The Role of Productivity, Technical Change and Farmer’s Efficiency in the Dynamic Growth of the Tilapia Industry

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Outline of Presentation
• Brief Industry Profile
• Genetic Improvements in Tilapia Strains
• Estimation of TFP using
  - Tornqvist Index approach
  - Parametric approach
• Identification of sources of output growth
• Some policy directions to boost tilapia production

Importance of Fishery Sector in Philippine Economy
• Fisheries contributes 2.2% to GDP
• Only a sub-sector in Agriculture but a net food producer
  Crops 61%
  Fishery 15%

Important source of FOREX
  Export 26,239 M PhP
  Import 7 M PhP
  Philippines is net exporter of fish

Source: BAS 2010

Fisheries Production by Sector, 2010

Growth in Fisheries Production

Source: BAS 2010

Average Growth rates: 1997-2010
Aquaculture - 7.66%
Municipal - 3.12%
Commercial - 2.75%

Tilapia (Oreochromis niloticus)
• Nearly a hundred different species of tilapia all over the world.
• Freshwater fish species which originated in Africa.
• Omnivorous fish
• Due to its prolific nature, it had spread worldwide and had become one of the most important aquaculture species especially in Asia.
Importance of Tilapia as an Aquaculture Species

In terms of production 11% - ranks 3rd (next to seaweeds and milkfish).
In terms of value 23% - also ranks 3rd (next to milkfish and tiger prawn).

Tilapia Production
Tilapia production (MT) and growth (%) 1997-2007

Phases:
- Phase 1: Prior to 1999
- Phase 2: 1999 - 2006
- Phase 3: 2006 - present

Source of basic data: BAS

Tilapia (Culture Environments)

Tilapia (Regional Production)

Top Producing Provinces
1. Pampanga (Region 3)  93,357.23  39%
2. Batangas (Region 4A)  54,077.41  22%
3. Rizal (Region 4A)  10,576.23  4%

Value of Production
Nominal and Real value of Tilapia production

Nominal value of production is growing faster than real value
Implication: real price of tilapia is declining over time

Source of basic data: BAS
Regional Net Supply of Tilapia

Country Level – production surplus of 95 M metric tons
Surplus producing regions
Region 2
Region 3
Region 4A
S OCCSKSARGEN

Development of Different Tilapia Strains

First introduced in the Philippines in 1950s
- *Oreochromis mossambicus*
- not successful as food fish species

1972: Tilapia aquaculture took off
- *Oreochromis niloticus*
- accepted as food fish mostly in Luzon

Mid 1970s: Sex-reversed tilapia
- all male tilapia
- using feeds with synthetic male hormone
- Freshwater Aquaculture Center (FAC) (Guerrero and Abella, 1976)

Development of Different Tilapia Strains

Late 1970s: Tilapia Genetic R&D started
- hybridization of Nile tilapia
- FAC-CLSU and ICLARM (now WorldFish)

1986 FaST (FAC Selected Strain)
- also called IDRC strain
- FAC-CLSU

1988 GMT (Genetically Male Tilapia)
- YY-male technology
- supermale tilapia with YY genotype
- alternative to hormone-treated sex-reversed tilapia
- (FAC, BFAR and University of Swansea)

Development of Different Tilapia Strains

1997 Genetically Improved Farmed Tilapia (GIFT)
- selective breeding technique
- WorldFish Center funded by UNDP
  in collaboration with FAC and BFAR

1997 GET-Excel
- Genetically Enhanced Tilapia
  Excellent strain that has Comparative advantage with other tilapia strain for
  Entrepreneurial Livelihood
- NFFT-BCAR

1998 Saline-tolerant Tilapia
- NFFT-BCAR (Munoz, Nueva Ecija)
- BEST (Brackishwater Enhanced Selected Tilapia)
- NITFDC-BCAR (Dagupan, Pangasinan)
- Molobicus strain

Productivity Growth in Tilapia Industry

Identifying the sources of output growth, whether such growth is sustainable?
- technological progress (modern strains, new cultural practice...)
- area expansion
- input intensification

Objectives:
- a. Identify the sources of growth in total factor productivity in terms of technological change, farmer’s efficiency, scale and price effects
- b. Identify the other sources of output growth aside from change in TFP, i.e., prices and intensity of input use
- c. Compare the relative contribution of the different sources of output growth to identify a strategic policy directions towards improving productivity of tilapia aquaculture

Definitions of Factor Productivity

- Ratio of output to a particular input (Partial FP)
- Ratio of output to total inputs (Total FP)
- TFP is growth in output “not” explained by the amount of inputs used in production
- determined by how efficiently and intensely the inputs are utilized in production

Two measures employed in the study
1. Parametric Approach (Frontier Production Function)
2. Tornqvist Index Decomposition
Measurement of Growth in Total Factor Productivity using Tornqvist Index

Properties of the Tornqvist TFP Index

Index

Decomposition of the Nominal Revenue Function:
Revenue increases due to either
- increase in output prices
- increase in input use (positive MP)
- growth in TFP

Decomposition of the Nominal Cost Function:
Cost increases due to either
- increase in input prices
- increase in production (positive MC)
- fall in TFP growth

Hence, TFP growth is both
- revenue enhancing and
- cost reducing

Growth Decomposition

Growth in Revenue:
\[ \ln \text{TR}_{st} = \sum \frac{1}{2} (r_{i,s} + r_{i,t}) \ln \left( \frac{P_{it}}{P_{is}} \right) \]
\[ + \sum \frac{1}{2} (c_{j,s} + c_{j,t}) \ln \left( \frac{X_{jt}}{X_{js}} \right) \]
\[ + \text{TFP} \]

Growth in Cost:
\[ \ln \text{TC}_{st} = \sum \frac{1}{2} (c_{i,s} + c_{i,t}) \ln \left( \frac{W_{jt}}{W_{js}} \right) \]
\[ + \sum \frac{1}{2} (r_{j,s} + r_{j,t}) \ln \left( \frac{Q_{it}}{Q_{is}} \right) \]
\[ - \text{TFP} \]

Since CRS is assumed together with competitive profit maximization, ΔTFP is interpreted as technical change.


Sources of Data

STRIVE FOUNDATION (1996)
- Pangasinan
- Pampanga
- Bulacan
- South Cotabato

BAS Cost and Return Survey (2002)
- Batangas
- Camarines Sur
- Nueva Ecija
- Pampanga

Published cost and return data

Growth in Tilapia Production

Output growth 1996-2002 = 8.48% or 1.41% annually

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Growth Rate

Source of basic data: BAS

Sources of Growth in Revenues / Cost (in percent) (1996-2002)

Component of Growth in Total Revenues:
- Pond Tilapia aquaculture

<table>
<thead>
<tr>
<th>Component</th>
<th>Pampanga</th>
<th>Nueva Ecija</th>
<th>Philippines</th>
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<tr>
<td>Increase in output prices</td>
<td>37</td>
<td>102</td>
<td>61</td>
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<td>Increase in input use</td>
<td>-18</td>
<td>7</td>
<td>33</td>
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<tr>
<td>Total Revenues</td>
<td>19</td>
<td>11</td>
<td>52</td>
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<td>Component of Total Cost Inflation:</td>
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<tr>
<td>Increase in input prices</td>
<td>20</td>
<td>11</td>
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<tr>
<td>Increase in output</td>
<td>3</td>
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<tr>
<td>Total Cost Inflation</td>
<td>3</td>
<td>96</td>
<td>60</td>
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Growth in TFP 1996-2002

Annual TFP Growth

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<th>Component</th>
<th>Pampanga</th>
<th>Nueva Ecija</th>
<th>Philippines</th>
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<tr>
<td>3.5</td>
<td>12</td>
<td>2.7</td>
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</table>
**Change in Input Use**

Increase in TR due to Input Use for Tilapia

Increase use (Fertilizer, Feeds) Decrease use (Seeds, Hired and Family Labor)

**Change in Input Prices**

Increase in TC due to increase in Input Prices of Tilapia

Increase prices of all inputs (Seeds, Feeds, Fertilizer, Hired and Family Labor)

**Decomposition of Growth in Total Factor Productivity through Parametric Approach (Frontier Production Function)**

\[ \Delta TFP = \Delta TC + (\sum \lambda_j \Delta X_j) + \Delta TE + \Delta \lambda_j - S_j \Delta X_j \]

Where:
- \( \lambda \) - slope parameter (output elasticities) of the production function
- \( RTS \) - returns to scale; \( \sum \lambda \) or sum of the output elasticities
- \( \lambda_j \) - ratio of individual output elasticity to RTS;
- \( \lambda_j = \frac{\lambda_j}{\sum \lambda} \)
- \( S_j \) - change in the use of input \( j \) between the two periods
- \( S_j = \frac{w_j x_j}{\sum w_j x_j} \)

**Sources of Data**

WorldFish Center Taal Lake - Tilapia Fish cages
2003 data - 49 respondents
2006 data - 67 respondents
Growth in Tilapia Production
Output growth 2002-2006 = 13.52% or 3.38% annually

Phase 1 - Prior to 1999
Phase 2 - 1999 - 2006
Phase 3 - 2006 - present

Source of basic data: BAS

Technical Change Effect

ΔTC is measured by the coefficient of the time dummy in the frontier production function run using panel data of 2003 and 2006

Although there was an observed technological progress in tilapia cage culture in Taal Lake, TC was very small, only 1.2% of TPF growth over three years

However, based on farmers interview, the strains that are commonly farmed in Taal Lake are not the modern strains but the traditional O. niloticus species

Technical Efficiency Effect

- Technical efficiency of tilapia cage operators increased significantly by 5%
- However, the TE in both periods were still very low (<70%), there is still plenty of room for increasing technical efficiency
- Technical change have little effect since farmers do not take advantage of the available technological improvements in terms of strain development
- Based on the results of the Tornqvist decomposition, TC can grow >10% in the future

Price Effect

In general, tilapia cage operation is not input price efficient

- to achieve input price efficiency:
  - there is under-utilization of fingerlings and capital inputs (can be increased);
  - over-utilization of feeds and labor input (can reduce it to be more price efficient)

Total TFP Growth

- Large positive price effect presents opportunity for intensifying input use
- Scale effect is negative suggesting increasing size of operation is no longer advisable
- Technical efficiency of farmers offers plenty of room for improvement
Summary of Results

<table>
<thead>
<tr>
<th>TFP Estimates</th>
<th>Batangas</th>
<th>Pampanga</th>
<th>Nueva Ecija</th>
<th>Philippines</th>
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<tr>
<td>Rental Index</td>
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<tr>
<td>Annual TFP Growth 1996-2002 (All technical change)</td>
<td>3.5</td>
<td>13.2</td>
<td>2.7</td>
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<tr>
<td>Frontier PF approach</td>
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<tr>
<td>Annual TFP growth 2003-2006</td>
<td>9.03</td>
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<tr>
<td>Technical Change Effect</td>
<td>0.39</td>
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<tr>
<td>Technical Efficiency Effect</td>
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<tr>
<td>Scale Effect</td>
<td>-2.70</td>
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<tr>
<td>Price Effect</td>
<td>9.59</td>
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In general, pond-based culture of tilapia has the potential for higher TFP growth.
- Intensive production
- Semi-intensive production
- Extensive production

Concerns and Constraints

- The phenomenal growth of the tilapia industry
  1. Availability of high quality (improved strains) fingerlings
  2. Culture intensity
     Note: Intensive production means high input use eg, feeds, seeds
     - Double squeeze in the profit margins of tilapia farmers
     - Serious issue in sustaining the growth of the industry

- Addressing the problem
  a. Cheap alternative for commercial feeds
  b. Reversing the trend in real tilapia prices
     - Demand creation in non-traditional tilapia consumption areas

- Environmental pollution caused by too much feeding leads to disease outbreak and fish kills
  - Good Aquaculture Practice
  - Awareness of proper environmental management is crucial in sustaining production and incomes of tilapia farmers

Strategies to further boost tilapia production:

- Quantity and price intervention policy
  Example: 1. Fingerling dispersal of BFAR (GET-EXCEL)
  - Cheaper and quality fingerlings for the farmers
  2. Farm-to-market roads to reduce transaction costs indirectly helping farmers to get better price for their harvest
  3. Altering consumer preference for tilapia thru food fairs
    - Live vs fresh chilled
    - Value addition (tilapia fillet)

- Investment in R&D can be focused on saline tilapia strains, eg.,
  (Molobicus from Pangasinan and BEST from BFAR Nueva Ecija)
  - Freshwater environment (10%)
  - Brackishwater environment (90%)

Thank You for your Attention