What Influences the Success of Aquacultural Research Projects?

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Introduction

• Research programs need periodic assessment

• One way: a “knowledge production function”

• Classic bibliometric approach to research evaluation doesn’t allow an exact matching of a study’s outputs and inputs

• A new approach to research assessment: directly focus on the information a study generates.
Conceptual Framework

\[ K = f ( E, M, C, I, \varepsilon ) \]

\( K \): knowledge an aquacultural study generates

\( E \): study expenditure

\( M \): research management policies, e.g. choice between experimental and survey methods

\( C \): human capital devoted to the study

\( I \): institutional, cultural, and environmental conditions under which the study is pursued

\( \varepsilon \): unexplained variation
We treat each AquaFish investigation as a production unit that uses research inputs to produce knowledge outputs. Then, we:

- **Assess research Outputs** ($K$)
- **Assess research Inputs** ($E, M, C, I$)
Research Output Measurement

**Difficulties in Measuring Research Output**

- Non-comparable outcomes
  
  E.g. Survival rate (%) versus Total phosphorus (mg/L)

- Intangible information (cannot be counted)

- Research is on-going, so assessment methods must be updatable

- Some projects fail in the sense that the hoped-for improvements don’t materialize
Bayesian Approach to Output Measurement

• focuses on the new information the study provides

• to measure new information, we compare

  -- what we used to think the outcome chances were.
  -- what we now think the chances are, based on our research
• Utility

$$U(d, Z, \Omega) = U(d | Z, \Omega) - U(d | \Omega)$$

utility of acting before the results

(higher) utility of acting after study results

• Research output $K$:

$$K = U(d, Z, \Omega)$$
Utility Computation Example

Example: 07MNE04UM. Its goal is to examine ways of reducing effluent and settling-pond pollution from Chinese shrimp production:

<table>
<thead>
<tr>
<th>Target outcome</th>
<th>Prior levels</th>
<th>Prior probability</th>
<th>Posterior mean</th>
<th>Posterior standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish yield (kg/ha)</td>
<td>Low 7000</td>
<td>0.10</td>
<td>8255.06</td>
<td>1438.05</td>
</tr>
<tr>
<td></td>
<td>Medium 8000</td>
<td>0.60</td>
<td>8255.06</td>
<td>1438.05</td>
</tr>
<tr>
<td></td>
<td>High 9000</td>
<td>0.30</td>
<td>8255.06</td>
<td>1438.05</td>
</tr>
<tr>
<td>Dissolved oxygen (mg/L)</td>
<td>Low 6</td>
<td>0.20</td>
<td>6.74</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>Medium 7</td>
<td>0.70</td>
<td>6.74</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>High 8</td>
<td>0.10</td>
<td>6.74</td>
<td>1.05</td>
</tr>
<tr>
<td>Total suspended solids (mg/L)</td>
<td>Low 20</td>
<td>0.10</td>
<td>47.12</td>
<td>12.33</td>
</tr>
<tr>
<td></td>
<td>Medium 30</td>
<td>0.70</td>
<td>47.12</td>
<td>12.33</td>
</tr>
<tr>
<td></td>
<td>High 40</td>
<td>0.20</td>
<td>47.12</td>
<td>12.33</td>
</tr>
</tbody>
</table>

compare the advantage of using the posterior rather than prior distributions when making shrimp management decisions.
Utility Computation Example

• Mean of shrimp producer’s prior distribution:

$$\text{Mean}_{PR} = P_L L + P_M M + P_H H$$

• Mean of the posterior distribution:

$$\text{Mean}_{P0} = P_L L' + P_M M' + P_H H'$$

• Variation the producer anticipates around his naive (pre-study) outcome expectation \(\text{Mean}_{PR}\), but evaluated in terms of the outcomes estimated from the study, is

$$\text{Var}^{P0}_{PR} = P_L (L' - \text{Mean}_{PR})^2 + P_M (M' - \text{Mean}_{PR})^2 + P_H (H' - \text{Mean}_{PR})^2$$

• The appropriate variance of the posterior distribution is based on the distances between the posterior mean and the three outcomes predicted. This is the posterior variance itself:

$$\text{Var}_{PO} = P_L (L' - \text{Mean}_{PO})^2 + P_M (M' - \text{Mean}_{PO})^2 + P_H (H' - \text{Mean}_{PO})^2$$
Utility Computation Example

The knowledge or utility gained from the study is the difference between the prior and posterior variation.

Utility is always positive:

\[
K = U(d, Z, \Omega) = U(d \mid Z, \Omega) - U(d \mid \Omega) = \text{Var}_{PR}^{PO} - \text{Var}_{PO}
\]
Research Discovery Assessment

\[ K = f (E, M, C, I, \varepsilon) \]

- Assessing research Output \((K)\)
- Assessing research Inputs \((E, M, C, I)\)
Research Input Measurement

• **Expenditures** \((E)\)
  - USAID fund
  - US cost share
  - Host Country cost share
  - Labor wage deflator across country

• **Research Management** \((M)\)
  - Controlled Experiment versus Statistical Survey
  - Sample size

• **Investigator and Collaborator FTE and Human Capital** \((C)\)
  - Distribution of Scientist and Collaborator Ages
  - Distribution of Highest Degrees

• **Institutional and Environmental Conditions** \((I)\)
  - On-Station versus Off-Station research
  - Transportation Modes
  - Road Conditions and Distances
Regression Analysis

Data on AquaFish research treatments, probabilities, and inputs were provided by the host-country AquaFish investigators. (2007-2009 & 2009-2011)

<table>
<thead>
<tr>
<th>Coordinator</th>
<th>US university base of respective project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steven Amisah</td>
<td>Purdue U</td>
</tr>
<tr>
<td>Gertrude Atukunda</td>
<td>Auburn U</td>
</tr>
<tr>
<td>Remedios Bolivar</td>
<td>North Carolina Stat U</td>
</tr>
<tr>
<td>Wilfrido Contreras</td>
<td>U Arizona</td>
</tr>
<tr>
<td>Eladio Gaxiola</td>
<td>U of Hawaii</td>
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<tr>
<td>So Nam</td>
<td>U of Connecticut</td>
</tr>
<tr>
<td>Gao Zexia</td>
<td>U of Michigan</td>
</tr>
</tbody>
</table>
Regression Analysis

|                          | Estimate | Std. Error | t value | Pr(>|t|) |
|--------------------------|----------|------------|---------|----------|
| **Expenditure:**         |          |            |         |          |
| USAID fund               | 4.089e-04| 1.045e-04  | 3.912   | 0.000113 *** |
| Costshare                | 7.467e-04| 1.493e-04  | 5.003   | 9.58e-07 *** |
| Labor wage deflator      | 9.117e+01| 1.701e+01  | 5.360   | 1.65e-07 *** |
| **Transportation:**      |          |            |         |          |
| Unpaved road             | -5.323e+01| 9.727e+00 | -5.473  | 9.31e-08 *** |
| Bus                      | -2.284e+01| 4.817e+00 | -4.742  | 3.26e-06 *** |
| Auto                     | 5.065e+01 | 8.328e+00 | 6.081   | 3.58e-09 *** |
| **Collaborator:**        |          |            |         |          |
| Collaborator worktime    | 1.099e-02 | 5.309e-03 | 2.070   | 0.039345 * |
Further Study

• More data are in need

• Other Utility functions will be employed into the output assessment

• Model specification: Heteroscedasticity, endogeneity, spatial-temporal data, etc.
Thank you!