Project report: Assessment and Recommendations for Two Sites with Active and Potential Aquaculture Production in the Rift Valley and Coast Provinces, Kenya

Aquaculture niche - Volunteer Assignment #9 - Value chain and small scale marketing

Beneficiary organizations: (1) Eldoret University, Eldoret, Kenya
(2) The Institute for Self-Reliant Agriculture, Enumclaw, WA, USA / Koins for Kenya, Mnyenzini, Kenya

Location: Eldoret and Mnyenzini, Kenya

Date of assignment in country: May 11-23, 2013

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Eldoret (Rift Valley Province)

Background:

Kenya has a long history of local fish consumption. The population in the Lake Victoria area (Rift Valley Province) Northwest of Nairobi, and coastal communities (Coast Province) in the South coastal region, have historically included fish in their diet. Migration from villages to urban areas and increasing commerce has created an increase in seafood demand, and the demand is poised to expand even further. Moreover, there is growing recognition of the need for greater consumption of high quality protein such as fish. Fish also represents an important dietary source of essential fatty acids and minerals.

There are three principal fish species consumed in Kenya, Nile tilapia, *Oreochromis niloticus*, African sharptooth catfish, *Clarias gariepinus*, and dagaa also known as omena, *Rastrineobola argentea*, and one principal species for export, the Nile perch, *Lates niloticus*. Minor species cultured include common carp, *Labeo*, black bass, rainbow trout, and ornamental species. Nile tilapia constitutes about 90% of the extensive and semi-intensive production in Kenya [1].

Available coastal fish consist primarily of small dried fish sold in open-air markets and small restaurants. Few ocean fish are caught, and are generally not sold locally, but rather exported. Kenya's near-shore fishery is estimated at 7,400 tons/year, but deep sea offshore fishing is conducted principally by foreign ships under Kenyan licenses. A principal impediment to domestic consumption of fresh ocean fish in the inland regions is difficulty and cost of transport, and perishability.

Lake Victoria boasts bountiful fisheries. Total annual production of fish in Kenya in 2003 was 180,000 metric tons, with 92% coming from Lake Victoria [2]. A continuing problem faced by Kenyan fishers is that Lake Victoria's Kenyan lakeshore is choked with water hyacinths. This makes it difficult to launch and navigate boats, entangles fishing gear, and results in harvests of only small fish. The preferred large Lake Victoria fish are caught and imported from Uganda creating an inflationary effect on the price of fish. Nevertheless, the fisheries of Lake Victoria are in decline due to degradation and loss of habitat, and increasing fishing pressure. Between 1999 and 2009, annual fish production declined from 200,000 MT to 114,000 MT [3]. It is now widely accepted that production is above the maximum sustainable yield. In recognition, the Kenyan Government supports aquaculture for stock rehabilitation as well as meeting the demand for domestic food fish and export markets.

The Kenyan government, in addition to a variety of aid organizations and other NGOs have long supported and encouraged aquaculture activities with the objective of increasing inland fish production for both personal consumption and profit. The Kenyan Government recognizes that in addition to the health benefits of fish, aquaculture can contribute to poverty alleviation, food security, and social well-being.

Fish culture has developed differently among the various regions of Kenya with development shaped by regional constraints and challenges. North of Nairobi, an experimental fish station was built in conjunction with Eldoret University (EU), formerly known as Moi University. The station, originally established in 1984, is funded in support of the University's Aquaculture Collaborative Research Support Program (ACRSP).

In 2009, the Kenyan Government initiated efforts to provide stimulus to the country's economy. As a part the effort, the Ministry of Fisheries Development (MFD) established the Fish Farming Enterprise Productivity Programme (FFEPP). The activities outlined under this program were to employ underemployed youths to construct fish ponds, construct hatcheries to provide participant farmers with seedstock, stocking of ponds, fish feed production, fish harvesting and marketing, and provide training in fish farming. The labor for pond construction, initial seedstock, and feeds are subsidized for new participants in aquaculture. This program is popular and has had a positive impact. Several farmers show interest in starting or continuing with aquaculture, and there is demand for more fish production. The MFD estimates that as a result of their 5.7 billion Ksh investment in aquaculture, an additional 150,000 farmers throughout 160 constituencies have started culturing fish since 2009 [4].

Objective: To assess the potential for increasing aquaculture production in areas where protein deficiency will benefit from increased fish production.

Activities: Eldoret (Rift Valley Province) May 13-16

May 13, 2013

Geraldine Matolla, Department of Fisheries and Aquatic Sciences, Eldoret University met us at the airport. The first stop was a visit to University of Eldoret where we were introduced to Administrators, the Department Head Mr. Dean, and other Departmental faculty. The next stop was a visit to the University's Fish Station.

Introductions were made to the station's Manager and Assistant Manager Josiah and Sammy, respectively. The station was in good order with several ponds in production. The system consisted of a 1.2 ha spring fed reservoir, with several ponds of varying sizes fed by gravity

flow. There is 1.3 ha of culture ponds consisting of 25-100 m^2, 6-300 m^2, 4-1,000 m^2, and 2-2,000 m^2 ponds. The depth of the ponds were estimated at 2-3' by observation of a few ponds not in production. The ponds appeared well constructed with appropriate slope. The ponds are fed from the reservoir via valves, with drainage through standpipes into common canals and discharged into a papyrus swamp at the far end of the farm.

Photo 1. Fish station pond series.

A concern voiced by station personnel was the slow growth rates of the fish. The staff was disappointed in the size of fish harvested following 8-12 months of culture. They attributed the slow growth to low water temperatures described as a seasonal effect with low nighttime temperatures. Further questioning and a review of pond management records suggested that the seasonal drop in night temperature was not responsible for the slow growth rates. The cool nighttime temperatures generally did not last more than a week, two at most. Although morning pond temperatures had reached as low as 17 ^{o}C, they generally remained above 20 ^{o}C. While 20 ^{o}C is suboptimal and will affect growth, it is well above the lethal lower temperature of 11-12 ^{o}C. The temperature effect on growth over such a short time frame would likely not have more than a marginal effect over the course of an 8-12 month growout cycle.

As part of the FFEPP, farmers are supplied pelleted feed reported as 26-37% protein. The station no longer qualifying for the government subsidized feeds prepares their own on site. The pellets they produced were in poor condition, crumbling, resulting in approximately 70-80% fibrous and powdery fines. The staff indicated the diets consist principally of wheat bran, with neither

vegetable or fish oil. Dietary ingredients are mixed (premix)[1] and then a small, amount of wheat flour, approximately 5%, and water added to the premix prior to pelleting. It is likely the high carbohydrate/fiber, low fat (estimated 2.0%) content of the diet has insufficient digestible energy to efficiently utilize dietary protein for growth.

We requested to see the staff feed their fish. Feed is hand delivered, measured by container volume, not by weight. The fines quickly disbursed over the surface of the pond and were not readily available to the fish. Fish were observed skimming the surface of the pond; however, wind dispersal and sinking likely relegated the feed to an expensive organic fertilizer. Omena, used as the fish meal ingredient is expensive as it competes with human consumption, making this a costly inefficiency. Closer visual observation and tasting of the feed suggested the fish meal was incorporated at a lower rate than stated. It is possible, whether for economic or supply reasons the particular batch observed was not made with the full complement of fish meal.

Photo 2 Fish feed supplied by Kenya government.

Analysis of these feeds found the protein of the grow out feed and the fingerling feed to be 13% and 14% respectively.

The various ponds exhibited different levels of primary productivity, but most appeared to have adequate plankton blooms. It is well understood by the staff that primary productivity provides

[1] Diet premix: wheat bran 55%; fish meal 20%; cottonseed cake 12.5%; and sunflower meal12.5 %.

nutritional value to the fish. Station personnel stated routine fertilization was standard procedure. This consists of weekly applications of 300 g urea, 200 g ammonium phosphate, and 5 kg (dry wt.) chicken manure per 100 m^2 surface area. The cost is 2,500 and 3,500 Kenyan shillings (Ksh)/50 kg for the urea and ammonium phosphate, respectively. Chicken manure ranges from 80 to 100 Ksh for 35 or 40 kg, respectively. The total cost 16,600 Ksh/ha/mo. This is a routine procedure without regard to needs, water volume, or seasonal adjustments, and the staff seemed to be unaware of even simple methods for measuring light penetration.

Examination of pond management records indicated pH and dissolved oxygen are tested sporadically, but dissolved oxygen more regularly. The pH averaged between 8.5 and 9.1, and was likely a result of over fertilization. However, the staff admitted the pH meter is not routinely calibrated, with most of them not knowing this was necessary. Due to insufficient time and equipment, the alkalinity of the reservoir and ponds remain unknown at this time. The staff was informed the pH values were only marginally high for tilapia, but could be a problem under high ammonia levels. Morning dissolved oxygen levels recorded were generally low, sometimes reaching or even slightly below 1.0 mg/L, again likely a result of inadequate attention to pond/plankton management.

Stocking, harvesting, and feeding management were a concern. The Station manager stated they routinely stock 1000 fingerlings/100m^2, and practice multiple partial harvests. These partial harvests result in ponds with an imprecise and unknown biomass. Stunting was apparent and likely a result of multiple year classes and spawning among the mixed year classes. Reduced fish growth was likely due to overcrowding, insufficient quantity and quality of feed, poor pond management, and poor water quality. At the stocking rates routinely employed and without supplemental aeration and quality feeds, the stocks will continue to exhibit growth limiting stress.

The production of fingerlings was a little uncertain. Hapas of various conditions were observed in three ponds, two containing a moderate number of fry, with one having mixed sized fry. The bulk of the nutrition is plankton, although a small amount of supplemental feed is offered. However, there does not seem to be a standardized protocol for amount or number of

feedings/day. There was some desire expressed by the Department Head to explore and conduct experimentation with sex reversal. The station managers, clearly understanding the benefits of all male populations of tilapia also expressed a desire to implement 17-α-methyl testosterone sex reversal.

There was also discussion regarding species selection and spawning of *Clarias gariepinus*. However, this would require production of catfish fingerlings from their own stock. Due to funding and other constraints, the current protocol employed requires sacrificing fish to gather pituitary extracts for inducing spawning. In addition, the males of the African catfish cannot be stripped for milt and consequently the sperm is obtained by sacrificing males [5]. The station manager indicated they had difficulties in obtaining successful artificial spawns in the past. Production of catfish by this process is likely too technical for the training and resources available.

May 14, 2013

Geraldine Matolla met us in the morning to take us to the fish market in Eldoret to investigate the types, sizes, and availability of fish and fish products forms, as well as the cost and marketing of these products. We visited an open-air market that sold lake fish, principally tilapia from Lake Victoria. The fish are caught on the Uganda side of the Lake and imported at considerable expense. The Kenya side of the lake is currently choked with water hyacinths making it too difficult to launch and navigate boats, entangles nets and fishing gear, and only smaller fish are harvested. The Kenyan fishers are also felt to be at a disadvantage relative to the Ugandans as the Kenyan fishers tend to be small artisanal fishers, whereas Ugandans utilize a more industrial approach. These factors paired with transportation costs, bribery at the border, and fish shortages have combined to drive up the price of fish.

The fish in the market were plentiful and ranged from 150 g to over 2 kg, with the majority above 1.5 kg, which is the desired size. A few fish dealers were willing to share information regarding their businesses and demand for product. The size of fish is important. Consumers generally want a two to three kg fish. This size was selling for 400 Ksh/kg, and smaller fish (less than 350 g) were selling for 150 Ksh/fish. One retailer claimed sales per day average over

20,000 Ksh, or approximately 50 kg/day. Fish can be purchased as fresh gutted, whole, scaled and scored, or as steaks. Some fish were gutted, scaled, scored and fried, or smoked. Many retailers had associated kitchens where the fish could be prepared for immediate consumption.

One retailer was adamant that his customers would not buy cultured fish because they were too small. However, they will buy smaller processed products. He also stated they could distinguish a difference in taste and texture from the wild caught fish, wild caught being preferred. In addition, he won't buy cultured fish because of their small size. The MFD has established a minimum size for lake fish as part of their management plan due to the stock declines in Lake Victoria. It is currently illegal to sell undersized fish in Kenya. Size of marketed pond raised fish frequently coincides with the size of these illegal fish. Nevertheless, several retailers did have smaller fish.

Photo 3 Market products

These small retail businesses employ between 4-6 people. The employees assist in daily runs to Lake Victoria to make fish purchases, assist in sales, and process the fish. Workers are generally paid according to their processing productivity. Many of the business owners in the market started this way, using their earnings to purchase fish to retail. An average worker can make about 400 Ksh/day, and more with greater productivity. Cooked fish was cheaper than fresh, approximately 300 Ksh/kg for cooked relative to 400Ksh/kg for fresh. Consumers prefer the flexibility of the fresh product. When purchased fresh it is usually prepared the same day.

Several of the business owners stated they sell over 50-100kg/day and sell out daily. Cost of transportation remains unknown, but fluctuates seasonally and is subject to other political and

economic considerations. However, information on transportation would allow a better economic comparison between locally pond produced fish and Ugandan imports.
A considerable amount of processing waste was observed. Waste removal is also an important business consideration. One retailer was questioned as to the amount of processing waste her business generated daily. Based on her sales volume and waste generated, it was calculated for every 50 kg of fish processed, there was the potential for 5 kg of processing waste. This equates to 1.5 kg dry weight of high protein (~ 50%) and fish oil (~ 30%) per retailer/day. There were at least ten fish seller/processors at this small market who sell five days per week. This could equate to the sale of up to500kg of fish sold at the market per day or 2500kg/week with 750kg of dry matter waste/week. When asked what she did with it she said she disposed of it, or sometimes fed it to swine. This product could make a valuable commodity as a feed ingredient.

One of the concerns expressed by the Station manager was the inability to find local feed ingredients, particularly oil, for manufacturing their fish feeds. Local conventional markets were visited to identify potential feed ingredients for a short-term fix. Companion animal feed bags were also examined to identify local feed mills. There are several pet feed companies in and around Nairobi. Potential feed ingredients, particularly oils, is cost prohibitive if only retail purchasing is available.

Photo 4 Sample of feed companies Kenya

May 15, 2013

Geraldine Matolla provided transport to the Fish Station for a scheduled fish farmer's field day. There were 47 current and potential farmers present to extract information, express concerns, and seek advice. Activities were officially postponed the night before the event due to a scheduling conflict involving the University's Vice Chancellor. The field day was advertised in print and on

the radio. It was uncertain how many potential participants had received word of the postponement, therefore we decided to attend for those that might not have received the word. Given the circumstances, participation was exceptional. Activities lasted most of the afternoon. The three most expressed concerns with pond production were the following:

1) A need for identifying and accessing affordable feed ingredients, and knowledge about formulating and manufacturing affordable fish feeds;
2) How to sell and market pond-raised fish at fair-market value in competition with Lake harvested fish;
3) How to manage predators such as turtles, birds, snakes, and river otters.

Photo 5 Seining a pond, Farmers Field Day.

Photo 6 Sizing and sexing of tilapia.

There were demonstrations on seining, harvesting, sex identification, water quality, pond management, feeding, and water management. Following the demonstrations, several farmers asked questions about pond construction and management, fish farming in general, and several questions were fielded regarding the three aforementioned issues. Although many of the active or potential farmers displayed an enthusiasm for more intensive culture, their knowledge base, access to resources, training, and extension services suggest extensive culture is more suitable.

We met with Mr. Mashuca, an extension agent for the Government. He works with approximately 300 farmers. In the late 1990's the Department of Fisheries and Aquatic Sciences at EU (then Moi University) provided fingerlings and training in pond management and construction [6]. However, training of extension agents was transferred to the Sagana Fingerling Production Station, some 227 miles away. One of the objectives of the FFEPP (Strategic Objective 4), is to strengthen the Ministry's aquaculture extension services to serve newly formed fish farmer clusters [7]. Mr. Mashuca is one of 12 aquaculture extension agents working with farmers in the district. These extension agents are divided among12 regions. The knowledge base and training of these agents varies widely and in some regards may be inadequate.

Mr. Mushuca accompanied us to three different farms and a feed mill co-operative. At the first site we did not meet with the farmer, but reviewed his pond construction and were informed about his management and harvesting practices by Mr. Mushuca. The pond was approximately 0.25 acre (0.1 ha), and lined with a plastic liner. Later it was discovered most fish farmers have been led to believe all fish ponds require liners. This is likely a result of the FFEPP strategic objective to construct at least 200 ponds in each of 140 constituencies, regardless the area or consideration for pond siting. As discussed below, poor siting has resulted in some ponds being constructed in rocky shale-laden soil following stripping of the clay-rich topsoil. With proper siting, many of the ponds constructed with expensive plastic liners would likely not need them.

At the second and third sites, we were met by the pond owners. Both farmesr had two active ponds in production and one was in the process of constructing a third. All ponds were approximately 200 m^2 in surface area and spring fed. The ponds appeared well constructed,

although they may have benefitted from slightly greater slope on the levies. The ponds under production had well established blooms.

The first farmer fed his fish with pelleted feed, albeit only once per day. The feed was obtained from a Government source, presumably from the area Co-operative or a feed mill under government contract. The farmer did express concern about replacing his feed when it is depleted, because of the high cost. Mr. Mashuca explained this farmer carries out regular pond harvests. He also stated this was one of the better farmers in his region.

The farmers in Mr. Mushuca's domain utilizing the government subsidized feed. The feed appeared to be of very poor quality, with little if any oil, containing low quality protein, and poorly manufactured. Unfortunately, this seems to be the industry standard in Kenya. One of the major constraints to successful expansion of aquaculture throughout Kenya is access to high quality feed ingredients and to quality affordable feeds [8]. Insufficient knowledge, inadequate equipment, poor understanding of feed formulations, poor access to affordable quality feed ingredients, insufficient information regarding ingredient composition, and insufficient numbers of feed manufacturers contribute to the high cost and poor quality of the fish feeds. The cost of feed keeps many farmers from feeding their fish. Moreover, a lack of suitable, affordable feeds was responsible for withdrawal of an integrated hatchery and growout commercial venture [9].

Photo 7 Pond construction near Eldoret

One of the strategic objectives of the FFEPP was to organize and register 15-100 farmers into clusters. The clusters, are to be encouraged to evolve into Co-operative movements to coordinate activities and for the distribution of fingerlings, feeds, and other inputs. To address the high cost of fish feed, the government has procured pelleting machines and given them to the Co-operatives to make their own feeds with locally available ingredients.

The area's Co-operative feed mill consisted of a grinder, mixer, and cold pressed pelleting machine. An operator for the equipment has been identified and he manufactures the feed as needed. Their current formulation calls for cottonseed meal mixed with wheat bran. Wheat flour was used as a binder; however, without the benefit of extrusion, the pellets are not stable and crumble easily. Using it in the ponds in this capacity, the feed does little more than serve as an expensive pond fertilizer. Samples of feed from the fish station in Eldoret, and manufactured fry and fingerling feeds provided through Government subsidies were collected. Dr. Riche is currently analyzing the feed for nutritional composition.

Photo 8 Feed manufacture equipment; sifter, mixer, pelleter

May 16, 2013

Transport to Eldoret International Airport for conveyance to Nairobi.

Observations:

There is tremendous interest and opportunity in this area to make fish available through pond production. The University of Eldoret has done an excellent job at making the station available for demonstration and practical applications. The staff and several farmers along with the area

extension agent have a fairly good understanding of the principals of aquaculture; however, all could benefit from refresher courses and in-service training. It appears technical aspects of site selection, good management practices, feed development and composition, pond management, water quality requirements, and species selection were insufficient. Lack of technical training is often cited as a major challenge to expansion of aquaculture in Kenya. There have been attempts to remedy this through training Fisheries Officers (FO) as extension specialists at Moi University and Sagana CRSP from 1999-2000. It was anticipated these personnel would provide extension services, and in turn would become trainers themselves. However, many FO were reassigned or left their positions, and their replacements, when filled did not have the same level of training. It is suspected much of the knowledge and techniques originally obtained have been lost or forgotten over the years. The Kenyan Government has established several aquaculture facilities across the country, and currently boasts of eight important ones. These facilities serve as research centers, training facilities for fisheries personnel and fish farmers, aquaculture demonstration centers and as a source of fingerlings for farmers. However, with turnover of FO and the quick explosion in numbers of fish farmers, it is likely the large number of new producers are being inadequately served, especially in areas far from the training facilities. It should also be recognized, historically there has been an uncoordinated promotion of aquaculture through the efforts of the Government, research institutions, Universities, NGOs that has hindered aquaculture, as farmers are left confused by extension personnel and other experts that give varying information.

It is clear the MFD's 5.7 billion Ksh investment was successful in its bid to increase aquaculture production. The program is reported to have created employment for over 28,000 fish farmers, short-term employment for over 280,000 youths, indirect employment of over 140,000 in support sectors, and created a demand for 28 million fingerlings and 14,000 tons of fish feed [10]. However, most of the increase in pond and farmer numbers are small subsistence ponds distributed over a broad area (160 constituencies). Inputs including labor, seedstock, and feeds were subsidized by the Ministry for these new participants in aquaculture. What is less certain is what will happen to these subsistence farmers when government subsidies are no longer available. It is unclear if the extension services are adequate or will remain in place, or how farmers will be able to continue to pay for feed and seedstock for production.

Recommendations:

There is a tremendous need for development and implementation of an in-depth, hands-on training program for farmers, and more importantly for extension personnel. This training should consist of modules that include: site selection, pond construction, water quality and management and compost building, stocking, sexing, hatchery development and management, feed stuffs and supplemental feeds and feeding rate, pond management, harvesting, record keeping, marketing and sales, pond repair and restocking.

There exists both a perceived and real need for diversification into other fish species for pond culture. Diversification leads to greater opportunities for economic return and can reduce the wide price fluctuations in the market due to periods of over-supply and shortages. Additionally, diversification provides some measure of protection against devastating industry losses.

Due to the level of training and resource availability, it is recommended that extensive culture using tilapia and catfish be stressed. For subsistence farmers the use of local fertilizers such as manure, local plant matter and kitchen waste to fertilize the ponds for plankton production should be stressed. Ponds should be stocked with tilapia at a rate of 3 fingerlings per m^2 and utilization of supplemental feeds consisting of local plant material and insect larvae, where available. Natural spawning within the pond management scheme should be emphasized. Similarly, 6 month production cycles should be emphasized with a full harvest every 6-7 months, a farmer with 6 ponds could harvest every month. Where possible, ponds could be constructed such that they empty from one into another to conserve inputs (fertilizer, plankton, and other nutrients) and water would be reused, water conservation being more important in arid and semi-arid regions. Natural spawning and fry management would allow re-stocking of fingerlings without the need for purchasing seedstock. A training program is essential for this area. It is believed that the interest is there for significant development.

In addition to fish farmer training, it is recommended regular in-service training and refresher courses for both fish station and extension personnel be offered. Such training would allow

opportunities for personnel to keep abreast of new developments in genetics, breeding, nutrition, disease control, and pond management. The exchanges afforded between field technicians at such trainings would not only foster collegiality, but also foster the exchange of ideas and allow personnel to share experiences on how to address similar situations. There would also be benefit from development and implementation of training to graduate extensive culture onto more intensive culture through higher level training modules.

It is recognized the MFD has attempted to address the high cost of feeds by donating feed manufacturing equipment to fish farmer Co-operatives. It is recommended that a training platform be developed to train farmer Co-operative members and at other potential training sites, such as the fish station at Eldoret, how to identify and source quality feed ingredients, procurement of ingredients, and appropriate methods for mixing, pelleting, drying, and storage of feed. It is further recommended that this platform include training in feed formulation and ingredient composition. It is imperative these "feed manufacturers" understand the importance of nutritionally complete and balanced feeds, and that suitable binders from local available sources be identified and incorporated into their feeds. While the Government's efforts to encourage private enterprise to manufacture feeds is commendable, there remains a considerable and fundamental lack of understanding regarding the manufacture of fish feeds, not just among the farmer's Co-operatives and other on-site manufacturers, but within the feed mills on Government contracts themselves.

Mnyenzini (Coast Province)

Background:

At the request of The Institute for Self Reliant Agriculture (SRA) a visit was made to the Koins for Kenya Center, Mnyenzeni, Kenya. The work was conducted in and around the village of Mnyenzeni, approximately 20 km NE of Mombasa. SRA has developed a working relationship with Koins for Kenya, a non-profit 501(c)3 community development organization. Koins for Kenya activities include school construction and classroom renovation, education, providing safe drinking water, establishing scholarships, training in micro-businesses, providing health and nutrition education, women's health services, and assistance and training in agriculture and

animal sciences for a community that covers 150 sq. mi. SRA provides funding and support in three principal areas; animal husbandry of goats and chickens, nutritional studies evaluating the link between increased protein intake (goat's milk) and health and school performance, and use of rotational gardens that are designed to minimize water evaporation.

Mnyenzeni lies within the Duruma-Wajir Low Belt geographical region of Kenya. The region is characterized as having both gentle and steep sided river valleys with well developed alluvial sections made up gently sloping, seasonally swampy grounds. Rain occurs as very localized and intense storms, which cause flooding and heavy runoffs. Precipitation generally comes during each of two seasons known as the long rains and the short rains, separated by dry seasons. The nearby valleys drain into the Mwatate drainage basin and out to the Indian Ocean. The climate is classified as semi-arid and vegetation as bushland. All streams within the drainage basin are classified as intermittent with regular occurrences of complete drying.

Objectives: To assess the potential for water retention systems that would serve to increased water availability, fish production and irrigation capacity in an area where water is very limited and protein deficiency is very prevalent.

Activities: Mnyenzini (Coast Province) May 18-22

SRA requested assistance to look at water issues for crop irrigation, and vegetable and protein production. Access to safe and sufficient drinking water is also a problem, however it was decided there was insufficient time to focus on all three issues. It was decided to focus on irrigation and protein production implementing aquaculture. It appears this region of the country is less familiar with aquaculture production, which is likely a function of its proximity to the coast.

<u>Aquaculture</u>

Two farmers were visited in Gona B village, a small village near Mnyenzeni. One of the strategic objectives of Phase II of the FFEPP is to harness rainwater at the household level to further enhance sustainable aquaculture. Whether, it was the intent of this strategic objective, or misinterpretation is not clear, but both farmers had constructed small ponds next to their homes to catch rainwater from their rooftops to fill and maintain water levels in their ponds.

The first farmer visited was Mechizi Ngati Chambuli. Mr. Chambuli constructed two ponds next to each other, both approximately 25 m^2. Both ponds were lined with plastic liners and covered with water cabbage (*Pistia* sp.). The expense of the liners limits pond size, and therefore production. The water cabbage is cultured to minimize evaporation; however, light penetration was minimized prohibiting phytoplankton development, serving to reduce nutritional benefits and oxygen production. The fish raised in these ponds were very small and stunted. It could not be determined if supplemental feeding with pelleted feeds was being implemented. Mr. Chambuli practiced partial harvests for personal consumption, not for profit. His harvesting strategy was to take the larger fish from pond 1 for consumption, and remove the small fish and place them in pond 2. Then from pond 2, take the larger fish and place them in pond 1. This was his management practice for two years. It was easily ascertained that the multiple fish removals and transfers led to the inability to assess the biomass within the two ponds. Stunting was likely a result of multiple year classes and spawning among the mixed year classes.

The second farmer visited was Swafia Shabani. Similar to Mr. Chambuli, Mr. Shabani had built a small pond next to his home, also approximately 25 m^2. We were requested to assist Mr. Shabani harvest his pond. This pond was also covered with water cabbage, in addition to being shaded. There was little evidence of plankton. Following removal of the water cabbage, several passes were made through the pond attempting to harvest fish with a mosquito net. The net neither reached the bottom, nor stretched from side to side. Approximately five fish were captured, averaging 1.0-1.5 g each. There was no evidence of larger fish. Mr. Shabani claimed to have harvested fish on a number of occasions for personal consumption. It was not clear if the pond had been restocked.

Like Eldoret, there is an extension agent in the region. We met with Santa Mwateni, Divisonal Agriculture Extension Officer, and Gideon Mutua, Agriculture Extension Officer, both with the Kasemeni Division. It is unclear at this time whether these extension agents have been trained in fish culture and pond construction, or if they provide aquaculture extension services in this area. It seemed readily apparent that both Mr. Chambuli and Mr. Shabani were receiving instruction regarding pond construction and management from the same source.

Photo 9 Harvesting local pond production in Gona B village, Kenya

Water Retention and Management

On May 19, we were taken on a tour of a few adjacent valleys within the area covered by the Koins for Kenya community projects, to assess the existing water delivery system. Several valleys were observed with well developed gentle slopes. There are a series of cisterns and lift stations for water delivery throughout the valley. This system has fallen in disrepair and/or has been vandalized. There were several areas where reservoirs had been constructed or excavated for access to drinking water and irrigation. Small earthen dams were constructed in Miyani and Mnyenzeni, and a few scattered hand-pump wells were observed. The dam in Mnyenzeni is used to fill a 0.2 ha watering hole.

Photo 10 Pond dug for water retention after levy failed.

There were several ponds where the clay soil was removed and the ponds were dug into the rocky shale-laden soil layer. This led to several wash-outs and inefficient use of dam height without the ability to capture or retain water level. In Photo 9 it is evident that siting was adequate and suitable for capture of rainwater. However the execution of construction and construction materials were inadequate, leading to the failure.

The area has significant potential to capture rainwater and run-off in several of the valleys through pond/reservoir development. These reservoirs could then be linked in series to supply fish ponds with water and provide crop irrigation during the dry season when needed.

Photo 11 Sloping valleys prime for pond system development

A presentation was given to the SRA group and Koins for Kenya personnel. After a few days of discussion and questions, the SRA group had gained a better understanding of the benefits of, and potential for aquaculture development in the area. It was recommended to SRA and Koins for Kenya to do a thorough life cycle-type assessment of proposed projects. Such an assessment can be used as a tool for getting community buy-in prior to initiating any large project. SRA also benefitted from experiencing the grassroots development implementing the Koins' philosophy of farmer ownership and community buy-in. Large dam development was discouraged because of the environmental and community impacts such development brings. It was determined that there was no need for large dam development to achieve sustainable extensive aquaculture programs in the area utilizing the natural strengths and resources within the area.

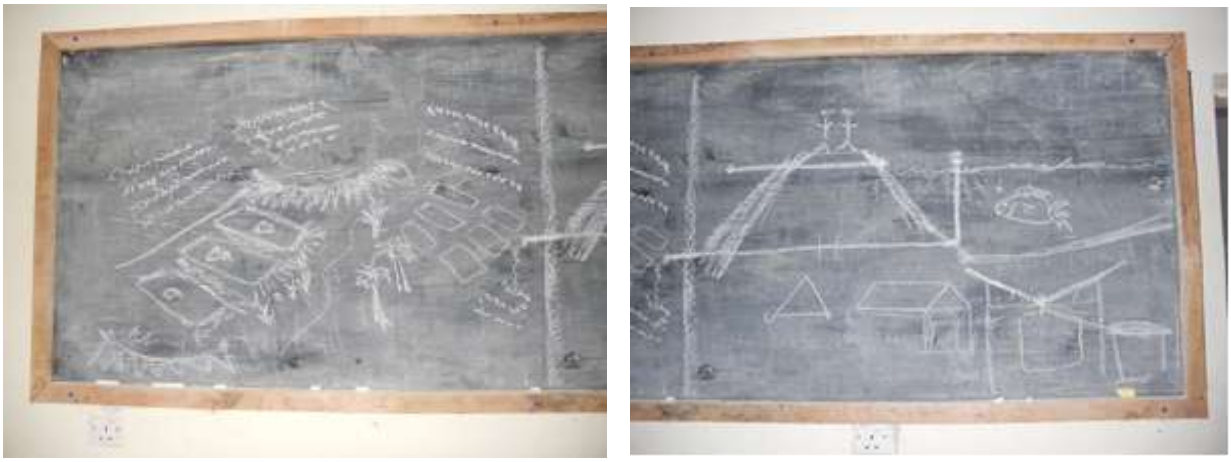

Photo 12 diagram of pond series and levy design cross cut.

Observations:

There is a tremendous "Western world" influence in this area due to the long-standing relationship and work of the Koins for Kenya group. The staff at Koins for Kenya include an animal scientist and horticulturalist, as well as a health education specialist, and nutritionist. The community and families that work with and benefit from this group have vested interests in the schools, and the training and support they receive in animal husbandry, rotational garden and crop production, and micro-business development. There is also tremendous interest in fish production. More importantly, they are in need of water retention for irrigation and survival. Several valleys would lend themselves to pond production that could provide both protein and water for animal husbandry and irrigation.

Recommendations:

Establish both American and host country teams to identify suitable and appropriate sites for reservoir and pond construction, and to work closely with stakeholders and the community. Identify the village champions that will work with farmers in the area. Nurture these farmers and extension personnel to educate them about the benefits of, and the potential for aquaculture. Educate the champions, farmers, and community what a properly managed pond can produce, both for sale and consumption. It is recommended that one of the schools be identified to implement a pond system and use that system as a community demonstration site. It is further

recommended that the local extension agents and some of the Koins for Kenya staff be encouraged to attend pond construction and pond management training in Eldoret.

Work closely with the local extension agents, as well as the Koins' animal scientist and horticulturalist to develop and implement a local training program. This program would include: all aspects of site selection, pond construction, water quality and management, compost building, stocking, sexing, hatchery development and management, feed stuffs, supplemental feeds and appropriate feeding rates, pond management, harvesting, record keeping, marketing and sales, pond repair and restocking. These trained extension agents would then train interested farmers and as they develop, additional technical training could be offered to increase production intensity.

It is also recommended that the Koins for Kenya community stock the community watering hole with fish as abatement for malaria. A mix of Nile tilapia and mosquito fish are recommended as both feed on mosquito larvae, but fill different ecological niches.

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