DEVELOPING TILAPIA AQUACULTURE IN HAITI: OPPORTUNITIES, CONSTRAINTS, AND ACTION ITEMS

PROCEEDINGS OF A WORKSHOP SPONSORED BY NOVUS INTERNATIONAL, AQUACULTURE WITHOUT FRONTIERS, THE WORLD AQUACULTURE SOCIETY, AND THE MARINE BIOLOGICAL LABORATORY

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NOVUS
SOLUTIONS SERVICE SUSTAINABILITY℠

AQUACULTURE WITHOUT FRONTIERS

WORLD AQUACULTURE SOCIETY

MBL Biological Discovery in Woods Hole

FOREWARD

After the devastating earthquake in 2010, informal discussions were held about potential forms of a post-crisis engagement with the part of the recovery and redevelopment process that involved aquaculture. This document represents the synthesis of discussions held at a consultative meeting organized and supported by Novus International, the Marine Biological Laboratory at Woods Hole, Aquaculture without Frontiers, and the World Aquaculture Society. Around 50 representatives participated in a one-day facilitated meeting in New Orleans, LA, in February, 2011.

The workshop brought together three groups interested in earthquake recovery and aquaculture development of the country: 1) Haitians working on the ground, including hatchery operators, tilapia growers, government officials, individuals and groups implementing projects for NGOs, and entrepreneurs; 2) generalists working for small to large, usually faith-based NGOs with a diverse portfolio of activities, including but not emphasizing small-scale aquaculture; 3) experienced scientists and commercial practitioners representing best practices and collective wisdom. To provide context, presentations were made about the current situation with aquaculture in Haiti. Then the group identified and discussed 1) models with the best potential for commercial development, 2) regions with the most suitable sites for ponds, 3) opportunities and constraints to aquaculture development, and 4) prioritized items for action.

The intent of this white paper is to summarize the proceedings of the workshop to provide guidance for decision-makers in business, government, and the NGO community. This document can bring focus to efforts to overcome the main impediments to the development of a cultured tilapia value chain in Haiti, with emphasis on feed, seed, and technology transfer.

EXECUTIVE SUMMARY

Establishing commercial-scale tilapia aquaculture in Haiti can contribute to economic development by providing employment opportunities throughout the value chain, especially in marketing. Aquaculture small and medium enterprises can be developed as export-oriented agribusinesses. Aquaculture development can also increase the local supply of fish, thereby improving human nutrition and national food security.

Although subsistence-level, non-commercial aquaculture has a role to play in providing fish to families and communities, small-scale models have limited potential for profitability and there is a need to develop aquaculture in Haiti as an agribusiness activity. Two production models were identified as having the best potential to serve as the basis for a commercial tilapia aquaculture sector in Haiti: combined reservoir-fish ponds-garden system and cage culture.

The best sites for tilapia pond aquaculture in Haiti are in the Central Plateau and the Northeast, near Fort Liberté, where layers of clay soil are sufficiently deep for pond construction. Areas with some but less potential are the Artibonite Plain, the Leogane Plain, the area near Nippes, and the Les Cayes Plain. There are numerous large natural lakes and constructed reservoirs that are suitable for commercial cage aquaculture.

The main opportunities for aquaculture development are the large local market demand for fish, the availability of skilled technicians to manage commercial operations, a low wage rate for unskilled labor, local hatcheries that produce tilapia seed, and the availability of some local feedstuffs that can be used in production of pelleted feeds.

The main constraints on aquaculture development are a lack of capital investment, a restricted availability of suitable sites for facilities, issues around the importation of feed and feed ingredients, a general lack of infrastructure to support aquaculture, and an absence of technology transfer programs.

The highest priority for action is the development of a local aquafeed production capacity. Other high-priority action items include the need for a system to provide farmers with information and training, the need to develop and demonstrate successful, commercially profitable, production system models, and the need to develop and implement a coordinated plan to support government policy.

INTRODUCTION

Haiti is the poorest country in the western hemisphere and among the poorest countries in the world. The Human Development Index (from the UNDP) is an index of well-being that combines measures of health, education and income; Haiti ranks 158 of 187 countries. Life expectancy is 62.1 years and per capita income is $1123/year, both lowest in the region. In Haiti, 72.1 percent live in poverty (less than $2 per day) and 54.9 percent of the population lives in extreme poverty (less than $1.25 per day).

The country has a population of 10.1 million and the population density of Haiti is among the highest in the world, at 363 per km^2, similar to the population density of Israel and India. Of countries with at least 10 million people, the population density of Haiti ranks fifth. Obviously this puts extreme pressure on an already degraded landscape, limiting the land's capacity to produce food and for the country to achieve food security.

The country does not grow enough crops or livestock to feed the people; over 60 percent of all food is imported. As with other foods, fish must be imported to meet national demand. Nearshore fisheries are overexploited and the degraded coastal environment is producing below potential, limiting local supply. Inland lakes and rivers are also overexploited. The current per capita consumption of fish in Haiti (4.5 kg/year) is far below the global average (18 kg/year), suggesting a large latent demand for fish in the local market.

After the 2010 earthquake, and following a period to address critical and immediate humanitarian needs, the focus has now shifted to long-term recovery. Agriculture development in rural areas is seen as a way to relieve pressure on the capital city. Tilapia aquaculture has received renewed attention as an option for economic development in Haiti.

COMMERCIAL CULTURE SYSTEMS

The prevailing view in the meeting was that successful aquaculture development in Haiti requires a commercial approach. Non-commercial, subsistence tilapia ponds less than 600 m^2 provide food for an extended family and neighbors but are not profitable. For various reasons, an entrepreneurial

approach to aquaculture in Haiti is lacking. The ideal culture system in Haiti is simple and labor-intensive; it must be economically sustainable. As such, it must be a fed system, although fertilized ponds may be suitable if pond size is sufficiently large. Two production systems were considered to have the best potential for commercial development.

Reservoir-Fish Pond-Garden. In this integrated system, a relatively large reservoir collects surface water runoff or streamflow. The reservoir stores water for use in smaller aquaculture production ponds. In commercial tilapia production, grow-out is divided into at least three stages. As needed, water can be siphoned or drained from production ponds to irrigate vegetable gardens. In Haiti, there are 154 reservoirs, 33 of which are capable of supporting three-stage commercial production.

Cage Culture. Multiple small-volume, high-density cages are placed in undrainable natural lakes or reservoirs. Fish are fed a pelleted diet that fully meets the nutritional requirements of the fish. Management of cages requires only 45 minutes of labor each day, indicating that it can supplement or complement other livelihood activities. Commercial cage culture is currently practiced in Lake Azuei and Lake Peligre.

Both culture systems are amenable to concentrated areas of aquaculture development, which contributes to regional economies-of-scale. For these culture systems, multiple production scales are possible, ranging from small scale to provide food for household or community consumption to commercial-scale enterprises for domestic or export markets.

BEST SITES FOR TILAPIA AQUACULTURE

There is a range of geographic types in Haiti, including coastal plains, plateaus, and many steep hills. Only 20 percent of land in the country has topography that is sufficiently flat for fish pond construction. Site selection is constrained by the availability of land with slope, soil type, and elevation that does not limit pond construction.

Despite restrictions imposed mostly by slope, there are numerous suitable sites for tilapia culture in ponds or cages. On flat or gently sloping land, the availability of water and well-graded soils for pond construction varies regionally in Haiti. The areas identified below represent regions where production farms can be clustered and economies-of-scale can be realized. Clustering applies to pond and cage aquaculture farms. Appropriate site section criteria and governmental oversight will be necessary to properly plan and regulate development of sustainable clusters.

Central Plateau. The best sites for pond aquaculture in Haiti are in the Central Plateau. The soil has clay and is good for pond construction. There are many (53) ponds and reservoirs, ranging from 2.2 – 22 acres. Caribbean Harvest operates a tilapia hatchery near Lake Peligre. The Central Plateau is also suited for an assortment of agribusiness options that could synergize with pond aquaculture.

Northeast – Ft. Liberte area. The region has excellent clay soil for pond aquaculture. There are seven lakes for aquaculture, ranging from 2 – 32 acres. There is an 8-acre fish farm that was renovated in 2008 and expanded in 2011 by the UN.

Artibonite Plain. The soil in the Artibonite Plain contains clay but the clay layer is not sufficiently deep for pond construction. There is excellent potential for rice-fish culture in the country's main rice-growing area in the lower reaches of the valley. There is also a government-owned and operated fish hatchery at Pont Sonde near Saint-Marc.

Leogane Plain and Nippes. The soil in this area contains clay but the layer is not sufficiently deep for pond construction. There are existing fish farms at Kiskeya (six 1000-m^2 ponds) and Christianville (concrete tanks).

Les Cayes Plain. There is some potential for pond aquaculture and rice-fish culture, but the area is subject to flooding.

There are numerous large lakes and reservoirs that are suitable for cage aquaculture.

Lake Azuei	22,000 acres
Lake Peligre	5,500 acres
Lake Miragoane	2,500 acres
Lagoon aux Boeuf	3,000 acres (brackishwater lagoon in the northeast)
Trou Caiman	800 acres

OPPORTUNITIES AND CONSTRAINTS ON AQUACULTURE DEVELOPMENT

Opportunities

The eroded hills, tumultuous history, and misery of the Haitian people are well-known to the outside world. This reinforces the impression of poor potential for sustainable development in Haiti. However, beyond a year-round temperature regime that is favorable for tilapia growth, there are other justifications to support aquaculture development.

There is a considerable local demand for fish. The local demand for fish in Haiti is about 17,000-20,000 mt/year. Domestic marine fisheries production is 5,000 mt/year and aquaculture and inland fisheries adds another 600 mt/year. Thus, there is a considerable shortfall (12,500 mt) that must be met by seafood imports, mostly in the form of salted or smoked fish. Per capita seafood consumption in Haiti is 4.5 kg/y, compared to a global average of more than 18 kg/y, indicating a large scope to increase fish consumption. There is also a good market for seafood in the Dominican Republic and the United States.

Trained technicians are available. More than 200 trained agronomists graduate every year with few opportunities for employment. Although inexperienced, agronomists are knowledgeable, and are capable of managing aquaculture farms with additional training. There is an Aquaculture Learning Center in Marigot, near Jacmel for basic training. Another training center recently opened at the University Notre Dame in Les Cayes.

The wage rate for low-skilled labor is low. The average wage rate is very low (US$3.00/day). The official unemployment rate is 43 percent, although it is likely greater. About 70 percent of the population earns less than US$2 per day and 54 percent earns less than US$1 per day. About half of the workforce is engaged in agriculture.

There is potential for development of local sources of plant feedstuffs for aquafeeds. The plant protein sources of *Jatropha*, sweet sorghum, moringa, leucaena, peanut, and cassava may offer potential for use in local feed manufacture. There are technical issues to resolve with the use of *Jatropha* in animal feeds but progress with digestibility, amino acid profile, and anti-toxins is encouraging. There are opportunities for corn production or supplemental feed, such as duckweed in integrated systems. There is one brewery (Prestige) in Haiti that produces brewer's waste. Other materials available include sugarcane bagasse and aquatic macrophytes.

Other opportunities identified included:

- Tilapia seed are available from several hatcheries.
- Existing national microfinance institutions (MFI) provide financial services to the poor.
- The government-owned station at Damien and other under-utilized government facilities are available as a business opportunity, although renovation would be required.

Constraints

The following items are considered lacking to a sufficient degree or extent to constrain the development of a farmed tilapia value chain in Haiti.

Capital investment. There is insufficient willingness to lend seed capital or provide credit from private or public lenders to potential investors. The risk of investing in aquaculture in Haiti is perceived to be greater than the potential benefits.

Suitable land or sites. Only 20 percent of the land area has slopes suitable for pond aquaculture. The best sites were identified and described in a previous section.

Feed. At this time, feed must be imported from the USA, although it is also available in the Dominican Republic. There is no feed mill for aquafeeds in Haiti. However, there are two feed mills that produce poultry feed and have the basic equipment. Operating a feed mill profitably is constrained by the need to source ingredients on the global commodity market and the lack of a local, feed-based, commercial animal agriculture sector that includes tilapia. Establishing a mill cannot be justified by the current local demand for aquafeed. Costs for shipping and handling imported feed are substantial. The logistics of shipping, handling and storage in port, clearing customs, and local transport are difficult.

Infrastructure. Although there have been some recent improvements, better transportation infrastructure is needed for distribution of feed, live fingerlings, and other inputs to farms, and products to market. Cold storage and ice-making facilities are needed to develop a cold chain to maintain product quality and minimize post-harvest losses. An unreliable electricity generation capacity and power distribution grid constrains cost-effective operation of mechanical equipment such as pumps and aerators.

Education, training, and technology- transfer programs. A system to extend knowledge and experience about culture techniques and best practices to farmers is not functional. Although this can be seen as symptomatic of weak government institutions, training programs can be conducted by NGOs, hatcheries, and perhaps in the future, feed mills. A central source of technical information, market data, maps, and contacts is needed.

Apart from these specific items that are lacking, there are larger-scale issues and concerns that can constrain aquaculture development. Prices on the global commodity grain markets will affect local feed price. Poor governance and weak government institutions present a chaotic enabling environment for business activity. Poor sanitation, combined with aquaculture, could raise public health concerns, particularly in light of the national cholera epidemic.

Finally, there is no consensus on an overall strategy for aquaculture among the relevant entities working in Haiti. Many organizations and groups are doing what they think is best but the effort is not coordinated, nor is it necessarily aligned with national priorities. Some kind of national consortium on aquaculture could be organized to improve communication and coordination.

Other miscellaneous constraints identified include needs for:

- research infrastructure
- research on aquaculture under specific local conditions.
- all-male fry
- broodstock management
- product marketing, esp. color variants
- long-term commitment to projects
- access to equipment, materials and supplies
- working with the culture

PRIORITIES FOR ACTION

The group recognized that resources for aquaculture development and investment in Haiti are limited. Therefore, workshop participants developed a prioritized list of action items based on facilitated discussions and a quantitative prioritization exercise. Highest priority items are considered essential for the expansion of an aquaculture sector in Haiti

Highest Priority

Develop a local aquafeed production capacity. Currently no feed mill in Haiti produces aquafeeds, which are currently imported. A feed mill with the necessary equipment to produce aquafeeds is seen as indispensable to the development of commercial aquaculture. The feed mill could be multi-purpose, producing feeds for poultry and fish. Developing a minimum local fish and poultry production capacity is necessary to create the incentive for an investment in a feed mill. A better understanding of the types and quantities of local ingredients is necessary to know the requirement for imported ingredients, critical to knowing the economics of feed manufacture. The cost-effective import of feeds manufactured outside the country should be explored as an alternative to developing local fish feed production capacity.

High Priority

Develop a system for providing farmers with information and training. A training curriculum relevant for fish farmers in Haiti is needed. A system for information exchange is also needed. Extension services can be provided by hatcheries, feed mills, and government agencies, and farmer-leaders.

Develop and demonstrate successful, commercially profitable, production system models. The models considered to have the best potential are 1) integrated reservoir - pond - garden system and 2) cage system for lakes.

Develop a coordinated plan to support government policy. NGOs and other actors can work to strengthen government institutions by supporting government policy on aquaculture. At minimum, NGOs and entrepreneurs should communicate with government aquaculture officials about their activities in aquaculture.

Medium Priority

Expand hatchery capacity and introduce improved strains. A reliable supply of high-quality fingerlings is an essential component of a cultured fish value chain and is a prerequisite for commercial-scale development. Improved varieties of tilapia (e.g., GIFT or Chitralada strains) broodstock should be used in hatchery seed production.

Develop responsible stock enhancement programs. There is considerable potential to enhance fish supply by supporting culture-based fisheries in lakes and reservoirs. Stock enhancement efforts should follow international protocols and be aligned with the FAO Code of Conduct on Responsible Fisheries and Aquaculture.

Conduct research on fish nutrition using locally produced feedstuffs. Potential feed ingredients (e.g., jatropha, moringa, and sweet sorghum) should be evaluated in production trials in commercial settings, using the production system models considered to have the best potential to support a commercial aquaculture sector. Understanding constraints on use of particular ingredients is necessary to support ingredient incorporation into aquafeeds at a sufficient feed production scale.

Develop and demonstrate successful, commercially profitable, production system models for non-fed greenwater ponds. Standardized pond configurations, fertilization protocols, and management systems need to be developed and demonstrated.

Lower Priority

Develop mechanisms or policies to foster clustering of producers in specific geographic areas. Most successful commercial aquaculture production sectors have developed in areas with concentrated farms or facilities. Identifying areas for concentrated development and providing incentives to establish fish farms in those areas can stimulate aquaculture development.

Develop marketing infrastructure. Better-quality roads and an expansion of the road network facilitates the transport of inputs to farms and fish to market. Cold storage facilities and ice-making capacity are needed to establish a cold chain. In general, an expansion of market opportunities can provide more outlets for farmed fish.

Develop and demonstrate successful, commercially profitable, production system models for 1) integrated rice-fish plots, 2) concrete periphyton ponds, and 3) aquaponics systems. Although these production systems are seen as not having as great a potential for commercial development as higher-priority systems, they do have potential for development in certain locations or situations.

CONCLUSION

The workshop identified opportunities, constraints, and priorities for action but did not specify the entities or organizations to implement the action, nor did it identify funding sources or mechanisms. As always, these issues represent the principal constraints to implementation of the priority actions identified in this document. Nonetheless, the information provided here can guide the activities and policies of NGOs, government agencies, and the international donor community in aquaculture development in Haiti.

A NOTE FOR NGOS

For NGOs interested in having an aquaculture component in their portfolio of activities, commercial models may represent too large an investment, particularly in the context of health delivery and other social services that are more core to the mission and thus higher priority. In this context, small-scale, non-commercial models can be applied at a family or small community level. For NGOs, small (50-200 m^2) earthen ponds for all-male tilapia, with vegetables or small livestock on the embankments, is a good basic model. Small concrete block ponds (2 x 8 x 1 m) is another model compatible with small land holdings.

ANNEXES

1. Workshop Agenda

2. Workshop Powerpoint Presentations
    a. Kevin Fitzsimmons - Tilapia Aquaculture in Developing Countries: An AwF Perspective
    b. Jean-Robert Badio - Overview of Aquaculture in Haiti
    c. Valentin Abe - Current Aquaculture Projects in Haiti: Prospects and Challenges
    d. Gael Pressoir - Prospects for Multipurpose Perennial Crop Cultivation in Haiti
    e. Patrick Woolley and Hans Woolley - Taino Fish Company
    f. Andy Kane et al. - University of Florida Sustainable Programs in Haiti: Protein Production, Wellness and Education

3. Workshop Participant Biosketch and Contact Information

4. FAO Aquaculture Overview of Haiti (1981)

5. Haiti National Program for the Development of Aquaculture and Inland Fisheries

6. Aquaculture Projects in Haiti (by Jamie Rhoads)

ANNEX 1

Workshop Agenda

Tilapia Aquaculture in Haiti

28 February 2011

Workshop Agenda

9:00 Greetings and welcome (Craig Browdy, Novus International)
Workshop mechanics (John Hargreaves)
Group self-introduction

9:15 Tilapia Aquaculture in Developing Countries: An AwF Perspective (Kevin Fitzsimmons, University of Arizona, America Tilapia Association)

9:30 Overview of Aquaculture in Haiti: Government Perspective (Jean Robert Badio, Director of Fisheries and Aquaculture for Ministry of Agriculture and Natural Resources, Government of Haiti)

9:50 Insights on Low-Input Aquaculture in Rural Haiti (Bill Mebane, Marine Biological Laboratory, Woods Hole, MA)

10:10 Overview of Current Aquaculture in Haiti: Challenges and Opportunities (Valentine Abe, Caribbean Harvest, Lake Azuei, Haiti)

10:30 Potential Alternative Feed Source Strategies for Tilapia Aquaculture in Haiti (Gael Pressoir, Chibas, Haiti)

10:50 Tilapia Markets and Marketing in Haiti (Hans Wooley, Taino Fish LLC, Haiti)

11:10 Ongoing Projects in Haiti - group contributions
Food for the Poor – Haiti (Clement Belizaire)
Operation Blessing (Bill Horan and David Darg)
Christianville Foundation (Andy Kane and Pascale St. Martin Francois)
Forward Edge International (Ron Stull and Frank Green)
Lazarus Project (Mark Eglington)
Glory Works (Tom Pokorni and Russell Cox)
Harding University (Troy Ramsey and Todd Patten)
Nelson & Pade (Rebecca Nelson and John Pade)

12:30 Lunch (provided)

1:00 Group Discussion – (facilitated by Hargreaves and Browdy)

A facilitated discussion that will review the list of questions appended below, capturing input from the group related to opportunities, constraints and solutions for the advancement of sustainable tilapia aquaculture in Haiti.

2:30 Moving Forward / Next Steps (Group)

Identification and prioritization of key interventions contributing to a coordinated strategy that fosters the sustainable development of tilapia aquaculture.

3:00 Break

3:30 Potential for Other Types of Aquaculture in Haiti (Mike Rust and others)
- Extractive aquaculture (seaweed and mangrove oysters)
- Enhanced fisheries (brush parks/acadjas, casitas), hatcheries?
- Hatcheries and stock enhancement
- Shrimp, marine finfish candidate species

4:00 Adjourn

Questions for Consideration and Discussion:

What are the tilapia production methods currently in use in Haiti?

- Ponds, tanks, cages
- Hatcheries

What is the availability of inputs for aquaculture in Haiti?

- Feeds or other sources of nutrition
- Water
- Land (best sites?)
- Electrical Power / Fuel
- Seedstock / broodstock / hatcheries
- Information / outreach

What are the important non-technical impediments to the development of tilapia aquaculture in Haiti? (Ex: land tenure, credit and micro-lending, training/knowledge, perceptions)

How can aquaculture be integrated into comprehensive water management systems, implemented at the community and watershed levels?

What are the best sites for concentrated aquaculture in Haiti? What are the geographic areas that are best suited for widespread development of aquaculture? (i.e., areas of irrigated agriculture)

What are the most appropriate production scales for tilapia aquaculture in Haiti?

- Small-scale, low-input (e.g., periphyton)
- Small-scale, feed based
- Commercial scale, feed based

What are the most appropriate small-scale and low-cost aquaculture technology packages that can be implemented by NGOs?

What are the education, outreach, information, and training needs for farmers, extension agents, and NGO technicians?

How can a coordinated strategy for aquaculture development be fostered? How can efforts among NGOs, government agencies, and international donors be coordinated? How can NGO efforts support the goals of the national agriculture investment plan? What are the most appropriate ways that NGOs can support government goals for aquaculture development or complement government activities?

ANNEX 2A

Workshop Powerpoint Presentations

Kevin Fitzsimmons

Tilapia Aquaculture in Developing Countries: An AwF Perspective

Tilapia Aquaculture in Developing Countries: An AwF Perspective

Kevin Fitzsimmons
University of Arizona, Professor of Environmental Science
World Aquaculture Society, Past-President
Aquaculture without Frontiers, Past-Chairman
American Tilapia Association, Sec. Tres

Feb. 28, 2011

Introduction

- Tilapia is the common name for fish in three genera *Tilapia, Sarotherodon,* and *Oreochromis*
- Family Cichlidae
- *O. niloticus, O. aureus, O. mossambicus* (Nile, Blue and Mossambique tilapia's respectively)
- Native to Egypt, Israel and Africa
- Miracle Fish

Tilapia the "Green" farmed fish

- Herbivore / omnivore, low trophic level feeder
- Algae, bacteria, and detritus (bioflocs) are important food sources
- Prepared feeds are mostly grains and ag by-products
- Promoted by aid agencies and NGO's
- *Dr. M. Gupta awarded World Food Prize for promotion of tilapia aquaculture, June 10, 2005*
- Disease resistant and tolerant of poor water quality. Anti-biotics and chemicals are not needed for commercial farming.

Nile, Mossambique and Red Tilapia

Production widely distributed around the world.

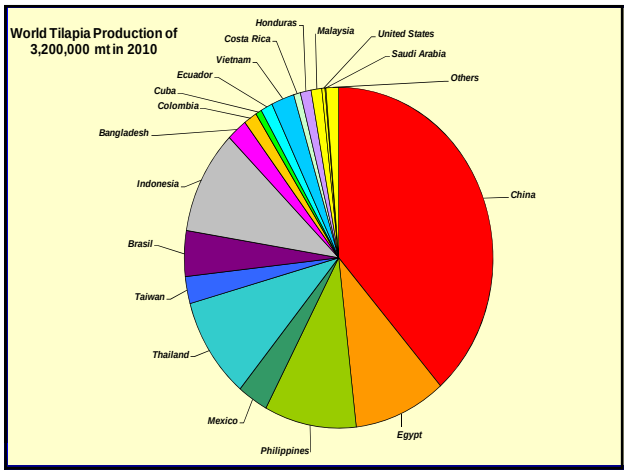
- Wild catch mostly replaced by farm raised
- Second, after carp, in global volume of farmed fish
- Used in many cuisine, hundreds of recipes
- Tilapia, boulti, chambo, lou fei, pla nil, St. Peters fish, freshwater snapper

Subsistence and Export Commodity

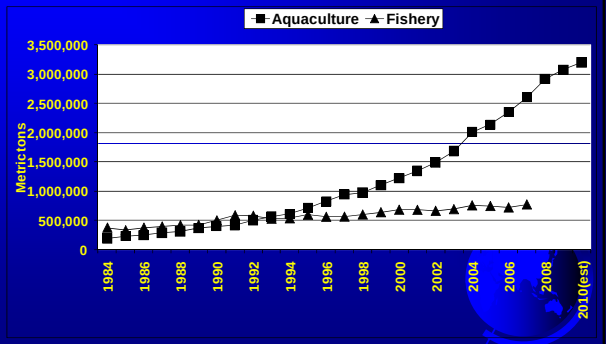
- Tilapia is unique in its role as a small livestock animal grown by subsistence farmers in developing countries around the world…..
- And
- It is widely grown and exported to high value markets to be served in expensive restaurants and grocery stores
- Commodity or specialty crop - BOTH, like chicken

Tilapia ideal fish for the resource limited

- Minimal investment to start
- Cages can be put in public waters
- Technology easily understood
- Several inputs available on farm
- Small ponds or tanks can be integrated
- Fish can be used in household or sold/bartered
- Fish can be dried for later consumption



Global production of tilapia



How did tilapia get so popular, so fast?

Tilapia - the aquatic chicken

- Grows in all kinds of farms
- Eats all kinds of food, mostly herbivorous
- Large eggs and easy to rear young
- Lots of ways to prepare the fish

Other benefits of Tilapia

- Simple hatchery technology
- Disease resistant
- Grow well at high densities
- Several color variants available
- More “domesticated” than most aquaculture crops

Established market demand

- Accepted in many national dishes
- Popular in many forms
- Live, Whole, fillets, fresh and frozen, smoked, sashimi





Grows well in most production systems

- Ponds
- Cages
- Raceways, round tanks, recirculating systems
- Ranching (lake releases)
- Freshwater, Brackish water, Estuarine, and Marine

Grows well in most production systems

- Polyculture with shrimp, catfish, carp
- Herbivorous and /or omnivorous
- Good growth in fertilized ponds
- Many agricultural by-products can be used in tilapia feeds or to fertilize ponds

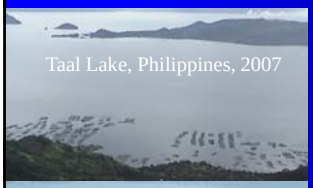
Pond culture in the Philippines

Intensive ponds

Ponds in Brazil

Ponds in Costa Rica

Multiple small cages



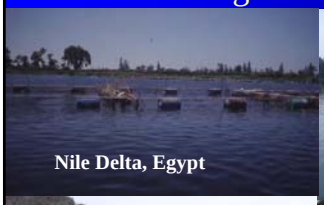
Taal Lake, Philippines, 2007

Irrigation Reservoir, Arizona

Taal Lake, Philippines, 2009

Paulo Afonso Reservoir, Brasil

Small cage farms



Nile Delta, Egypt

Lake Kenyir, Malaysia

Guilin, China

All tilapia farms have dogs, even cage farms

Floating cage

Hapa (net pen)

Tropical Inland Integrated System

- Tilapia → oil palm, rice, sugar cane

Costa Rica

Mexico

Guyana

Industrial Tilapia production

- AwF notes that large scale production also provides many jobs for rural workers
- Especially hatchery and processing jobs for women

Tilapia (June 2007, Tesco, UK)

F

$18 US per kg whole fish!!!!

Various preparations

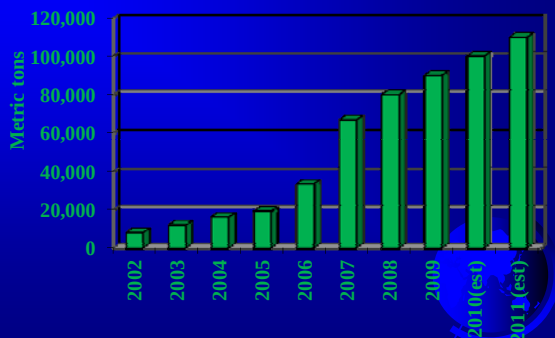
Many recipes

Byproducts - Tilapia Leather

Current Global Market Trends

- Increase in demand for all forms of tilapia
- Demand increase will be greatest for frozen fillets
- Demand increase will be significant for fresh fillets
- High profit margin for prepared meals assembled and packaged in developing countries

Bangladesh tilapia aquaculture



Bangladesh

- Many small ponds
- Integrated with rice and vegetable farms
- Consumers with preference for fish
- AwF and other groups assist with tech transfer and training

Conclusions

- Global tilapia production exceeded 3,200,000 metric tons in 2010.
- Constantly improving farming, processing and packaging for food safety, quality assurance, traceability, and environmental safeguards (with little, if any, increase in price).
- Other aquaculture species will follow the tilapia model.

Conclusions

- Tilapia has long been called the aquatic chicken.
- Instead…...
- The "terrestrial tilapia"

Tilapia: the most fun aquaculture species of the 21st century

http://www.youtube.com/watch?v=Bh2673ncWJg

ANNEX 2B

Workshop Powerpoint Presentations

Jean-Robert Badio

Overview of Aquaculture in Haiti

Workshop on Aquaculture of Tilapia in Haiti
New – Orleans February 28, 2011

by : Badio, Jean Robert
Director of Fisheries & Aquaculture in Haiti
Ministry of Agriculture / Haiti

COUNTRY PROFILE

Background: Haiti is located between Cuba to the Northwest , Jamaica to the Southwest, Puerto Rico to the East , Bahamas to the North, and Colombia to the south. Haiti is bounded on three sides by water. To the North by the Atlantic Ocean, to the south by the Caribbean sea, and to the west by the Windward passage.

DEMOGRAPHICS

Haiti total area	: 10,714 sq miles (27, 750 Km2)
Land area	: 27,560m2
Sea area	: 190 km
Population	: 10,000,000 with an average annual increase of 1,8 %
Capital	: Port au Prince , with 4,5 millions
Administrative	: Ten(10) Departments :
Climate	: Tropical climate with medium temperature 70 to 80 degrees Farenheit or 25 to 28 Celsuis.
Rainfall	: Annual rainfall varies from a high of 3,600 mm to a low of 600 mm. The rainy season begins in October continues till December.
Literacy Rate	: 53 %
Education	: By law , education is free and compulsory in Haiti for children between the ages of 7 to 13 . However access to that free education is limited to many people due to insufficient financial resources for parents to purchase the required school books and uniforms.

OVERVIEW ON AQUACULTURE IN HAITI

Coastline	: 1,535 km to 1770 km
Fishers population	: 52,000 fishers (part time and full time)
Fisheries production	: 16,500 tons (600 tons of lobsters; 200 tons of lambi and 50 tons of shrimps representing about 95 % of Haiti fisheries production; value 54 millions of dollars $ US representing 1,5 % of the PIB)
Imports	: 12, 500 tons per annum to satisfy the local demand.
Aquaculture production	: 400 tons (mostly tilapia and carp)
Continental production	: 600 tons (more than 22 ,000 ha of body of water)
Hatchery production	: 3,5 millions of fingerlings per year
Cage production	:
Consommation per capita	: 4,5 kgs per annum

LAND & CLIMATE CONDITIONS

Haiti presents ideal climatics conditions for the development of aquaculture. There is great potential for aquacultural development in various zone in the country. Throughout the ten (10) departments in the country, more than 23,000 hectares of land unsuitable for agriculture are very favorable for the development of commercial aquaculture fish farms.

CURRENT PRODUCTION

Currently aquaculture in Haiti is characterized by a non commercial subsistance scale, low-input, feed-based activities mostly for personal consumption or local sale. Tilapia is the main principal species used in aquaculture in Haiti. Fingerlings production of tilapia is carried out by the government hatchery (ODVA) and some private sectors. The demand for tilapia fingerlings is over 200 million when we take into consideration: (22,000 ha of bodies of water + 81 artificial lakes between 2 to 10 ha + 120 ha of fish ponds etc....)

EMERGING PARTNERSHIPS

The Direction of Fisheries and Aquaculture of the Ministry of Agriculture which is the body of the government responsible for the development of aquaculture in Haiti is trying through a technical cooperation with some Cuban experts to increase the production in ODVA hatchery (tilapia and carp) and create new centers of fingerlings production

OBSTACLES:

- Lack of seedstock (for fresh or marine water)
- Lack of agricultural products for feedstock
- Low level of production and lack of commercial approach
- Lack of infrastructure development and services
- Scarcity of people with adequate training and experiments
- A model of aquaculture farm with proven profitability.
- No credit available
- Lack of information (limited data collection)
- Lack of research in the viability of aquacultural development in Haiti

RECENT DEVELOPMENTS

In 2009 the government of Haiti through the Direction of Fisheries and Aquaculture of the Ministry of Agriculture brought together private-sector players , officials, professors, and others interested parties to investigate the development of aquaculture in Haiti. This committee proposed the following steps:

-Conducting a study on the revision of commercial trade policy
-The inventory all existing aquaculture activities in the country
-Exploration of mechanisms for promoting modern aquaculture.
-Evaluation of resources and aquaculture potential
-Conducting studies on conservation, transformation, and commercialization
-Production of fish feed
-Stocking of bodies of water
-Establishment of farms & production in cages and ponds
-Increased production in existing hatcheries
-The creation of new centers of production
-Rehabilitation of farms with established potential
-Training and technical assistance for fish farmers
-Monitoring and evaluating activities.

CONCLUSIONS

Aquaculture (freshwater – brackish –marine) is very feasible in Haiti . There is a real potential for the development of this sub-sector. The program outlined in this presentation will help create the necessary conditions for investment by the private sector in order to achieve in the next ten years the production of the marine fisheries from 16, 000 tons to 35 000 tons with pond aquaculture production increasing from 400 to 5000 tons and the inland water production from 600 to 10,000 tons .

The lines of action defined in this program will support the government particularly the Directorate of Fisheries and Aquaculture (DPAQ) of the Ministry of Agriculture and Natural Resources to better understand and manage resources; boost the sector; and contribute to achieving the millenium development goals—including food security, the fight against poverty, and the reduction of the risk of natural disasters in the sector .

Thus, on behalf of the Government of Haiti, we would like to ask that all future action taken in the sub-sector of aquaculture be based on the government program for a better implementation and control (planning and decision -making) of all resources in order to avoid costly, unresearched, poorly-planned, and poorly-executed "duplicate activities" in the sector.

MESI BOKOU

ANNEX 2C

Workshop Powerpoint Presentations

Valentin Abe

Current Aquaculture Projects in Haiti: Prospects and Challenges

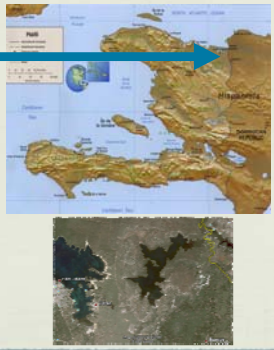
CURRENT AQUACULTURE PROJECTS IN HAITI: PROSPECTS AND CHALLENGES

Valentin Abe, Ph.D.
Caribbean Harvest-Haiti

COUNTRY DATA

- Seafood consumption in Haiti: 17 - 20,000 Tons per year
- Domestic marine production: 5,000 Tons per year
- Aquaculture and inland fisheries: 600 Tons/year
- 70.4% of the population with less than $2 a day
  - 54% of the population with less than $1 a day
- 70% of the population operates in the informal sector
  - Unemployment averages 45%

The Northeast



Type of soil: type 13 clay soil, excellent for pond aquaculture

One brackish water lake (Lagoon aux Boeuf, 3000 acres) excellent for cage aquaculture

Seven man-made lakes size from 2 to 32 acres that can be used for aquaculture.

Presence of an abandoned fish farm (8 acres) that could be renovated and put to production

The Central Plateau

Good clay soil. This region presents the best opportunity for pond aquaculture

The region is host to 53 man-made lakes size ranging from 2.2 to 22 acres

The Central Plateau

Presence of the Caribbean Harvest Hatchery Annex:

- Six tanks with 24 hours aeration capacity

- Fingerling production capacity: 600,000 per year

The Central Plateau

- Hosts the second largest lake in Haiti (5,500 acres)
- Excellent for cage culture
- Presently, a cage culture program is in operation with 200-4 cubic meter cages by 2012.

The Artibonite Plains

- The vastest plain in Haiti, excellent for rice-fish culture.
- the soil contains clay but not deep enough for large fish ponds
- The Artibonite is host to the government owned fish hatchery of Pond-sonde.

The plains of Cul-de-sac (Western Region)

- The second vastest plain of Haiti
- Soil not suitable for pond aquaculture
- Hosts the largest hatcheries in the country (Caribbean Harvest)
- Hosts two lakes:
* Lake Azuei (22,000 acres)
* Trou Caiman (less than 800 acres)
- Near Port-au-Prince (market strategy)

The Caribbean Harvest Hatchery

- 36 Steel tanks
- 6 bio-filters
- Production capacity of 2.5 million fingerlings per year -2011
- Production of 5 million fingerlings by 2013

The Fish Cage Culture Operation by CH

- 700 cages by 2012
- Production of over 2 million pounds of fish a year by 2012
- Fish produced by fishermen living around the lake

The Leogane Plain and the Nippes

-Vast plains along the National Road 2
- The soil in the area is not quite suitable for aquaculture (clay content is not deep enough
- Hosts the Christian Ville fish farm (concrete tanks), Quisqueya Aquafarm (6 earthen ponds, 1000 sq.m each) and lake Miragoane (2,500 acres) which is the site of cage farming.
- The Nippes area hosts the now defunct first commercial fish farm in Haiti.

The Caye Plain

- Plain similar to the Artibonite Plain

- Excellent potential for pond aquaculture and/or fish rice culture, however the area is often subject to flooding.

Haiti needs Private Investments

- *Private Investments for commercial fish farming*
  - *Pond aquaculture using watershed ponds as reservoirs*
  - *Cage culture (both marine and freshwater aquaculture)*
  - *Feed mill for domestic feed production*
  - *Processing plant*

DEVELOPMENT OF LAND AQUACULTURE

- Using watershed ponds as reservoirs
- 154 reservoirs, 33 are suitable for a three step production

FEED PRODUCTION IN HAITI

- Feed are imported from the US
- Pelleted floating feed for cage culture and semi to intensive culture systems.

PROCESSING PLANT

- Improve fish image in stores
- Improve marketing and the way fish are sold on the street

ANNEX 2D

Workshop Powerpoint Presentations

Gael Pressoir

Prospects for Multipurpose Perennial Crop Cultivation in Haiti

CHIBAS

Prospects for a multipurpose (Energy & Protein) perennial crop cultivation in Haiti

CHIBAS

"3F" crops (FUEL + FOOD + FEED)

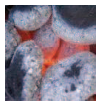
- **Edible Jatropha varieties:** protein + biofuel + solid biomass + reforestation + honey
- **Sweet Sorghum varieties:** fuel (ethanol from cane juice) + food (grain) + feed (fodder)

A Multipurpose Crop the products & biproducts of the *J curcas* value chain


Electricity


Soap


High Protein animal feed


Briquettes

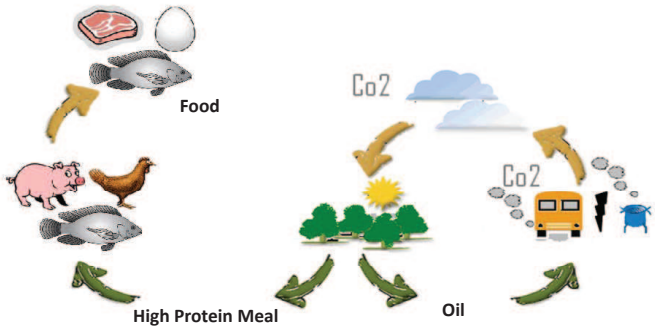

Vegetable fuel oil or Biodiesel


Honey


Reforestation

Jatropha (local) market chain

An animal feed producing crop!



Food & Energy Security can go hand in hand

Potential of Jatro-meal

Edible Jatropha could yield

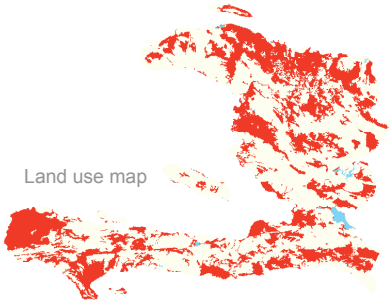
- 1 ton of Crude Protein
- > 1 ton of Vegetable Oil

per hectare of marginal and non-utilized land (3.5 tons of seeds per ha)

Land availability for Jatropha

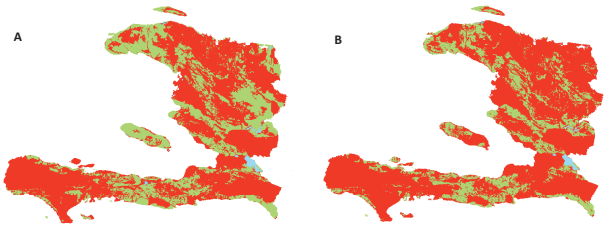
- How much land can be used to grow Jatropha ?
- Expected yields ?
- What are the profits from growing Jatropha ?

Mapping the risks (red):
Land use, environment,
areas suitable for food crops,
other socio-economic risks, etc…



Land availability for Jatropha

In green: area where you can grow Jatropha while limiting the negative impacts.
A: >800,000 ha
B: >500,000 ha



There is enough land to meet Haiti's diesel market!

Both model eliminate areas currently cultivated as well as humid mountains that could be reforested with fruit producing trees. Second model also eliminates all densely populated areas and areas that are fairly "flat"

Nutritional values

	Fishmeal	Jatropha meal	Soy meal	Wheat meal
Proximate composition (g / kg)				
Crude protein	635	655	471	143
Phytate (% dry matter)	–	9.4	2.41	–
Amino acids composition (g/ kg)				
Arginine	35.3	* **68.6**	36	5.4
Histidine	**17.7**	**20.7**	14.4	3.4
Isoleucine	**22.8**	**25.5**	19.6	4.2
Leucine	**41.6**	**45.6**	35.7	9.1
Lysine	**40.9**	21.5	**29.1**	3.3
Methionine	**16**	**10.4**	6.2	2
Phenylalanine	21.8	* **28.7**	24.3	6.5
Threonine	**23**	**21.2**	17.8	3.7
Tryptophan	4.9	* **7.1**	6.4	1.4
Valine	**29.3**	**30.1**	21.2	5.1

V . Kumar et al , 2010, in Aquaculture Nutrition

Potential of Jatro-meal

Is Tilapia sensitive to Trypsin inhibitors?

- Best results for Jatropha meal in carp are with a short or no heat treatment

  Heat treatment: inactivation of Trypsin inhibitors…. But it lowers protein availability

Solutions:

- Heat treatment of the meal (effect on protein availability)

Potential of Jatro-meal

Is Tilapia sensitive to high Phytate content?

Solutions:

- Addition of phytase
- Selection of low phytate varieties (medium to long term)

Other feed sources

- **Moringa leaves:** high levels of antinutritional components that have to be removed by solvent extraction).

  Very high content in phytate, phenolics, saponins.

  Heat treated or raw Moringa leaves can only be used as a supplement at low concentration.

Other feed sources

- **Yeast:** 30-40% protein, could be obtained in Haiti from the breweries of sugarcane or sweet sorghum juices
- **Dried Brewer's Grain:** Only one beer brewery in Haiti. DBG currently available and not being used.

  High in Lysine and other essential amino acid (low in methionine)

Other feed sources

- **Quality Protein Maize:** Only contains 2.7 g of Lysine per kg! That is much less than Jatropha meal! But potentially better than wheat meal.

  Can be used in combination with a source of protein (Jatropha or soymeal)
- **Others:** Poultry by-products, coffee pulp, Leucaena leaf meal, + all sources of carbohydrates (maize, sorghum, sweet sorghum jaggeree, etc…)

Local production of Protein for Tilapia feeding

- Meal from edible Jatropha varieties probably offers the best solution to produce large quantities of protein from local sources
- Tests and feeding trials should be started ASAP
  - Full fatted Jatropha meal (cooked or uncooked)
  - Defatted Jatropha meal (cooked or uncooked)
  - Supplemented or not with phytase, methionine, lysine

ANNEX 2E

Workshop Powerpoint Presentations

Patrick Woolley and Hans Woolley

Taino Fish Company

Taino Fish

- Patrick Woolley – Founder & COO
- Hans Woolley – Founder & CEO

Taïno FISH 1

Challenges: Access

- Access to Equipment, Materials & Supplies
- Logistics
  - Coordination and Communication across local aquaculture industry
  - Access to Data
    - Market Data, Scientific Data (Meteorological, Geological), Commercial Listings, Maps, Addresses, etc…
  - Transportation (Traffic congestion)
- Access to Relevantly Trained Workforce

Taïno FISH 2

Challenges: Costs

- Customs (Import / Export)
- Distribution Infrastructure
- Energy Availability & Cost (Ice / Storage)
- Access to Capital

Taïno FISH 3

Challenges: Marketing

- Marketing to Haitians
  - Education & Awareness
- Superstition (Cholera / Earthquake)

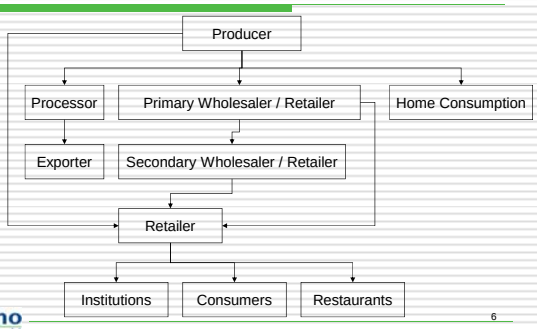
Taïno FISH 4

Market Prices

Species	$ / lb Open Market	$ / lb Supermarket
Tilapia (whole)	$2-3	N/A
Tilapia (filet)	N/A	$8-10
Red Snapper	$3-5	$8-10
Conch (not cleaned)	$3-4	$6-8
Conch (cleaned)	$5-6	$10-12
Shrimp	$3-4	$6-8
Lobster	$ 6–8	$12-16
Marlin	$3-4	$6-8

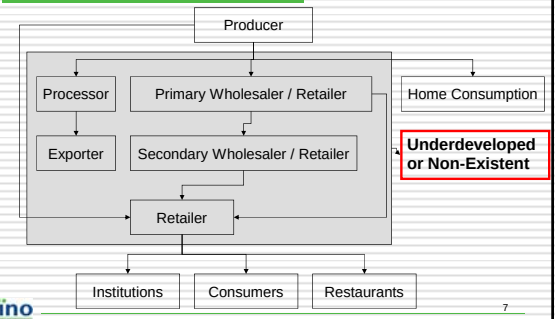
Taïno FISH 5

Typical Distribution Channels for Farm Raised Fish



Taïno FISH 6

Haitian Distribution Challenge



Taïno FISH

7

Distribution: Applying Proven Solutions

Thailand / Philippines

Haiti

Taïno FISH

8

Q & A

Taïno FISH

9

ANNEX 2F

Workshop Powerpoint Presentations

Andy Kane et al.

University of Florida Sustainable Programs in Haiti: Protein Production, Wellness and Education

UF Sustainable Programs in Haiti:

Protein Production, Wellness and Education

Andrew Kane

Bernard Okech, Edsel Redden, Afsar Ali, Judy Johnson

Zindoga Mukandavire, Richard Rheingans,

Pascale St. Martin Francois, J. Glenn Morris,

Gregory Gray and Michael Perri

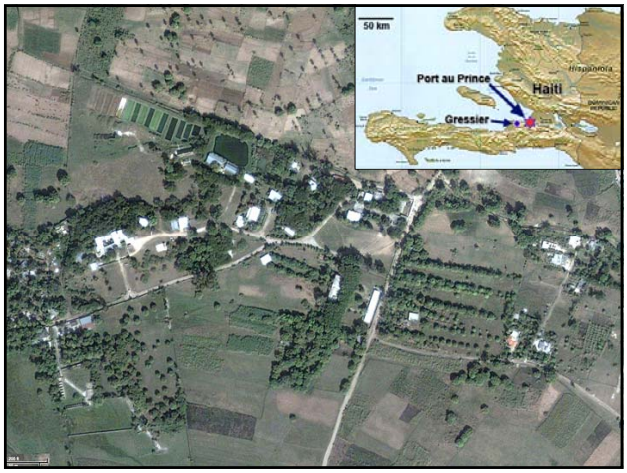
Department of Environmental and Global Health
College of Public Health & Health Professions
Emerging Pathogens Institute
University of Florida

Demen Miyò Pou Âyiti

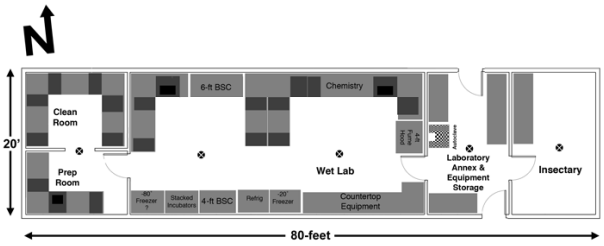
("A Better Tomorrow for Haiti")

Integrate public health and agriculture using school-centric & community-based approach

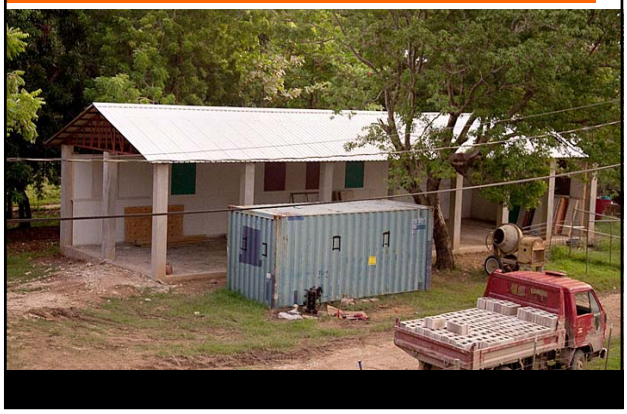
- **Protein production**
- **Hygiene & sanitation**
- **Family wellness program**
- **Vaccination program**
- **Establish field laboratory**



Establish field laboratory



Establish field laboratory



Establish field laboratory

Protein Production

- Implement sustainable, measurable agriculture and aquaculture solutions. Emphasis on animal protein to reduce malnutrition and undernourishment.
- Educate and support Haitian farmers in production, management and business.
- Microfinancing (in-kind loans) with transition to Haitian microenterprises.

Protein Production: Poultry

Protein Production: Poultry

Protein Production: Fish

Protein Production: Fish

Protein Production: Fish

Protein Production: Fish

Protein Production: Fish

Protein Production

Protein Production

Protein Production

Protein Production

ANNEX 3

Workshop Participant Biosketch and Contact Information

Workshop on Tilapia Aquaculture in Haiti

28 February 2011

Participant Profiles

Valentin Abe is Executive Director of Caribbean Harvest, one of the largest tilapia hatcheries in the Caribbean, and the Caribbean Harvest Foundation. A native of the Ivory Coast, he moved to Haiti in 1997 where he directed the Haiti Fisheries Program funded by the Rotary International Foundation. He also started the biggest tilapia cage farming in the Caribbean. He was selected as one of Time Magazine's 100 Most Influential People in the World in 2010 and is a member of the Clinton Global Initiative. (valentin_abe@yahoo.com)

Jorge Arias is Global Director for the Aquaculture Division of Alltech, a producer of additives for the animal feed industry. Alltech is sponsoring an elementary school in Ouanaminthe, working on a coffee project with a local cooperative, and starting a small-scale poultry production unit in 2011. (jarias@alltech.com)

Jean Robert Badio is the Director of Fisheries and Aquaculture for the Haitian Ministry of Agriculture and Natural Resources, where he has worked since 1993. He has prepared consulting reports on tilapia, carp and marine aquaculture in Haiti for the FAO and other NGOs. He completed his degree in Agronomy at Damien, the State Agriculture University of Haiti and has a Master's of Aquaculture from Auburn University. (robertbadio@yahoo.fr)

Clement Belizaire is a member of the Food for the Poor Haiti project team. (cbelizaire@foodforthepoorhaiti.org)

Chris Benton is a team leader for a project that Long Hollow Baptist Church (Tennessee) is planning to do in Haiti. Currently the church is partnered with the village of Les Cayes and is exploring the potential for aquaculture there. (benton589@gmail.com)

Craig Browdy is the senior manager for aquaculture research at Novus International. A past president of the World Aquaculture Society, he has been a member of the AWF proposal review committee since its inception. Partnering with groups like AWF, Heifer International, Vitamin Angels, AWARD scholarships and others, Novus is supporting education and the development of sustainable animal and human nutrition efforts in the developing world. Through efforts like the current workshop, Novus resources are being made available to help achieve our vision help feed the world affordable, wholesome food and achieve a higher quality of life. Our Mission is to make a clear difference in sustainably meeting the growing global need for nutrition and health in developed as well as developing markets worldwide. (Craig.Browdy@novusint.com)

Dave Conley is a Senior Consultant and Founding Partner at The Aquaculture Communications Group, LLC. He is a Director of Aquaculture without Frontiers (AwF) and the project leader for two projects in Haiti for which AwF is providing funding and/or technical support. (dave@aquacomgroup.com)

Russell Cox is an entrepreneur who has been to Haiti several times and has a keen interest in developing aquaponics there.

David Darg is Operation Blessing International's Director of International Disaster Relief. Besides overseeing OBI response to 41 disasters in 16 countries last year, David has lived in Haiti since the earthquake and directs all OBI's effort in-country. (David.Darg@ob.org)

Pat Duncan is the Director of the Georgia Center for Aquaculture Development at Fort Valley State University. She has over 30 years experience with marine and freshwater fish and shellfish aquaculture. She is currently working with recirculating aquaculture systems, aquaponics, bio-integrative systems, shrimp, prawns and tilapia. She is working to develop small-scale systems for tilapia and aquaponics with solar power. Her interest in Haiti is about how to help the technical transfer of appropriately sized, independently powered aquaponic systems. She has provided information to church groups and others in Haiti. (duncanp@fvsu.edu)

Mark Eglington owns Bluebeyond Fisheries, LLC, a tilapia hatchery and grow-out facility in Desert Hot Springs, California. He also volunteers at Village of Hope (Lazarus Project, affiliated with Food for the Poor) in Croix De Bouquet. He is interested in hatchery and lake stock enhancement programs. (bluebeyondfisheries@gmail.com)

Kevin Fitzsimmons is a Professor of Environmental Science and Director for International Programs at the University of Arizona. He is also a past President of the US and World Aquaculture Societies and also served for two years as Chairman of Aquaculture without Frontiers. Kevin's specific interest in Haiti is related to a Farmer to Farmer grant he is administering for USAID and AwF to provide support to aquaculture volunteers to assist sustainable rural aquaculture in developing nations. (kevfitz@cals.arizona.edu)

Marie Pascale St. Martin Francois is a native of Jeremy, Haiti, and a graduate of the College of Agriculture and Veterinary Medicine, State University of Haiti. She has helped to direct several lake management studies through the National Program of Artificial Lakes, based on Lascahobas. She has recently started a MS program with Andy Kane at the University of Florida focusing on improving aquaculture and protein production in Haiti. (pfrancois@ufl.edu)

Frank Green works with Forward Edge International. (frank@forwardedge.org)

John Hargreaves is an independent consultant with over 30 years of experience with tilapia aquaculture, including production in ponds, raceways, cages, and recirculating systems, aquaponics, and hatcheries. He lived in the Virgin Islands for 7 years in the 1980s and has traveled widely in the Caribbean region. (jhargreaves01@yahoo.com)

Bill Horan is President of Operation Blessing International (OBI). OBI, a global humanitarian charity, operates in 23 countries, and since the earthquake, runs relief and recovery programs in Haiti that include support of Haitian hospitals, providing medical services, purification of drinking water, operation of a home for disabled orphans and participation in aquaculture and aquaponics programs. It is his intent to help stimulate Haitian participation in aquaculture programs that include cage culture, the stocking of fresh water lakes and raising gambusia for biological mosquito control. OBI has recently set up an aquaponics system at our children's

home near PaP and hope that it will serve as a model and training facility for multiple operations throughout Haiti. (Bill.Horan@ob.org)

Andrew Kane is the director of the Aquatic Pathobiology Laboratory at the University of Florida, and an associate professor of environmental and global health in the College of Public Health and Health Professions. He has been working with other University of Florida colleagues in Haiti focusing on tilapia production, chicken production, water sanitation, malaria control, and school- and faith-based family wellness programs. General programmatic interests include effects of environmental stress on aquatic organisms, environmental health as a component of public health, and scientific communications. (kane@ufl.edu)

Susan Laramore is an Assistant Research Professor in the Aquaculture Department of Harbor Branch Oceanographic Institute at Florida Atlantic University. She has expertise in disease and biosecurity issues in aquaculture and experience in culture of shrimp, oysters and clams. She has been to Haiti previously – Port au Prince, Croix des Boquetes and Saint Marc. (slaramo1@hboi.fau.edu)

Ken Leber is the Director of the Center for Fisheries Enhancement at Mote Marine Lab. His primary focus has been on replenishment and supplementation of wild stocks in estuarine and marine systems, and he is also working on developing new fisheries by stocking freshwater-tolerant anadromous species in inland ponds, lakes, and reservoirs. (KLeber@mote.org)

George Lockwood, a past president of WAS, has been engaged in aquaculture since the early 1970's raising abalone, salmon and oysters, and has worked with other marine and freshwater species. Since 1994 he has been heavily involved with the construction and operation of a school in Hinche, with 1,000 students through 13th grade. With assistance from Food for the Poor, they are able to provide a hot meal each school day. The school owns a 7-acre parcel that may be suitable for tilapia aquaculture. (GeorgeSLockwood@aol.com)

Kevan Main is the Director of Aquaculture Research at More Marine Laboratory in Sarasota, Florida. Her research is focused on developing sustainable, land-based recirculating sytems and on developing culture technologies for marine fish and invertebrates. She is working with producers to develop culture methods for subtropical species. (KMain@mote.org)

Lisa Martin is a Sustainable Supply Development Scientist for Mars Petcare US. She is researching sustainable alternatives to whole fish from marine environments. The company prefers to use quality by-products after processing for human consumption. She is looking into the possibility of using material that a processor might discard. Our sustainability principals require us to trace back to origin all seafood/fish materials we use. (lisa.martin@effem.com)

Bill Mebane is superintendent of the Marine Resources Aquaculture Engineering Division, Marine Biological Laboratory, Woods Hole, Massachusetts. He is also Director of the MBL's Sustainable Aquaculture Initiative in Haiti. He has been actively involved in developing low-resource tilapia production techniques in Haiti since 2002, primarily in the rural mountain areas between Leogane and Jacmel. Current projects in Haiti include research on developing locally made fish feeds and the construction of an Aquaculture Learning Center in Marigot. He has been

assisting with cage culture operations on Lake Azuei and fish production systems for Partners in Health medical clinics. (wmebane@mbl.edu)

Rebecca Nelson and **John Pade** own a company that is currently installing an aquaponic system in northwest Haiti. This system, the first of a much larger planned project, will annually produce about 3500 lbs of tilapia and 27,500 leafy greens or other vegetables. (nelson@aquaponics.com)

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James Rhoads has six years of professional experience in Haiti including agricultural research and project management. He currently works for Meds & Food for Kids, a St. Louis-based non-profit that manufactures Ready to Use Therapeutic Food in Cap Haitian and leads research in peanut agricultural development. He is also a consultant for Novus International's activities in Haiti. He has an M.S. in Natural Resources from Cornell University. (jrhoads@mfkhaiti.org)

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Mike Rust worked in northern Haiti in 1987 to investigate the potential for seawater culture of red tilapia in Ft. Liberte Bay. He now works for NOAA and is currently transitioning from being the program manager of the Aquaculture Research Program at NOAA's Northwest Fisheries Science Center in Seattle to being the national NOAA Aquaculture Science Coordinator in Silver Spring, MD. Dr. Rust is interested in marine aquaculture and stock enhancement as tools for development. (Mike.Rust@noaa.gov)

Da Costa Kouassi Sebastino is an ichthyologist, fishbreeder, and a senior researcher in the program “Continental Fishery and Aquaculture” of the National Centre of Agronomic Research of Côte d’Ivoire. He is President of the Ivorian Society of Agronomic Sciences (IAAS / AISA) and co-director of publication of the scientific journal “Agronomie Africaine." He is currently a Fulbright visiting scholar at the LSU AgCenter. (dacostaks@hotmail.com)

Ron Stull is a small-business owner who works with Forward Edge International. He sees the importance of working to cure poverty through the implementation of sustainable ventures in impoverished areas to support local community members through food security and income generation. Tilapia farming is an area of interest for a sustainable venture. (ron@forwardedge.org)

Laurel Valchuis is a Senior Analyst for HighQuest Partners, a strategy consulting firm working the agriculture and food industries. She is currently working on a report assessing the market viability of expanding soybean meal use in tilapia production in the Caribbean Basin. HighQuest specializes in aiding client decisions regarding opportunity for expansion, geography specific market feasibility, and opportunity implementation logistics. (lvalchuis@highquestpartners.com)

Jonathan Villaire has been aquaculture coordinator of the projects department at Food for the Poor since October 2009. Currently he is working on sustainable aquaculture projects to aid the poorest populations of Haiti. (jvilaire@foodforthepoorhaiti.org)

Dan Ward is the lead research assistant at the Marine Biological Laboratory, in the sustainable aquaculture program. He is a Ph.D. student at the University of Rhode Island, studying the connection between nutrition and immunology. He is interested in alternative protein sources that can be locally sourced in Haiti, and is taking an active role in designing diets and conducting feed trials at the MBL for sustainable tilapia culture in Haiti. (dward@mbl.edu)

Tom Welch is a Global Aquaculture Specialist with Zeigler Bros, Inc., a family run company that has been selling high quality feeds of over 75 years and has been selling tilapia feeds to Haiti for about two years. With the help of Joe Van Wingerden at Prins USA Inc., they have successfully grown the business with Operation Double Harvest that has a tilapia farm near PaP. (tom.welch@zeiglerfeed.com)

Hans Woolley is founder and Chief Executive Officer of Taino Aquaculture S.A., a tilapia farm on Lake Azuei. He is also President of eVite, a social-planning website for creating, sending, and managing online invitations. (hwoolley@gmail.com)

Patrick Woolley is founder and Chief Operating Officer of Taino Aquaculture S.A. (pgwoolley@yahoo.com)

ANNEX 4

FAO Aquaculture Overview of Haiti (1981)

From: ADCP. 1981. Aquaculture development in the Caribbean. Report of a mission to Antigua, Haiti, Jamaica, Montserrat and St. Lucia, June–July 1980. UNDP/FAO.

http://www.fao.org/docrep/006/P4495E/P4495E04.htm

4. HAITI

4.1 Background

Haiti occupies one-third (about 27 560 km^2) of the western part of the island of Hispaniola which is located between Puerto Rico and Cuba; the eastern two-thirds is occupied by the Dominican Republic. Hispaniola is the second largest Caribbean island and the most mountainous, about 75 percent is rough mountainous terrain. Many mountains exceed 2 000 m and the highest, Pico Duarta in the Dominican Republic, is 3 100 m. Because of the rough terrain the road network is poor and travel is time-consuming. Large stretches of the coast are inaccessible by road.

The mountains which separate Haiti and the Dominican Republic prevent the moist trade winds from reaching Haiti. Most of the country is semi-arid. About 33 percent is cultivated (Alderighi, 1979). Vegetation has been cleared from most of the mountains with the result that Haiti is now the most eroded country in the West Indies. Forty percent of its total arable area has been either ruined or severely affected (Macpherson, 1979). The lowlands are relatively small and isolated areas, where irrigation is extensively practised.

There are many short rivers with steep gradients flowing from the mountains to the sea. Most are small and a great number dry up in the dry season. There is one large river, the Artibonite, which flows into the Gulf of Gonave. The total area of lakes and lagoons is approximately 23 000 ha of which two are large lakes, Etang Saumâtre (or Lake Azuey) which is a natural lake of about 16 000 ha, and Lake Peligre, a reservoir of 3 200 ha created in 1956–57 by construction of a hydro-electric dam across the Artibonite river. L'Etang Saumâtre has no surface outlet and is fed by springs arising from calcareous rocks. The western part of the lake is slightly saline but the water in the eastern part is fresh.

According to Lin (1952), the natural stock of Lake Azuey consisted mainly of small Poeciliidae (Gambusia dominicensis Regan, Limia melanonotata Nich, and May, L. nigrofasciata Reg.) and one slowly growing Cichlidae (Cichlosoma haitiensis). In 1954 l'Etang Saumâtre was stocked with 17 000 mirror carp fingerlings and 50 000 Tilapia mossambica fingerlings (Lovell and Moss, 1971), but according to Lin and Tal (1956), the number of T. mossambica fingerlings released in the lake at the end of 1954 was 6 000. Almost nothing is known about the productivity of the lake and the actual catches are very low. Fishing methods are quite primitive and there are almost no boats and very few nets.

Lake Peligre was drained in 1969–70 for the installation of a hydroelectric generator. It was refilled in 1971–72 and stocked in 1973 with carp and T. mossambica (Smitherman, 1973). No information is available concerning the natural productivity of this lake or the actual production.

Haiti has many small bays and inlets along its coast, some of which are extremely well protected. There are some 17 000 ha of mangrove forest, of which about half is in 'Departement de Artibonite' and 20 percent is in 'Departement du Nord' (FAO, 1978a).

As mentioned earlier, because Haiti lies on the leeward side of the island, it gets relatively little rain. The Arbre and Cul de Sac Plains, for example, receive only 50 to 75 cm of annual rainfall. The heaviest rains fall from May to October in this region, with a dry season from December to April. On the north coast the main rainy periods are September to January and March to June. However, some rain falls every month.

Average maximum temperatures in the north are 33.3°C in the summer and 28.3°C during winter. The corresponding average minimum temperatures are 22.2°C and 18.3°C.

With an area of 27 750 km^2 and 5.5 million inhabitants (1978), Haiti is a very densely populated country. There are serious constraints concerning land since the average population density of 200/km^2, is amongst the highest in the world. With annual population growth at 2.4 percent (FAO, 1980), this situation will become worse in future years.

Agriculture is in the hands of small holders; only 5 percent of holdings are larger than 5 ha. Crops are produced primarily for family subsistance and, consequently, the used cash is not widespread and living standards are low. Gross National Income per caput was recently estimated at U.S.$ 260[1] per year (World Bank, 1980). Distribution of income is uneven.

Generally speaking, there is a severe shortage of animal protein in the population's diet, especially in the rural areas. The regular sources of animal protein are animal husbandry (poultry, goats, sheep, pigs and cattle), dairy products, fish (from marine fisheries, inland waters or from aquaculture) and imports.

The Mission came across only one thorough historical study of availability of fish and other animal proteins in Haiti. It was produced by SCET International of France in 1977 (France, 1977). Relevant tables from that report have been translated and reproduced in Annex 5. A study of those tables shows that in 1976:

[1] U.S.$ 1.00 = Haitian Gourdes 5

a. the per caput consumption of meat was 13.77 kg/year and 26.39 kg for dairy products; the latter figure is relatively high compared to those calculated for other tropical countries;
b. the per caput fish consumption was very low: 1.18 kg/year for seafood; only 0.06 kg for fresh water fish; 0.36 kg of imported fish and fishery products; that is to say, the overall consumption of available fish products (8 292 t in 1976) was about 1.6 kg/year;
c. imports of fish and fishery products have been decreasing since 1970, as shown in Table 5 of Annex 6. Salted fish (mostly herring and cod) were 58 percent of the imports in 1956 and 1977, and smoked fish (mostly herrings) 42 percent in 1956 and 37 percent in 1976.

According to Mongodin (1977), there are enough agro-industrial by-products (see Annex 6 for detailed information) in Haiti to support an expansion of cattle production (meat and milk) and, to a lesser extent, of pig production. However, it will be very difficult, for several reasons (lack of

adequate and sufficient pasture land, high investments, etc.), to improve the meat production in the country and to meet the minimum needs of the population.

In this situation it appears logical that fish production be given high priority, with the aim of relieving the scarcity of animal protein that now is prevalent in the population's diet while avoiding the need for increased imports.

4.2 Present State of Fisheries

Fishing in Haiti is characterized by non-commercial subsistence scale activities, mostly for personal consumption or local sale.

The marine fishery is primarily for reef fish such as snapper. There are some 3 000 full-time and 5 000 part-time fishermen. They fish in inshore waters using mostly unmechanized small wooden boats and dug-out canoes. Typical gears used are hand lines, cast nets and beach seines. The spiny lobster fishery uses pots. Demersal resources of the narrow shelf area are heavily exploited and a restriction has been placed on the taking of lobsters. There is a possibility that the marine catch could be increased through greater utilization of migratory pelagic species, but no assessment of the potential has yet been made, and this type of fishing is beyond the capabilities of present fishing craft.

The total marine catch in 1976 was estimated at 7 650 tons comprising 7 130 t of fish, 500 t of spiny lobster (mainly Panulirus argus), 10 t of shrimp (mainly Penaeus brasiliensis) and 10 t of conch (Strombus gigas) (France, 1977).

Data concerning distribution, sales and consumption of fish are not systematically collected in Haiti. The information given below is derived from observations made by the Mission and information received from local observers.

The Mission visited about twelve markets, some wholesale/retail ones at the seashore and some weekly ones at country fairs. The following are the main observations:

i. In all markets the quantity of fish on display is small; even in the rural fairs it did not surpass 100 kg in any one market.
ii. With the exception of landing centres, cured fish dominate. In some internal markets it was as high as four-fifths of the total on display.
iii. The majority of the cured product imported is salted or smoked herring.
iv. Unit sales are very small. The imported wet-cured product is sold in cuts, one cut usually weighing less than 10 g.
v. Prices for imported cured fish were observed to range from U.S.$ 2 to U.S.$ 4 per kg (equivalent): prices for canned sardines are U.S.$ 1.20 for 400g; local Macrobrachium (raw or cooked) U.S.$ 2.50 per kg (equivalent). Prices for (almost) fresh Tilapia mossambica were recorded to be about U.S.$ 0.40 per kg. See table 3.

Thus, most fish sold in inland markets seemed to be bought for use as condiment and at a high price in relation to average incomes. Consumption of fish as a main dish would seem to be limited to relatively well-off sections of the population living in urban areas, and to some of the coastal communities (for the less attractive species). This is probably a matter of deficient supply more than lack of demand.

4.3 Status and Potential of Aquaculture

4.3.1 Freshwater aquaculture

Fish culture was introduced in Haiti in 1950–54 by the FAO Technical Assistance Project 'Development of Fish Farming in Haiti'. For the first two years work was concentrated on the construction of nursery and experimental ponds at the Damien Fish Culture Station and at Mariani.

Tilapia mossambica was introduced from Jamaica in 1951 and in the same year common carp fingerlings came from Alabama, U.S.A. (Lin, 1952). In 1952, fingerlings of Trichogaster pectoralis were introduced from Singapore and common carp from Israel (FAO, 1956).

Fry production of common carp and T. mossambica started at the end of 1951 and fingerlings of these two species were stocked in rivers, lakes and irrigation canals where they reproduced naturally. Trichogaster pectoralis disappeared from the Damien station around 1955.

Extension work was initiated in 1952. Farmers received assistance in building small ponds and were supplied with fingerlings. According to FAO (1956), 46 ponds with a total area of about 5 ha were constructed by the end of 1954.

During the implementation of the project two fellowships on fish culture were provided by FAO, enabling Haitians to study modern commercial fish farming abroad.

According to FAO (1956) and Lin (1952), yields between 2 300 kg and 2 600 kg of fish were obtained per ha/year in ponds at Mariani and at the Damien Fish Culture Station.

At the end of the project (1954), the Fisheries Service took charge of the implementation of the programme.

In 1958, the Fisheries Service was created by law, and made responsible for marine and freshwater fisheries. The Service concentrated mainly on freshwater fisheries and fish farming.

A programme of production of fingerlings of common carp and T. mossambica was carried out at the Damien Fish Culture Station during the period 1958–65. During these years the total fingerling production, according to the Fisheries Service, was 1.5 million of which 754 000 were common carp and 799 000 were T. mossambica. The average annual production was 108 000 carps/year and 114 000 T. mossambica per year. From 1966 to 1977 production declined and only 616 500 fingerlings were produced. The average production was 37 000 carp fingerlings and only 14 000 T. mossambica fingerlings per year. The emphasis has clearly been on carp fingerling production.

A stocking rate for common carp and T. mossambica, used by the Fisheries Service, is one fingerling per 2 m^2 (= 50 fingerlings/are or 5 000/ha). The actual fingerling production of the Damien Fish Culture Station (about 51 000 fingerlings/year) is thus less than needed to stock 10 ha of fish ponds.

For supply of carp fingerlings farmers are now completely dependent upon the Fisheries Service which has neither vehicles nor funds for transporting fingerlings to the distribution centres. The distribution of fingerlings is now restricted to the area around the Damien Fish Culture Station and is carried out by individual farmers using public transport.

The practice of stocking only common carp in the rural ponds is not the best method to improve fish farming since the common carp does not reproduce well and regularly in small ponds without special management. If tilapia had been used for stocking the situation might have been different. Tilapia reproduce in ponds and farmers could use their own fingerlings for re-stocking their ponds, if they were given adequate help in pond management.

According to Randolph (1978), 5 207 ponds were constructed during the years 1958–77. A lack of adequate management and a lack of trained personnel in the Fisheries Service resulted in fish farming coming more or less to a standstill in 1965–6.

The Fisheries Service estimates that in 1980 about 500 ponds remained in production in the country. No census of existing ponds is available. According to Mr. A. Garnier, Chief of the Fisheries Service, rural fish culture based on common carp is still going on, but the extent of this activity could not be verified by the Mission.

The Mission visited fish farmers at Leogane, the only area in the southern peninsula where private ponds are still in operation.

The following are the main observations of the Mission after visiting five homestead ponds and discussions with their owners/managers:

a. The surface of the ponds, constructed by manual labour, is between 28 and 112 m^2. Only one pond (1 080 m^2) was constructed with the help of a tractor, utilizing a mechanical shovel. The construction by contract of this pond took one month. A 112 m^2 pond was constructed in 1978 by hand labour and took 3 men one week or 18 man-days. At a salary of U.S.$ 1.00/day, the cost of construction could have been U.S.$ 18 for 112 m^2, or U.S.$ 16/are.
b. All the ponds visited were fed by irrigation channels and water supply was stated not to be a problem.
c. All 5 ponds were said to be used for carp culture and nobody stocked tilapia. Reported stocking densities are between 1 and 7 carp fingerlings per m^2. The size of fingerlings is between 3 and 5 cm.
d. Ponds are seldom fertilized and farmers do not know the use of compost.
e. Carps are fed with wheat bran, bread fruits, ground maize (U.S.$ 1.20 for 5 lbs, or U.S.$ 0.53/kg), rice bran and sweet potatoes.
f. No information on quantities of fish harvested from the ponds could be obtained.
g. Present fertilization of the ponds and construction of new ones is held up because of the lack of fingerlings. Three of the five ponds visited were filled with water but did not contain any fish.
h. It would seem that the very limited rural fish culture now practised produces fish primarily for home consumption, not for sale. No doubt sometimes fish is sold, or exchanged for goods or services, but this is not the rule.

All freshwater fisheries research is carried out at the Damien Fish Culture Station which has 19 ponds covering a total area of 2.8 ha. The stocks of fish included specimenns of common carp T. mossambica and local species of the freshwater prawn Macrobrachium.

Staff complement is: one Chief of Station, one agronomist, one hydro-biologist, one fisheries agent, one foreman, and five labourers.

Because of the limited budget staff are few and technically unqualified, and maintenance of the station is poor. Little research has been done and it has apparently been difficult to maintain the programme of fingerling production.

The 1980/81 budget for the entire Fisheries Service was said to be the equivalent of U.S.$ 150 000, most of which is absorbed by salaries.

The ponds are supplied by gravitation from an irrigation canal which supplies water to lower lying plantations; apparently at times the fish farm gets less water than it needs. At the time of the Mission's visit to the station the irrigation canal contained plenty of water but only nine of the station's nineteen ponds were filled. All 19 ponds might be used all the year round if a pump were provided, costing a few thousand dollars, to extract water from an existing well. It would be possible to place the station in good working order for a reasonable expenditure.

An abandoned fish culture station exists at Deseaux, near Bois Dehors, on the Artibonite plain. The station has 8 ponds with a total water area of 3.2 ha. The dikes and monks still stand. The station receives water from the local irrigation system. The station has not been used for fish culture for some years; at the time of the Mission's visit rice was cultured in 6 of the ponds, the other 2 were serving as pasture to rehabilitate the farm. Both dikes and monks would need to be repaired and pond bottoms levelled. These are labour intensive activities and it should be possible to make the ponds suitable for fish culture with a modest expenditure.

The Fisheries Service intends to give high priority to revival of fish culture in the Artibonite plain. The fish culture station at Deseaux would be an ideal location for production of fingerlings. It would also serve as a centre for demonstration of viable fish culture practices. The centre would cooperate closely with the ODVA (Offices de Développement de la Vallée de l'Artibonite).

Freshwater prawns of the genus Macrobrachium are abundant in some rivers. They are brought into the ponds in the Damien Fish Culture Station by the irrigation canal. According to Lin (1952), the species in Haiti are Macrobrachium carcinus and M. acanthurus.

The Member for Parliament (Deputé) of Thomazeau, who represents the ‘Conseil d'Action Communautaire’ formed by the communities around l'Etang Saumâtre, has an ambitious plan to introduce cage culture in the lake. It would involve a total of 360 people (12 groups each of 30 members). Production is projected to be about 450 kg of fish/day from 25 cages, each of 12 m^3. The cages would be constructed of bamboo and covered with netting. Estimated project cost is U.S.$ 32 900. It has been presented to TEXACO with a request for financing.

In northern Haiti the Mission visited the sites of two enterprises intended to farm fish commercially: one close to Limonade and the second at Fort Liberté.

The enterprise at Limonade was started at the beginning of 1971. It is located about 1 kilometre northeast of the main road (Cap Haïtien - Port Liberté) and consists of 25 ponds covering a total

surface of 5.9 ha. Eleven of the ponds have an area of 270 m^2 and are used as nursery ponds, the remaining 14 each measure 0.4 ha. The fish culture unit is part of a larger farm producing maize and tobacco.

Water is obtained by pumping from a nearby well. The pump (250 gallons/min) feeds the water into pipes (galvanized) of 5 to 6 in diameter, through which it is brought to the ponds. Drainage is also achieved by pumping.

The manager of the farm, Mr. Willies Starley, gave the Mission the following information:

The ponds are stocked with Tilapia nilotica, the brood stock having been imported from Florida and Alabama (at one time the farm had also Chinese grass carp). Breeders are stocked at the ratio of 10 males to 50 females in the nursery ponds. Fingerlings are harvested at 12 to 14 cm and placed in the grow-out ponds. They are reared until they are about 18 cm (which takes about 3 months).

They are then sexed by hand. Females are removed from the ponds, and the males are placed in the grow-out ponds at a stocking rate of about 2/m^2. They are harvested about 11 months later at a weight of 450 g.

The ponds are fertilized with phosphate (dosage not known). The fish are fed with a mixture of ground maize, cotton seed cake, broken rice, ground coffee fibre, and potato tops, at a ration of 4 percent of body weight 5 times a day. The Mission understood that the farm manger supplies these ingredients mostly according to their availability and not according to their nutritional value.

The farm has not done well in attempts to sell the tilapia. It has been offered for sale in nearby villages gutted and iced, for the equivalent of U.S.$ 1.50/kg, but little has been sold. This may be for the simple reason that gutted and iced large tilapia is a high-priced product with which the villagers are completely unfamiliar. Fish can be sold to restaurants in the larger towns (Cap Haïtien and Port-au-Prince) but experience is that it is difficult to obtain payment.

Mr. Starley has plans to expand the pond area to a total of 20 ha, not because he is content with the commercial aspects of the operation but because he is going to excavate nearby land in order to recover the clay for sale.

It seems to the Mission that the first thing to do in order to improve the commercial results of the farm at Limonade is to sell the fish at less than 200 g, which is an acceptable size in today's markets in rural Haiti. It also seems likely that the cost of feed would be reduced, and growth enhanced, if a nutritionally more balanced feed was consistently supplied. Feeding once a day should be sufficient. Lastly, if possible, the ponds now under construction should be drained.

The farm at Fort Liberté is financed by the Belgian Technical Assistance (Administration Générale de la Coopération au Développement, AGCD). The project manager is the vicar of the Catholic Mission who is also a member of the Conseil Communautaire of Fort Liberté, which has made 100 ha of land available to construct a 10 ha fish farm. PROTOS, a Belgian non profit making group for technical cooperation for development, is impelementing this 3-year project with one biologist, under the supervision of the Conseil Communautaire of Fort Liberte.

The aims of this project are: (a) to make the population aware of the advantages of fish culture and the incorporation of fish into their diet; (b) to train fish farmers and counterpart staff to be able to take over the project; (c) to build a demonstration centre for fish farming; and (d) to produce and distribute fingerlings to fish farmers.

The farm is situated adjacent to a large bay on what was formerly tidal land; brackish water enters the ponds closest to the bay. At the time of the Mission's visit there was a total of 26 ponds covering a water surface of about 1.9 ha. The project aims to have, eventually, over 60 ponds. Construction is carried out manually (indicating a rate of excavation of close to 2 m^3/man/day). Payment is in part by food supplied by CARE. The ponds are supplied with water by gravity from a nearby river.

T. mossambica was taken from the nearby river and introduced into the ponds. They are fed, early in the morning, with a mixture of: rice bran, peels from manioc, ground coffee fibre, leaves from sugar cane, peanut husks. Bird guano is collected locally and introduced into the ponds.

The Manager of the farm, Mr. Marc Verdegem, has carried out feeding trials in a few ponds. Observations from these ponds for the period May-June 1980 show that in spite of high feeding rates (20–30 percent of body weight), growth has been slow, 0.44 g to 1 g per fish per day. The trials lasted only one month and results are not conclusive. Mr. Verdegem is considering the introduction of T. nilotica from the farm at Limonade.

Since late 1979 some 800 kg of T. mossambica have been sold. There is a local preference for 200 g fish rather than 100 g fish; the former selling at close to U.S.$ 0.90/kg (equivalent) while the fish of 90 kg size would sell for about half that price.

At Limbé, the Mission had discussions with the experts of the FAO project ‘Protection et Aménagement du Bassin Montagneux du Limbé’ and with Mr. Turkoz, Chief Technical Adviser of the project ‘Centre de Formation en Aménagement des Bassins Versants’. The people in charge of these projects hope to introduce fish farming in response to inquiries made by the local farmers.

Agricultural and agro-industrial waste products suitable as feed and/or fertilizer (compost) in monoculture of T. nilotica and in polyculture of T. nilotica with carps, are available in Haiti (see Annex 5), but the information requires review: some of the products listed in the Annex are already used in animal husbandry (pig and cattle raising) and their geographical distribution is not clear.

4.3.2 Mariculture

There is no ongoing commercial or subsistence mariculture in Haiti. At Fort Liberté a Catholic Mission is sponsoring an oyster culture project. It is supported by the same bilateral Belgian organization that is developing pond culture of T. mossambica also at Fort Liberté. A biologist is attempting hanging culture, starting with imported Crassostrea gigas. The oysters have not done well and most have died; trials with a local oyster, Crassostrea luca, have not been successful either. The main causes are believed to be the wide fluctuations in salinity caused by runoff after heavy rains, and attacks by boring sponges.

Haiti is the only country visited by the Mission where the local population consume oysters. They are eaten boiled either as a main dish or as an ingredient in other preparations. The

Mission saw oysters in the markets at Aquin, on the south coast, Gonave and Les Cayes. The oysters observed at Aquin were mangrove oysters; the biggest specimen seen measured 1.5 cm in diameter after being preserved in lime juice. A can of oyster meat weighing 2.3 kg sold for U.S.$ 4.00.

Seaweeds are not consumed in Haiti and little is known about their occurrence.

A former fishery officer is attempting to promote culture of spiny lobster at Petit Paradis, on the southern coast of the North-Western peninsula, where there is a sizeable lagoon with a narrow mouth (2 m wide and 8 m deep). The proposal, as outlined to the Mission, would involve:

i. screening the mouth of the lagoon, and
ii. keeping berried females in pots until they spawn, expecting that the larvae will remain in the lagoon.

As the spiny lobster has a long larval life and predators most likely cannot be prevented from entering the lagoon, the Mission is not optimistic about the results of the proposed culture.

Haiti has a long coastline with varied configurations. Many of the bays are surrounded by steep hills. These bays offer excellent protection from tropical storms for such installations as floating net cages. Fin fish, for culture in cages, could be collected from the numerous reefs. At Gonave the Mission saw many small groupers in the market; their size was ideal for stocking in cages and subsequent rearing. It seems likely that also brood stock and fry, if desired, could be collected from the reefs. Trash fish for feed, and alternative feeds, seem however to be scarce.

4.4 Recommendations for Aquaculture Development

Aquaculture, both in freshwater and in brackish-marine waters, is feasible in Haiti. The main constraint to its development is the scarcity of people with adequate training and experience. It is evident that for quite a number of years the junior staff of the Fisheries Department have not had the possibility of receiving appropriate training. Those persons in Government who could give impetus to development of aquaculture know neither what the possibilities are, nor how to proceed effectively in order to revive rural fresh water fish culture. In fact, the Fisheries Service is not able to demonstrate any successful fish culture at the Damien Fish Culture Station.

The first priority for the Government should be to train its existing staff: extension workers, fish farm managers and senior (departmental) aquaculture technicians. Training of extension workers and fish farm managers is best done in Haiti and would require the participation of expatriate experts, through a technical assistance project. A draft project document for such a project is attached as Annex 7. Suitable training for senior aquaculturist technicians is given in French and English at the FAO/UNDP Regional Aquaculture Training Centre at Port Harcourt, Nigeria, and in Spanish at the Regional Aquaculture Training Centre in Pirassununga, Brazil.

Neither of the current activities in mariculture described above will, within the next few years, help solve Haiti's food problem in any significant manner, even were they technically successful and increased in scope. Also their economic viability is still to be proven. It is therefore the Mission's view that first priority should be given to the development of freshwater culture, which can, where developed effectively, improve the rural standard of living. Given the rather limited resources available for the next few years, efforts in the field of mariculture should be limited to

laying the foundation for its later development. Preparation should include: (a) training of one or two middle-level staff in mariculture (oysters, seaweeds, penaeid shrimps, cage culture or marine fish), and (b) surveys of the availability of, exploitation of and trade in such items as oysters, seaweed, snappers and groupers; also investigations into potential supplies of feed. The proposed technical assistance project includes a provision of funds to cover the foreign currency payments that these activities will require.

The Mission recommends that the main obejctive for the proposed technical assistance project be the revival of rural fish culture in Haiti - however, with one major change. Emphasis should be shifted from culture of carps to the culture of tilapias, with or without carps. Culture of tilapia is a well established practice in other parts of the world. Its main advantage is the fact that the farmer, once he has understood its principles, usually is able to carry on without further Government assistance; he can obtain most inputs through his own labour:

In preparing for the technical assistance project (Annex 7) the Government should:

- survey existing and abandoned fish ponds, recording their size, location and present use;
- initiate rehabilitation of the Damien Fish Culture Station
- make the administrative arrangements required to bring the fish culture station at Des-eaux under the control of the future project, and initiate its rehabilitation;
- identify those areas that have sufficient water for development of fish culture in ponds;
- in such areas, carry out surveys of the availability of feed and fertilizer ingredients (noting quantities and period of availability, price, transportation cost, alternative use).

If these activities are not completed at the time the technical assistance project starts, its first task would be to complete them. It would then:

- train extension workers;
- train fish farm managers;
- rehabilitate abandoned fish ponds, and through the extension service - which the project will create - promote and assist in the construction of new ponds;
- convert the Damien Fish Culture Station into a demonstration and training centre;
- locate, and assist in the construction of, rural centres for fingerling production; and,
- study the feasibility of integrated farming (fish-cum-duck, fish-cum-chicken, fish-cum-pig, etc.).

ANNEX 5

Haiti National Program for the Development of Aquaculture and Inland Fisheries

http://www.gafspfund.org/gafsp/sites/gafspfund.org/files/Documents/Haiti_NationalAgricultureInvestmentPlan.pdf

HAITIAN NATIONAL AGRICULTURAL INVESTMENT PLAN

B. Development of Sub Sectors

B.2. Aquaculture and fisheries

Situation of the sub sector

4.33 According Damais et al. (2008), the sector has more than 50,000 fishermen and fish farmers who together produce about 16,000 tons of fish per year (only 320 kg per fisherman per year), including 400 tons / year from aquaculture, for population of 10 million. The country annually imports 10,000 tons of fish per year worth 10 million USD. Exports are estimated at 500 tons per year, worth $ 5 million. With 2.5 kg / person / year, fish consumption is very low. By comparison, fish consumption in Jamaica is about 17 kg / person / year. Institutional capacity in the sector is rather weak.

Constraints

4.34 The main constraints to fisheries development are the lack of baseline data, weak institutional capacity, use of rudimentary fishing equipment and low productivity, small size and outdated vessels that prevent the exploitation resources away from the coast and limit the time and number of fishing days, the lack of organization of fishers, the lack of conservation increasing the risk of losses at all levels of marketing channels, lack of regulation contributing to the depletion of the resource (the existing 1978 law on fishing is not applied or updated).

Among the major constraints in aquaculture is the low level of production and lack of a commercial approach (lack of fingerling production, lack agricultural products for feedstock, lack of infrastructure for processing – packaging-marketing, and lack of technical support for commercial sector potential)

4.35 With 1,700 km of coastline, there is considerable potential in marine resources. In addition, there are opportunities to explore the potential for fishing for large pelagic fish. It is also important to note the existence of numerous bodies of water (including lakes, rivers, reservoirs), fishing technologies easily assimilated by persons engaged in the fishing trade and domestic demand for fish greater than the local supply.

Analysis and strategic vision for the sub-sector

4.36 Like other sectors of the economy, fisheries (marine and inland) and aquaculture have been trapped by poverty, which prevented the exploitation of marine resources off the coasts and also prevented the realization of the potential of aquaculture. The development of these activities could contribute to the fight against poverty and food insecurity. It will be build by the private sector, focusing on the integration of small producers in this sector.

4.37 Although fisheries and aquaculture have been relatively little affected directly by the earthquake of January 12, 2010, it remains vulnerable to natural disasters. The country is often hit by hurricanes that can cause damage and casualties in the fishing communities, while floods and mudslides can cause the same damage in communities of aquaculture. However, the latest earthquake has affected the marketing system because of cuts in roads and communications, the decline in demand due to a sharp decrease in the purchasing power of much of the population, but also because of the large number of people leaving the capital to settle in rural areas.

4.38 Direct damage to the sector after the last earthquake include ice plants and cold storage facilities and also loss of production due to lack of electricity. Some fishermen have lost their FADs (fish aggregating devices) and some fish farmers have suffered damage to ponds and lost fish.

Description of selected interventions

4.39 A program is proposed to support the government action plan of 2009 for the fisheries and aquaculture. The proposed program also supports the approach of the 2009 Working Group on Competitiveness set up by the President of Haiti, particularly in terms of public-private partnership and export. The program will build on the Code of Conduct for Responsible Fisheries and its guidelines. It will support the government, particularly the Directorate of Fisheries and Aquaculture (DPAQ) of the Ministry of Agriculture, Natural Resources and Rural Development, to better understand and manage resources and boost the sector and contribute to achieving the Millennium Development Goals, including the fight against poverty, food security and reducing risks of natural disasters in the area. The program will focus on the action of small farmers producing for the domestic market as well as larger scale operators who produce both for domestic and export market. Particular attention will be given to marginalized groups and women.

4.40 Lines of actions defined in the Investment Plan are aimed to create sustainable revenue streams and derive from those proposed in the development programs of marine fisheries, aquaculture and inland fisheries. These programs were prepared in 2009 by a working group bringing together private sector players, officials and professors MARNDR Faculty of Agronomy and Veterinary Medicine.

4.41 The activities to be implemented will include:

Maritime fishing:
In the short term:

- Organizational strengthening of fishermen and merchants, while emphasizing on partnership between the operators and the private sector
- Studies on the processing, storage and marketing
- Updating of the fisheries law
- Training and ongoing support of young professionals in fisheries
- Training and ongoing support of industry players
- Acquisition and provision of fishing equipment

In the medium to long term:

- Development of alternative types of fishing, with an emphasis on FADs and improved artisanal craft
- Establishment of physical infrastructure to facilitate the transportation, storage, processing and marketing of seafood
- Installation of cold chain
- Development of economic incentives for investment in the sub-sector

Aquaculture and inland fisheries:
In the short term:

- Conducting a study on revision of commercial trade policy
- Evaluation of resources and aquaculture potential
- Conducting studies on transformation, conservation and commercialization
- Production of fish feed

In the medium to long term:

- Stocking of water bodies
- Establishment of farms: production in cages and ponds
- Increased production in existing hatcheries, and creation of new centers of production
- Rehabilitation of farms with established potential
- Training and technical assistance for fishermen
- Monitoring and evaluating activities

4.42 The program will help create the necessary conditions for investment by the private[1] sector using bank loans or other means to achieve additional production of 30,000 tons / year, after a period of 10 years, including 5,000 tons / year in fisheries and 25,000 tons / year in aquaculture. This additional production, some 11,000 tons / year will be exported. The program would create

[1] It has been estimated that to implement the activities outlined, the private sector will invest an estimated fifty million USD at current prices.

nearly 70,000 jobs and its contribution to gross national product is estimated at about USD $100 million per year.

Cost Estimate

Table 9: Summary presentation of the component costs for Fisheries and Aquaculture

Actions	Costs (USD)
Short term	***5 700 000***
- Establishment of organizational and legal bases	300 000
- Studies on processing, storage and marketing	100 000
- Assessment of resources and potential aquaculture	1 000 000
- Establishment of pilot farms	300 000
- Awareness / Training / Technical Assistance	1 500 000
- Establishment of hatchery	500 000
- Acquisition and provision of fishing equipment	2 000 000
Medium - long term	***26 800 000***
- Consolidating the organizational fabric	3 000 000
- Institutional Strengthening of the DAPQ	500 000
- Rehabilitation of fish farms	2 000 000
- Installation of fishing equipment and infrastructure	10 000 000
- Training / Technical Assistance	8 000 000
- Stocking of water bodies and catchment ponds	3 000 000
- Monitoring and evaluating actions	300 000
Total	**32 500 000**

(Data Source: Marine Fisheries Development Program; National Program for the Development of Aquaculture and Inland Fisheries)

*Document translated via Google translate with formatting and clarification adaptations by James Rhoads.

ANNEX 6

Aquaculture Projects in Haiti
Jamie Rhoads

Aquaculture Projects for Tilapia Production in Haiti- November 2012						
Project Name	**Location**	**Contact**	**Type of production**	**Anticipated production**	**Notes**	**Website**
Caribean Harvest	Lac Azuei	Dr. Valentin Abe	cage	>250 cages	Caribbean Harvest is largest player in Haitian aquaculture. Supported by CGI and Social Enterprise Fund.	http://www.caribbeanharvestfoundation.org/
Caribean Harvest/Heifer International	Lac Peligre	Dr. Valentin Abe	cage/stocked lake	>250 cages		http://www.aquaculturewithoutfrontiers.org/wp-content/uploads/2010/04/Haiti-Aquaculture-Trip-Report.pdf
Caribean Harvest/Partners in Health	Boucan Carre- Near Mirelbalais	Dr. Valentin Abe	hatchery	>50,000/month	supply for Lac Peligre- reversed sexed as of summer 2012	
Caribean Harvest	Croix des Bouquettes	Dr. Valentin Abe	hatchery	>500,000/month	supply for Lac Azeul- non-sex reversed (?)	
Taino Aquaculture	Lac Azuei	Patrick Wooley	cage	>2 cages	Start up private business	
CODEP	Leogane	John Winings/Bill Mebane	pond/hatchery	~50 concrete ponds	Concrete hillside ponds with gravity system. Supplying reversed sex fingerlings from small hatchery by the coast	http://www.haitifundinc.org/
Kiskeya Aqua Ferme	Leogane	Dr. Arielle Adrien	pond	8 earthen ponds	large drainable ponds, strong potential with improved management and feed inputs	http://kiskeyaferme.com/
Christianville	Leogane/Gressier	Andy Kane	pond	13-15 concrete ponds	Large infrastructure. See AwF report for details. Connections with UFL.	http://www.fishministrieshaiti.org/
Sant Fòmasyon Pisikilti	Fort Liberte	Alexandre Edem	pond	40+ earthen ponds	Very well maintained system using stream diversion, local predators for population control. Started as FAO project with Belgian NGO in the 70's, reopened 2006 with UN funding, expanded 2011 with UN funding. Tilipia, carp and local species	
Operation Blessing	PaP		pond/hatchery/ornamental	2 high productivity ponds and ~200,000 fingerlings/month hatchery	two aerated ponds with high densisty and improved genetic reversed sexed fingerlings available, converted aquaponic system to ornamental production of several species	http://www.ob.org/_where/haiti/index.asp
Aquaculture Learning Center	Marigot	Bill Mebane	pond	>2000 fish/rotation	developed as training center near Jacmel	
Welt Hunger Hilfe/Agro Action Allemagne	Jacmel/Petit Goave		pond		NGO financed project	
Northwest Haiti Mission	Port de Paix		aquaponic		Nelson and Pade system	http://www.nwhcm.org/aquaponics-system-nears-completion
KZO Sea Farms	Fort Liberte		mariculture- cage		looking for interest/investment in large scale mariculture system for Cobia production	http://kzoseafarms.com/KZO_SEA_FARMS/Welcome.html
National Hatchery	Pont Sonde- near St. Marc	Jean Robert Badio			has Cuban technicians currently and is now adding sex reversal to system	
Damien Aquaculture Training Center	PaP	Jean Robert Badio			currently not operational	
Luke's mission	fondwa, near Leogane		aquaponic		currently not operational	
DEED	Marmelade		pond	12+ earthen ponds	DEED is USAID/DAI project. Financing ends Fall 2012. Unsure of local management.	