Aquaculture and Horticulture: Pathways to improved income, diet diversity and nutrition

The Feed the Future Nutrition Innovation Lab team
The Innovation Lab for Nutrition pursues applied research that supports the goals of USAID’s Feed the Future initiative and builds individual and institutional capacity for analysis and policy formulation in developing countries in Asia and Africa. In collaborations with its partners, the lab has so far published more than 90 peer-reviewed publications in a range of impactful journals, 300 presentations at various conferences, and provided short-term (workshops) and long-term trainings (Master’s and PhD) to more than 3000 individuals.

**Bangladesh**
- Linking Agriculture and Health for dietary diversity, income and nutrition (BAHNR Study)

**Sierra Leone**
- A sub-study to determine how EED influence the effectiveness of supplementary feeding on Moderate Acute Malnutrition (MAM) recovery

**Estonia**
- Egypt
  - Secondary analysis on causes and solutions to address stunting in Egypt

**Mali**
- Country with supported research

**Ethiopia**
- Country with supported research

**Uganda**
- Uganda Panel Evaluation of USAID Community Connector Program
- Aflatoxin Levels in Women and Infants: Birth Cohort Study
- Assessment of Environmental Enteropathy in Uganda
- Capacity building - Annual symposia, Bangalore Boston Nutrition Collaborative

**Ghana**
- Country with supported research

**Kenya**
- Country with supported research

**Nepal**
- Empirically understanding agriculture to nutrition pathways (POSHAN community studies)
- Measuring the quality of Nutrition Governance (PoSHAN Policy Research)
- Maternal Exposure to Mycotoxins, Birth Outcomes and Stunting in Children (Afla cohort study)
- An evaluation of sustained activities of an enhanced homestead food production intervention (AAAMA)
- An in-depth assessment of the knowledge, attitudes and practices of front-line workers (FLW study)
- Child Development in Rural Nepal: relationship to diet and livestock holdings
- Livestock Programs in Nepal: Effects on Health and Nutrition 4 Years Post-Intervention
- Capacity building - Annual symposia, Bangalore Boston Nutrition Collaborative, and Research Methods workshops

**Malawi**
- Promoting nutrition capacity development to meet National priorities

**Mozambique**
- Assessing Aflatoxin levels in Children under five years of age in Nampula province

**Tanzania**
- Assessment of the impact of a Homestead agriculture and nutrition project (HANU) in Rufiji district, Tanzania
GLOBAL AND LOCAL PARTNERS
ORDER OF BUSINESS

1. Introduction by moderator, Shibani Ghosh
2. Patrick Webb – findings from aqua/hort intervention research
3. Robin Shrestha – findings on cost-effectiveness of innovative value chain technologies
4. Patrick Webb – preliminary findings on food safety concerns and demand for processed packaged foods in rural markets
5. Q&A moderated by Hannah Koehn
KEY QUESTIONS

1. Are there additive benefits of promoting combined aquaculture and horticulture (on income, diets and nutrition)?

2. What are the cost constraints relating to uptake, scaling and profitability of innovative value chain technologies?

3. What frontier food security issues are of concern when considering rural markets? eg. food safety, spending on processed packaged foods, mycotoxins, etc.,
RESEARCH APPROACH

- Longitudinal panel survey in 3,060 households located across 102 unions of the FTF zone of influence.

- Respondents interviewed 3 times over 2 years on diets, livelihoods, aqua./hort., marketing, food safety.

- Embedded sub-studies on technology innovation adoption, perceptions of food safety.

![Pie chart showing distribution of responses]

- Neither 13% N=1090
- Either 61% N=4983
- Both 26% N=2249
MORE EXPOSURE = MORE FARM DIVERSITY

Mean Production Diversity by Exposure to USAID program (all households)

Number of crops/fish species farmed

...AND HIGHER NET INCOME FROM AGRICULTURE
#### CHANGE IN HOUSEHOLD SPENDING

<table>
<thead>
<tr>
<th>US$/capita</th>
<th>Total household expenditure</th>
<th>Household food expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>No USAID program exposure</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Exposed to one USAID program</td>
<td>0.040</td>
<td>0.024</td>
</tr>
<tr>
<td>Exposed to multiple USAID programs</td>
<td><strong>0.348</strong></td>
<td><strong>0.366</strong></td>
</tr>
<tr>
<td>N</td>
<td>2802</td>
<td>2802</td>
</tr>
</tbody>
</table>

*β-coefficients are shown in the table above; * p<0.05

*Models adjust for engagement in aquaculture and horticulture, baseline dietary diversity/fish consumption, female caregiver’s education level, household food insecurity access score (HFIAS)*
# Change in Dietary Diversity

<table>
<thead>
<tr>
<th></th>
<th>Household</th>
<th>Child</th>
<th>Female caregiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neither aquaculture NOR horticulture</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Either aquaculture OR horticulture</td>
<td>0.139</td>
<td>0.081</td>
<td>0.039</td>
</tr>
<tr>
<td>Aquaculture AND horticulture</td>
<td>0.246*</td>
<td>0.156*</td>
<td>0.155*</td>
</tr>
</tbody>
</table>

| N  | 2800 | 2791  | 2801 |

β-coefficients are shown in the table above; * p<0.05

*Units of diet diversity is food groups

*Models adjust for exposure to USAID programs, baseline diet diversity, education (household head for household model, female caregiver for child and female caregiver models), HFIAS
FISH INTAKE ROSE IN CHILDREN <24M

* Significantly higher compared to Round 1 p<0.05 (logistic regression, controlling for wealth, education, gender of head, etc.)
CHANGE IN SMALL FISH CONSUMPTION

<table>
<thead>
<tr>
<th>Diff R3-R1 (grams)</th>
<th>Child</th>
<th>Female caregiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>No USAID program exposure</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Exposed to one USAID program</td>
<td>-0.308</td>
<td>0.154</td>
</tr>
<tr>
<td>Exposed to multiple USAID programs</td>
<td>3.736*</td>
<td>7.041*</td>
</tr>
<tr>
<td>N</td>
<td>2791</td>
<td>2801</td>
</tr>
</tbody>
</table>

β-coefficients are shown in the table above; * p<0.05

Models adjust for engagement in aquaculture and horticulture, baseline fish consumption, female caregiver’s education level, HFIAS
## EATING ASF REGULARLY REDUCES STUNTING

<table>
<thead>
<tr>
<th>Length-for-age Z-score</th>
<th>Age group: 12-24 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child consumed 1 type of ASF <strong>yesterday</strong></td>
<td>0.060</td>
</tr>
<tr>
<td>Child consumed &gt;2 ASFs <strong>yesterday</strong></td>
<td><strong>0.245</strong></td>
</tr>
<tr>
<td>Child consumed 1 type of ASF 6 months ago</td>
<td>0.095</td>
</tr>
<tr>
<td>Child consumed 2 types of ASF 6 months ago</td>
<td><strong>0.231</strong></td>
</tr>
<tr>
<td>N</td>
<td>1,381</td>
</tr>
</tbody>
</table>

Reported estimates are from OLS regressions. * p<0.05; ** p<0.01.

Model controls for starchy staples, consumed any fruit and vegetables, consumed legumes nuts and seeds, age, age^2, age^3, gender, child had diarrhea in the past 2 weeks, caregiver’s education, caregiver’s height, type of latrine. Regressions include district x survey round fixed effects.
Exposure to multiple programs on aqua., hort., clean water, market access, behaviour change, etc.

>diversity of farm output

>market engagement

>net income growth (sales)

>net food expenditure

>diet diversity (hh, mother, child)

>intake of small fish, fruit, ASF

<<risk of child stunting (if eggs or meat/dairy in a >diverse diet) controlling for wealth, educ., water, etc.
1. Positive multipliers from concentrating investments by geography *and over time*; not once-and-done.

2. SBCC helps promote fish (and dairy) and OFSP. More to do.

3. Success in aquaculture: i) more educated, ii) less poor, iii) more labor, iv) more investable cash, v) self-trading (to more distant markets). Hort. products sold locally.

4. Yes, farm diversification can impact stunting, *with* access to markets. Not just roads; trucks, credit access (making it feasible to adopt risk), information and inputs; and technology.
Adoption of Innovative Supply Chain Technologies in Rural Bangladesh

Feed the Future Innovation Lab for Nutrition team
A sub-study on cost-effectiveness and adoption of technologies to improve access to higher quality diet

Three technologies - 107 households

Data collected bi-weekly over 3 years

Cost-benefits analysis using a Land Use System (LUS) approach
1. CHIMNEY SOLAR DRYER

Air enters front of dryer. Warm air rises in chimney to produce airflow. Air flow is concentrated in a small cross section to cause high airspeed past product.

80 cm high ‘table’ covered with black plastic or cloth. Clear plastic film is placed over the trays and the sides of the table.
CHIMNEY SOLAR DRYERS

- 3 Dryers: 1 used for fish, 2 for fruits/vegetables

- Cost per dryer:
  - Establishment cost: US $138
  - Operations & maintenance cost: US $64/year

- Training: 41 Farmers and local traders (27 males, 14 females)
- Duration of operation (annual basis): 2-8 months
LESSONS LEARNED

Effect on Quality of products (compared to traditional open sun):

- drying time reduced by 34%
- higher % of relative humidity
- Reduced % of weight loss
- better visual quality
- No use of chemicals (insecticides)
- Reduced contamination with rodent, flies, insects, dusts
ECONOMIC ASSESSMENT - DRYERS

Strengths:
• low start-up cost (cheaper, uses local materials)
• market demand and price (dry vs fresh)

Weaknesses:
• types of products dried (low vs high market value)
• market distance
• *Demand for larger commercial dryers but higher establishment costs*
2. CoolBot Cold Rooms
CHARACTERISTICS OF COOLBOTS

• 3 Coolbot rooms - used for storing fruits and vegetables

• Cost per room:
  
  * Establishment cost: US $13,065
  * Operations and maintenance: US $278/year

• Training: 34 mostly Farmers (30 males, 4 females)
• Duration of operation: 3-8 months per year
• Capacity utilization – 2-7% per year
LESSONS LEARNED - COOLBOTS

Effect of Cooling Methods on quality of stored products:

• minimal product weight loss in when stored over 5 weeks
• Better visual quality and firmness
• No need for insecticides
• Reduced risk of decay or contamination
**Strengths:**
- Market demand high in off-season
- Better market prices

**Weaknesses:**
- High set-up costs
- Low capacity utilization
- Limited farmer understanding of economic value-addition via storage of products
- Market access
FLOATING GARDENS

- Indian spinach vines
- Growing tomato plants in the garden
- Farmer in front of her floating garden bearing bottle gourd vine tomato and red amaranth
- Floating garden with turnip and tender Chinese cabbage
- Freshly cut Indian spinach from floating garden
CHARACTERISTICS - FLOATING GARDENS

36 Floating gardens; 1 per household, used for producing vegetables, seedlings and fruits

Costs:

- **Establishment cost:** US $123
- **Operations and maintenance:** US $55/year

Trainings: 41 Farmers and local traders (27 males, 14 females)

Duration of operation: 3-5 months per year

- Better growth performance, visual quality, yield and phytochemical composition in medium with 50% water hyacinth+30% charcoal+20% vermicompost.
- **No use of chemicals (insecticides)**
ECONOMIC ASSESSMENT OF FLOATING GARDENS

**Strengths**
- Relatively low start-up cost

**Weaknesses**
- Profit insufficient to offset establishment and maintenance cost
- Types of products dried (low vs high market value commodities)
- Cannot be used during rainy season
- Longer-term environmental impacts unknown

Fig 3. Discounted Annual Flow of Benefits - Floating Gardens

- Taka
- Month

![Graph showing the discounted annual flow of benefits over time for floating gardens.](image-url)
KEY TAKE-AWAYS

• Of the technologies tested, the UCD Chimney dryer shows the most promise

• Economic viability (adoption, scaling, profitability) depends on access to markets and relative prices

• Actual costing of any innovation must be integrated into all future assessments of technological effectiveness

• Future programs promoting outputs and sales of perishable foods may need to include SBCC aimed at producers and consumers
FINAL THOUGHTS

- Investments in agriculture still matter. They directly contribute to improved diets, ASF and hort. intake of children and women, and even to reduced stunting...

- ...if projects provide additionality: multiple entry points, reinforcement of messages, building knowledge and appetite for innovation. This means not just adding SBCC, but technology interventions, market literacy, credit access.

- Next generation research on ag-nut must focus on cost-effectiveness of programs from uptake lens, time to delivery of nutrition outcomes, and costing of cross-program effects.