FUTURE OF BIOFLOC TECHNOLOGY IN ASIA

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FUTURE OF BIOFLOC TECHNOLOGY IN ASIA

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1. INTRODUCTION

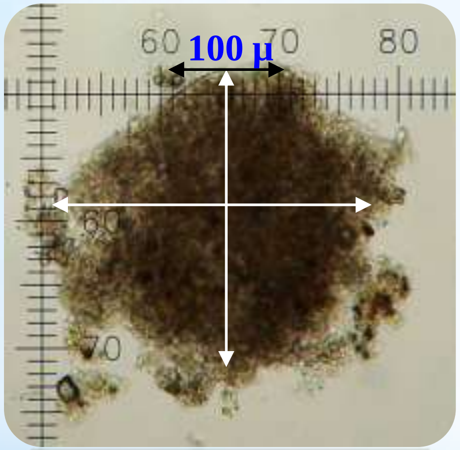
Biofloc, a very recent technology seem a very promising for stable and sustainable production as the system has self nitrification process within culture ponds with zero water exchange (Yoram, 2000, 2005a&b). The technology has been successfully applied commercially in Belize by Belize aquaculture (McIntosh, 2000a, b & c, 2001). It also has been applied with success in shrimp farming in Indonesia, Malaysia (Nyan Taw 2004, 2005, 2008, 2010 &2011). The combination of two technologies, partial harvesting and biofloc, has been studied in northern Sumatra, Indonesia (Nyan Taw 2008 *et. al*).

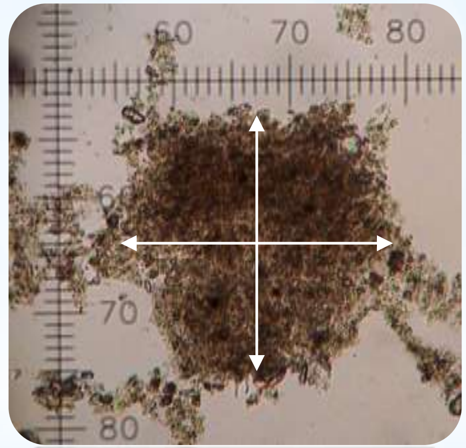
Presently, a number of studies by major universities and private companies are using biofloc as a single cell protein source in aquafeeds.

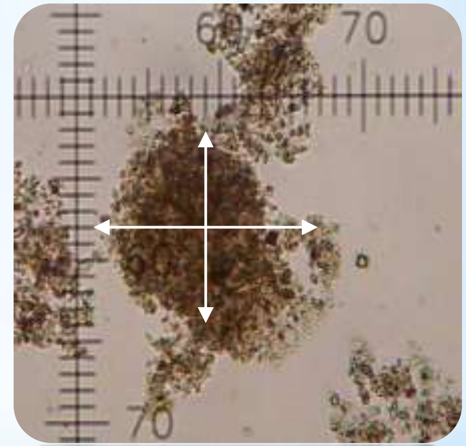
With emerging viral problems and rising costs for energy, biofloc technology appears to be an answer for sustainable production not only in Asia but throughout the world

2. BIOFLOC

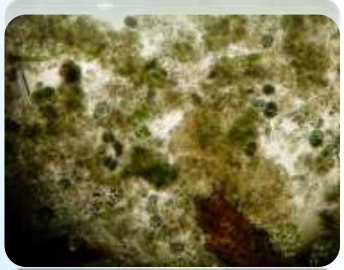
FLOC COMMUNITIES AND SIZE







Brown



Green

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)***

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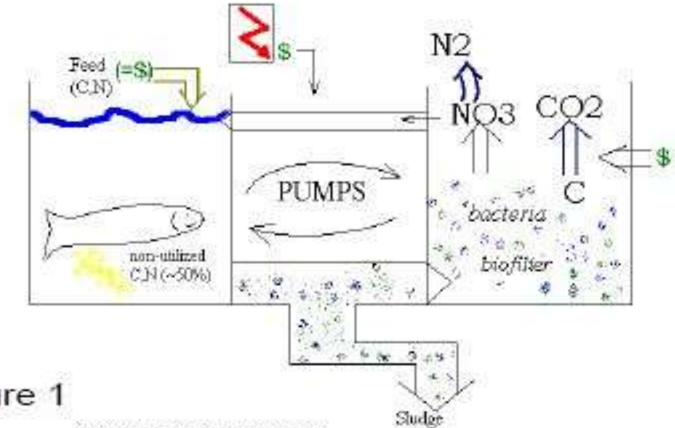
Basic Concept of Biofloc Technology

Yoram Avnimelech, 2000, 2005

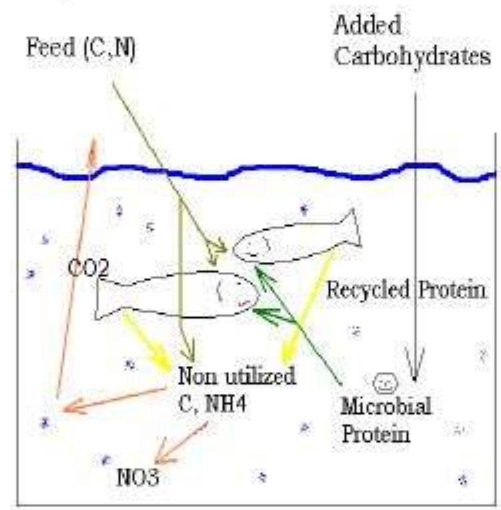
Figure 1



EXTERNAL BIOFILTER SYSTEM

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



ACTIVATED SUSPENSION POND

Biofloc technology is a system that has a self-nutrification process within culture pond water with zero water exchange (Yoram, 2012)

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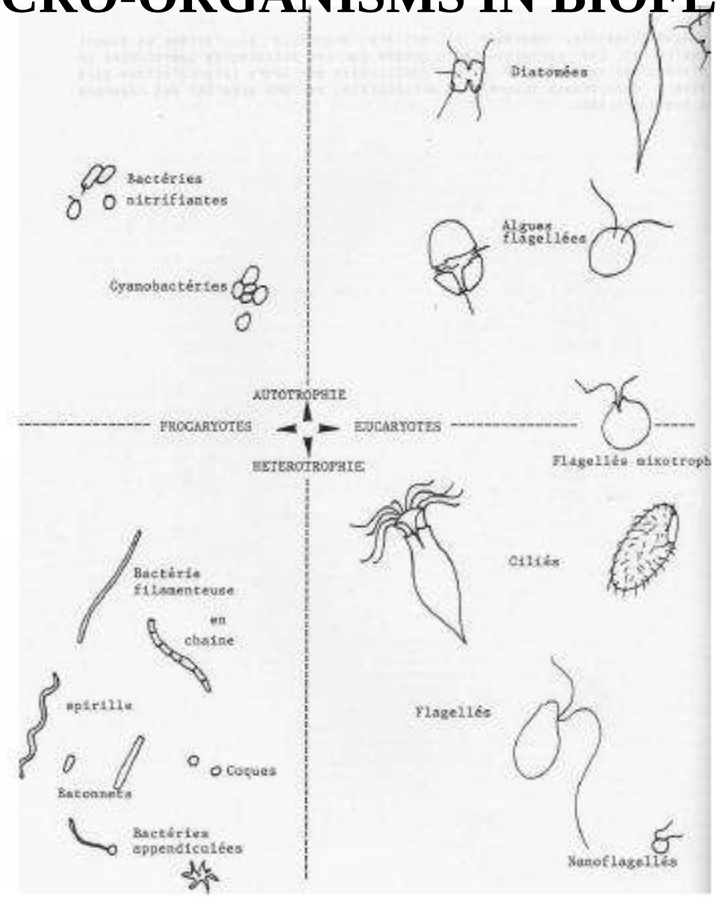
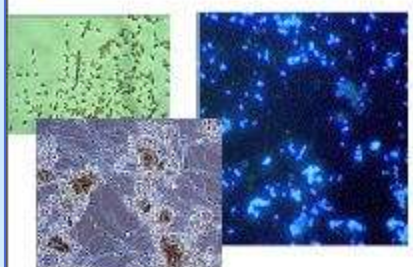
MICRO-ORGANISMS IN BIOFLOC

Los "microorganismos"...



bacteria



Heterotróficas, nitrificantes...

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

Diatomeas, "nativas"... etc

Microalgas

Dinámica y intereracción...

Bottom-up/top-down...

Cadena alimentaria/ M.O. disuelta

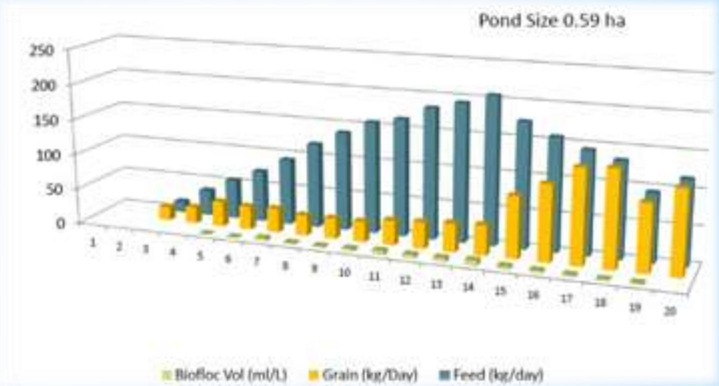
Fotos: Yoram Avnimelech

Kind courtesy of Mr. Mauricio Emerenciano

3. COMMERCIAL SHRIMP CULTURE IN BIOFLOC

Basics

1. High stocking density - over 130 – 150 PL10/m2
2. High aeration – 28 to 32 HP/ha PWAs
3. Paddle wheel position in ponds (control biofloc & sludge by siphoning)
4. Biofloc control at <15 ml/L
5. HDPE / Concrete lined ponds
6. Grain (pellet)
7. Molasses
8. C&N ratio >15
9. Expected production 20–25 MT/ha/crop with 18-20 gm shrimp
10. Extra out put – biofloc as protein source
11. Red color shrimps after cooking

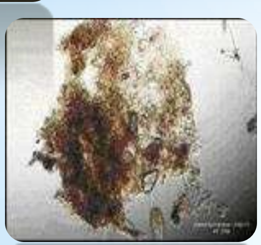


Feed & grain application and biofloc

High aeration & PWAs position

High density

Grain pellet



Bioflocs

Biofloc

Dark Vannamei

Red Vannamei

Pond Water Preparation

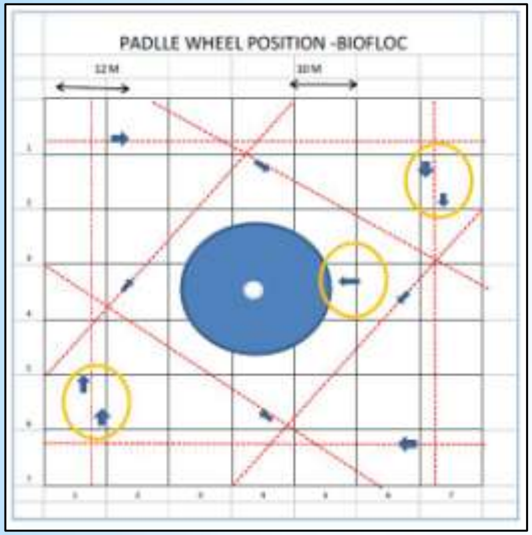
For already treated water in series of treatment reservoirs in

HDPE lined 0.5 ha production ponds

Day	Activity
1	Urea 8 kg & TSP 1 kg Grain pellet 30 kg & Dolomite 50 kg
2	Tea seed cake 15 ppm
4	Grain pellet 30 kg & Dolomite 50 kg
6	Grain pellet 30 kg & Dolomite 50 kg
8	Grain pellet 50 kg, Molasses 8 kg & Kaolin 50 kg
10	Grain pellet 50 kg
12	Kaolin 50 kg

Nyan Taw AA 2006, LV

Basic position of paddle wheel aerators' position for BFT



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Sampling Method
Measuring procedure

1 liter sample from sub-surface

Let it settled for a few minute

Read density of bioflocs in cone (ml/l)

Nyan Taw AA 2006, LV

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Belize, Central America
Biofloc system culture

Belize Aqua Ltd – A view

Belize Aqua Ltd - ponds

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

Performance
First Commercial Trail in Indonesia

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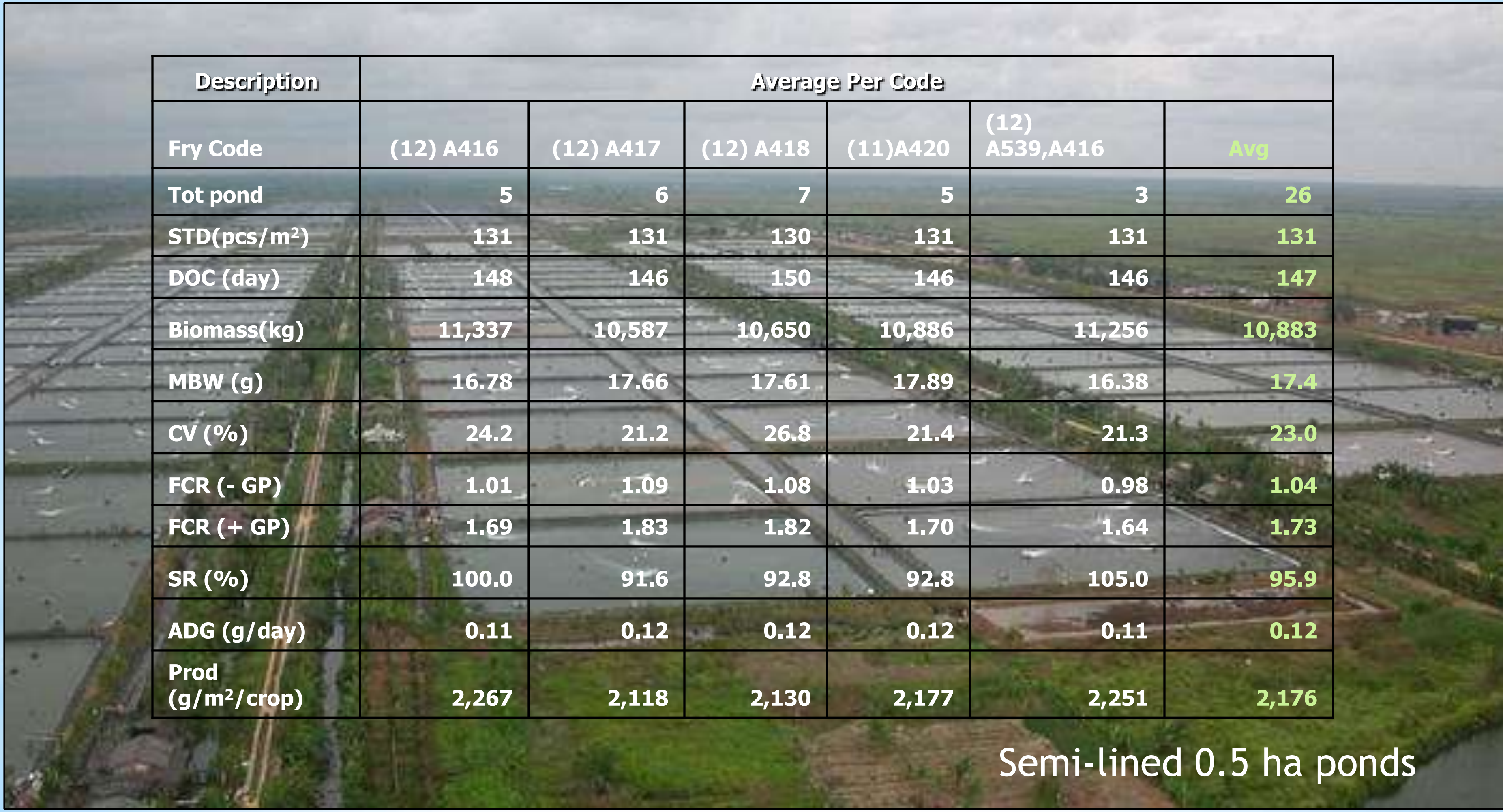

Description	Average Per Code					
Fry Code	(12) A416	(12) A417	(12) A418	(11)A420	(12) A539,A416	Avg
Tot pond	5	6	7	5	3	26
STD(pcs/m²)	131	131	130	131	131	131
DOC (day)	148	146	150	146	146	147
Biomass(kg)	11,337	10,587	10,650	10,886	11,256	10,883
MBW (g)	16.78	17.66	17.61	17.89	16.38	17.4
CV (%)	24.2	21.2	26.8	21.4	21.3	23.0
FCR (- GP)	1.01	1.09	1.08	1.03	0.98	1.04
FCR (+ GP)	1.69	1.83	1.82	1.70	1.64	1.73
SR (%)	100.0	91.6	92.8	92.8	105.0	95.9
ADG (g/day)	0.11	0.12	0.12	0.12	0.11	0.12
Prod (g/m²/crop)	2,267	2,118	2,130	2,177	2,251	2,176

Semi-lined 0.5 ha ponds

Nyan Taw & Saenphon C. (WAS, Bali 2005)
Nyan Taw (AA, L Vegas 2006)

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Biofloc & Partial harvest
Medan, Indonesia

Nyan Taw, et al, GAA Sep/Oct 2008

Brown biofloc

Green biofloc

Nyan Taw. *et al* WAS 2009 Mexico

Biofloc combined with Partial harvest Performance, Indonesia

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

Pond/size	System	Energy Input		Density	Partial	Harvest				Production		FCR		SR	Energy Efficiency -kg/HP	
		(Pond)	(Ha)	(M2)		DoC	Biomas (Kg)	Size No/kg	MBW (gr)	Kg/Pd	Kg/Ha	GP	Feed	(%)	Std Capacity	Efficiency
1	Phyto	16 (PW)	27 (PW)	100	1	118	434	47	21.28				1.60	75.72	560*	**720**
5896 m2					Final	127	11,027	43	23.26	11,461	**19,439**	0				
2	Bio Floc	18 (PW)	31 (PW)	145	1	108	2,092	59	16.95	13,508	**22,910**	0.59	**1.20**	84.07	680*	**739**
					2	121	1,016	55	18.18							
5896 m2					Final	131	10,400	52	19.23							
3	Bio Floc	18 (PW)	30 (PW)	146	1	109	2,108	56	17.86	14,386	**24,219**	0.56	**1.14**	80.95	680*	**807**
					2	122	999	50	20.00							
5940 m2					Final	130	11,279	47	21.28							
4 4704 m2	Bio Floc	16 (PW)	34 (PW)	257	1	85	1,962	93	10.75	17,963	**38,229**	0.58	**1.12**	86.54	680*	**1,124**
					2	99	1,896	75	13.33							
					3	113	1,871	62	16.13							
					4	127	2,587	56	17.86							
					5	134	2,475	53	18.87							
					Final	155	7,192	47	21.28							
5 2,500 m2	Bio Floc	9 (PW) 3 (BL)	36 (PW) 12 (BL)	280	1	84	924	86	11.63	12,371	**49,484**	0.48	**1.11**	102.35	680*	**1,031**
					2	99	1,455	74	13.51							
					3	113	1,324	61	16.39							
					4	127	1,448	57	17.54							
					5	134	1,043	54	18.52							
					Final	155	6,177	50	20.00							
6	Bio Floc	7 (PW) 3 (BL)	28 (PW) 12 (BL)	145	1	110	1,166	51	19.61	6,545	**26,180**	0.50	**1.10**	86.35	680*	**655**
					2	124	367	49	20.41							
2500 m2					Final	127	5,012	47	21.28							
7	Bio Floc	9 (PW) 3 (BL)	36 (PW) 12 (BL)	145	1	110	892	61	16.39	6,615	**26,460**	0.50	**1.10**	100.8	680*	**551**
					2	124	323	57	17.54							
2500 m2					Final	130	5,400	54	18.52							
										82,849	**29,560**	0.53	**1.13**	88.1		

Nyan Taw, *et al*, GAA Sep/Oct2008
Nyan Taw *et al*, WAS 2009 Mexico

Biosecure Modules,
Blue Archipelago, Malaysia

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HDPE lined ponds with center drain, secured outlet gates & Main supply canal

Biosecurity – crab fence & bird scare

Pond out let gate

Sub inlet

250 & 1000 micron screen net

HDPE Lined secondary supply canal

Nyan Taw, Biosesurity….GAA Nov/Dec 2010
Nyan Taw, *et.al.* Malaysian ….GAA March/April 2011

Performance
Blue Archipelago, Malaysia

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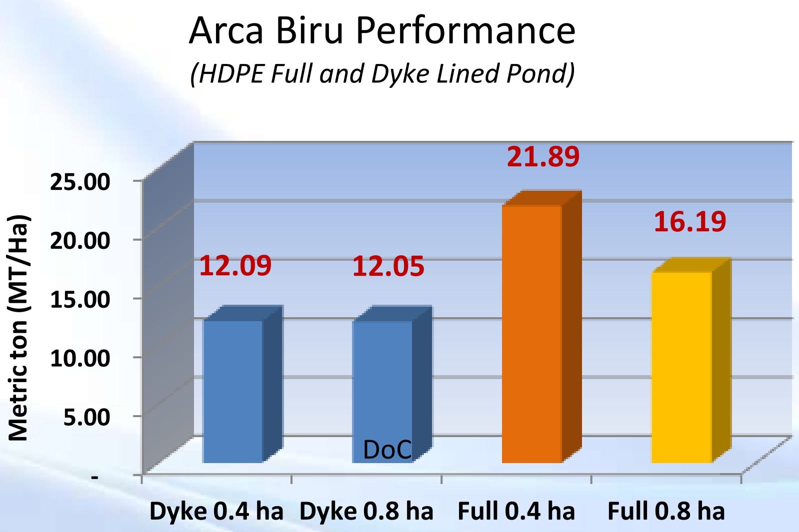

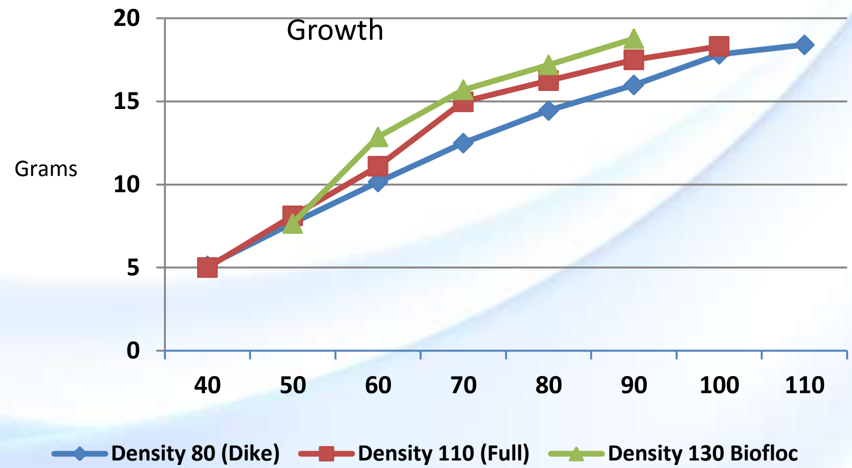

PRODUCTION PERFORMANCE OF ARCA BIRU FARM			
Production Parameter	System/size/type		
	Biofloc 0.4 ha HDPE	Semi-Biofloc 0.8 ha HDPE	Conven 0.8 ha HDPE Dyke
No of Ponds	2	19	119
PWA Energy (Hp)	14	24	20
Stocking Density	130	110	83
DOC (days)	90	101	111
SR (%)	89.16	81.35	83.19
MBW (gr)	18.78	18.31	17.80
FCR (x)	1.39	1.58	1.77
ADG (gr/day)	0.21	0.18	0.16
Avg Harvest tonnage (kg)	9,006	12,950	9,616
Production (Kg/Ha)	22,514	16,188	12,019
Prod per power input (Kg/Hp)	**643**	**540**	**481**

Nyan Taw, *et.al.* GAA March/April 2011

P. monodon Cultured in biofloc

Can *P. monodon* be cultured in biofloc systems?

- Typical production in ponds with a stable floc and stocked with about 45 PL/m^2 was 10 to 12 t per hectare
- Target harvest weight 35 g
- FCRs when shrimp were 30 g was 1.3:1
  (excluding molasses added to pond)

From:

David M. Smith, et al, 2008

Development of protocols for the culture of black tiger shrimp, *Penaeus monodon*, in “zero” water exchange production ponds

iSHARP Integrated Shrimp Farming Project Malaysia (Potential for Biofloc Technology)

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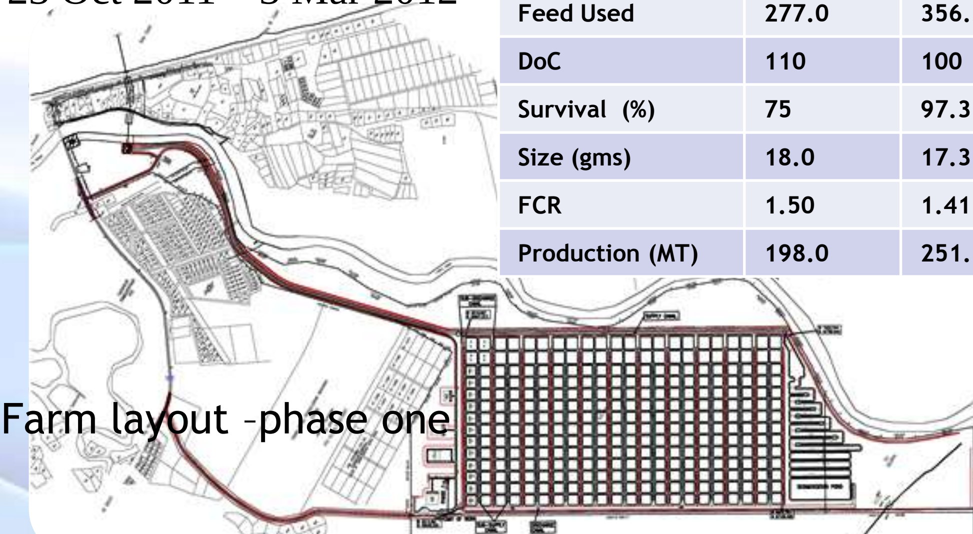
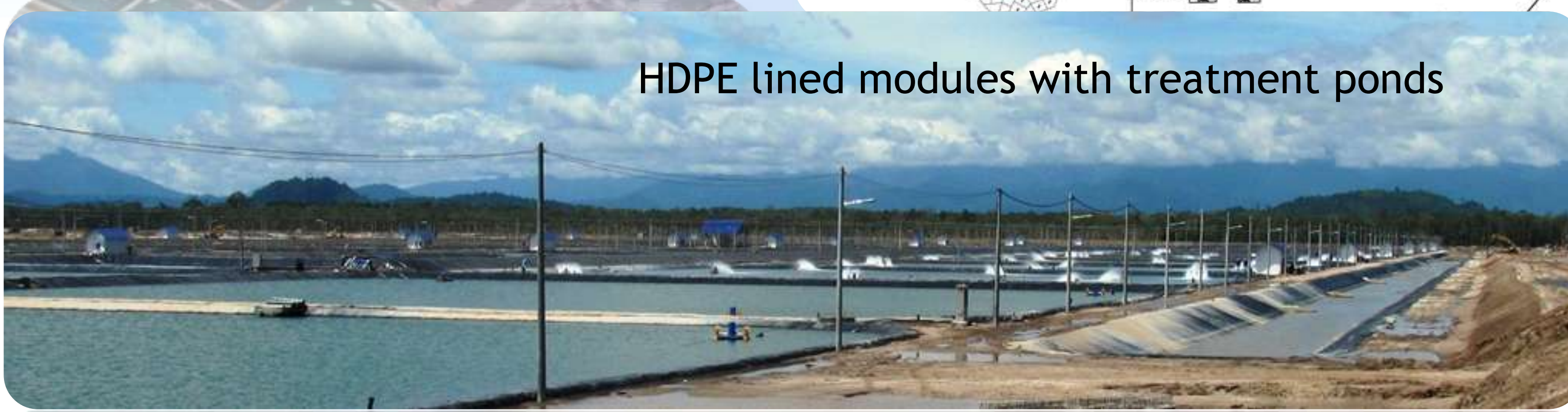
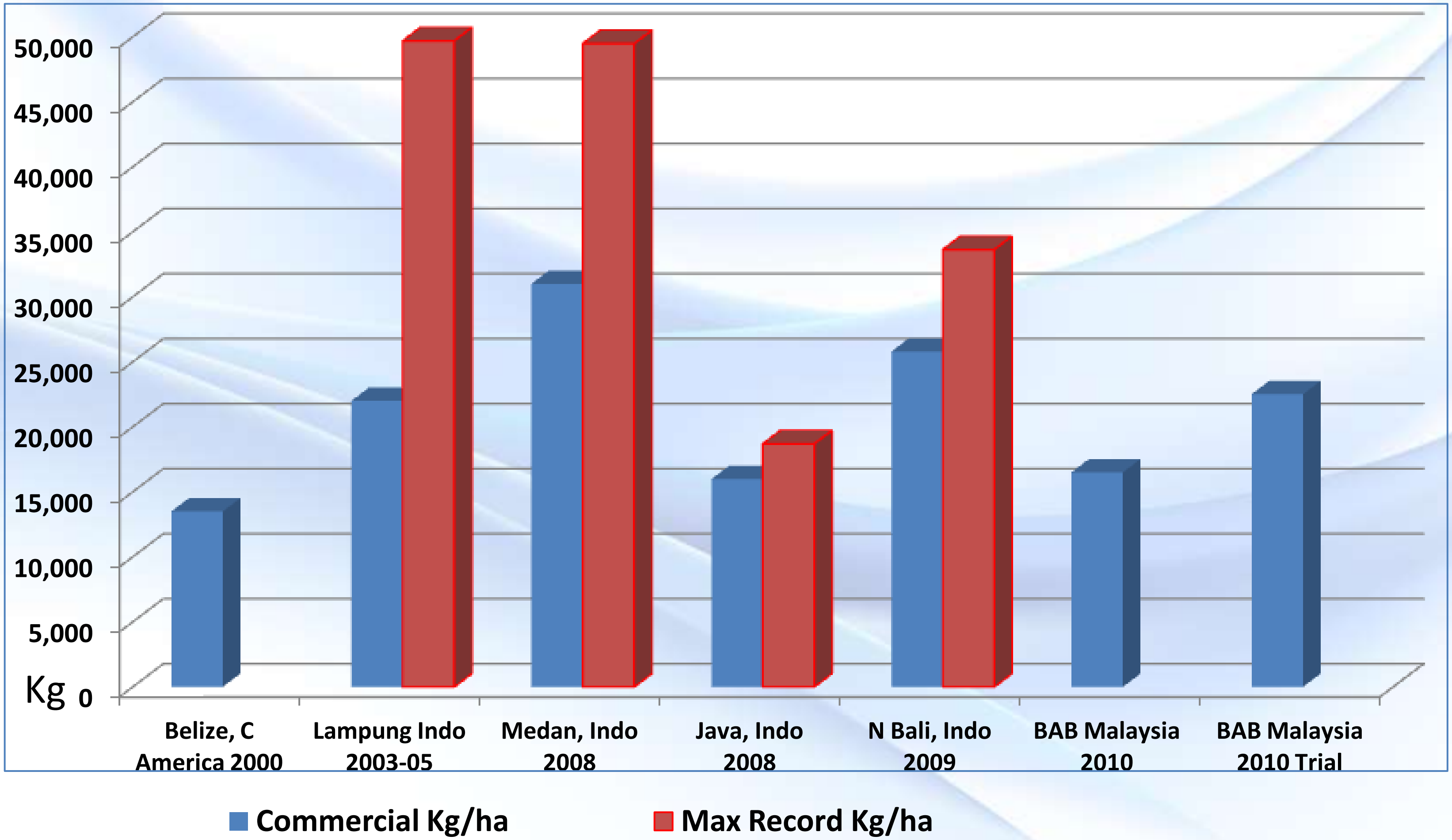
Trial Performance
Two Modules
Culture cycle - 1st Trial
23 Oct 2011 – 3 Mar 2012

Parameters	Planned	Actual
Stocked ponds	48	48
PL required (mill)	14.6	14.59
Harvested ponds	48	48
Feed Used	277.0	356.3
DoC	110	100
Survival (%)	75	97.3
Size (gms)	18.0	17.3
FCR	1.50	1.41
Production (MT)	198.0	251.5





Biofloc in shrimp culture
Production Performance



4. THE PITFALLS

Commercial products to beware of

1. Instant Biofloc
2. Probiotics as starter for Biofloc

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

PWAs – direction one way only
Un-coordinated paddle wheel position
Number of PWAs not correlated to stocking density or carrying capacity
Can develop biofloc but cannot control

5. UTILIZATION OF BIOFLOC TECHNOLOGY FOR SHRIMP BROODSTOCK, NURSERY, RACEWAYS, ETC.

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SUPER-INTENSIVE (RAS)

Ocean Institute, Hawaii, Moss (2006)

Stocking Density	300 /m3
FCR	1.49
Size	24.7 g
Production	7.5 kg/m3

Texas A & M Univ. Samocha (2009)

Stocking Density	450 /m3
FCR	1.52
Size	22.36 g
Production	9.37 kg/m3

BFT IN BROODSTOCK, NURSERY, RACEWAYS & INDOOR COMMERCIAL PRODUCTION



Indoor tanks, raceways & broodstock culture , Indonesia

Indoor biofloc farm in Italy (Shrimp news International April 2012)

Broodstock farming trials New Caledonia (Chim et al 2011)

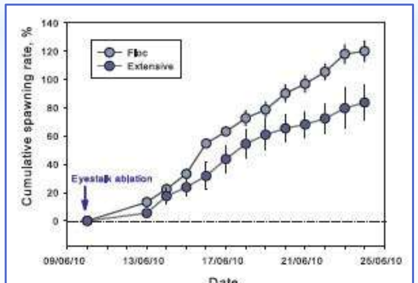

Fig 2 : Cumulative spawning rate according treatments

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


Biofloc Studies in Mexico and Brazil.
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Bio-Floc experimental device
(twenty-four 40l plastic tanks)
Outdoor
(six-teen 20,000l outdoor bio-floc lined tanks)
Bio-floc control
Indoor
(Six 12,000l indoor bio-floc lined tanks)
16
UMDI, Sisal
UNAM-México
Kind courtesy of Dr. Mauricio Emerenciano

6. BIOFLOC AS AQUAFEED PROTEIN SOURCE

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Crude Protein – range 35-50%

(Slightly deficient in arginine, lysine & methionine)

Crude Lipid – range 0.6-12%

High Ash – range 21-32 %

(Conquest & Tacon, 2006)

Tabela 2 – Composição Bromatológica com base na matéria seca de agregados microbianos formados em diferentes experimentos

Fonte	PB (%)	Carb (%)	EE (%)	FB (%)	Cinzas (%)
McIntosh et al (2000)	43,00	-	12,5	-	26,5
Tacon *et al* (2002)	31,20	-	2,6	-	28,2
Soares (2004)	12,0-42,0	-	2,0-8,0	-	22,0-46,0
Emerenciano *et al* (2006)	30,40	29,10*	0,47	0,83	39,20
Wasielesky *et al* (2006)	31,07	23,59	0,49	-	44,85

PB - proteína bruta; Carb. - carboidratos; EE - extrato etéreo ou lipídios; FB - fibra bruta

(Emerenciano et. al, 2012)

Composition of microbial flocs on dry matter basis, mean values with standard errors, as determined by laboratory analysis ($n = 2$).

Parameter	Microbial flocs
	[g/100 g]
Crude protein	49.0 ± 1.5
Carbohydrate[a]	36.4 ± 0.9
Total ash	13.4 ± 0.6
Crude fat	1.13 ± 0.09
Crude fiber	12.6 ± 0.1
Calcium	1.28 ± 0.07
Phosphorus	1.29 ± 0.08
Sodium	1.27 ± 0.03
Potassium	0.75 ± 0.13
Magnesium	0.41 ± 0.05
	[mg/kg]
Zinc	181 ± 1
Copper	92.5 ± 3.0
Manganese	35.0 ± 0.5

[a] Calculated value (Merrill and Watt, 1973): carbohydrate = 100 − (ash + crude protein + moisture + total fat).

(Kuhn, et. al, 2009)

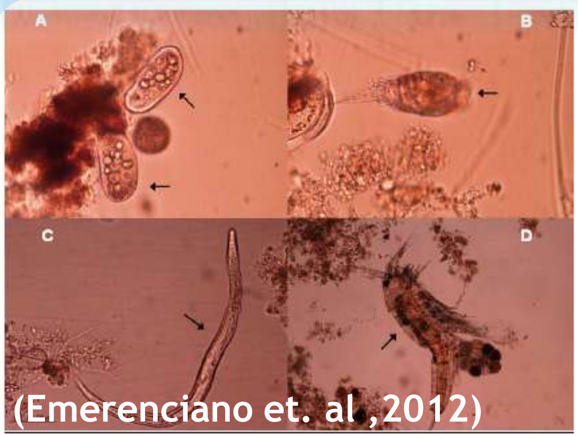
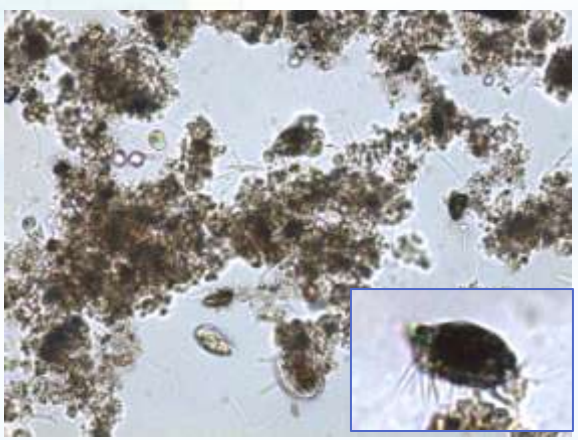
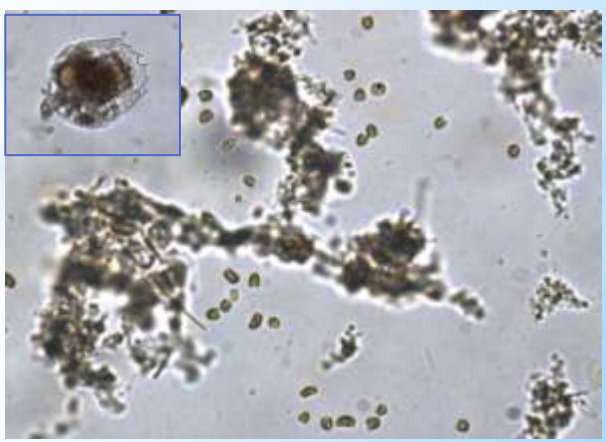


Figure 2 – Grazers often observed in BFT system such as ciliates protozoa (A), flagellates protozoa (B); nematodes (C) and copepods (D) (10x magnification) (Source: Emerenciano et al., 2012)





iSHARP ponds biofloc, Malaysia

ECOMOMICS OF BIOFLOC TECHNOLOGY

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	BIOFLOC	AUTOTROPHIC	REMARKS
Production (MT)	22 MT/ Ha	21 MT/ha	Increase in production = more profit
Growth (gms/day)	0.16 to 2.1	0.13 to 0.16	Larger shrimp size = better price
FCR	1.1 to 1.3	1.5 to 1.7	Lower FCR = lesser feed cost. FCR 0.1 = 3-4% of feed cost.
Biofloc as Protein source	Crude Protein - 35-50%	none	Shrimp/fish consume biofloc. Biofloc can be harvested to replace protein in aqua feed.
DoC (Days of Culture)	90 -100 days	110-120 days	Less DoC = increase production cycles (eg from 2 to 2.5 cycles/ year. More revenue.
Energy Efficiency (HP)	650 – 1,100 Kg/HP	400 - 600 Kg/HP	More efficiency = less energy cost
Shrimp color (red)	Salmon scale > 28	Salmon scale < 24	Strong red = Better price
Stability	CV < 25 %	CV > 25 %	Lower CV = More productivity
Sustainability	Flush out < 1.5%	Flush out > 10 %	More sustainability = Higher production
Water exchange	Zero water exchange	Minimum or flow through	Energy saving in water pumping
Gross profit	> 35 %	< 30 %	The more the profit the better

8. FUTURE OF BFT IN ASIA

BIOFLOC TECHNOLOGY IN INDONESIA

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BIOFLOC TECHNOLOGY – WORLD WIDE

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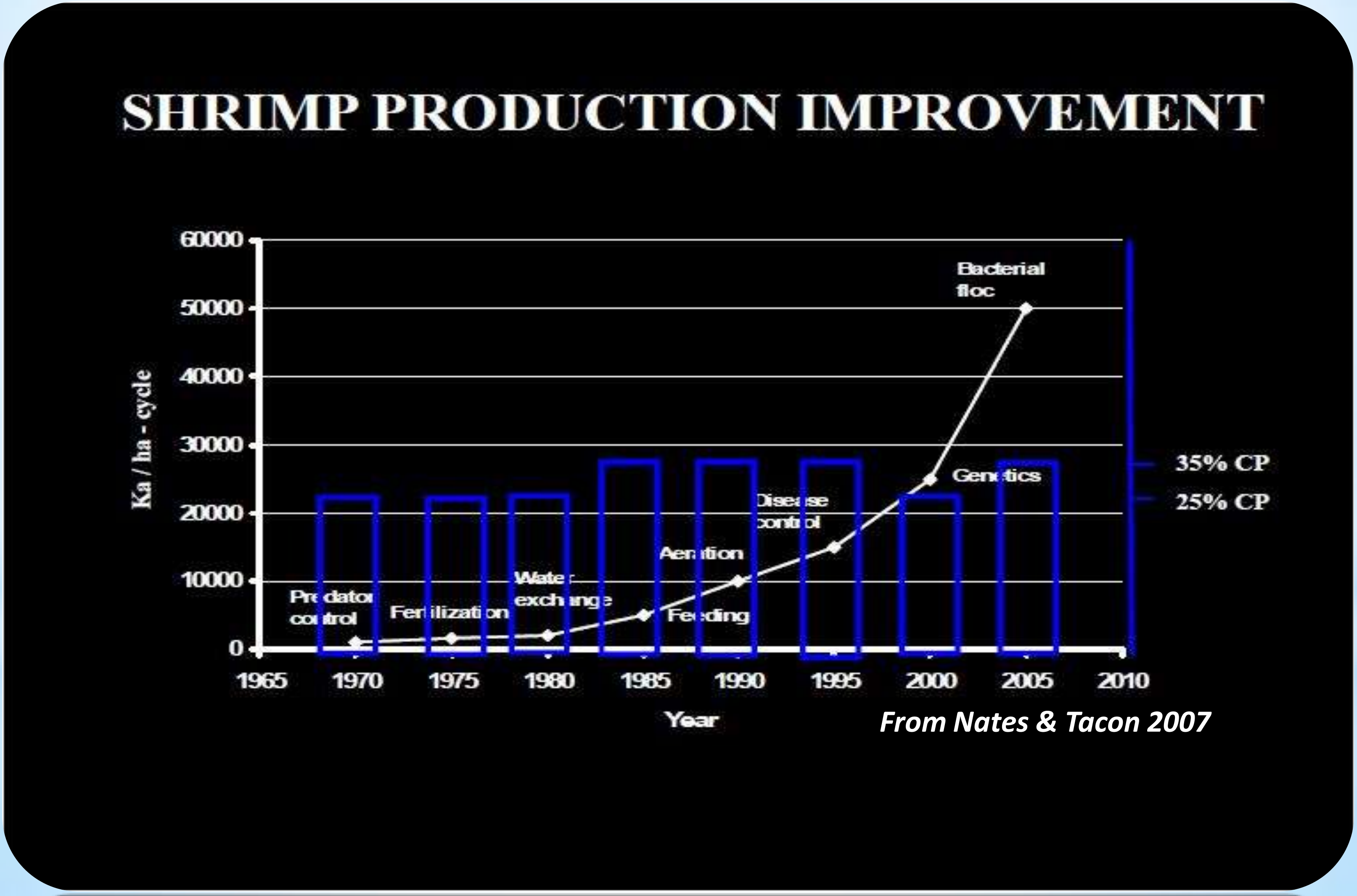
FUTURE OF BFT IN ASIA ?

WHITE SHRIMP (*L. vannamei*) – CHICKEN OF SEA ?



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THANK YOU