# PART II. RESEARCH PROJECT INVESTIGATIONS

# TOPIC AREA

## PRODUCTION SYSTEM DESIGN AND BEST MANAGEMENT ALTERNATIVES

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### DEVELOPMENT OF LOW-COST AQUAPONIC SYSTEMS FOR KENYA

Production System Design and Best Management Alternatives/Experiment/13BMA05AU

**Collaborating Institutions and Lead Investigators**

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**Objectives**

1. Design a small-scale aquaponic system for educational purposes and hobby production of fish and vegetables.
2. Design a moderate-scale aquaponic system for potential commercial application.
3. Construct a small-scale system and a moderate-scale system to develop proof of concept and training.
4. Assess the government funded Economic Stimulus Programme impacts on fish farming in terms of supply enhancement, rural poverty alleviation, and food security.

**Significance**

Aquaponic systems have become a primary tool for teaching agriculture and natural resources around the world (Graber and Junge, 2009; Rakocy, 2000). The systems have also become popular with small-scale hydroponic producers in many locations, enabling some small-scale fish farmers to generate substantial incomes for their households. In Kenya, the large number of small pond systems, often less than 200 meter square, are not proving capable of producing enough fish to be of financial interest to farmers. One option to increase fish productivity and at the same provide an additional revenue stream is to integrate the fish culture more directly with vegetable production. The rapid cash flow with vegetables, especially lettuce, basil, parsley, and bok choy, provide a more direct return for the farmer.
The Kenyan Government promote farming of fish for food, profit and employment, and to supplement the capture fisheries funded the Ministry of Fisheries Development under the Economic Stimulus Programme (ESP) that subsidized the distribution of fingerlings. Funding began in the financial year 2009/2010 and continued through to 2011/2012. This program focuses on increasing fish production throughout the country. Although focused more broadly than aquaponics, the ESP provides a unique opportunity and context for implementation of aquaponics and other novel production strategies.

**Quantified Anticipated Benefits**

We anticipate that the demonstration unit will be in a high visibility location and receive attention from faculty, staff, students, and local area farmers. We expect that at least 200 individuals will observe the workings of the unit. The fish and vegetables produced will be consumed by students or sold to generate funds for student activities. The unit will be instructive for farmers who have ponds and wish to use the nutrient enriched water to irrigate field and vegetable crops. We will document the increased levels of nitrogen that can contribute to fertilizing plants and reducing the costs for chemical fertilizers for farmers.

**Experimental Design**

**Task 1. Design a small-scale aquaponic system for educational purposes and hobby production of fish and vegetables**

A small-scale aquaponic system will be designed using ready available materials from the local area. The goal will be to design a physical system that is low cost, easy to replicate and will have the ability to maintain up to 50 kg of tilapia and irrigate and fertilize 250 heads of lettuce (approximately 100kg) or other plants. We will focus on minimal electrical demand and the potential to operate with a single solar panel. The design will be shared with a couple of outside experts (Rakocy, Ebling, and Timmons) for evaluations and comments.

**Task 2. Design a moderate-scale aquaponic system for potential commercial application**

We will utilize some basic design parameters from the University of the Virgin Islands (Rakocy et al. 2000; 2004) and the University of Arizona (Licamele 2009) to design an appropriate scale aquaponics system for farmers in Kenya. The goal will be to design a system that would utilize water from a pond to irrigate and fertilize up to 1000 square meters of vegetables. We will consider two models, one a hydroponic system with water returned to the fish, and the other a one way model with water going only to the vegetables with none being returned. The designs will be shared with a couple of outside experts (Rakocy, Ebling, and Timmons) for evaluations and comments.

**Task 3. Construct the small-scale system to develop proof of concept and training purposes**

On campus we will construct a model small-scale system based on the design that we have after input from outside colleagues. The operational system will be used to test the methods, the equipment, and subsequently train students and local farmers. Data on water quality, growth rate and yield of fish and plants, and energy demand will be collected. A simple enterprise budget will be prepared based on the capital costs, operational costs and revenue sales that would be generated from such a system.

**Task 4. Construct a moderate-scale system**

We will construct a system at the demonstration fish farm across the road from the main Eldoret Campus. Data on water quality, growth rate and yield of fish and plants, and energy demand will be collected for the moderate scale system. An enterprise budget will be prepared based on the capital costs, operational costs and revenue sales that would be generated from the moderate-scale system. The operation will be utilized for training staff and students as the interest level in these systems continues to expand.

**Task 5. Assess the broader impacts of the fingerling distribution program**

This activity will measure outcomes of Economic Stimulus Programme (ESP) in terms of its impacts on aquaculture development, rural economic growth, poverty alleviation and food security. The assessment will use administrative records and field observations to estimate the nature and kind of benefits the effort has had on supply, household incomes, and rural development in Kenya. Results from the impact analysis of rural aquaculture development will also be useful to private investors for making sound investment decisions especially in areas of seed and feed production.

**Impact Assessment**

Several current fish farmers have expressed interest in aquaponics as a method to increase farm productivity. There is growing demand for food from organic farms across Kenya, especially from the tourist trade vendors and from the general public concerned with the misuse of chemical fertilizers. An aquaponic growing system could help meet this demand and present a business opportunity for capable growers. Commercial flower growers have also expressed interest in aquaponics to make better use of their greenhouse facilities and to diversify their product stream. Teachers are also likely to take the idea of integrated farming as a valuable teaching tool. At the end of the project, we will conduct a survey following up with the farmers who have expressed interest in the farming system to determine how many have adopted some of these practices or otherwise altered their production methods using aquaponics.

**Schedule**

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| July 2013 | Begin design of small-scale system |
| August 2013 | Begin design of moderate-scale system |
| September 2013 | Send designs for outside reviews and comments |
| October 2012 | Begin construction of small-scale system |
| November 2013 | Begin collection of trial data |
| December 2013 | Begin construction of small-scale system |
| January 2014 | Collect data from each system. |
| February 2014 | Continue data collection from each trial |
| April 2014 | Harvest systems and determine growth and yield |
| May 2014 | Compile results and analyses of both systems. |
| June 2014 | Prepare and submit final reports |

**Deliverables**

| **ITEM** | **MECHANISM (E.G. PODCAST REPORTS FACTSHEETS ETC.).** |
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| Description of systems | Leaflet for farmers |
| Results of trials | Applied report |
| Growth and yield results | Journal article |
| Comparative perspective on production strategies, feed, and seed supply | Joint seminar with ILRI collaborators on African aquaculture production systems |