Expending Pacific White Shrimp (*Litopenaeus vannamei*)
Farming in Biofloc System

Nyan Taw

Kochi, India
17-20 January 2011
Introduction

Shrimp farming has become competitive and as such the technology utilized needs to be efficient in all aspects – productivity, quality, sustainability, bio-security and to be in line with market demand.

Basic Concept of Biofloc Technology

Yoram Avnimelech, 2000, 2005

Data on feed protein utilization

- ASP Tilapia ponds (Avnimelech) 45%
- ASP ShConventional fish, shrimp ponds 20-25%
- Srimp ponds (McIntosh) 45%
- Closed shrimp tanks (Velasco) 63%
- ASP shrimp ponds, $^{15}$N study
  Michele Burford et al. 18-29% of total N consumption
The ‘Biofloc (Floc)

FLOC COMMUNITIES AND SIZE

The biofloc
Defined as macroaggregates – diatoms, macroalgae, fecal pellets, exoskeleton, remains of dead organisms, bacteria, protest and invertebrates.
(Decamp, O., et al 2002)

As Natural Feed (filter feeders – L. vannamie & Tilapia) : It is possible that microbial protein has a higher availability than feed protein (Yoram, 2005)
Basic of BFT in Shrimp Farming

1. High stocking density - over 130 – 150 PL10/m2
2. High aeration – 28 to 32 HP/ha PWAs
3. Paddle wheel position in ponds
4. HDPE / Concrete lined ponds
5. Grain (pellet)
6. Molasses
7. Expected production 20–25 MT/ha/crop

Feed & grain application and biofloc

High aeration

Grain pellet

Bioflocs

Dark Vannamei

Red Vannamei
Pond Operation
High Aeration

Vannamei - Bacterial Floc PWA 15 HP (7 x 1HP and 4 x 2HP)

NOTE:
PWA 1 HP
PWA 2 HP
Rope

Siphoning
Paddle Wheels position

Feeding
Sampling Method
Measuring procedure

1 liter / 2 places/ 15 cm deep/ between 10-12 am

Let it settled for 15-20 minutes
Read density of flocs in cone (ml/l)
Feed, Grain Pellet and Biofloc
Control Biofloc

Brown biofloc

Green biofloc

Black biofloc

Black gill

Biofloc - general view at surface
Bio-Floc Technology (BFT): avances, manejo y aplicaciones de los sistemas superintensivos en la Acuicultura.

Los “microorganismos”...

**Diatomeas**, “nativas”... etc

**Microalgas**

**bacteria**

**Fuentes y exigencias de C, N, etc...**

**Heterotróficas, nitrificantes...**

**Dinámica y interacción...**

**Bottom-up/top-down...**

**Cadena alimentaria/M.O. disuelta**

Kind courtesy of Mr. Mauricio Emerenciano

**Fotos: Yoram Avnicelech**
Belize, Central America
Biofloc system culture

BELIZE SHRIMP FARM (McIntosh, 2000b&c)
*L. vannamei* Mexican strain
Pond size 1.6 hectare
Pond type Fully HDPE lined
Aeration input 48 HP of PWA
System Heterotrophic zero water exchange
Production 13,500 kg/ha/crop
Carrying capacity 550 kg shrimp/HP of PWAs
Farms Using Bio-floc Technology in Indonesia

DAERAH ADMINISTRASI INDONESIA

- Medan
- Bangka
- Dipasena
- Lampung
- CPB CP
- Bali
- Anyer
- East Java
- Bali
Shrimp Farms in Indonesia where BFT was applied
Production Performance
TD - R&D, Trail & Commercial

Floc System Production R&D, Trial and Company Commercial Ponds
Period 2003 - 2005

- **R&D:** Density 100-200 pcs/m², MBW 16.41 g, Biomass 9.905 kg, SR 81.7 %, FCR 1.29 (number of ponds = 46)
- **TRIAL:** Density 140 pcs/m², MBW 16.56 g, Biomass 10.082 kg, SR 87.0 %, FCR 1.42 (number of ponds = 13)
- **CCP:** Density 130 pcs/m² (standard), MBW 16.99 g, Biomass 9.557 kg, SR 85.5 %, FCR 1.21 (number of ponds = 131)
## Global Medan

### Partial Harvest/Biofloc Performance

Partial Harvest Performance with Bio Floc Technology (February - July 2008)

<table>
<thead>
<tr>
<th>Pond/size</th>
<th>System</th>
<th>Energy Input</th>
<th>Density</th>
<th>Partial</th>
<th>Harvest</th>
<th>Production</th>
<th>FCR</th>
<th>SR</th>
<th>Energy Efficiency -kg/HP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 5896 m²</td>
<td>Phyto</td>
<td>16 (PW)</td>
<td>100</td>
<td>118</td>
<td>434</td>
<td>47</td>
<td>21.28</td>
<td>11,461</td>
<td>19,439</td>
</tr>
<tr>
<td>2 5896 m²</td>
<td>Bio Floc</td>
<td>18 (PW)</td>
<td>145</td>
<td>108</td>
<td>2,092</td>
<td>59</td>
<td>16.95</td>
<td>13,508</td>
<td>22,910</td>
</tr>
<tr>
<td>3 5940 m²</td>
<td>Bio Floc</td>
<td>18 (PW)</td>
<td>146</td>
<td>109</td>
<td>2,108</td>
<td>56</td>
<td>17.86</td>
<td>14,386</td>
<td>24,219</td>
</tr>
<tr>
<td>4 4704 m²</td>
<td>Bio Floc</td>
<td>16 (PW)</td>
<td>257</td>
<td>85</td>
<td>1,962</td>
<td>93</td>
<td>10.75</td>
<td>17,963</td>
<td>38,229</td>
</tr>
<tr>
<td>5 2,500 m²</td>
<td>Bio Floc</td>
<td>9 (PW)</td>
<td>280</td>
<td>84</td>
<td>924</td>
<td>86</td>
<td>11.63</td>
<td>12,371</td>
<td>49,484</td>
</tr>
<tr>
<td>6 2500 m²</td>
<td>Bio Floc</td>
<td>7 (PW)</td>
<td>145</td>
<td>110</td>
<td>1,166</td>
<td>51</td>
<td>19.61</td>
<td>6,545</td>
<td>26,180</td>
</tr>
<tr>
<td>7 2500 m²</td>
<td>Bio Floc</td>
<td>9 (PW)</td>
<td>145</td>
<td>110</td>
<td>892</td>
<td>61</td>
<td>16.39</td>
<td>6,615</td>
<td>26,460</td>
</tr>
</tbody>
</table>

## Performance - Shrimp Farms at Java & Bali, Indonesia using Biofloc Technology

**Karang Asem, Bali, Indonesia**

<table>
<thead>
<tr>
<th>Pond</th>
<th>A2</th>
<th>A3</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond size</td>
<td>2,600m²</td>
<td>2,500m²</td>
<td>2,000m²</td>
<td>2,000m²</td>
<td>2,000m²</td>
<td>600m²</td>
<td>600m²</td>
<td>600m²</td>
</tr>
<tr>
<td>PL tebar</td>
<td>129/m²</td>
<td>134/m²</td>
<td>167/m²</td>
<td>167/m²</td>
<td>167/m²</td>
<td>152/m²</td>
<td>152/m²</td>
<td>152/m²</td>
</tr>
<tr>
<td>DoC</td>
<td>125</td>
<td>125</td>
<td>126</td>
<td>91*</td>
<td>125</td>
<td>125</td>
<td>135</td>
<td>147</td>
</tr>
<tr>
<td>SR %</td>
<td>91</td>
<td>92</td>
<td>89</td>
<td>85</td>
<td>85</td>
<td>92</td>
<td>92</td>
<td>91</td>
</tr>
<tr>
<td>FCR</td>
<td>1.3</td>
<td>1.42</td>
<td>1.36</td>
<td>1.45</td>
<td>1.44</td>
<td>1.61</td>
<td>1.52</td>
<td>1.58</td>
</tr>
<tr>
<td>Harvest/pond</td>
<td>6,232 kg</td>
<td>5,695 kg</td>
<td>5,645 kg</td>
<td>2,493 kg</td>
<td>5,248 kg</td>
<td>2,018 kg</td>
<td>1,725 kg</td>
<td>1,943 kg</td>
</tr>
<tr>
<td>Harvest/ha</td>
<td>23,969 kg</td>
<td>22,781 kg</td>
<td>28,225 kg</td>
<td>12,464 kg</td>
<td>26,235 kg</td>
<td>33,645 kg</td>
<td>28,750 kg</td>
<td>32,361 kg</td>
</tr>
</tbody>
</table>

**Singaraja, Bali, Indonesia**

<table>
<thead>
<tr>
<th>Pond</th>
<th>B3</th>
<th>B4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond size</td>
<td>2,500m²</td>
<td>2,500m²</td>
</tr>
<tr>
<td>PL tebar</td>
<td>152/m²</td>
<td>152/m²</td>
</tr>
<tr>
<td>DoC</td>
<td>147</td>
<td>147</td>
</tr>
<tr>
<td>SR %</td>
<td>85</td>
<td>81</td>
</tr>
<tr>
<td>ABW</td>
<td>24.39</td>
<td>24.39</td>
</tr>
<tr>
<td>FCR</td>
<td>1.63</td>
<td>1.59</td>
</tr>
<tr>
<td>Harvest/pond</td>
<td>6,304 kg</td>
<td>6,005 kg</td>
</tr>
<tr>
<td>Harvest/ha</td>
<td>25,212 kg</td>
<td>24,020 kg</td>
</tr>
</tbody>
</table>

**Global group demo ponds in Bali on BFT**

**Based on report from Mr. Suritjo Setio, 8 September 2009**

**Java, Indonesia (Avnimelech 2009)**

<table>
<thead>
<tr>
<th>Pond</th>
<th>D6</th>
<th>D5</th>
<th>D8</th>
<th>D7</th>
<th>D9</th>
<th>D4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL tebar</td>
<td>115/m²</td>
<td>115/m²</td>
<td>141/m²</td>
<td>172/m²</td>
<td>176/m²</td>
<td>139/m²</td>
</tr>
<tr>
<td>DoC</td>
<td>113</td>
<td>121</td>
<td>118</td>
<td>121</td>
<td>121</td>
<td>108</td>
</tr>
<tr>
<td>SR %</td>
<td>85</td>
<td>106</td>
<td>77</td>
<td>79</td>
<td>53</td>
<td>75</td>
</tr>
<tr>
<td>ABW</td>
<td>16.7</td>
<td>15.36</td>
<td>17.3</td>
<td>17.89</td>
<td>20.08</td>
<td>15.5</td>
</tr>
<tr>
<td>FCR</td>
<td>1.37</td>
<td>1.6</td>
<td>1.51</td>
<td>1.75</td>
<td>2</td>
<td>1.65</td>
</tr>
<tr>
<td>Harvest/pond</td>
<td>8,214 kg</td>
<td>7,374 kg</td>
<td>8,566 kg</td>
<td>6,739 kg</td>
<td>5,256 kg</td>
<td>7,533 kg</td>
</tr>
<tr>
<td>Harvest/ha</td>
<td>16,300 kg</td>
<td>18,700 kg</td>
<td>18,500 kg</td>
<td>14,600 kg</td>
<td>11,400 kg</td>
<td>16,400/kg</td>
</tr>
</tbody>
</table>

**Based on report from Suri Tani Pemuka, Indonesia**
Blue Archipelago, Malaysia

Biosecure modular system with BFT

250 & 1000 micron screen net

Seawater Intake – 2.4 km offshore

Biofloc
### Blue Archipelago, Malaysia
Arca Biru Sdn Bhd Shrimp Farm

#### PRODUCTION PERFORMANCE OF ARCA BIRU FARM

<table>
<thead>
<tr>
<th>Production Parameter</th>
<th>System/size/type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biofloc 0.4 ha HDPE</td>
</tr>
<tr>
<td>No of Ponds</td>
<td>2</td>
</tr>
<tr>
<td>PWA Energy (Hp)</td>
<td>14</td>
</tr>
<tr>
<td>Stocking Density</td>
<td>130</td>
</tr>
<tr>
<td>DOC (days)</td>
<td>90</td>
</tr>
<tr>
<td>SR (%)</td>
<td>89.16</td>
</tr>
<tr>
<td>MBW (gr)</td>
<td>18.78</td>
</tr>
<tr>
<td>FCR (x)</td>
<td>1.39</td>
</tr>
<tr>
<td>ADG (gr/day)</td>
<td>0.21</td>
</tr>
<tr>
<td>Avg Harvest tonnage (kg)</td>
<td>9,006</td>
</tr>
<tr>
<td>Production (Kg/Ha)</td>
<td>22,514</td>
</tr>
<tr>
<td>Prod per power input (Kg/Hp)</td>
<td>643</td>
</tr>
</tbody>
</table>
Bio-floc in Raceways/Wet Lab Experiments, Trials & Growout

1. Nursery—nursed for 1 to 2 weeks then to GO
2. Super-intensive /intensive culture (to market size)
4. Broodstock testing– trials for quality of broodstock family lines (two to four months ).
5. First phase of the three phase culture system.
# Raceway Technology

## Biofloc Trials - Nursery & GO

<table>
<thead>
<tr>
<th>Description</th>
<th>Stocking Density (pcs/m²)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>550</td>
<td>130</td>
</tr>
<tr>
<td><strong>Pond</strong></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Initial MBW (g)</strong></td>
<td>4.9</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>Period (days)</strong></td>
<td>57</td>
<td>90</td>
</tr>
<tr>
<td><strong>Harvest Biomass (kg)</strong></td>
<td>374</td>
<td>151</td>
</tr>
<tr>
<td><strong>Final MBW (g)</strong></td>
<td>13.8</td>
<td>18.4</td>
</tr>
<tr>
<td><strong>FCR</strong></td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Survival rate (%)</strong></td>
<td>66</td>
<td>88</td>
</tr>
<tr>
<td><strong>ADG (g/day)</strong></td>
<td>0.16</td>
<td>0.19</td>
</tr>
<tr>
<td><strong>Productivity (kg/m²)</strong></td>
<td>5.2</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Productivity (kg/ha)</strong></td>
<td>51,893</td>
<td>21,001</td>
</tr>
</tbody>
</table>

*Image credit: Nyan Taw, et.al. Role of R&D ... World Aquaculture 2005 Bali*
Raceway trials in BFT

Global Group Raceways at Anyer, Indonesia

The raceway system with biofloc is being applied for trials for *L. vannamei* broodstock family selection.
Wet Laboratory – Trial Tanks

Global Group facility at Anyer, Indonesia

1. Shrimp feed trials using transferred Biofloc
2. Small scale experiments at request
3. Freshwater tolerance experiments
4. Nursery stage experiments
Bio-Floc experimental device
(twenty-four 40l plastic tanks)

Indoor
(Six 12,000l indoor bio-floc lined tanks)

Outdoor
(six-teen 20,000l outdoor bio-floc lined tanks)

Bio-floc control

Kind courtesy of Mr. Mauricio Emerenciano
Potential of BFT – PERU
Lined and covered

Piura - Intensive with freshwater covered

Piura - Inside covered pond

Tumbes - Extensive with SW

Grain
Potential for BFT – GUATEMALA
Lined with high energy input
Potential for BFT – CHINA
Lined, covered & high energy input
Development of BFT (Productivity)
Advantages/ Disadvantages

Advantages

1. Bio-security very good (from water) – to date WSSV negative using the system.
2. Zero water exchange – less than 100% exchange for whole culture period.
3. Production (Carrying capacity): 5-10% better than normal system
4. Shrimp size bigger by about 2.0 g than normal system
5. FCR low – between 1.0 to 1.3 (without GP)
6. Production cost lower by around 15-20 %.

Disadvantages

1. High energy input – paddlewheels 28HP/ha.
2. Power failure critical – maximum one hour at any time (better zero hour failure)
3. Full HDPE lined ponds – minimum semi-HDPE lined
4. Technology similar but more advance – need to train technicians
SHRIMP PRODUCTION IMPROVEMENT

Sergio Nates Dec 2006
Thank You

Nyan Taw