Semi-intensive polyculture of seabream and sole in earth ponds

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To develop effective tools for higher:
  - Competitiveness
  - Productivity
  - Profitability

SUSTAINABILITY of semi-intensive polyculture in Portugal and Spain

Minimizing environmental impacts

Improving quality & public image of products
Semi-intensive Polyculture

Test the production of seabream and sole, at different densities and using a eco-friendly feed

PORTUGAL AND SPAIN

SUSTAINABLE AQUACULTURE – Environmental | Socio-economic | Profitable
Semi-intensive Polyculture

**Specific Objectives:**

1. **Increasing revenue per ton of feed** supplied to the system, while **reducing its environmental impact**, through polyculture of species with different feeding niches: seabream (feed, macroalgae), and Senegalese sole (benthos, feed).

2. **Increasing production** per hectare within sound environmental conditions.

3. Launch basis for a **certification process** to increase added value to production.
Semi-intensive Polyculture

Farm Sites:

- Aqualvor (fish farm)
- EPPO facility (IPIMAR)
Farm site:
EPPO facility (IPIMAR)

Species stocked:
Gilthead seabream (95%)
Senegalese sole (5%)

Conditions to be tested:
Standard (1.5 Kg/m³)
higher density (3 Kg/m³)
eco-friendly feeds

Earth ponds:
6 of 765 m³
**Farm site:**
EPPO facility (IPIMAR)

**Stocking:**
April / May 2008
Eco feeds started to be supplied later than planned March 2009 (~180 g fish)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tanks</th>
<th>Initial Weight (g)</th>
<th>Fish (n)</th>
<th>Final Density (Kg/m³)</th>
<th>Production (tons/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>11 &amp; 14</td>
<td>24.2, 2.05</td>
<td>3384, 171</td>
<td>1.55</td>
<td>26.27</td>
</tr>
<tr>
<td>High</td>
<td>12 &amp; 15</td>
<td>24.2, 2.05</td>
<td>6769, 342</td>
<td>3.09</td>
<td>52.54</td>
</tr>
<tr>
<td>Eco</td>
<td>13 &amp; 16</td>
<td>24.2, 2.05</td>
<td>3384, 171</td>
<td>1.55</td>
<td>26.27</td>
</tr>
</tbody>
</table>
Species stocked:
Gilthead seabream (95%), Senegalese sole (5%)

Conditions to be tested:
- Final densities (1.5 to 3 Kg/m³)
- Eco-friendly feeds

Monitoring:
- Production (size and number)
- Water quality (pond & effluent)
- Macrobenthos communities
- Flesh quality (compare to “intensive” products)
Farm site: EPPO facility (IPIMAR)
Case study Polyculture

Farm site:
EPPO facility (IPIMAR)

Relative growth rate - May 2008 to July 2009

Tank

Eco  Eco  Low  Low  High  High

(%/day)
Case study: Polyculture

Farm site: EPPO facility (IPIMAR)

Final Density

<table>
<thead>
<tr>
<th>Tank</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eco</td>
<td>1.09</td>
</tr>
<tr>
<td>Eco</td>
<td>1.05</td>
</tr>
<tr>
<td>Low</td>
<td>1.22</td>
</tr>
<tr>
<td>Low</td>
<td>1.25</td>
</tr>
<tr>
<td>High</td>
<td>2.72</td>
</tr>
</tbody>
</table>
Case study Polyculture

Farm site:
EPPO facility (IPIMAR)

Final Production
(Ton/ha)

Tank

Eco  21,71
Eco  20,85
Low  24,14
Low  24,79
High 54,01
High 54,01
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

FCR

- Eco: 4.0
- Eco: 3.0
- Low: 2.0
- Low: 1.0
- High: 0.0
- High: 0.0
Fam site: EPPO facility (IPIMAR)

Sole final weight

<table>
<thead>
<tr>
<th>Eco</th>
<th>Eco</th>
<th>Low</th>
<th>Low</th>
<th>High</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>393</td>
<td>158</td>
<td>320</td>
<td>265</td>
<td>125</td>
<td>77</td>
</tr>
</tbody>
</table>

(g)
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

Sole recovered

<table>
<thead>
<tr>
<th></th>
<th>Eco</th>
<th>Eco</th>
<th>Low</th>
<th>Low</th>
<th>High</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>69%</td>
<td>43%</td>
<td>4%</td>
<td>99%</td>
<td>20%</td>
<td>99%</td>
</tr>
</tbody>
</table>
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

Sole production

(Ton/ha)

Eco: 1.2, Eco: 0.3, Low: 0.1, Low: 1.2, High: 0.2, High: 0.7
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

Macrobenthos Density  ANELIDS  Month 14 - June 2009

(nr/m²)

Eco  Eco  Low  Low  High  High

NEMATODS
OLIGOCHAETS
Alkmaria romijni
Streblospio shrubsolii
Oriopsis metchnikowi
Capitella capitata
Diopatra neapolitana
Nereis diversicolor
POLICHAETS
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

Macrobenthos Density MOLLUSCS Month 14 - June 2009

- BIVALVS: Cerastoderma glaucum
- Gastropods: Abra ovata, Hydrobia ulvae, Hydrobia minorecensis, Limapontia depressa

(nr/m²)

1000000
100000
10000
1000
100
10
1

Eco Eco Low Low High High

BIVALVS

Hydrobia ventrosa
Hydrobia ulvae
GASTEROPODS
Abra ovata
Cerastoderma glaucum
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

Total N (μmol/L) Month 13 - May 2009

- Eco
- Eco
- Low
- Low
- High
- High
- Blank

Outlet Midpoint Inlet
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

<table>
<thead>
<tr>
<th>(Thousand € / ha)</th>
<th>Polyculture revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.5</td>
<td>Eco</td>
</tr>
<tr>
<td>3.6</td>
<td>Eco</td>
</tr>
<tr>
<td>0.7</td>
<td>Low</td>
</tr>
<tr>
<td>14.0</td>
<td>Low</td>
</tr>
<tr>
<td>2.7</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>
CONCLUSIONS:

1. Polyculture of seabream and sole is viable, but only at low sole and seabream densities. Bottom condition is a major determinant for sole success.

2. Higher densities (up to 3 Kg/m³) lead to macrobenthos depletion.

3. Higher densities (up to 3 Kg/m³) do not seem to have a negative impact on water effluent quality.

4. Eco-feeds do not affect growth performance, but benefits on effluent quality need to be better studied.
Thank You!

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Eco-friendly feeds

**Objectives:**

Develop feed formulations to be used in semi-intensive fish farming systems with minimal environmental impact

- by reducing waste and nutrient loads to the environment
- by reducing the pressure on natural fish stocks exploited for fish meal and oil
**Formulation used in Polyculture Case Study**

Based on Lab-scale experiments
See presentation Dias et al.

- 60% of fish meal replaced by vegetable ingredients
- Soluble P excretion reduced to 1/4 of a conventional feed

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishmeal FAQ (CP 63%)</td>
<td>10.5</td>
</tr>
<tr>
<td>CPSP G</td>
<td>2.5</td>
</tr>
<tr>
<td>Haemoglobin powder</td>
<td>7.0</td>
</tr>
<tr>
<td>Soybean meal 48</td>
<td>12.5</td>
</tr>
<tr>
<td>Soy protein concentrate</td>
<td>6.0</td>
</tr>
<tr>
<td>Peas concentrate</td>
<td>8.0</td>
</tr>
<tr>
<td>Wheat gluten</td>
<td>5.0</td>
</tr>
<tr>
<td>Wheat meal</td>
<td>8.6</td>
</tr>
<tr>
<td>Wheat DDGS</td>
<td>9.7</td>
</tr>
<tr>
<td>Corn gluten</td>
<td>11.0</td>
</tr>
<tr>
<td><strong>Fish oil</strong></td>
<td><strong>10.0</strong></td>
</tr>
<tr>
<td><strong>Soybean oil</strong></td>
<td><strong>3.0</strong></td>
</tr>
<tr>
<td><strong>Linseed oil</strong></td>
<td><strong>2.9</strong></td>
</tr>
<tr>
<td>Vit &amp; Min Premix</td>
<td>0.4</td>
</tr>
<tr>
<td>Ca propionate</td>
<td>0.2</td>
</tr>
<tr>
<td>Mono Ca-phosphate</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>L-Lysine</strong></td>
<td><strong>0.3</strong></td>
</tr>
<tr>
<td>L-Arginine</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>DL-Methionine</strong></td>
<td><strong>0.3</strong></td>
</tr>
</tbody>
</table>
Case study: Polyculture

Farm site: EPPO facility (IPIMAR)

Daily Mean Dissolved Oxygen (%)
Case study: Polyculture

Farm site: EPPO facility (IPIMAR)

Relative growth rate - February to July 2009

Tank: Eco, Eco, Low, Low, High, High

(%/day)
Case study Polyculture

Farm site: EPPO facility (IPIMAR)

Mortality

Tank

<table>
<thead>
<tr>
<th>Eco</th>
<th>Eco</th>
<th>Low</th>
<th>Low</th>
<th>High</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>32%</td>
<td>22%</td>
<td>6%</td>
<td>11%</td>
<td>4%</td>
<td>97%</td>
</tr>
</tbody>
</table>
Case study: Polyculture

Farm site: EPPO facility (IPIMAR)

Total Susp. Solids (mg/L) Month 2 - June 2008

- Inlet
- Midpoint
- Outlet
- Blank

Eco, Eco, Low, Low, High, High
Fam site:
EPPO facility (IPIMAR)

Case study Polyculture

Total Susp. Solids (mg/L)
Month 13 - May 2009

Inlet
Midpoint
Outlet

Eco
Low
High
Blank
Case study: Polyculture

Farm site: EPPO facility (IPIMAR)

Total P (μmol/L) vs Month 13 - May 2009

- Eco
- Low
- High
- Blank

- Inlet
- Midpoint
- Outlet