CAPSTONE EXPERIENCE 2015

PURDUE UNIVERSITY

Agricultural & Biological ENGINEERING

Shipping Container Aquaculture in Haiti

Claire Haselhorst (ENRE), Laura Johnson (ENRE), Caroline G. Kelemen (ENRE)

Statement of Problem and Objectives:

A main goal is to design an aquaculture system to provide on site protein and educational resources for Village of Hope in Haiti. The system must fit within a 40 foot shipping container while requiring minimal fuel and labor inputs. The only energy available is electrical energy supplied by diesel generators. Standing water promotes water borne health problems which demands a constant flow in the design. Construction material has to be under $10,000.00 and readily available in Haiti.

Background:

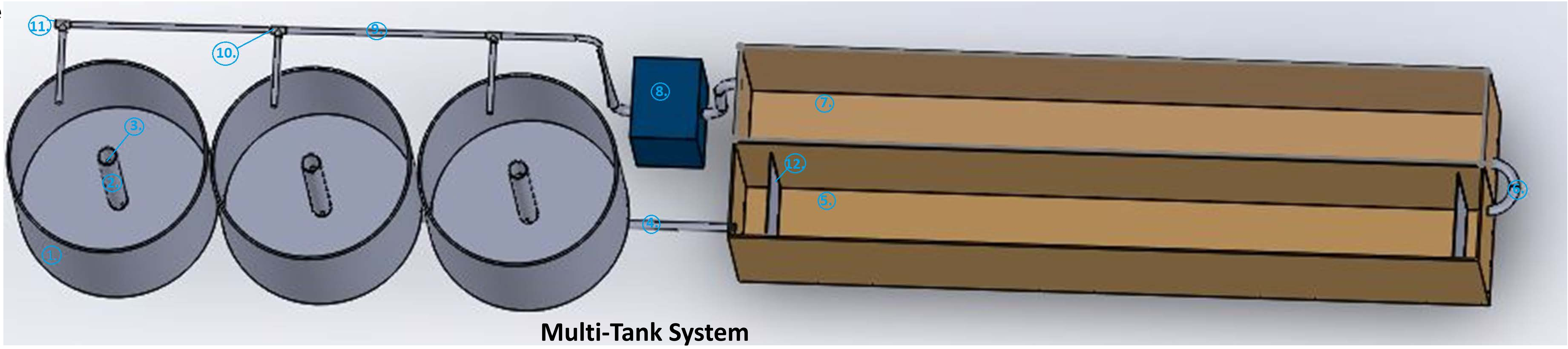
Village of Hope is located 45 minutes inland of Port Au Prince. In Haiti, a majority of the land is owned by a few people, which restricts how much land is available for smaller farming operations. Intensive agriculture could be helpful in efforts to increase local food production. Village of Hope recognizes this opportunity and is looking for ways to incorporate higher level education into food security and availability through aquaculture systems. This project is a portion of what will hopefully be a full agricultural college.

Alternative Solutions:

One of the two main systems the team investigated was a Biofloc aquaculture system. Biofloc is a system involving one long tank that holds all of the fish. Since this system is usually limited by the amount of oxygen dissolved in the water, air stones or similar aeration devices line the sides of the tank. Treated water is pumped back along the length of the tank. This combination of water and air gets the water in the tank circulating and promotes the development of microbes that can remove the ammonia produced by the fish. The fish consume these microbes, saving money on feed as well as ammonia removal. However, this system is less intuitive, adaptable, and reliable. Based on the needs of the project sponsors and technical advisors, the multi-tank aquaculture system was selected for the Village of Hope system.

Multi-Tank Aquaculture Unit Descriptions:

1. Fish Tank
2. Outer Stand Pipe
3. Inner Stand Pipe
4. 2” Food Grade Pipe
5. Sedimentation Tank
6. 2” Elbow Pipe
7. Nitrogen Fixation Tank
8. Water Pump
9. 1” Food Grade Pipe
10. 2” T-Joint
11. Stop and Valve
12. Break Wall (part of tank)



Multi-Tank System

Analytical System Model:

Operational Requirements:			Sedimentation and Denitrification:	
Individual Grow out Tank Volume (gal)	235		Minimum Settling Tank Volume (gal)****	720
Total Volume (gal)	705		Minimum Settling Tank Surface Area (ft^2)	24
Fish Density (lb/gal) °	0.3		Minimum Denitrifying Medium (ft^3)**	14
Total Number of Fish per Tank at a Grow out weight of 150g	214		Minimum Denitrifying Tank Surface Area (ft^2)	24
Feeding Rate (lb/day/tank)*	3.2		**Tank Inflow and Outflow Velocities:**	
Circulation Rate (gal/min)**	48 to 96***		Outflow Velocity (fps)	4.89
Air Flow Requirements (cfm)**	35		Inflow Velocity (fps)	19.58

°Limiting factors were space, fuel for aeration, and water circulation. These reduced the number of fish produced by the unit and the daily growth goals of the system

*Based on a daily growth goal of 4g and the tilapia growth rate: 1kg of fish growth per 1.7kg of feed

**Sized based on the projected total daily feed rate of 9.6 lb/day

***Range in flow requirement from 5-10 gal/min/lb feed/day. For tilapia and other hearty fish, a low spectrum flow is acceptable.

****Sized for a minimum retention time of 15 min. with the minimum flow rate requirement. Ideal retention time would be 30 min. for temperamental fish. The design presented above has a larger tank than the minimum requirement.

Total System Budget:

Item	Estimated Cost	Description
Fish Tanks	$1,000	Will vary based on availability in Haiti- feed bins, plastic water catchment containers, or frames with food grade liners
Piping/ Fixtures/ Plumbing	$600	Piping to move water through systems
Sedimentation System	$800	A large tank with two spillways that help slow and trap large sediment
Denitrification System	$800	A large tank filled with balls that add surface area to encourage bacteria growth
Air Compressor/ Aeration System	$2,000	Air compressor to be fitted with bubblers and split into all fish tanks and denitrification system
Water Pump	$1,300	Moves water faster and allows tanks to be level
Maintenance	$1,500	Storage closets, siphons, tank cribs, nets, misc.
Total	$8,000.00	

*Budget based on off-the-shelf costs, when constructing, materials could be obtained through other cheaper means

Global Impacts and Sustainability:

This project could have a very big impact on the world and environment, as it adds wealth and food security to one of the poorest countries in the world. The fish species and system design were specifically selected so that, with good management practices, the global net protein could be increased without the environment suffering. Water that is siphoned out of the sedimentation tank is rich with fish manure containing nitrogen in the form of ammonia. When nitrogen is in this form, it is an excellent fertilizer for crops. The use of this water on a nearby garden would help in reducing water and fertilizer use for food production. The overall sourcing of protein, fertilizer, and garden water would greatly increase the community’s self reliance, productivity, and sustainability. As these systems get distributed across Haiti, more readily available, quality food will be accessible.

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