Final Report and Recommendations Resulting from CRC/WIOMSA Volunteer Assignment in Tanzania June 26 to July 10, 2005

Mariculture Business Development

Michael A. Rice & Edwin Requintina, Sr.

Phase 1: Mariculture Extension Workshop, Maszon's Hotel Zanzibar:

Our participation in the Mariculture Extension Workshop sponsored by the Coastal Resources Center and the Western Indian Ocean Marine Science Association (WIOMSA) included a presentation on the design and management of milkfish ponds; a practical demonstration on the construction and use of a milkfish fry-collecting net by Edwin Requintina; and four presentations by Michael Rice on the rationale for and methodologies of extension practice and on methods for small-scale finfish, seaweed and molluscan aquaculture. Copies of the presentations are provided as an appendix to this report on CD-ROM.

Volunteer, Dr. Michael Rice discussing aquaculture extension with workshop participants

Volunteer, Edwin Requintina demonstrating milkfish fry collection using a Philippines-style scissors net constructed as a demonstration exercise at the workshop

Phase II: Field Extension Activities:

Seaweed Farms in Bagamoyo

On July 2, 2005 we traveled to Bagamoyo to meet with seaweed farmers, and offer suggestions to improve production. The villagers were waiting for our arrival and they presented a written set of project accomplishments since the last extension visit from the project extension personnel. We offer the following observations and recommendations:

- Production of seaweed is meeting villagers' expectation at this time. They showed us a full storeroom and stated they were awaiting arrival of the seaweed buyers from Zanzibar.

- We observed that some of the seaweed on drying racks in the village was coated by a grayish fungus that might affect the market price. The racks in question were shaded part of the day by trees in the village. We suggested situating the racks in open areas where their exposure to direct sunlight can be maximized.

Villagers at Bagamoyo showing their seaweed drying racks

- There was no boat available to transport us to the floating raft culture of seaweed or to the site where the villagers are culturing seaweed using traditional stake and line methods. However, villagers reported their satisfaction with seaweed production from both systems.

- Villagers expressed the need for a boat to transport farmers to the seaweed culture sites. They stated the difficulty in harvesting and transporting seaweed with their small *ngalawa* fishing boats – the boats are so small that they can harvest only one seaweed line when the seaweed thalli are fully grown. We recommend bamboo rafts or pontoon rafts that could be poled out to the work site as the optimal work platform and transport craft.

- We noted that a relatively light-weight and large capacity marine plywood boat lay on the beach near the various fishing craft. This boat was approximately five meters in length and one and a half meters maximum beam with a flat bottom that facilitated landing on a sandy beach. The boat could have been easily modified as an inboard-motorized vessel using a 10 horsepower cast iron block Briggs and Stratton engine. We inquired as to when the boat was built. The fishermen stated that the boat was constructed 15 years ago, and had been abandoned as unserviceable three years ago. This means that the boat had an effective lifetime of 12 years. We inquired as to the approximate cost of materials for such a boat. The fishermen reported that about Tsh 2 million would be required for building materials. Previous estimates by Ms. Rebecca Savoie of the Smallholder Empowerment and Economic Growth through Agribusiness and Association

Development (SEEGAAD) Project put the cost of a 10 horsepower Briggs and Stratton Engine at about Tsh 4 million with the cost for additional supplies and engineering work to motorize a boat at Tsh 1 million. The villagers stated that annual seaweed sales were already in the Tsh $4-5 million/year range without a boat. Based on these conservative sales estimates (based on harvests with no boat), the costs of a boat could be possibly financed over a three to four year period while maintaining profitability and cash flow within the seaweed farming group.

Marine Scientist Dr. Flower Msuya discusses seaweed farm tender boats with Bagamoyo villagers

- We suggest the following as the optimum combination of vessels to carry out seaweed farming in Bagamoyo. This is the combination of a raft for use as a work platform (as described above) and a small three meter motorized boat for use in inspecting and tending the farms. At harvest time, the raft could be towed to the work site. It may be wise to introduce the raft to the village first – i.e., before the motorized vessel – i.e., as a step-wise strategy in introducing technology.

- The Fisheries Extension Officer at Bagamoyo explained that when she put seaweeds into a cage, it acted as a fish attracting device (FAD). After lengthy discussion, volunteer Edwin Requintina explained methods for constructing Philippines-style FADs or *payaos*. The *payaos* are essentially rafts of bamboo anchored with poured concrete blocks with a worn automobile tire as the anchor eye. Ropes of sufficient length up to 200m long would hold the *payao* in place. Hanging from the bamboo raft would be whole palm fronds that serve as a surface for algal growth. Small herbivorous fish seek refuge among the fronds, and then

larger predatory fish follow. Harvesting is accomplished by setting the *payao* adrift while keeping the mooring line afloat with a buoy. Once the *payao* is free and adrift, an encircling ring net or purse seine is deployed to haul in the fish, after which the *payao* is repositioned onto the mooring line. Although very effective in aggregating fish, *payaos* should be introduced with care – including with an eye for defining the upper limit to be used in any fishing area. The *payaos* are implicated in severe fisheries depletion in the Philippines and other areas in Southeast Asia. Use of valuable *Eucheuma* seaweeds as FADs may be an inappropriate use of a salable resource. Palm fronds are usually available and cost-free in fishing villages and can be used in FADs for three to four weeks before they disintegrate in the seawater and need to be replaced.

Volunteers Requintina and Rice learn the technique of the traditional bow drill from a Bagamoyo boat builder

Milkfish Farm in Mpafu Village Mkuranga (Kirago site)

On July 4, 2005, the volunteers traveled to the Village of Mpafu to the salt evaporator beds of Mr. Kirago who is experimenting with fish culture. This visit resulted in the following observations and recommendations.

- It was noted that although the site is 80 km from the wholesale fish markets in Dar es Salaam, the travel time by private vehicle to the Mpafu farms was a minimum of four hours (several hours longer during traffic jam periods). Large quantities of transported milkfish would spoil if proper icing and transport services were not contracted by the farmers in Mpafu, as there are no suitable trucking or ice-making services in the Mkuranga area. Local trucks in Mkuranga are clearly unsuitable for transport of highly perishable cargo.

- The Kirago Farm has soils with a high sand content that is sub-optimal for the construction of fishpond dikes. Soil types with higher percentages of clay/loam are better for dike construction.

- The perimeter dikes at the Kirago Farm were constructed at a height below the level of high spring tide, so they were severely damaged as receding spring tides that overflowed the dikes receded back to sea. This error in dike construction destroyed the concrete main water supply gate for the farm.

Extension Agent Mr. Muganga stands on the ruined main water supply gate of the Kirago Farm caused by high spring tides overflowing the main perimeter dike

- The Kirago Farm lacks the manpower to sufficiently maintain their dikes on a regular basis. Most of the farm workers are women who lack the physical stamina to engage in the rigorous demands of earth moving by hand.

- The Kirago Farm staff did not know the way to the nearest sandy beach for fry collection – a critical piece of knowledge.

- The original plan upon visiting the Kirago Farm was to demonstrate the construction of watertight wooden fishpond gates. Lumber was pre-positioned at the farm, but ahead of the visit the farm staff failed to measure the dikes' linear dimensions. Without accurate measurements, a proper plan for dike positioning and construction was not possible. After two visits to the Kirago Farm, the volunteers were able to measure existing perimeter dike dimensions and develop a dike construction and positioning plan (appended to this report) with copies supplied to Mssrs. Muganga and Sandey who are on-site extension agents.

- Mr. Kirago lacks some of the qualities desired of an ideal extension cooperator for the SUCCESS project and has unrealistic and unclear expectations concerning what he was being asked to do and provide versus what the project could provide. It is not clear how committed he is to improving the business operations of his current salt operations and converting a portion of his salt ponds to fishponds. He seemed unwilling to contribute labor needed to implement some of our recommendations, including a reconstruction of the water supply gates, in spite of the fact that the project was willing to provide all of the materials for construction. For this and the aforementioned reasons, it was decided that the wooden dike demonstration should be carried out at the nearby Mukadam Farm where there was another willing salt operator interested in converting to milkfish ponds and contributing the labor for dike modifications, gate construction and installation. After considerable discussion, all the lumber was relocated to Mukadam Farm.

Moving lumber for wooden gate construction to Mukadam Farm

- Although we recommend that a low level of Extension assistance be provided to Mr. Kirago, we feel that the Kirago Farm is not the most optimum location in Tanzania for a pilot demonstration of milkfish rearing technology that could be emulated by others if developed. Other better possibilities exist.

Milkfish Farm in Mpafu Village Mkuranga (Mukadam site)

Approximately 1 km from the Kirago Farm and in the same mangrove forest area are the salt evaporators and the proposed Mukadam Fish Farm. The following observations and recommendations are offered as a result of a visit to this site.

- Like the Kirago site, the Mukadam site has very poor access to proper transportation and support infrastructure. This seriously constrains the options for marketing a highly perishable crop. This jeopardizes development of this site to anything beyond relatively small-scale farms for supplying local consumption.

- Unlike the Kirago site, soil conditions have a relatively clay-loam fraction that makes the site better for construction of low-maintenance dikes.

- The perimeter dikes at the Mukadam site are constructed above the high spring tide marks, so the farm is in relatively good shape.

Volunteer Edwin Requintina demonstrating the method of determining low tide baseline elevation datum, tide range determination, and the method for transferring tide measurements to make proper dike and pond bottom elevations

- On the first visit (July 4), the volunteers were provided the dimensions by the cooperators of the dike's perimeter. These provided the basis for an initial dike layout and construction plan. However on the second visit (July 6), the volunteers

measured the dike to verify the dimensions provided and found that all dike measurements were inaccurate by ±25%. This necessitated a complete rewrite of the layout and construction plan. It is important to emphasize to cooperators that "guestimates" of area and volume dimensions make business planning and calculation of construction costs difficult if not impossible. Proper planning relies upon accurate information. The revised Mukadam site plan is appended to this report with copies supplied to Mssrs. Muganga and Sandey.

- Like the Kirago farm, access to the open sandy beach adjacent to the mangrove forest is difficult. This will make milkfish fry collection a challenge.

- Design drawings for a wooden main water supply gate at the Mukadam site are appended to this report and were supplied to Mssrs. Muganga and Sandey who will continue with the gate construction and demonstration.

Edwin Requintina discusses pond layout methodology with extension agents Sandey and Muganga at the Mukadam Farm

Milkfish Farm in Bagamoyo (Regent Enterprises site)

On July 7, 2005 the volunteers traveled to Bagamoyo to visit the salt evaporator facility and experimental fish farm operated by Regent Enterprises. The Regent Enterprises site is a very successful and profitable salt evaporator business. We offer the following observations and recommendations:

- The site is within one hour of Dar es Salaam by mostly paved roads and relatively light traffic, making commercial transport and marketing much easier that either of the Mkuranga sites.

- The Regent Enterprises complex consists of approximately 180 hectares of salt flats and reclaimed mangrove area under various stages of development, with title held by the company itself.

- Operators of the company express a keen business sense. For example, on site is a salt warehouse that is well stocked with bagged salt ready to be delivered to markets during the rainy 'off season' of salt sales. Another example of business sense was demonstrated by an immediate knowledge of how much cost went into fueling diesel-powered centrifugal pumps supplying water to evaporation ponds and how it affected the "bottom-line" profits of the salt business. These are business savvy people.

Salt storage warehouse at the Regent Enterprises salt pans

- The soil quality at this site is perfect for construction of fishpond dikes. The subsoil consists of organic clay loam that is overlain by a sandy top layer.

- There is a permanent workforce on site that is knowledgeable of construction techniques for sturdy dikes using the 'mud-block' placement system. Furthermore, they use staking methods to guide construction and keep the dikes straight.

Newly constructed dike at Regent Enterprises site using quality clay-loam blocks and proper slope, base and crown dimensions

- There is a site manager living on-site who is knowledgeable about all operations.

- The tidal range exterior to the perimeter dikes is 1.0 to 1.5 meters, which is optimum for milkfish pond construction.

- The existing main gate of the farm is approximately 3 meters in width with single planking to form the gate closure. This design is exceptionally leaky in that water cannot be retained by the board joints. The recommendation is that the gates be modified with double doors so that the median space can be packed with mud to make the gates more effective in retaining water. The cooperator liked the idea and stated he would try it out.

Main water gate at Regent Enterprises salt pans in Bagamoyo

- There appears to be a high ground water table at the site that necessitates the operators building up the salt evaporator beds on mounds to expedite the drying process. This is a good management technique.

- The presence of red *Halobacterium* sp. in the salt evaporator beds was noted. The cooperator was advised that a slight modification of his evaporators to include a catchment basin at the end of the bed that is downwind from the prevailing wind direction would allow the ponds to have a dual use – both as salt production beds and as a source of brine shrimp (*Artemia* spp.) cysts for sale or for use as fish food on-site. Halophilic bacteria like *Halobacterium* and halophilic algae are the food for brine shrimp. As the salt beds dry out, adult brine shrimp retreat to the catchment basin. As the salinity in the catchment basin reaches 150 parts per thousand, the female brine shrimp start producing buoyant parthenogenic cysts that are carried to the corners of the catchment basins where they can be scooped up, dried and sold. It was also noted that as the brine shrimp filter feed, the quality of salt improves because the amount of organic material in the salt is reduced and crystallization increases.

The Regent Enterprise site may be ideal for the main milkfish demonstration site for a number of reasons in addition to the above points.

- The site already has in place seawater pumps that can be operated to top off ponds during emergency situations, giving the operator good management options if water quality suddenly goes bad.

Water is pumped into high salt pans by diesel engine driven centrifugal pump at Regent Enterprises salt pans

- The cooperator stated an interest in developing a milkfish farm demonstration project in a pond identified at the northeast corner of his farm near the main water supply.

- There are potential milkfish fry and fingerling collection areas nearby with easy access. There were milkfish fingerlings spotted in the main supply canal.

- The volunteers offered a demonstration of the difference in morphology between predator *Elops* sp. fish and the milkfish *Chanos chanos* in samples seined from the cooperator's existing experimental fry ponds.

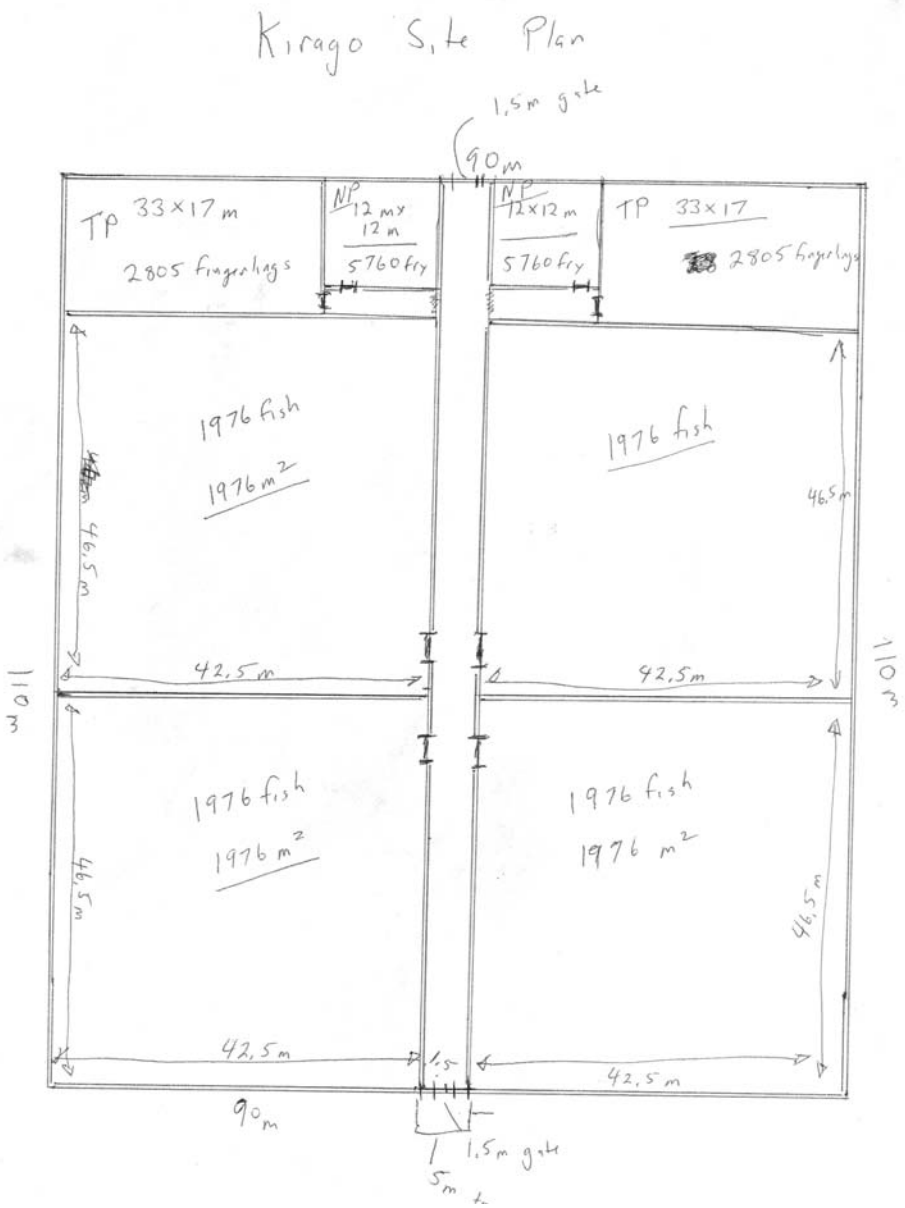
- The cooperator has taken the initiative to seek out technical assistance from scientists at the University of Dar es Salaam and government agencies. He was extremely delighted to share knowledge with foreign experts as well.

- The cooperator is willing to assume most of the costs of developing the milkfish demonstration project. However, access to technical assistance remains the biggest stumbling block.

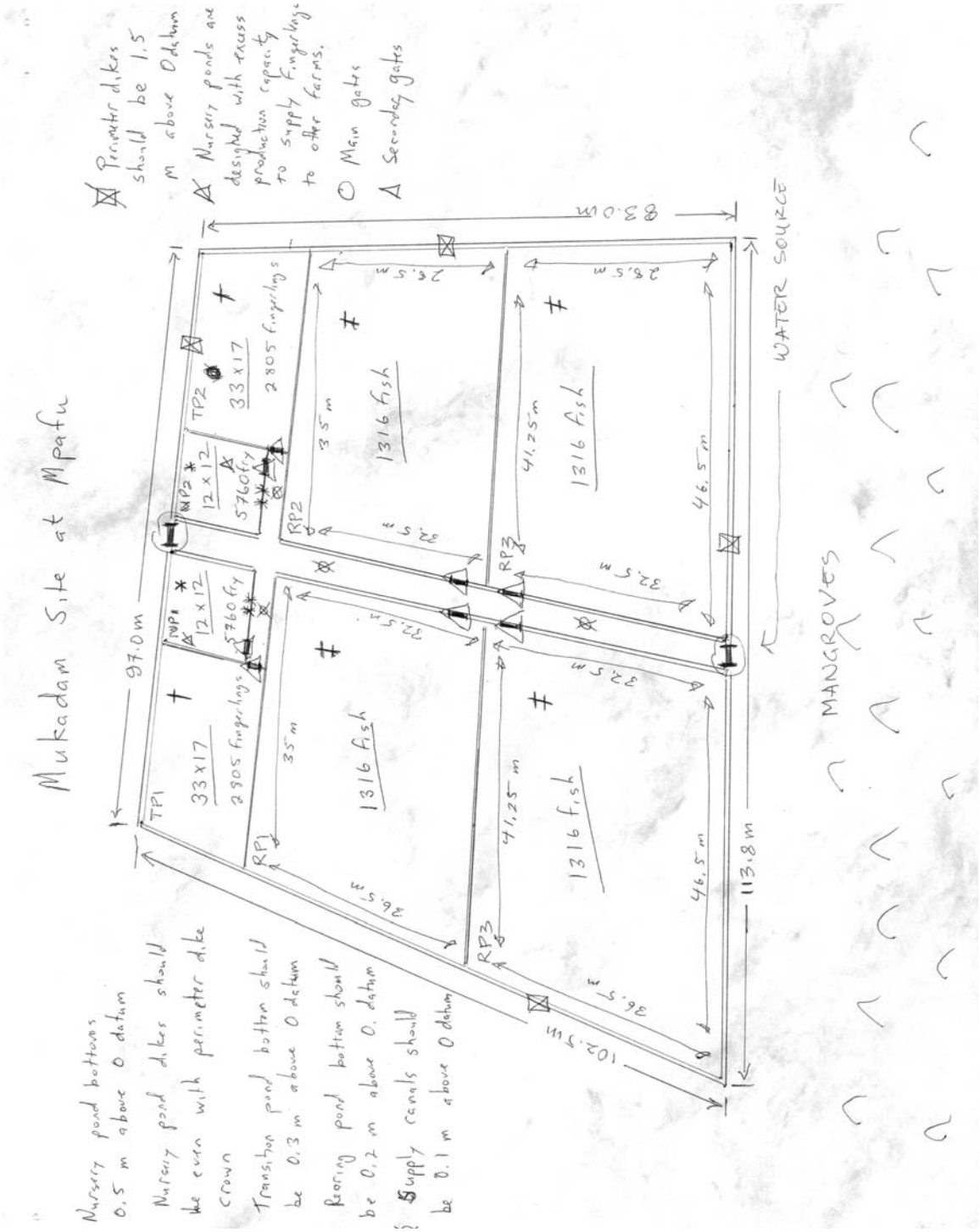
Experimental fry rearing ponds built by owner of Regent Enterprises salt pans without any prior technical assistance. Netting on one pond is an experiment to exclude bird predators.

In conclusion it is recommended that the Regent Enterprises salt operations site be considered the primary site for any milkfish demonstration project in the Dar es Salaam area or Tanzanian Central Coast. This site has the greatest likelihood of success as a demonstration project – as compared to other possible sites in Tanzania. There may exist some criticism that efforts to develop extension cooperators who are already more established in their businesses, may not be helping the "poorest of the poor" directly. However, experience shows that the poor are often adverse to the risks involved in becoming an entrepreneur as any risky venture that does not have a reasonable assurance of success can put them over the edge of an already precarious economic existence. The extension literature also shows that the best "innovators" and "early adopters" of new technologies are rarely the poorest members of society and typically are those that are better off economically and therefore can afford to take more risks. In light of that reality, by offering technical assistance to an entrepreneur that exhibits the qualities of an innovator and early adopter, we can increase the likelihood that the milkfish farming innovation will be adopted successfully. Since this businessman's operation is labor intensive and will use local labor to fill that need, then we will indirectly help the "poorest of the poor." In addition, by establishing a successful demonstration farm in this manner, it will increase the likelihood that over time, later adopters, who are often poorer members of society, will ultimately be able to benefit from milkfish farming, following this farmer's example. Furthermore, pond culture of any fish is indeed a tricky business and it demands personalities with attention to detail to make for a successful operation.

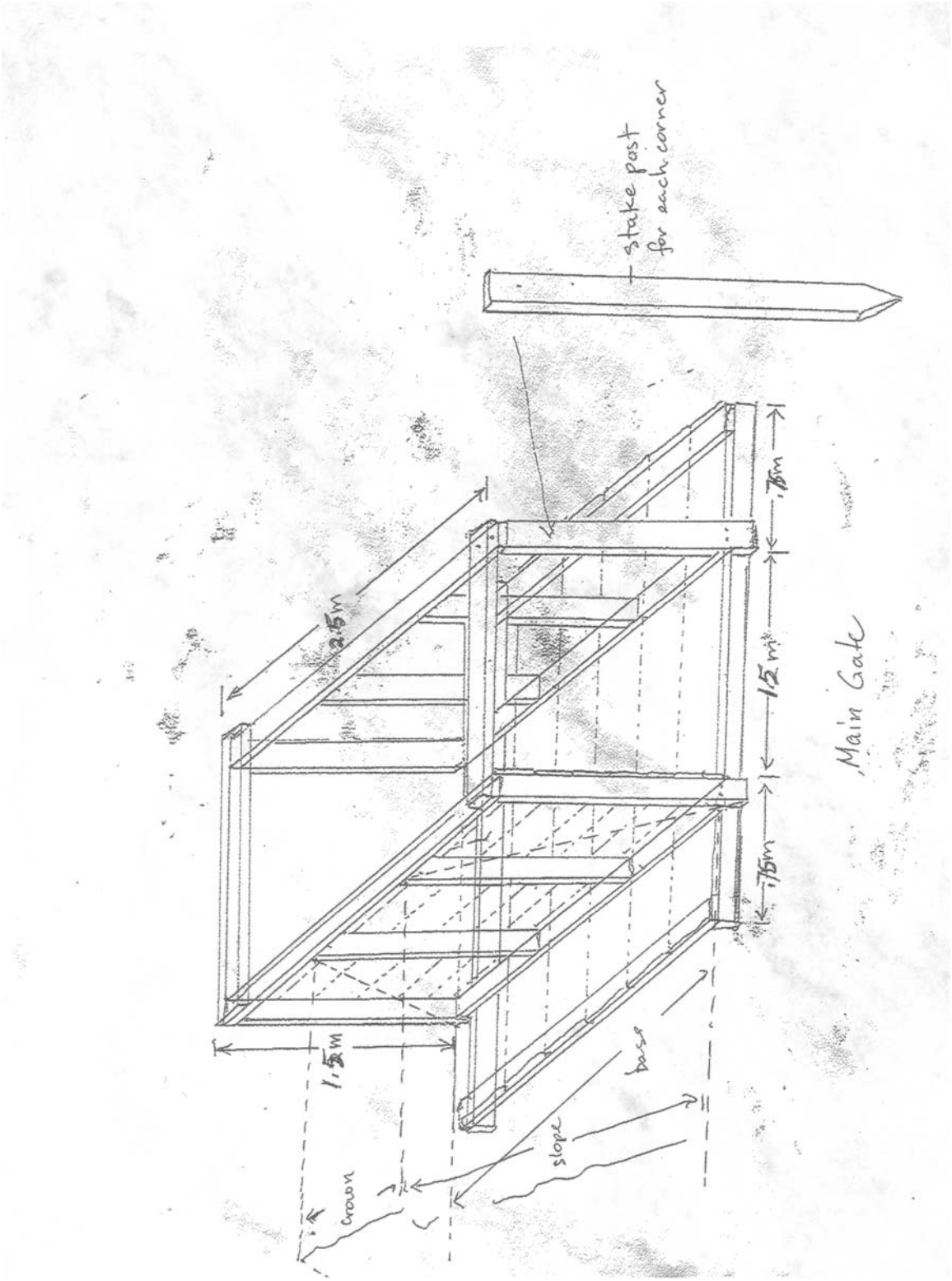
APPENDIX 1


Kirago Site Plan
1.5m gate
90m
TP 33×17 m
2805 fingerlings
NP 12 m× 12 m
5760 fry
NP 12×12 m
5760 fry
TP 33×17
2805 fingerlings
1976 fish
1976 m²
46.5m
42.5m
110m
1.5
90m
1.5m gate
5m

APPENDIX 2


Mukadam Site at Mpafu
Perimeter dikes should be 1.5 m above 0 datum
Nursery ponds are designed with excess production capacity to supply fingerlings to other farms.
Main gate
Secondary gate
Nursery pond bottoms 0.5 m above 0 datum
Nursery pond dikes should be even with perimeter dike crown
Transition pond bottom should be 0.3 m above 0 datum
Rearing pond bottom should be 0.2 m above 0. datum
Supply canals should be 0.1 m above 0 datum
97.0m
83.0m
102.5m
113.8m
TP1
TP2
33x17
2805 fingerlings
12x12
5760 fry
RP1
RP2
RP3
1316 fish
35m
36.5m
32.5m
41.25m
46.5m
28.5m
WATER SOURCE
MANGROVES

APPENDIX 3


stake post
for each corner
2.5m
.75m
1.5m
.75m
1.5m
Main Gate
base
slope
crown

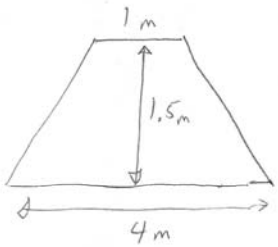
APPENDIX 4

Dike earth volumes

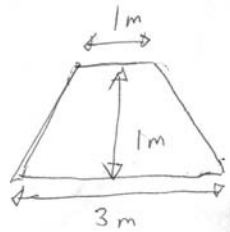
1) Perimeter 294m × 3.75 m^2 = 1104 m^3

2) Main Canal 185.5m × 3.75 m^2 = 696 m^3

3) Secondary Dikes 210m × 2 m^2 = 420 m^3



Primary (Perimeter) Dike
Cross Section
(3.75 m^2)



Secondary Dike
Cross Section
(2.0 m^2)

Elevations:
Nursery ponds 0.5m above 0 datum
Transition ponds 0.3m above 0 datum
Rearing ponds 0.2 m above 0 datum
Supply canals 0.1 m above 0 datum

Stocking densities:
Nursery ponds - 40 fry/m^2
Transition ponds - 5 fingerlings/m^2
Rearing ponds - .1 fish/m^2