SHRIMP FARMING IN BIOFLOC SYSTEM:
REVIEW AND RECENT DEVELOPMENTS

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INTRODUCTION

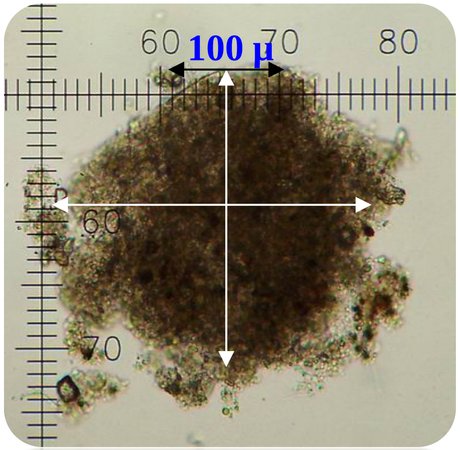
Biofloc, a very recent aquaculture technology seem a very promising for stable and sustainable production as the system has self-nitrification process within culture ponds with zero water exchange. Fish and shrimp use these microorganisms aggregated as additional feed source increases productivity, reduces FCR , possibly prevent diseases and consequently a sustainable production. Recently a book on biofloc technology was published by Yoram, et al (2012) (co-authored by Taw).

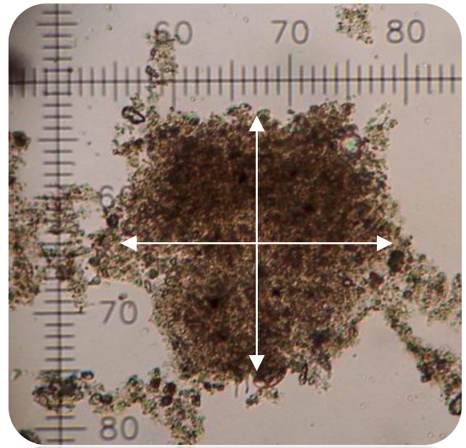
Biofloc technology initially known as bacteria floc was initiated in fish (tilapia) by Yoram in late 1980s and shrimp farming in Belize in late 1990s by McIntosh (1999 & 2000). The biofloc technology was scaled up to commercial scale since late 2002 (Taw et al, 2005, 2008, 2010 & 2014) in Indonesia and in Malaysia (Taw et al, 2010, 2011, 2012 & 2013). Semi-biofloc system has also been applied in earthen ponds with success *using P. monodon (*Smith 2008*) and L. vannamie (*Taw & Tun 2013*).* In Full biofloc system production can be as high as nearly 50 mt/hectare/cycle during R&D trials, however for commercial scale a production of 20-25 mt/ ha/ cycle is normal (Taw et al 2010,2011 &2012). As from semi-biofloc a production of 15-16 mt/ha/ cycle can be achieved (Taw et at 2012 & 2013). Super-intensive biofloc system in raceways with *L. vannamei* are been studied by Moss (2006) and Samocha (2009) reaching to a production of 7.5 and 9.37 kg/m3 respectively. In fish (tilapia) production of between 20-40 kg/m3 in small concrete tanks can be expected. Presently, a number of studies by major universities and private companies to utilize biofloc as a single cell protein source in aquafeeds.

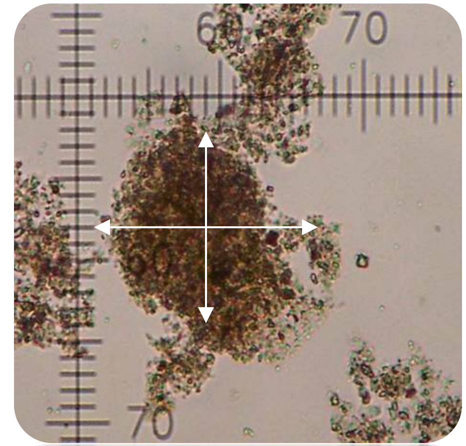
According In-Kwon (2012 &2014) there were more than 2,000 bacterial species in well-developed biofloc water. This biofloc may enhance immune activity based on mRNA expression of six immune-related genes – ProPO1, ProPO2, PPAE, ran, mas and SP1. With emerging new viral diseases such as EMS/AHPND in Asia, a preventive solution with biofloc technology has become essential for sustainable production in shrimp farming.

BIOFLOC

FLOC COMMUNITIES AND SIZE

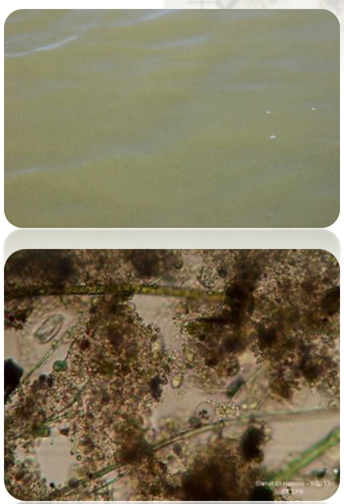




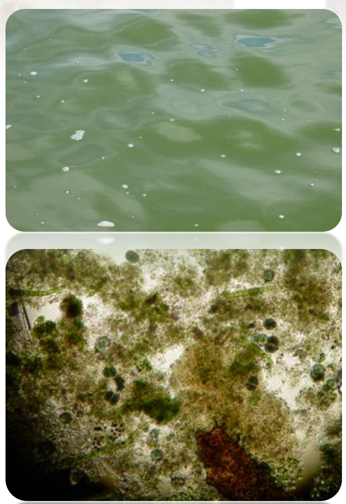


The biofloc

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



Brown

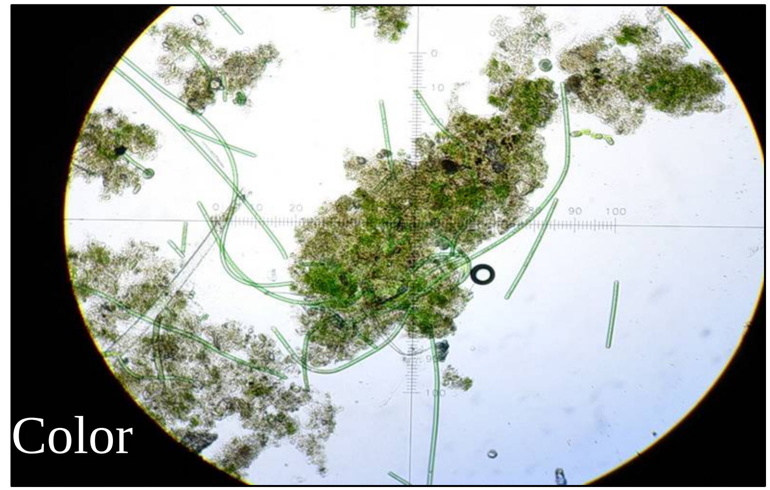


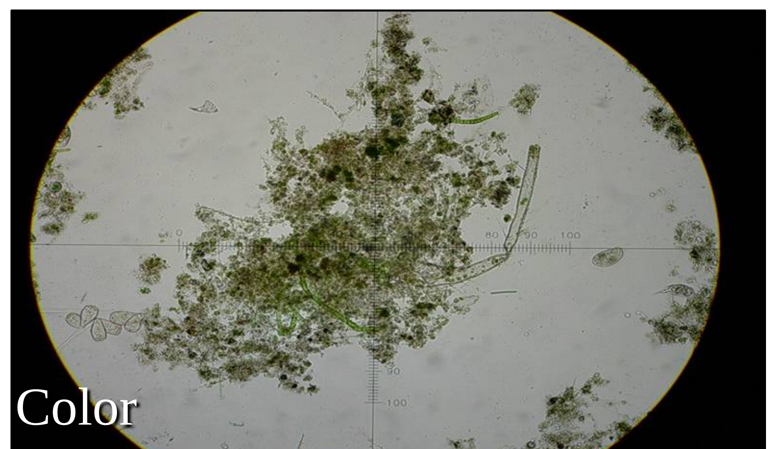
Green

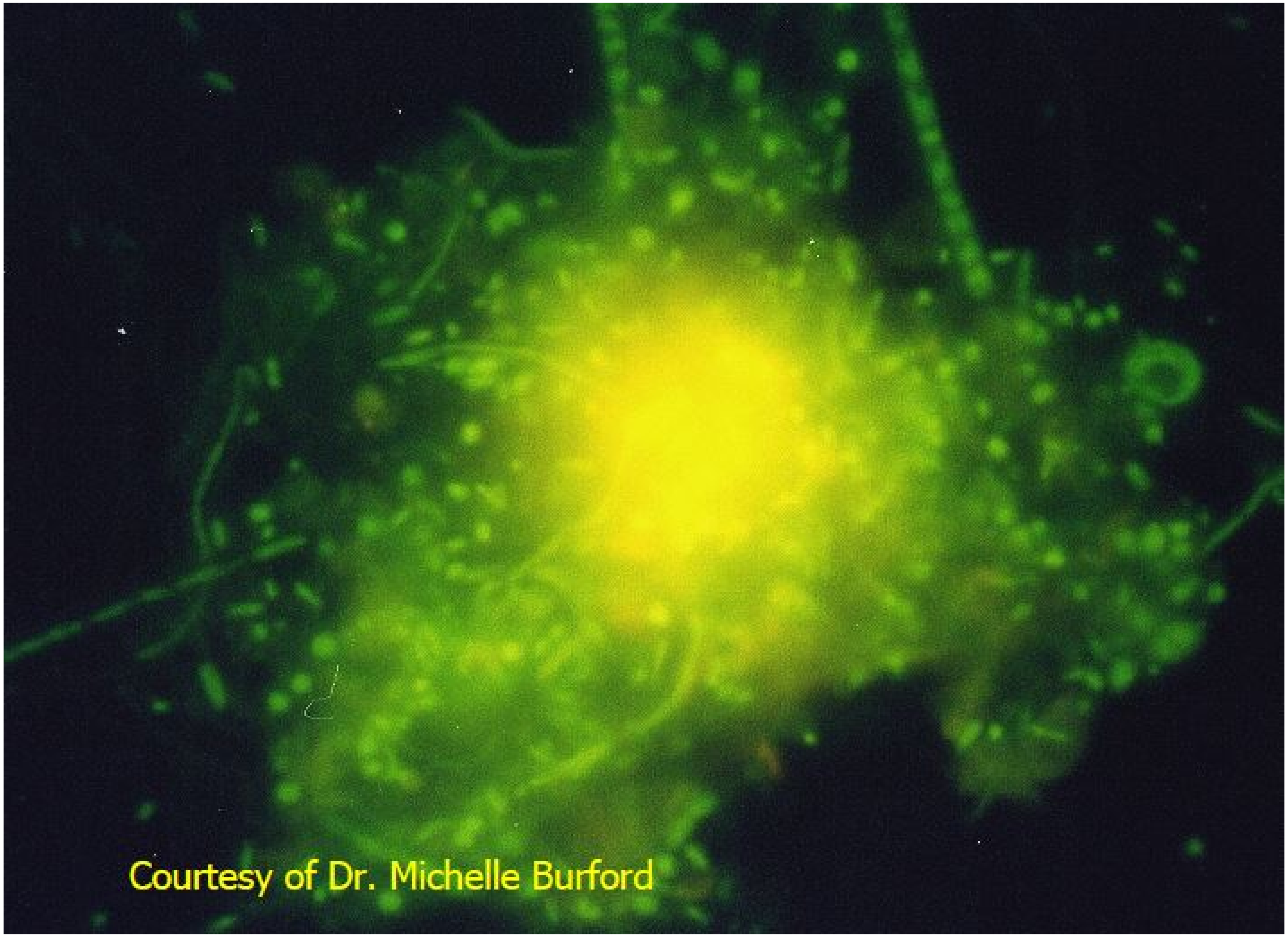
As Natural Feed (filter feeders – *L. vannamie* & Tilapia) : *It is possible that microbial protein has a higher availability than feed protein (Yoram, 2005)*

BIOFLOC

Biofloc color in pond & under microscope





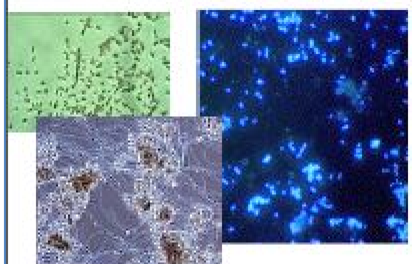

Courtesy of Dr. Michelle Burford

BIOFLOC COMMUNITIES

Blue Archipelago

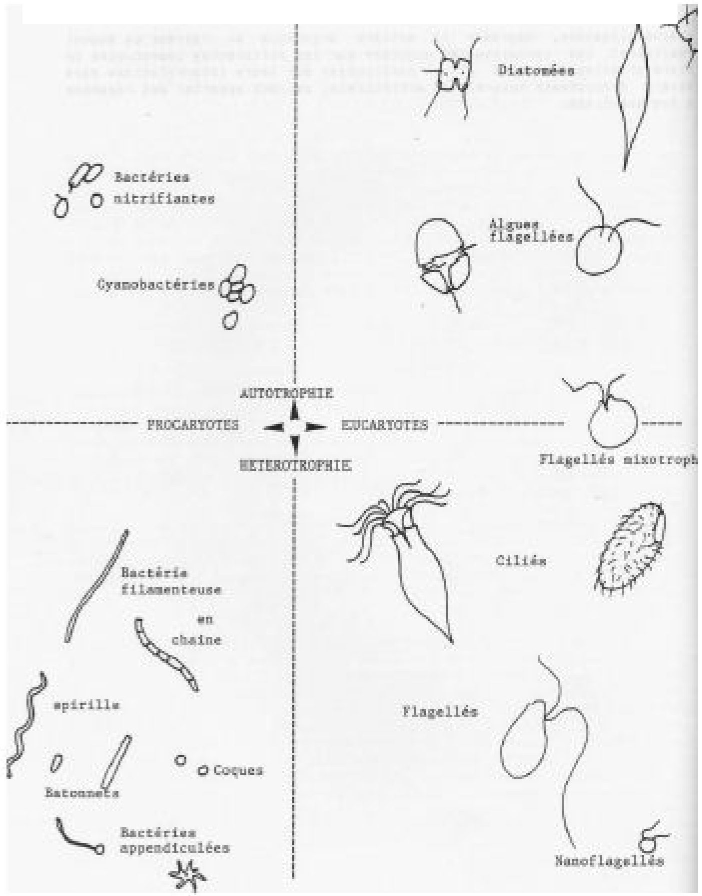
Los "microorganismos"...

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

BIOFLOC TECHNOLOGY CONCEPT

Figure 2.3: Scheme of recirculating aquaculture system (RAS)

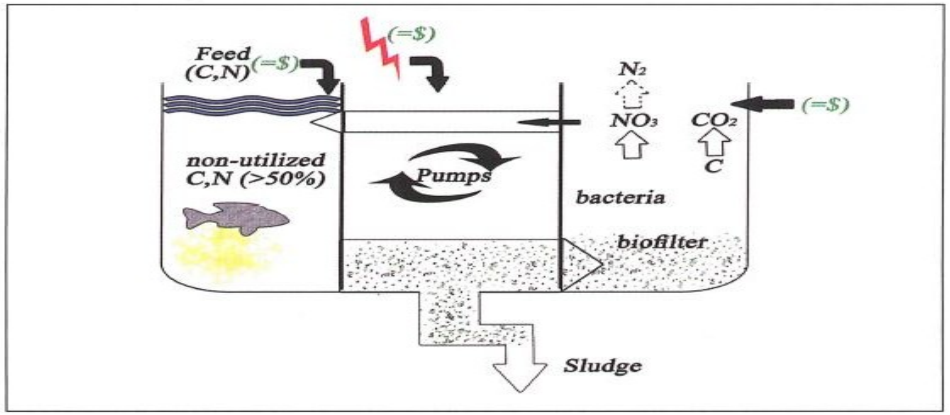
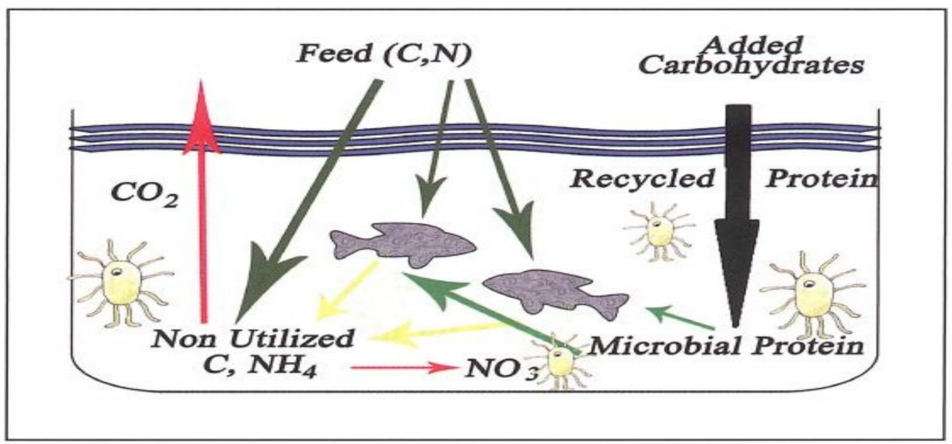


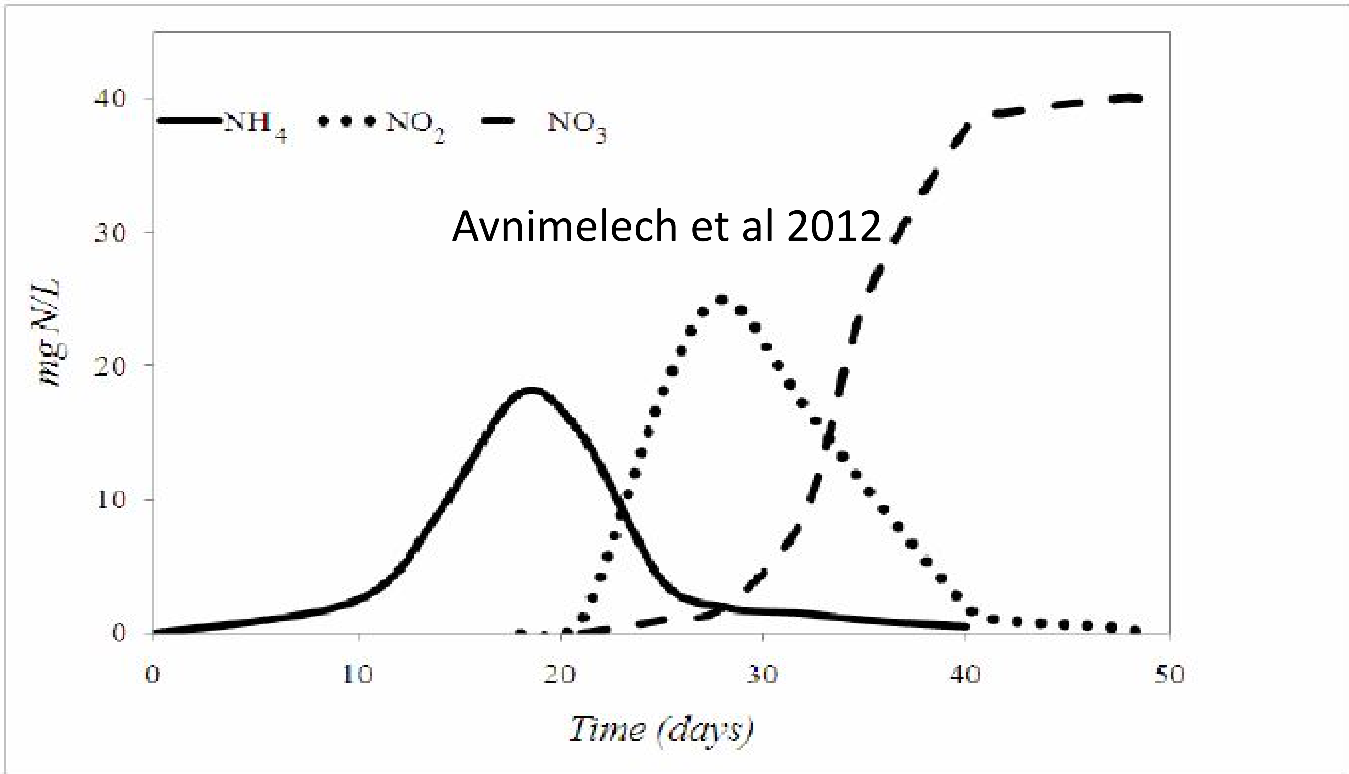
Figure 2.4: Scheme of Biofloc technology (BFT) system



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

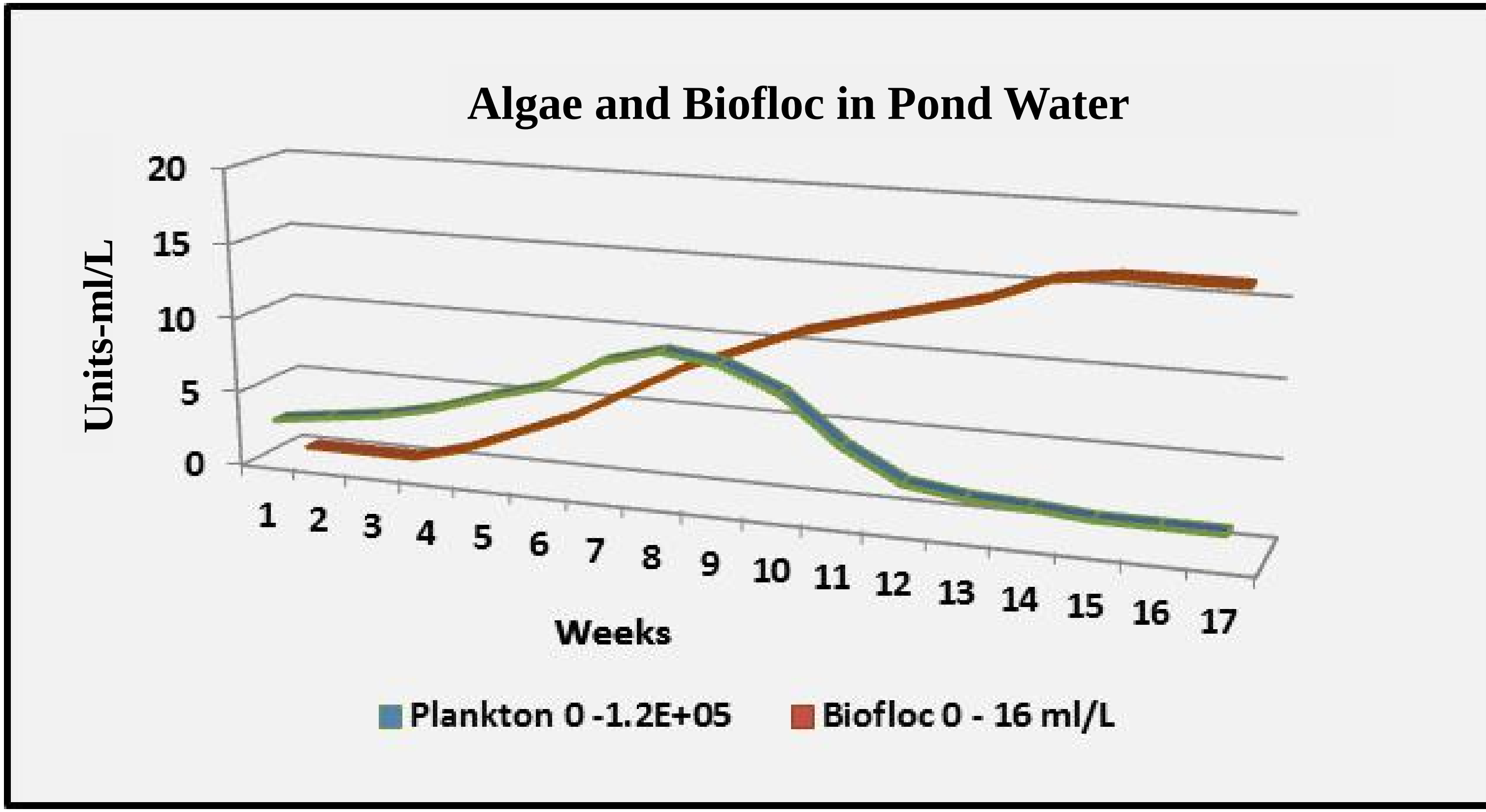
NITRIFICATION SEQUENCE

Nitrification sequence in BFT pond



Avnimelech et. at, 2012 (data from experimental pond Dor, Israel)

ALGAE TO BIOFLOC IN POND WATER



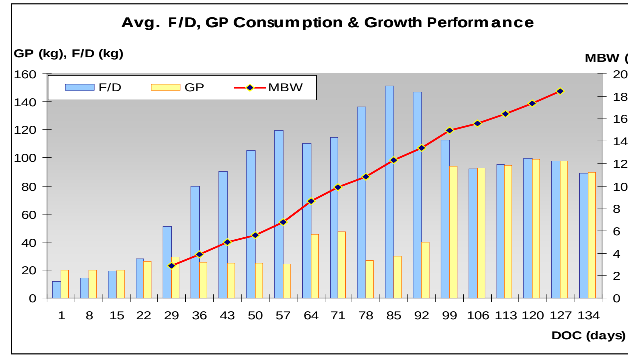
Development of biofloc system

- It may take a few weeks, depends on the biomass.
- First algae develop. Transition, foam formation then it get brown.
- Transition is fast with tilapia, longer with shrimp
- Add carbon if TAN is above ~2 mg/l

SHRIMP FARMING IN BIOFLOC SYSTEM

SUMMARY

1. High stocking density - over 130 – 150 PL10/m2 (80-100PL10/m2)
2. High aeration – 28 to 32 HP/ha PWAs (20--24HP/ha)
3. Paddle wheel position in ponds (control biofloc & sludge by siphoning)
4. Biofloc control at <15 ml/L (<5 ml/L)
5. HDPE / Concrete lined ponds (Earthen ponds)
6. Grain (pellet)
7. Molasses
8. C&N ratio >15
9. Expected production 20–25 MT/ha/crop with 18-20 gms shrimp (13-16 MT/ha)

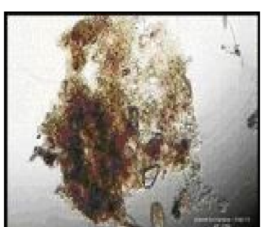


Feed & grain application & Growth

High aeration & PWAs position

High density

Grain pellet



Bioflocs

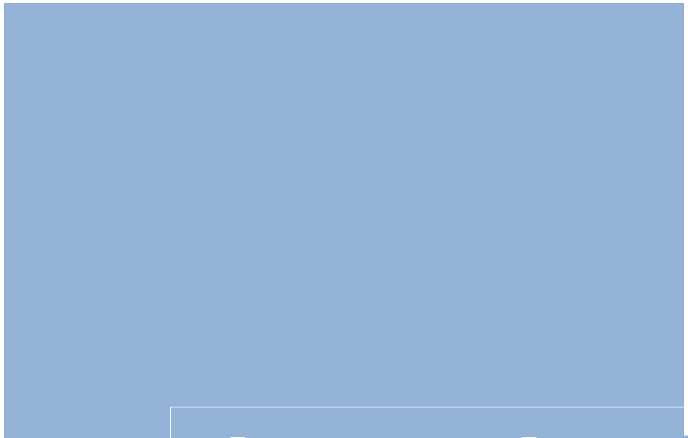
Biofloc

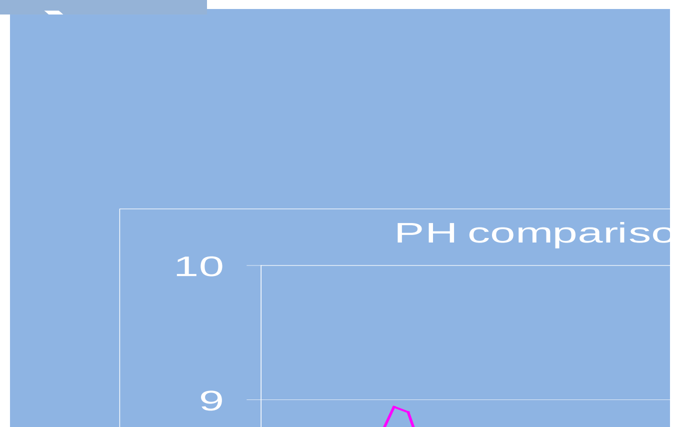
Dark Vannamei

Red Vannamei

POND WATER ENVIRONMENT

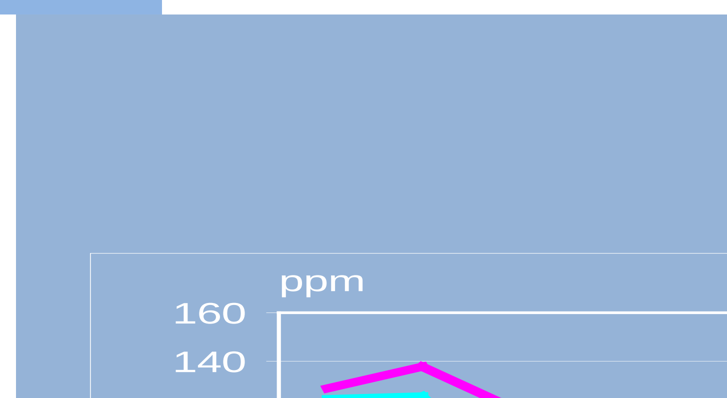
DO – Algae & Biofloc





pH – Algae & Biofloc

Alkalinity – Algae & Biofloc



Chandaeng, S. et al.(2005): Taw, N (2006)

SHRIMP FARMS PERFORMANCE
(McIntosh 2000 b & c)


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

Saenphon C. & Nyan Taw (WAS, Bali 2005)

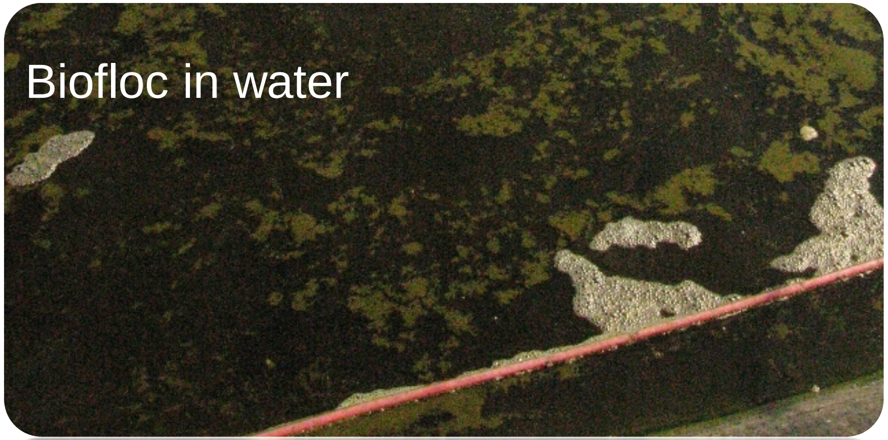
Nyan Taw (AA, L Vegas 2006)

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

0.5 hectare ponds

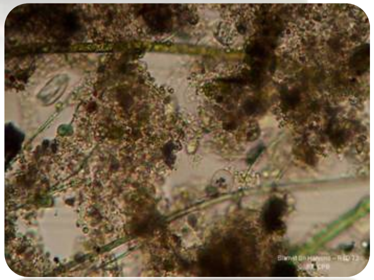
BIOFLOC & PARTIAL HARVEST

Medan, Indonesia

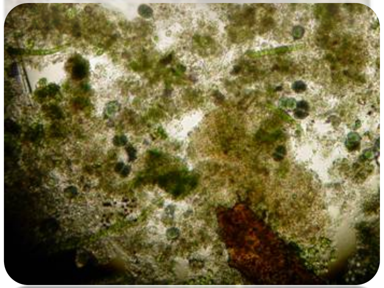


Nyan Taw, et al, GAA Sep/Oct 2008

Brown biofloc



Green biofloc



Nyan Taw. ***et al*** **WAS 2009 Mexico**

BIOFLOC AND PARTIAL HARVEST

Medan, 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 5896 m2	Phyto	16 (PW)	27 (PW)	100	1	118	434	47	21.28	11,461	**19,439**	0	**1.60**	75.72	560*	**720**
					Final	127	11,027	43	23.26							
2 5896 m2	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							
					Final	131	10,400	52	19.23							
3 5940 m2	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							
					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 2500 m2	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							
					Final	127	5,012	47	21.28							
7 2500 m2	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							
					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

P. monodon CULTURED IN BIOFLOC

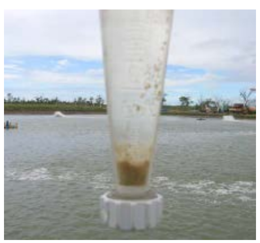
Can *P. monodon* be cultured in biofloc systems?

- 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:

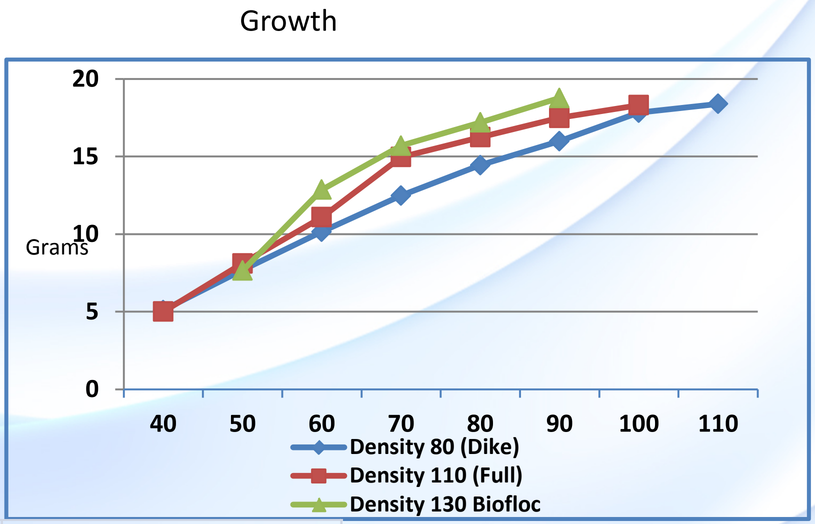
David M. Smith, et al, 2008

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



PERFORMANCE –BIOFLOC & SEMI BIOFLOC

Acar Beru, Blue Archipelago, Malaysia

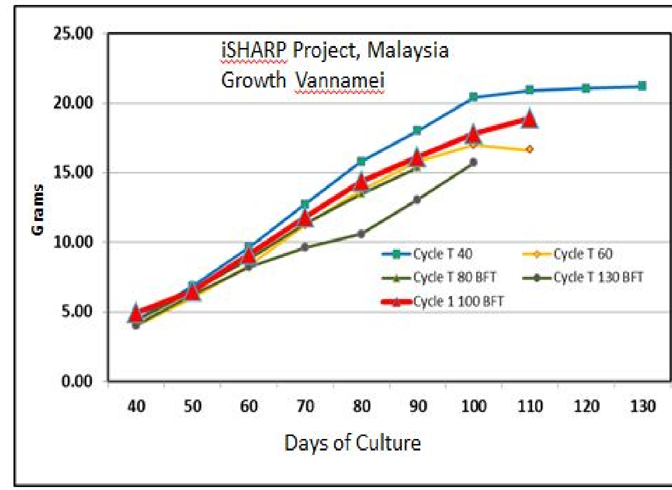


PRODUCTION PERFORMANCE OF ARCA BIRU FARM

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

ISHARP BLUE ARCHIPELAGO, MALAYSIA
SEMI-BIOFLOC PERFORMANCE

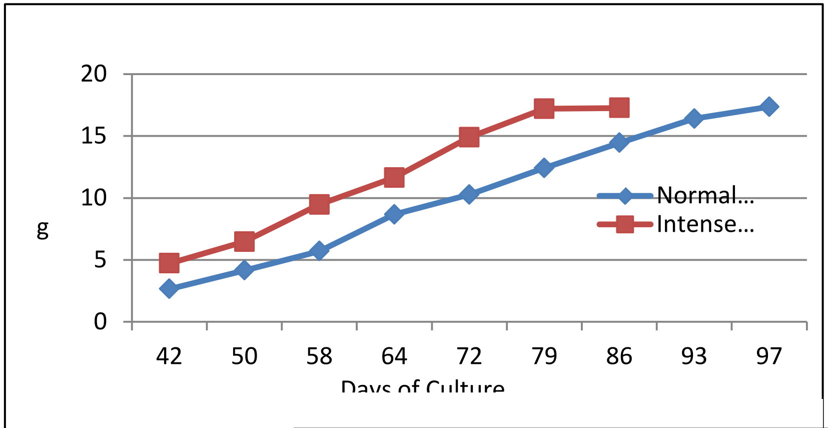


Nyan Taw *et. al. GAA Jan/Feb* 2013

Production Performance CYCLE Trial & 1 for Modules 1 & 2

Production Parameter	CYCLE Trial - Modules 1 & 2				CYCLE 1 -Modules 1 & 2	
	Density 40/m2	Density 60/m2	Density 80/m2	Density 130/m2	Density 100/m2	Density 100/m2
No of ponds	20	16	8 BFT	4 BFT*	24 BFT	24 BFT
Paddle Wheels Aerators (HP)	12	12	12	16	12	12
Days of Culture (DoC)	113	108	94	88	100	99
Survival Rate (%)	112.23	101.22	106.05	69.56	97.30	104.92
MBW (grams)	21.65	17.41	13.86	12.56	16.05	16.31
FCR	1.34	1.47	1.32	1.74	1.39	1.26
Average Production (kg/pond)	4,875	5,294	5,828	5,677	7,714	8,547
Average Production (kg/ha)	9,749	10,587	11,655	11,354	15,428	17,093
Prod per power Input (Kg/Hp)	406	441	486	355	643	712

BIOFLOC IN BALI, INDONESIA



NO VIRAL (IMNV or WSSV) OUTBREAKS 2009-2013

SHRIMP FARM BALI - Biofloc technology

Culture period August- November 2012

Pond	A2	A3	F1	F2	E1	E2*	B1	B2	B3	C1	C2	C3
Pond Size (M2)	2,400	2,600	2,800	2,800	1,000	750	2,000	2,000	2,000	600	600	600
PL Stocking Density (No/m2)	170	148	150	145	150	180	155	155	155	175	175	175
Aeration (hp)	18	18	16	18	6	4	12	12	12	12	6	4
Days of Culture	97	97	97	95	95	45	82	82	81	82	82	81
Body weight (gm)	18.4	18.12	15.32	17.3	16.48	4	19.5	18.5	16	14.68	19.72	18.48
Feed Conversion ratio	1.26	1.35	1.49	1.29	1.46		1.2	1.4	1.25	1.35	1.1	1.14
Survival (%)	105.8	104	101	106	94.7		103.9	94	92.9	97.4	98.5	101.9
Production (kg)/pond	7,914	7,281	6,388	7,682	2,345		6,307	5,399	4,622	1,503	2,050	1,981
Production (kg/ha)	32,976	28,004	22,814	27,436	23,450		31,535	26,995	23,110	25,050	34,167	33,017
Production/power input (kg/hp)	440	405	399	427	391		526	450	385	376	342	495

* Aeration problem - DO dropped <1.0ppm

Farm total Production: 53,472 kg (26,736 kg/ha)

In this cycle ponds B1,B2, B3,C1,C2 & C3 intense control less DOC to just over 80 days- more cycles/year

Taw & Setio, Jan-Feb GAA 2014

SHRIMP CULTURE - SEMI-BIOFLOC IN MYANMAR

Earthen pond bedside Soft Shell Crab Farm

Table 1. Production performance of the *P. vannamei* farm trials at Kyauktan shrimp farming zone

Pond no (All of 6,400 m²)	Aeration energy (hp)	Stocking density (m²)	Survival (%)	FCR*	Partial	Harvest			Production (kg/ha)	Carrying capacity (kg/hp)
						DOC	Production (kg)	MBW (g)		
A 1	16	91			1	90	2,643	10.0		
					Final	107	3,826	14.5		
			90.7	1.23	Total		6,469		10,107.8	631.8
A 2	16	83			1	90	2,760	10.0		
					Final	102	2,005	13.0		
			71.2	1.17	Total		4,765		7,445.0	465.3
A 3	16	93			1	89	2,430	10.0		
					Final	107	3,451	14.6		
			82.6	1.26	Total		5,881		9,189.0	574.2
B 1	16	98			1	82	2,570	10.0		
					Final	97	3,226	13.5		
			82.3		Total		5,796		9,056.0	566
B 2	16	95			1	83	3,026	9.2		
					Final	110	3,750	15.0		
			91.2	1.34	Total		6,776		10,588.0	661.8
B 3	16	98			1	84	1,700	9.4		
					2	97	2,328	12.7		
					Final	105	3,174	15.5		
			94.3	1.27	Total		7,202		11,253.0	703.3

*FCR —Feed conversion ratio

Shrimp sampling

Two modules-earthen ponds: one module consisted of 1 reservoir and 3 production ponds

No viral outbreaks

L. vanamei Post Larvae imported from Thailand by Air

Taw & Tun, AquaAsia 2013

FISH (TILAPIA) IN BIOFLOC SYSTEM

Taw – Saudi JFRC Workshop 2014

Implications:

- High Biomass 20-30 kg/m3
- High feeding (ca 500 g feed/m3 per day!)
- Very high microbial activity
- High floc volume (20-50 ml/l).
- Very high natural feed storage.
- High levels of feed residues
- Need to drain out daily (or twice daily) excessive sludge.
- Pond constructed to facilitate sludge draining and perfect mixing.
- High and effective aeration: 10-20 hp/1000 m2 pond

SHRIMP IN RACEWAYS & TANKS

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)

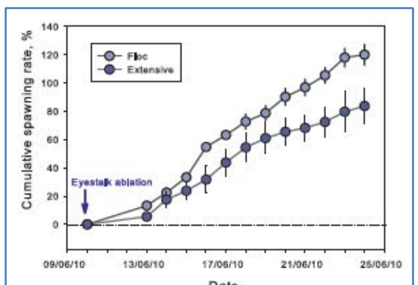


Fig 2 : Cumulative spawning rate according treatments

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

UTILIZATION OF BFT
SHRIMP BROODSTOCK, NURSERY, RACEWAYS, ETC.

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

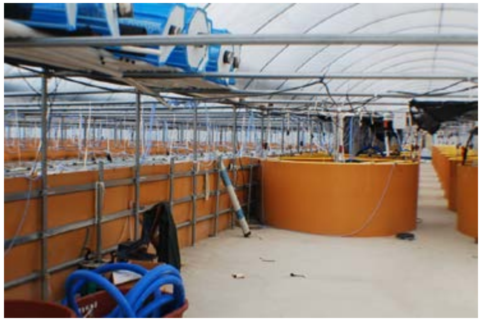
BIOFLOC AS DISEASE CONTROL

BIOFLOC MAY ENHANCE IMMUNE ACTIVITY

More than 2,000 bacterial species were found in well-developed biofloc water

Biolfocs may enhance immune activity, based on mRNA expression of six immune-related genes.

ProPO1, proPO2, PPAE, ran, mas and SP1



From – In-Kwon Jang, IWA International Water Congress, 2012, Busan, Korea

BIOFLOC STUDIES IN MEXICO & BREZIL

Blue Archipelago
Quality | Safety | Ecology

BIOFLOC AS AQUAFEED PROTEIN SOURCE

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)

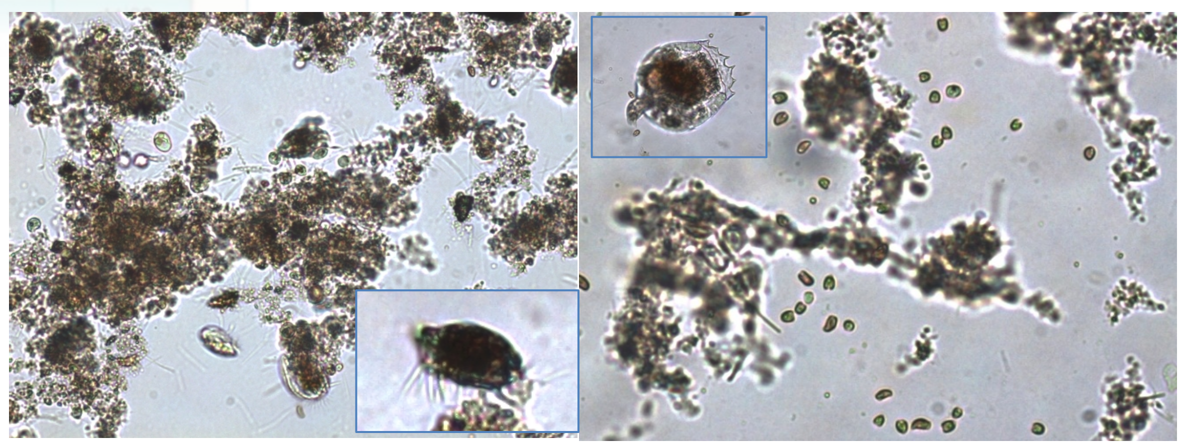
Composition of microbial flocs on dry matter basis, mean values with standard errors, as determined by laboratory analysis ($n = 2$).

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

FUTURE OF BIOFLOC TECHNOLOGY

What Makes Bioflocs Great For Shrimp?

Feeding trials conducted by Virginia Tech in partnership with Texas A & M University compared high-quality shrimp diets with and without bioflocs.

Kuhn, D.D, et. al, (2011)

Shrimp grew 10 to 50% faster on diets that contained bioflocs compared to those without them.

Perspectives

Even though we have not yet identified what component of bioflocs accelerates shrimp growth, knowledge of what does not contribute can help us better understand shrimp nutrition and lead to innovative findings in the future.

From an industry standpoint, this is not as important as the demonstrated benefits that biofloc can offer. Bioflocs are advantageous because they are produced in a manner that is not only sustainable, but may also offer valuable water treatment options, resulting in an alternative ingredient to fishmeal in shrimp diets.

BIOFLOC BASIC MANAGEMENT CONCEPTS FOR SHRIMP CULTURE

1	**Semi-biofloc to Full biofloc system feasible**
2	**Use treated water only**
3	**Zero water exchange (only topping up)**
4	**Earthen to HDPE full or semi-lined ponds**
5	**Aerators to have pond water (biofloc) in suspension (22-24 hrs)**
6	**Correct aerators' position and number very important**
7	**Excess sludge need to be removed –specially for full biofloc**
8	**Biofloc volume control (<5 - 15 ml/L)**
9	**Control C/N ratio to above >15**
10	**Molasses & Grain pellet required (Carbon source)**
11	**Operate in accordance with Carrying capacity of pond essential (species/stocking density/pond type/operating system)**

Aquacultural Engineering Society
Biofloc Technology Working Group

Workshop on Biofloc Technology and Shrimp Diseases

December 9-10 2013
Saigon Exhibition and Convention Center, District 7, HoChiMinh City, Vietnam

Summary

Workshop on Biofloc Technology and Shrimp Diseases
Ho Chi Minh City, Vietnam, December 9, 2013,

To summarize this discussion, the main attributes of biofloc systems that reduce the risk of shrimp disease are:

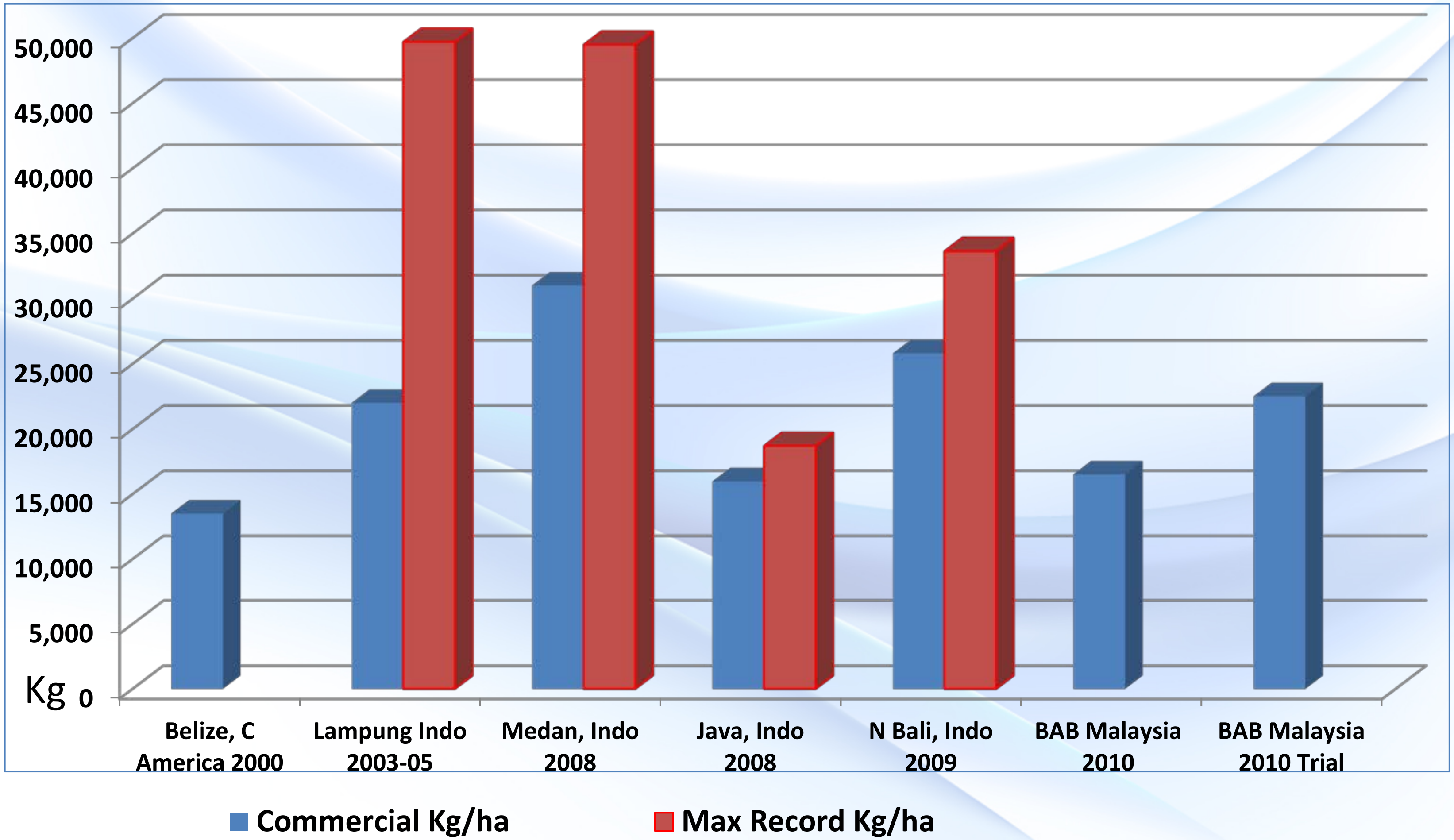
1. **Low rates of water exchange improve pathogen exclusion (biosecurity).**
2. **Continuous aeration provides stable water quality (DO and pH).**
3. **A diverse and stable microbial community stimulates the non-specific immune system and limits development of opportunistic species like Vibrio.**
4. **Regular removal of accumulated sludge controls biofloc concentration to moderate levels.**

Biofloc/EMS Conference, December 2013-
SHRIMP NEWS INTERNATIONAL 27 December 2013

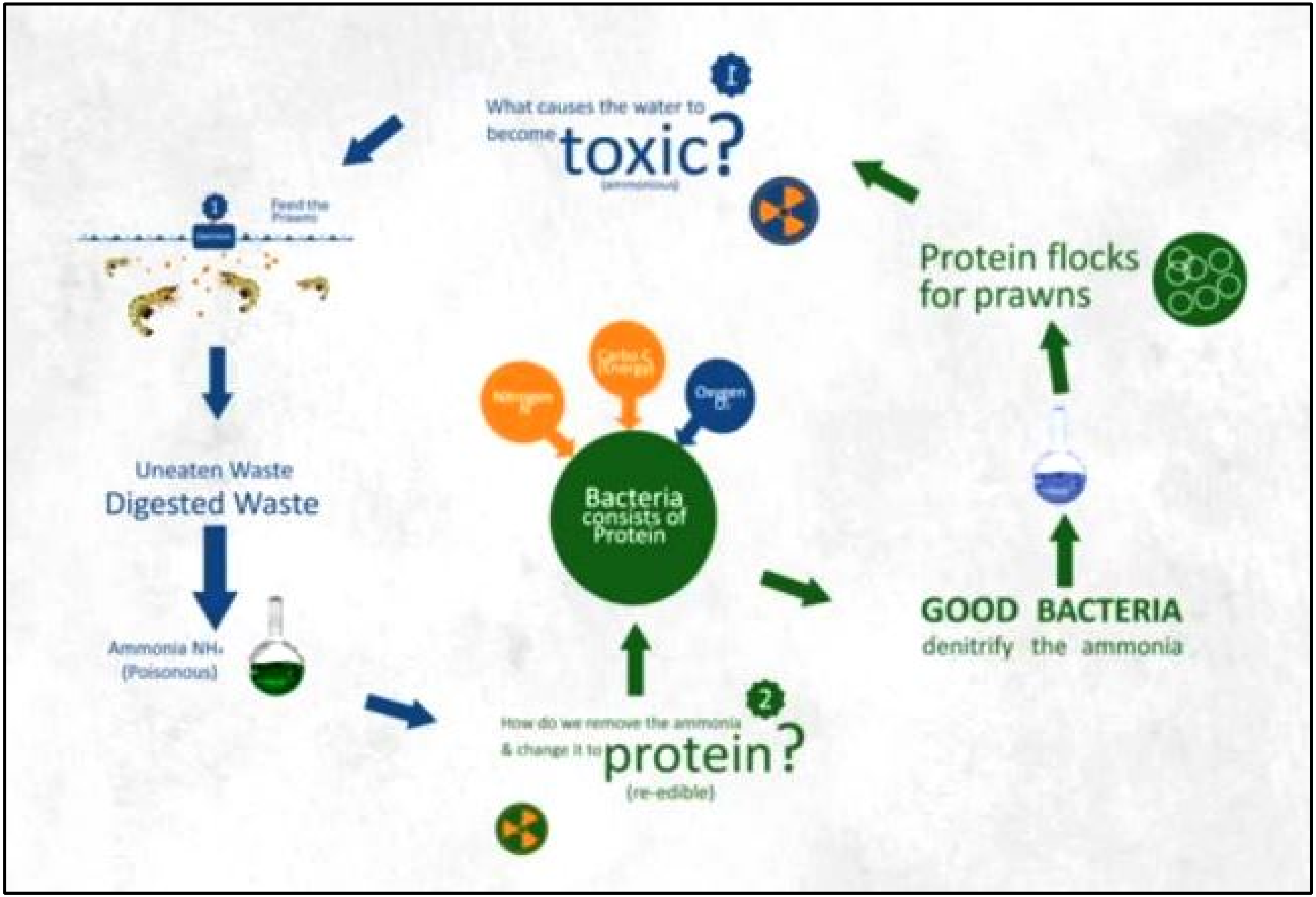
ECOMOMICS OF BIOFLOC TECHNOLOGY

	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
Production Cost	< 15-20 % than Autotrophic	Standard Autotrophic	Less production cost = more profit
Feed Mill - production	Less sale but more sustainable sale	Normal sale	Feed mill should include grain pellet for biofloc with which sustainable sales could be secured.

BIOFLOC IN SHRIMP FARMING
Production Performance



Taw – Saudi JFRC Workshop 2014



YouTube. [Aquaculture Prawn Farming: Water Purification Process](). Gavin Langley. June 2, 2014.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7-11 June

Thank You


Aquaculture America 2006 Las Vegas
EXIT
Shaun M. Moss, George Chamberlian, Rod Mcneil, Joe , -----, ------, Daniel F. Fegan,
Yoram Avnimelech, Tim Hering, ----, ----
------, Tzachi M. Samocha, Bob Rosenberry, J. Michael Mogollon Nyan Taw