Sustainable Tilapia Pond Model for Rural Communities in Honduras

Houston Felkins, Joshua Passantino, Thomas Zhang
Auburn University Department of Biosystems Engineering

Introduction

Honduras is one of the poorest countries in Central America with a GDP per capita of $4.3K compared to the $53K of the US. Western Honduras has ideal conditions for tilapia raising. Our client, Mission Uproach, wishes to provide means for rural farmers in the area to run their own tilapia farm and generate revenue for their families. The client needs a design that is inexpensive and can be easily maintained by few workers.

Objectives

- Provide a scalable design for 200 m² tilapia ponds that can be adapted to varying sites dependent on the resources available for different farmers and the local terrain.
- Design a solar collection system with a flat-plate solar collector to keep the temperature of a pond within the optimal temperature range for tilapia growth between 25-28 °C.
- Provide an easily understood maintenance plan for growing and expanding the tilapia ponds.

Target Area

Figure 2. Topographic map showing the potential areas for implementation in Honduras. The star marks the client location

Design Approach

- A modular approach is used for this model. The analysis is based off of one 200 m² pond. If a farmer has enough room for more ponds, then multiple ponds can be built and the costs and profits will vary proportionally.
- The yearly weather data and the energy balance shown by Equation 1 and are used to estimate the temperature change in the pond and show how a solar collector would raise the temperature.
- The performance of the solar collector is estimated using the average solar radiation hitting the target area per month and performing a heat balance to determine the collector temperature.

Figure 3. Schematic of pond design. A slope 10° slope is assumed for the site. The pond will be drained by raising and lowering a sluice gate as shown in the diagrams

Figure 4. Proposed solar collector system diagram

Figure 5. Design for an inexpensive, easily built flat-plate solar collector

Figure 6. Monthly average temperature in the collector after one sunny day and the temperature rise in the pond from running the system at the average collector temperature

Figure 7. Temperature model with and without the solar collector

Solar Heating System & Pond Temperature

\[
\frac{dT}{dt}_{pond} = E_{solar} - E_{reflected} + E_{sky} - E_{conv} + E_{solar} - E_{drain} + E_{rain} + E_{collector} + E_{fill}\] (1)

Pond Design Specifications

- Pond area: 200 m²
- Water Supply:
  - Inexpensive, easily built flat-plate solar collector
  - Water from local farms
  - Water supply available at $4/m³

Figure 8. Mass Balance for One Tilapia

Figure 9. Gains and losses projection for three cycles

Cost Analysis

- Total Cost: $961
- Feed Costs per Cycle:
  - Feed: $2,000
  - Bicarbonate and pH test strips: $420
  - Urea: $46
  - Gasoline: $200
- Total Cost: $961

Acknowledgements

The Super Tilapia Bros. would like to thank Dr. Mark Dougherty, Dr. Jeremiah Davis, Dr. Steven Taylor, and Ms. Karen Veverica for their assistance and guidance through the design process.