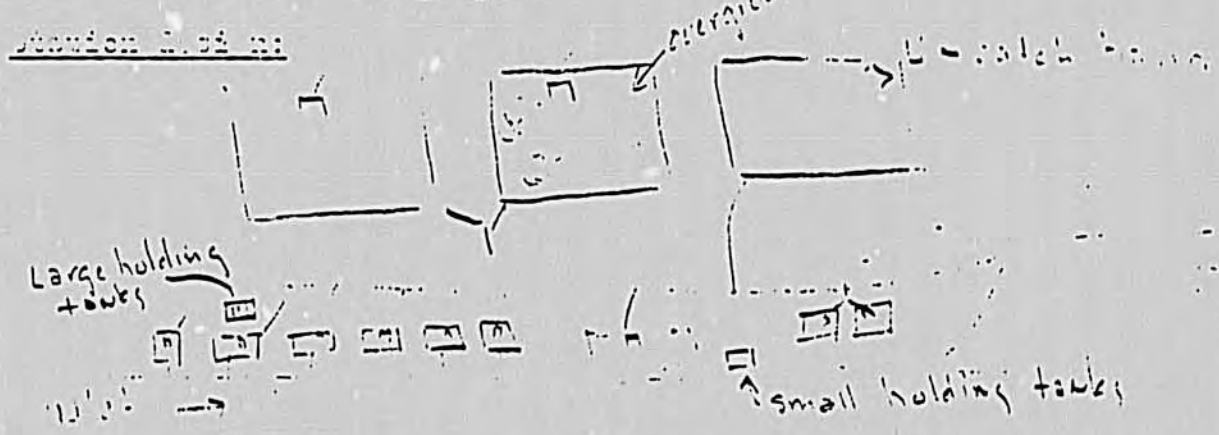
- advised to lower water level - stop water flow

- grass was being cut down to bare earth, so [illegible] presence of snakes

- generally, the station was in moderately poor repair, and management was very bad

- the frequency of Mr. Dzilikhi's visits to the station was hard to tell - but [illegible] after 2 out-of-country training, he understands very little about fish culture, in spite of his [illegible] to talk - talk - a lot of bullshit - to be avoided if possible as an [illegible] for the project ?

- <u>Station layout:</u>



  - small ponds = 9 = 0.5 2 ares each
  - large ponds = 3 = 35-40 m on a side, or about 15 ares each
  - total area

- wheat bran available (±) at [illegible] - 3 km toward Ligali from town, cost 2[illegible]/kg

- whitewash (lime) 40-50 kg for 400 [illegible]

- 134 private ponds recorded in the prefecture, of up to 4 ares each

<u>renovation needs:</u>
- clean out & repair canals
- remortar inlet structures
- remortar monks
- replace inlet system to holding tanks, and remortar
- dig out shallow ends of ponds, so as to give a more gradual slope
- build a storage shed

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[illegible] - [illegible] prefecture

- a barrage pond of 5.5 ha

- has a spillway on one side that is adequate to handle high water flow during the rainy season - made of stone and mortar

- 100 m long

- water temp (surface) = 69°F
  (9 am)

- secchi disc 30 cm

- reservoir water has an opaque greenish color, indicating a relatively rich plankton bloom

- advised to obtain piroques, gill nets & trotlines with which to fish the lake

- need to sample & introduce T. nilotica if not already present

Bisenyi Prefecture Fish Station

- (not visited)

- located in commune de Mayove, on the road between Kahongori and Gisarama

- far inland from lake Kivu

- a moniteur piscicole is stationed there

Gruma Prefecture Fish Station

- (not visited)

- commune de

- actually, is closer to Kigali than Gruma

- 2 ponds of 0.30 ha each

- groupe scolaire School Nyagamanga - pour les femmes
  - train A-2 level agricultural agents
  - 2 ponds of 0.25 ha each

[illegible] equipment for the [illegible] and [illegible]

[illegible] Handling equipment

No.	Item
1	Seine [illegible]' bag with [illegible]" bar and [illegible] lead line
1	mimeo type - 15'
1	Microscope, binocular head, 3-4 place nosepiece with (optional) [illegible] objectives, [illegible] field eye piece, plain stage, mirror illumination, abbe condenser (not [illegible] quality)
1	Microscope, stereoscopic, zoom, (7-30x), [illegible] opaque stage
3	Microscope prepared glass slides 1x3" plain
10	Microscope slide cover lenses
1	Buckets, plastic heavy duty 5 gal
3	[illegible] type [illegible]
3	Dipnets, large with metal frame
3	small quarium type 3"
1	Quinaldine anesthetic 1 liter
300	Cups, plastic heavy 5 gal
1	Netting, 1/4" nylon 300'roll
1	Dark thread, not monofilament, spool
2	Soil auger with extension rods to 15'
3	Screening, plastic coated or vinyl-type 100' rolls

[illegible] equipment

1	Typewriter, manual office with [illegible] keyboard
1	Mimeo graph machine, manual
1	Balance, triple beam ohaus 760 + weight set
12	Dissecting tool, student set
12	Dissecting trays - aluminum, wax filled 8x12"
1	Camera, [illegible], 135mm, case, [illegible] and close up lenses
2	Projector, Kodak Carousel 750 zoom lens case [illegible]
1	Screen projection 50"
2	Pencil sharpener, manual adjustable sizes
30	Reference books (calibrate to provide list)
3	Aquarium, 20 gal glass
50	Bottles, wide mouth museum type
2	Plankton net
1	Surveyors level - rod set, metric
12	Thermometer, pocket, all metal dial 0-100°C
3	Water analysis kit
4	Syringes, graduated plastic 2ml - 100 ml, 2ml - 100 ml
10	Bottles, [illegible]
1	Layer, survey, 30 m (metric)

Supplies for mimeo machine, chalk, [illegible] pencils for [illegible], spare bulbs - trays for projector, stapler, etc.

BEST AVAILABLE DOCUMENT

[illegible] - [illegible], mechanical and carpentry tools for fully stocked

No.	Item
[illegible]	[illegible] barrel, [illegible] heavy duty
1-	Shovel, long handled pointed
[illegible]	Axe, [illegible]
1-	Saw, heavy rubber type
7	Rake, garden
24	machete - or local grass cutting blades
2	lanterns, kerosene with 2 mantels
1	Carpenter hand tool set
1	First aid kit
1	Mechanic tool set - metric sizes
1	Portable sprayer - 12V trickle type (Sec. [illegible])
1	Pump, wire (foot operated type)

-. Vehicles

One each for the two advisors and the Mi [illegible] station - Toyota pick-up or equivalent (local purchase?).
Vehicles equipped with small tool set, emergency wire pump, wire repair kit, first aid kit and fire extinguisher. Also with frame over bed and removable canvas top. Estimated cost-local purchase $14,[illegible]

-. Furniture

Training room will need tables and chairs for 2[illegible] plus return in front. Also lockable cabinets for materials and supplies black-board.

Kitchen facilities will need cooking and serving utensils to accomodate 2[illegible] people.

Dormitory. Bedding, lockable wardrobes, a table [illegible] 2 chairs for each room, fully equipped bathroom - toilets, , sinks

BEST AVAILABLE DOCUMENT

ANNEX H

611 (e) Certification

Rwanda - Fish Culture Project

I, Eugene R. Chiavaroli, the principal officer of the Agency for International Development in Rwanda, taking into account, among other things, the demonstrated capacity and willingness of the Government of Rwanda to provide counterpart funds and support for costs incident to AID financed projects in Rwanda, particularly the Rwanda Agricultural Education Project and the Food Storage and Marketing Project, do hereby certify that, in my judgment, the Government of Rwanda has shown both the financial and human resource capability to effectively maintain and utilize the assistance provided under the Fish Culture Project.

Eugene Chiavaroli

February 5, 1981

ANNEX I

TECHNICAL SERVICES

POSITION DESCRIPTIONS

1. TRAINING ADVISOR/TEAM LEADER

Qualifications: MS Degree with technical competence and experience in tropical fish culture and extension work. French language capability.

Duties: 1. Serve as advisor to the GOR and USAID on matters related to fish culture and fish culture extension programs.

2. Organize and conduct training programs for fish culture extension workers, rural organizations and farmers.

3. Develop appropriate training materials and extension literature for use in both training and extension.

4. Serve as team leader for USAID contract group and provide administrative support and leadership to the project.

Station: Live in Butare and base work at the Kigembe Fish Culture Station.

2. FISH CULTURE EXTENSION SPECIALIST

Qualifications: University degree with relevant experience in fish culture extension work. French language capability.

Duties: 1. Assist directors of prefectural fish culture programs in the training, supervision and on-the-job support of fish culture extension specialists.

2. Provide technical advice relative to pond site location and design and the production and distribution of fish fingerlings.

Station: Initial base will be Butare, travel required.

3. CONSULTANT SERVICES

Short-term consulting has been budgeted at the rate of two months per year over the project life. Half of this would be used for support of mid- and end-of-project evaluation personnel and contractor in-country supervisory visits. The other half would be used to secure services of specialists as related to specific project needs. For example, in the first year of the project, there is the need of a schistosomiasis expert to screen fishponds for vector snails and to instruct project

personnel in the detection and control of any problem that might occur in this regard. Likely in the second year of the project, there will be the need of an extension media specialist to help design a public awareness campaign using mass media such as posters, radio, etc. Additional needs for up-dating on pond fertility and fish production methods, fish utilization, or other topics, are foreseen in the life of the project.

REPUBLIQUE RWANDAISE

Kigali, le 31 JANV 1980 file FC

N° 257 /12.02

Annex K. Government of Rwanda Request for the Fish Culture Project

MINISTERE DE L'AGRICULTURE
ET DE L'ELEVAGE
B. P. 621 KIGALI

Monsieur Eugène R. Chiavaroli
Attaché pour la Coopération
Agence des Etats-Unis pour le
Développement International
KIGALI

Réf. N° :

Annexe :

Objet :
Pisciculture au Rwanda
Projet AID n° 696-0112.

Monsieur,

Suite à votre lettre n°16/80 du 10 janvier 1980 relative à l'objet repris en marge et après un examen approfondi du document d'avant-projet de la proposition de l'USAID pour le financement d'un projet de Pisciculture au Rwanda; j'ai l'honneur de porter à votre connaissance que celui-ci rencontre l'approbation du Ministère de l'Agriculture et de l'Elevage en plusieurs points-clés et qu'une consultation entre vos services techniques et les notres pourraient avoir lieu à une date que je vous laisse le soin de fixer pour l'élaboration finale du dossier technique.

Vous en souhaitant une bonne réception, je vous prie d'agréer, Monsieur, l'expression de ma considération très distinguée.

LE MINISTRE DE L'AGRICULTURE
ET DE L'ELEVAGE
F. NZAMURAMBAHO.-

C.P.I. à :

- Monsieur le Directeur Général de l'Agronomie
  KIGALI
- Monsieur le Directeur des Eaux et Forêts
  KIGALI

ANNEX L

Draft Authorization and Waiver Request

ACTION MEMORANDUM

FROM:

SUBJECT: Project Authorization

PROBLEM: Your approval is required for a grant of $2,470,000 from the Section 103 Agriculture, Rural Development and Nutrition Appropriation for the Rwanda Fish Culture Project (696-0112), which amount constitutes the entire AID obligation to be provided in tranches of $1,165,000 in FY 81, $800,000 in FY 82, and $505,000 in FY 83, subject to the availability of funds, to help in financing foreign exchange and local currency costs for the project. Your approval is also required for certain technical services and commodity procurement waivers described herein.

DISCUSSION: The possibility of AID participation in a fish culture project in Rwanda was first discussed in early 1977. At that time, the Government of Rwanda proposed that AID assist in the construction of government-owned fish ponds, one in each of the country's 143 communes. The present project has emerged, after long negotiations, focusing more on direct support to farmers with less emphasis on government-owned facilities.

The purpose of the project is to develop the capacity of Rwandan farm families to build and maintain productive on-farm fishponds. Rwandan farmers are attempting to farm fish in some 3,000 ponds which have existed since colonial times but with little success. The lack of extension services has been identified as the major constraint to improved increased production in these ponds, and strengthening extension services will be the objective of the project.

The project will provide assistance to the following areas:

A. Training of 12 fish culture supervisors and 50 fish monitors who will provide the interaction with the farmers to assure that the project succeeds.

B. Renovation of the National Fisheries Training Center at Kigembe as well as the ten prefectural fish stations. These facilities

will be used for training, for demonstration and for fingerling production.

C. Assure that fingerlings are available to participating farmers.

D. Put back into production 80 of the existing ponds.

The beneficiaries of the project will be approximately 2,500 farm families who will directly participate in the program over the next four years.

WAIVERS: A procurement source/origin waiver of Section 636 (i) of the FAA, from Geographic Code 000 (U.S. only) to Geographic Code 935 (Special Free World) for the purchase of project vehicles and motorcycles, and spare parts, in the amount of $94,530 is requested. A waiver of Section 110 (a) of the FAA is also requested on the bases of justification contained in the Project Paper.

The Project Paper proposes that the long-term technical assistance, and eight months of the short-term technical assistance, be obtained under an agreement with the Food and Agriculture Office, Organization of the U.N. A waiver authorizing this procurement is requested.

JUSTIFICATION TO CONGRESS: The Project has been presented to Congress in both the FY 80 and the FY 81 Congressional Presentations.

RECOMMENDATION: That you sign the attached Project Authorization.

APPROVED :_____

DISAPPROVED:_____

DATE :_____

PROJECT AUTHORIZATION AND REQUEST FOR ALLOTMENT OF FUNDS

NAME OF COUNTRY: Rwanda

NAME OF PROJECT: Rwanda Fish Culture

NO. OF PROJECT : 696-0112

1. Pursuant to Section 110(a) of the Foreign Assistance Act of 1961, as amended, I hereby authorize the Agricultural Survey and Analysis project for Rwanda (the "cooperating country") involving planned obligations of not to exceed $2,470,000 in grant funds over a four-year period from date of authorization, subject to the availability of funds in accordance with the AID OYB allotment process, to help in financing foreign exchange and local currency costs for the project.

2. The project consists of technical assistance, training, material and personnel support, and construction components designed to help the Government of Rwanda to strengthen its capacity to deliver extension services, including the necessary inputs to farmers who want to participate in fish farming.

3. The Project Agreement(s) which may be negotiated and executed by the U.S. Ambassador to Rwanda, by the principal AID officer in Rwanda or by the officer to whom such authority is delegated in accordance with AID Regulations and Delegations of Authority subject to the following essential terms and covenants and major conditions, together with such other terms and conditions as AID may deem appropriate.

4. <u>Source and Origin of Goods and Services</u>

Goods and services, except for ocean shipping, financed by AID under the

project shall have their source and origin in the Cooperating Country or in countries included in AID Geographic Code 941, except as AID may otherwise agree in writing. Ocean shipping financed by AID under the project shall, except as AID may otherwise agree in writing, be financed only on flag vessels of the United States or the Cooperating Country.

5. Conditions and Covenants

The Cooperating Country shall covenant that:

a. Expenditures of grant funds will be pursuant to annual work plans and detailed budgets supporting expenditures required to carry out the annual work plan, except as AID may otherwise agree in writing. The first annual work plan and budget will be prepared by the Ministry of Agriculture and approved by AID.

b. Suitable candidates for project-financed training will be made available on a timely basis. Further, persons trained under the project will be subsequently assigned or retained in positions with the Ministry of Agriculture commensurate with the nature and level of fraining received, or in such other positions as the Parties to the Agreement may agree in writing.

c. Payment of salaries by the Government to ASAU staff and prefectural agronomes will commence per the schedule indicated in the budget section of the project paper.

d. Ministry officials will help cooperate with AID in formulating and carrying out on-going and end-of-project evaluations to determine progress toward attainment of project objectives, constraints to project achievements and impact of the project on agricultural planning and resources utilization.

6. Waivers

Notwithstanding Paragraph 4 above, and based upon the justification set forth in the Project Paper, I hereby approve the following waivers:

a. A waiver of Code 000 (U.S.) procurement source/origin policy set forth in Section 636(i) of the FAA, 1961, as amended, to permit procurement of five pickup of sedan-type vehicles and twenty-two motorcycles and related spare parts, having an approximate total cost of $94,530 from Rwandan or Code 935 (Special Free World) source and Code 935 origin. I have concluded (1) that exclusion of procurement of the project vehicles and motorcycles from countries included in AID Geographic Code 935 would seriously impede attainment of United States foreign policy objectives of the Foreign Assistance Program and (2) that special circumstances exist which justify waiver of the requirements of Section 636(i) of the Act.

b. Based on the justification set forth in the Financial Plan, Part II, Section D.2. of the Project Paper, I also hereby waive the cost-sharing requirements of Section 110(a) of the FAA, as provided by Section 124(d) of the Act, except that the Cooperating Country shall be required to provide financial or "in kind" contributions in the approximate equivalent value of $589,000, as provided for in the Financial Plan Section of the Project Paper.

c. A services procurement waiver to permit the procurement of two long-term technicians (4 years each) and eight months of short-term consultancies from the Food and Agriculture Organization (FAO) of the United Nations. It is hereby determined that the procurement of such services from other than the Cooperating Country and countries included in Code 941 would seriously impede attainment of U.S. foreign policy

objectives and the objectives of the foreign assistance program.

APPROVED: _____

DISAPPROVED: _____

DATE: _____

DATE : January 30, 1981

REPLY TO
ATTN OF: AAO/Rwanda

SUBJECT: Vehicle Procurement Waiver

TO : Action Memorandum for AA/AFR

Problem

Request for a procurement source/origin waiver from Geographic Code 000 (U.S.A.) to Geographic Code 935 (Special Free World).

A. Cooperating Country:	Rwanda	
B. Name of Project:	Fish Culture Project 696-0112	
C. Nature of Funding:	Grant	
D. Description of Commodities:	4 Toyota Stout-type light pickup truck	40,800
	1 VW-type vehicle	7,300
	22 Motorcycles (125cc)	34,100
	Spare parts (15%)	12,330
		94,530
E. Probable Origin:	Japan, Brazil	
F. Source:	Rwanda	

Discussion

Section 636(i) of the Foreign Assistance Act of 1961, as amended, prohibits AID from purchasing motor vehicles unless such vehicles are manufactured in the United States. Section 636 (i) does provide, however, that "...where special circumstances exist, the President is authorized to waive the provision of this act in order to carry out the

purpose of this act." That authority has been delegated to you by A.I.D. Delegation of Authority No. 40, dated March 5, 1978.

Experience with U.S.-manufactured vehicles in Rwanda (a few in the possession of the U.S. Embassy in Kigali) indicates that frequent breakdowns can prevent operation of a U.S.-manufactured vehicle for weeks on end while spare parts are ordered from the United States. Even if the full range of spare parts required to maintain the vehicles were available, competent repair facilities outside the U.S. Embassy are non-existent. The situation is exacerbated as vehicles age and are subjected to poor maintenance. On the other hand, certain European and Japanese vehicle dealerships and many country garages carry spare parts and maintain acceptable repair facilities for European and Japanese model trucks and cars. In the case of motorcycles, only Japanese dealerships and repair facilities for Japanese products are available in Rwanda. Most of the European and Japanese model dealerships have competent mechanics who have been trained in the factories of the respective manufacturers.

Primary Justification

The vehicles and motorcycles covered by this waiver request, which can be serviced and repaired locally, are essential to the effective implementation of the Fish Culture Project. The trucks will be used by the technical assistants in the course of their work, and one for use by the Kigembe Fish Station. The latter will be replaced in the last year of the project. The small vehicle (VW-type) will be used by the Rwandan on-going evaluation team. The motorcycles will be used as transport for the ten Prefectural Fish Station Managers and one will be purchased for the Kigembe Training Center and will be replaced in the last year of the

project. As indicated previously, service capabilities and spare parts are not available for U.S.-manufactured vehicles.

Recommendation

Based on the foregoing, it is recommended that (1) you conclude that special circumstances exist which justify the waiver of the requirement of procurement of U.S.-manufactured vehicles and motorcycles under the FAA Section 636(i), and (2) you certify that exclusion of procurement from the sources requested herein would seriously impede attainment of United States foreign policy objectives and objectives of the Foreign Assistance Program.

APPROVED: _____

DISAPPROVED: _____

DATE: _____

ACTION MEMORANDUM FOR THE ADMINISTRATOR

FROM : AA/AFR

SUBJECT: Services Procurement Waiver

Problem: Request for a services procurement waiver to permit a Host Country Contract with the U.N. Food and Agriculture Organization (FAO) for the services listed in the Discussion section below:

A.	Cooperating Country:	Rwanda
B.	Authorizing Document:	Project No. 969-0112
C.	Project:	Rwanda Fish Culture
D.	Nature of Funding:	Grant
E.	Description of Services:	Two long-term technicians (8 years total) and twelve months of short-term consultancies
F.	Approximate Value:	$1,000,000 for technical services The FAO will execute the entire project costing approximately $2.4 million.
G.	Probable Source:	Food and Agriculture Organization, U.N.

Discussion. The FAO will be requested to execute all elements of the Rwanda Fish Culture Project, including technical assistance, commodity procurement, construction/renovation of facilities, and supervision of local cost expenditures. Guidelines for execution of the project by FAO will be contained in the Project Grant Agreement to be signed by AID and the Government of Rwanda (GOR). The GOR will conclude an agreement directly with the FAO for the FAO services.

A. The technical assistance being requested of the FAO includes both a Fish Culture Extension Specialist and a Fish Culture Training Advisor for the four year life-of-project, and short-term consultancies in such fields as rural engineering, aquaculture, rural economics, sociology, marketing, research and environmental monitoring. The long-term technical assistants will be required to have experience in fish culture programs under conditions which are similar to those which exist in rural Rwanda, and must have French language fluency in order to assist in preparing training curricula and in conducting formal and on-the-job training. Short-term assistance will need to have comparable technical and language skills.

B. Construction and renovation at the National Fisheries Center to permit training of extension workers and farmers, and at each of the ten

prefectural fingerling production/demonstration stations, will be directed by the FAO technical assistance team.

C. Training of Rwandan extension staff to be conducted in-country, with some training of key personnel in the Ivory Coast and in Nigeria.

D. Local costs for in-country procurement and for support to the Extension Service which AID has agreed to bear on a phase-out basis, will be released by the FAO team to the Rwandan Fish Service, and the use of the funds monitored by the FAO team.

A contractural arrangement with the FAO is recommended for the following reasons:

(A) AID has had little success in recruiting technicians with experience and with French language capability who are prepared to live in rural Rwanda over an extended period of time. Over the past fifteen months efforts have been underway to find technicians for four projects with no one yet in sight. The language requirement, the isolation of Rwanda, the lack of education and health facilities for children, and employment opportunities for dependents are the most prevalent constraints to recruitment for Rwanda. The AID projects have suffered serious delays in implementation because of our inability to provide the necessary technical assistance.

The Fish Culture Project site, Kigembe, offers even more of an obstacle than usual since it is located one hour from the nearest small town (Butare) and is virtually without basic comforts. Should the technicians live in Butare, the lack of English-speaking schools realistically limits the field of recruitment to unmarried technicians or childless couples and thus further restricts the possibility of providing experienced and timely technical assistance.

The FAO, on the other hand, has a wide field for recruitment which includes French speakers. The FAO has fish culture specialists in many countries of the third world, including Africa, and has a pool of well-qualified, experienced technicians from which to draw, technicians who will not find the foreign atmosphere, or the isolation, impediments to accepting a long assignment in Rwanda.

(B) Administrative support requirements placed on AID have to be kept to a minimum. The AID mission in Rwanda is small and is likely to remain so. Every attempt has to be made to allow the use of the limited U.S. and Rwandan personnel as effectively as possible, including the reduction in the amount of attention given to administrative support of contractors. For AID to support a contract team of two families based in Kigembe and and 12 months of short-term assistance in four years will be time-consuming and difficult. With FAO technicians, administrative actions will be substantially reduced. They will find their own housing,

purchase furniture and appliances, clear customs, pack and ship their effects, arrange air travel, use international mail and generally live off of the economy.

(C) The FAO is already engaged in a lake fisheries project in Rwanda, the development of which parallels the AID project for pond fish farming. Implementation of both of these elements of fish production by the same agency can result in certain economies, particularly of short-term technical assistance requirements and an interchange of expertise and information. Moreover, the coordination which will be essential in later years of the two projects as increased production from both lakes and ponds demands increasing attention to commercialization and processing/preservation will be assured by a single implementing agent, the FAO.

The FAO and AID have long been discussing ways of combining our special strengths and resources for the benefit of the LDC's and initiatives to enter into a cooperative working relationship with FAO are underway. The arrangement requested by this Request for Waiver is clearly in line with AID policy of "doing more with less."

Recommendation. That you (a) approve a waiver from Code 941 to allow procurement of the required technical services from the FAO, and (b) certify that exclusion of the procurement of these services from other than the Cooperating Country and countries included in Code 941 would seriously impede attainment of U.S. foreign policy objectives and objectives of the foreign assistance program.

RWANDA FISHERIES

611(a) Statement

The physical facilities proposed under this project for construction and for renovation are adequate to achieve the intended purpose of the project activity.

The proposed design and construction method involves adequate rural engineering practices. Tentative sites for the proposed new fish ponds have been identified. Environmental Assessment has been made and recommendations therein will be taken in consideration during design, construction, operation and maintenance of these activities.

In the opinion of REDSO engineering the proposed design planning for execution, construction, and arrangements for supervision of construction and of maintenance are adequate and the cost estimates are reasonably firm and therefore, meet requirements of FAA 611(a) of 1961 as amended.