Acknowledgements

The presentation is based on studies and surveys experienced by the author on Biofloc (BFT) in Indonesia, South & Central America, China and Malaysia.

The author would like to sincerely thank the staff and members of Global group, Indonesia for their hard work to make the study possible.

Sincere thanks are also due to Mr. Octo Rachnalim (Global group, Indonesia) for the permission to use the studies and surveys experience during the service to Global group. Dr. Shahridan Faiez (CEO) and Mr. Christopher Lim (COO), Blue Archipelago for their support. Professor Yoram Avnimelech for his comments and advise.
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.

BFT (Biofloc) system is at present highly sought technology for Pacific white shrimp culture due to high efficiency, productivity, sustainability and with lower FCR. The basic system of bio-floc technology was given by Avnimelech (2000, 2005a&b). The system was successfully applied in commercial culture of shrimps by McIntosh (2000a,b & c, 2001), McNeill (2000), Nyan Taw (2005, 2006, 2009), Nyan Taw & Saenphon Ch. (2005); Saenphon Ch. et.al. (2005). BFT in combination with partial harvest was presented at WA 2009 in Veracruz, Mexico by Nyan Taw (2009). Recently, Avnimelech (2009) published a book entitled “Biofloc Technology: A Practical Guide Book”.

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, 15N 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, facial 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 lined ponds
5. Grain (pellet)
6. Molasses
7. Expected production 20–25 MT/ha/crop

Feed & grain application and biofloc

High density

Grain pellet Bioflocs

High aeration

Dark Vannamei Red Vannamei
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
First Biofloc Commercial Trial
Central Pertiwi Bahari (CP, Indonesia)

<table>
<thead>
<tr>
<th>Description</th>
<th>Fry Code</th>
<th>Average Fat Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tot pond</td>
<td>(12) A416</td>
<td>5</td>
</tr>
<tr>
<td>STD(PCS/m²)</td>
<td>131</td>
<td>131</td>
</tr>
<tr>
<td>DOC(day)</td>
<td>142</td>
<td>146</td>
</tr>
<tr>
<td>Biomass(kg)</td>
<td>11,337</td>
<td>10,987</td>
</tr>
<tr>
<td>MBW(g)</td>
<td>16.78</td>
<td>17.66</td>
</tr>
<tr>
<td>CV(%)</td>
<td>24.2</td>
<td>21.2</td>
</tr>
<tr>
<td>FCR (- GP)</td>
<td>1.01</td>
<td>1.09</td>
</tr>
<tr>
<td>FCR (+ GP)</td>
<td>1.09</td>
<td>1.83</td>
</tr>
<tr>
<td>SR(%)</td>
<td>100.0</td>
<td>92.6</td>
</tr>
<tr>
<td>ADG(g/day)</td>
<td>0.11</td>
<td>0.12</td>
</tr>
<tr>
<td>Prod(g/m²/crop)</td>
<td>2,267</td>
<td>2,118</td>
</tr>
</tbody>
</table>

Semi-lined 0.5 ha ponds

Nyan Taw (2005, 2006)

Production Efficiency (CPB)

Efficiency: Increased from 9.0 MT to 21.8 MT/ha pond.
Carrying capacity: Increased from 430 kgs to 680 kgs/HP (PWA)

Biofloc Production Performance
TD - R&D, Trail & Commercial (CPB)

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

Nyan Taw (2006)

Partial harvest/Biofloc
Global Group, Medan
Partial harvesting by cast nets
### Global Group Medan

#### 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>Harvest</th>
<th>Production</th>
<th>FCR</th>
<th>SPI</th>
<th>Energy Efficiency kg/HP Std Capacity Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,696 m²</td>
<td>Phyto</td>
<td>16 (PW) 27 (PW)</td>
<td>100</td>
<td>1</td>
<td>2,092</td>
<td>0.50</td>
<td>84.07</td>
<td>680² 720</td>
</tr>
<tr>
<td>5,896 m²</td>
<td>Bio Floc</td>
<td>16 (PW) 31 (PW)</td>
<td>145</td>
<td>1</td>
<td>2,109</td>
<td>0.50</td>
<td>80.95</td>
<td>680² 607</td>
</tr>
<tr>
<td>5,744 m²</td>
<td>Bio Floc</td>
<td>16 (PW) 34 (PW)</td>
<td>257</td>
<td>1</td>
<td>1,117</td>
<td>0.50</td>
<td>85.54</td>
<td>1,124</td>
</tr>
<tr>
<td>2,500 m²</td>
<td>Bio Floc</td>
<td>25 (PW) 36 (PW)</td>
<td>293</td>
<td>1</td>
<td>2,475</td>
<td>0.50</td>
<td>85.54</td>
<td>1,124</td>
</tr>
<tr>
<td>2,500 m²</td>
<td>Bio Floc</td>
<td>25 (PW) 36 (PW)</td>
<td>293</td>
<td>1</td>
<td>2,475</td>
<td>0.50</td>
<td>85.54</td>
<td>1,124</td>
</tr>
<tr>
<td>2,500 m²</td>
<td>Bio Floc</td>
<td>3 (BL) 7 (PW)</td>
<td>145</td>
<td>1</td>
<td>3,185</td>
<td>0.50</td>
<td>85.35</td>
<td>680² 655</td>
</tr>
</tbody>
</table>


### Global Group Demo Farm

Karang Asem, Bali, Indonesia

- Full concrete pond - 2,600 m²
- Biofloc system culture
- High aeration

- Full concrete pond - 2,000 m²
Shrimp farms using BFT

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>124/m²</td>
<td>167/m²</td>
<td>187/m²</td>
<td>152/m²</td>
<td>132/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>147</td>
<td>136</td>
<td>147</td>
</tr>
<tr>
<td>SR %</td>
<td>91</td>
<td>91</td>
<td>92</td>
<td>92</td>
<td>92</td>
<td>92</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>ABW</td>
<td>20.57</td>
<td>20.2</td>
<td>18.18</td>
<td>17.25</td>
<td>18.53</td>
<td>23.05</td>
<td>21.14</td>
<td>21.27</td>
</tr>
<tr>
<td>FCR</td>
<td>1.72</td>
<td>2.4</td>
<td>1.91</td>
<td>1.91</td>
<td>1.91</td>
<td>1.91</td>
<td>1.91</td>
<td></td>
</tr>
<tr>
<td>Harvest / pond</td>
<td>6,233 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>33,645 kg</td>
<td>20,750 kg</td>
<td>32,361 kg</td>
<td></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>85</td>
</tr>
<tr>
<td>ABW</td>
<td>24.39</td>
<td>24.39</td>
</tr>
<tr>
<td>FCR</td>
<td>1.83</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>

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>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>PL tebar</td>
<td>113</td>
<td>121</td>
<td>118</td>
<td>121</td>
<td>108</td>
<td>106</td>
</tr>
<tr>
<td>DoC</td>
<td>113</td>
<td>121</td>
<td>118</td>
<td>121</td>
<td>108</td>
<td>106</td>
</tr>
<tr>
<td>SR %</td>
<td>74</td>
<td>74</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>ABW</td>
<td>16.7</td>
<td>16.36</td>
<td>17.3</td>
<td>17.59</td>
<td>20.08</td>
<td>15.5</td>
</tr>
<tr>
<td>FCR</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</td>
<td>1.97</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

SUMMARY
Development of BFT (Productivity)

According to Shrimp News International (2006) no one knows how many shrimp farms are employing the bio-floc technology. The best examples of the of farms that have implemented the new technology are: 1. Belize Aquaculture, Ltd., in Belize. 2. OceanBoy Farms in Florida, USA, and 3. PT Central Pertiwi Bahari in Indonesia.
Bio-floc in Raceways/Wet Lab Experiments, Trials & Growout

1. Nursery—nursed for 1 to 2 weeks then to GO
2. Grow-out culture to market size (15-20 gm)
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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>550</td>
</tr>
<tr>
<td>Pond</td>
<td>2</td>
</tr>
<tr>
<td>Initial MBW (g)</td>
<td>4.9</td>
</tr>
<tr>
<td>Period (days)</td>
<td>57</td>
</tr>
<tr>
<td>Harvest Biomass (kg)</td>
<td>374</td>
</tr>
<tr>
<td>Final MBW (g)</td>
<td>13.8</td>
</tr>
<tr>
<td>FCR</td>
<td>1.2</td>
</tr>
<tr>
<td>Survival rate (%)</td>
<td>66</td>
</tr>
<tr>
<td>ADG (g/day)</td>
<td>0.16</td>
</tr>
<tr>
<td>Productivity (kg/m³)</td>
<td>5.2</td>
</tr>
<tr>
<td>Productivity (kg/ha)</td>
<td>51,893</td>
</tr>
</tbody>
</table>

Nyan Tanu, 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
Tilapia trials in freshwater BFT

Global Group facility at Anyer, Indonesia

BFT Farms with difficulties

Medan
Uncordinated paddle wheel positions
Number of PWAs not correlated to stocking density or carrying capacity
Can develop biofloc but cannot control

Medan & Bangka

PWAs – direction one way only
Number of PWAs not correlated to stocking density or carrying capacity
Can develop biofloc but cannot control
BFT farms with difficulties

Lampung
Excess aeration
PWA and air diffusers number & position not control or in wrong position

Potential of BFT – PERU
Lined and covered

Piura - intensive with freshwater covered
Piura - inside covered pond
Piura - intensive FW Nursery
Piura - Extensive with SW
Tumbes - Extensive with SW
Grain
Potential for BFT – GUATEMALA
Lined with high energy input

Potential for BFT – CHINA
Lined, covered & high energy input
Potential for BFT – CHINA
Lined, covered & high energy input

Potential for BFT – Malaysia
Ideal layout and bio-securied
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

Thank You

Nyan Taw

Blue Archipelago
Quality | Safety | Ecology
References


McIntosh, Robin P., 2000a Changing paradigms in shrimp farming. III Pond design and operation consideration The Advocate February 43-45

McIntosh, Robin P., 2000b Changing paradigms in shrimp farming. IV Low protein feeds and feeding strategies. The Advocate April 44-50

McIntosh, Robin P., 2000c Changing paradigms in shrimp farming. V Establishment of heterotrophic bacterial communities The Advocate December 52-54

McIntosh, Robin P., 2001, Changing paradigms in shrimp farming. VI Establishment of heterotrophic bacterial communities The Advocate February 52-58

McNeil, Roberick, 2000, Zero exchange, aerobic, heterotrophic systems: Key considerations. The Advocate June 72-76


POTENTIAL FOR DEVELOPMENT OF BIOFLOC TECHNOLOGY FOR PACIFIC WHITE SHRIMP (Litopenaeus vannamei) FARMING

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Biofloc technology (BFT) has become a highly sought technology in Pacific white shrimp farming. The technology was initially started successfully in Belize (Chamberlain, et.al, 2001a & b; McIntosh, 2000 & 2001). The technology has been also applied with success in Indonesia (Kopot & Taw; 2004; Chandaeng, et.al, 2005; Taw, 2005 & 2006), and black tiger shrimp in Australia Smith (2008). The most recent study was by combination of two technologies, partial harvest and biofloc, in northern Sumatra, Indonesia (Taw, et.al, 2008; Taw, 2009).

Since then there have been many commercial trials especially in Indonesia from North, Middle to South Eastern Sumatra, from West to East Java and to Bali with successes and failures. Similarly, China and Malaysia shows interest in the technology. South and Central American countries are also interested in their intensive culture systems to adopt the technology. The success or failure of the technology was mainly due to lack of understanding on the basic concept of the technology in commercial application. Present presentation evaluates the technology applied in commercial farms and its development potentials.