ECONOMICS OF BIO FLOC BASED FARMING

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Biofloc technology

Biofloc technology became more and more popular with advent of farming of Pacific white shrimp, *Penaeus vannamei*. The technology initiated by Yoram Avnimelech (2000) in Israel and was initially implemented commercially in Belize by Belize. It also has been applied with success in shrimp farming in Indonesia, Malaysia, Australia etc.

The combination of two technologies, partial harvesting and biofloc, has been studied in northern Sumatra, Indonesia (Nyan Taw 2008 et. al). The system has been successfully incorporated in bio secure modular culture system (Nyan Taw, 2011). With emerging viral problems and rising costs for energy, biofloc technology appears to be an answer for sustainable production at lower cost. The technology has applied also in super-intensive raceways to produce more than 9 kg shrimp/ m^3. The raceway applications have supported nursery and grow out to shrimp brood stock rearing and selection of family lines.

In ICAR-CIBA, a number of studies using biofloc as a protein source in shrimp feeds were conducted. In any aquaculture business as defined by economics-savings are also considered as profit. Savings such as from feed, time, energy, stability and sustainability can be calculated as profit.

Biofloc system

For optimized, sustainable commercial bio floc shrimp culture, high-density polyethylene- or concrete-lined ponds are basic requirements. High stocking densities of 130-150 post larvae/m^2 and high aeration rates of 28-32 hp/ha is also essential. Paddlewheel aerators are placed in ponds to keep dissolved-oxygen levels high and guide sludge toward the central areas of ponds. The sludge can then be siphoned out periodically when needed. The aerators help suspend the bioflocs in the pond water – a main requirement for maximizing the potential of microbial processes in shrimp culture ponds. The suspended biofloc is also readily available as feed for shrimp. Pelleted grain and molasses are used to sustain carbon: nitrogen ratios above15.

Generally, incoming water is screened to prevent larval crustaceans (especially crabs) from entering reservoirs and culture ponds. The most important factor is to make sure the screening, chemical treatment and aging process are efficiently used before stocking ponds with shrimp. Only specific pathogen-free post larvae should be stocked. Once ponds are stocked, a major factor to control is biofloc volume. Biofloc volumes need to be maintained below 15 ml/L. Green or brown water is acceptable, but black water is an indicator of abnormal conditions. Grain pellets and molasses supply sources of carbon as needed. Generally, grain pellet applications vary from

15to20% of the total feed used during operations. Molasses can be applied two or three times. Dissolved oxygen needs to be monitored as frequently as possible to keep levels higher than 4mg/L. Especially in biofloc systems, aerators need to be constantly monitored for malfunctions and repaired or replaced without delay.

In sum biofloc system can be summarised as:

- High stocking density - over 130 – 150 PL10/m^2
- High aeration – 28 to 32 HP/haPWAs
- Paddle wheel position in ponds (control biofloc & sludge bysiphoning)
- Biofloc control at <15ml/L
- HDPE / Concrete lined ponds
- Grain(pellet)
- Carbohydrate
- 8 C&N ratio >15
- Expected production 20–25 MT/ha/crop with 18-20 gms shrimp.

Culture performance

A comparison of the expected cost savings and culture performance of the biofloc system to a traditional autotrophic system:

- Shrimp grow faster and yield a larger harvest in bioflocsystems.
- Feed conversion is better with biofloc, so feed costs are lower.
- Days of culture is reduced and hence more cycles can be taken
- Less water is exchanged with biofloc technology, less pumping costs and the pond systems are more stable than in autotrophic culture. Greater output with bioflocs also improves energyuse.

In addition to intensive fish and shrimp culture, biofloc technology has been applied in super-intensive raceways to produce over 9 kg shrimp/ m^3. The raceway applications have supported nursery, growout and shrimp broodstock operations, as well as selection of family lines. Though feed sales may reduce quantitatively it will be sustained in the long run

Economic perspectives

Since, biofloc technology option needs to be economically evaluated in farmers' angle so that the technology can be adopted and up scaled if it is economically advantageous over auto trophic system. Data on costs and returns obtained from trials conducted by ICAR-CIBA are presented in Table.1.

It can be noted from the Table.1, the fixed input items are approximately Rs.2.72 lakhs. The plastic items may need replacement after two years which is taken care in accounting for fixed investments in a five year cash flow. The variable inputs cost about Rs.5.6 lakhs per cycle. Each year optimally 6cycles can be taken in normal circumstances. Hence, year wise costs and returns are calculated on assumption of 6 cycles per year.

The sensitivity analysis in Table.1 portrays the results of financial analyses of the production data. Apart from normal, best and worst cases were created based on sale price of nursery grown larvae and survival rate in percent, the two critical parameters in BFT. The IRR is the largest in best case scenario of 90% survival and sale price of Rs.1/piece, which is not very difficult to achieve in professionally manged hatcheries. Even in the worst case scenario of 80% survival and sale price of Rs.0.90/piece,the entrepreneur will get an IRR of 39% which is reasonable.

Table. 1 Cost of production of Nursery grown shrimp seeds under biofloc culture technology

S.No	Costs (Rs.)	Year 0	I cycle	Year 1 (6 cycles)	Year 2	Year 3	Year 4	Year 5
A	**Fixed Cost**							
1	100 ton lined nursery pond with central drainage	80000				36000		
2	Aerator and Aeration system	30000				13500		
3	Lab for water quality, microbiology + DO meter	20000				9000		
4	Biosecurity nets and fixers	25000				25000		
5	Nets , Pipes etc + drain pit	25000				25000		
6	Plastic item(Mug, Feeding tray, Basket)	12000				12000		
7	Storage room, blower room, staff quarters, Wash room, OHT	50000						
8	Generator, cabling, lighting, pumps	20000				6000		
9	Kitchen and mess	10000						
	Total Fixed cost	**272000**				**126500**		
B	**Operational cost**							

	(I) Seed @ 0.40 Rs/per seed (Including transportation) SD @ 7000 nos/cu m		280000	1680000	1680000	1680000	1680000	1680000
	(II) Seed testing x 3 times		9000	54000	54000	54000	54000	54000
	(IIi) Disinfectant (Bleaching, NAOH)		4000	24000	24000	24000	24000	24000
	(IV) Feed @ FCR 0.8 (150 kg @100/-)		15000	90000	90000	90000	90000	90000
	(V) Carbon source-900 @ 25/-		22500	135000	135000	135000	135000	135000
	(VII) Mineral and Other supplements		8000	48000	48000	48000	48000	48000
	(V) Diesel @ 54 Rs/1 lit./Power for Water pumping		7425	44550	44550	44550	44550	44550
	Labour Cost 24 hour duty 6 labour per 4 tank x 15,000 Rs incl food stay incentive		45000	270000	270000	270000	270000	270000
	Technician 2 x30,000 incl food incentive etc		30000	180000	180000	180000	180000	180000
	Management cost incl. seed selection, accounts, purchace, Training, sales, travel		15000	90000	90000	90000	90000	90000

Table.2 Profit of production of Nursery grown shrimp seeds under biofloc culture technology

S.No	Costs in Rs.	Year 0	I cycle	Year 1 (6 cycles)	Year 2	Year 3	Year 4	Year 5
	Labour during stocking , harvest and transportation plus ice, oxygen etc		7500	45000	45000	45000	45000	45000
	Testing Costs		3000	18000	18000	18000	18000	18000
	EMI Principal+ Interest@14% for 7 lakh loan (fixed and 1 cycle VC)			76514	229542	229542	229542	153028
	Variable costs		**443425**	2755064	2908092	3034592	2908092	2831578
	Total Cost A+B	**272000**	**443425**					
	Revenue		560000					
Normal	**Gross Returns Nursery grown shrimp seed sold @ 1.00 per piece (SR 80%)**	**0**	**560000**	**3360000**	**3360000**	**3360000**	**3360000**	**3360000**
	Total expenditure Expected per annum 6 cycles	**272000**	**443425**	**2755064**	**2908092**	**3034592**	**2908092**	**2831578**
	Net profit /Profit (D-C)	-272000	116575	604936	451908	325408	451908	528422
	B/C Ratio		1.263	1.220	1.155	1.107	1.155	1.187
	Rate of Return	**111%**						
Sensitivity analysis for Price and Production changes								

Best	**Gross Returns Nursery grown shrimp seed sold @ 1.00 per piece (SR 90%)**	**0**	**630000**	**3780000**	**3780000**	**3780000**	**3780000**	**3780000**
	Total expenditure Expected per annum 6 cycles	**0**	**443425**	**2755064**	**2908092**	**3034592**	**2908092**	**2831578**
	Net profit /Profit (D-C)	-272000	186575	1024936	871908	745408	871908	948422
	B/C Ratio		1.421	1.372	1.300	1.246	1.300	1.335
	Rate of Return	**172%**						
Worst	**Gross Returns Nursery grown shrimp seed sold @ 0.90 per piece (SR 80%)**	0	504000	3024000	3024000	3024000	3024000	3024000
	Total expenditure Expected per annum 6 cycles	0	443425	2755064	2908092	3034592	2908092	2831578
	Net profit /Profit (D-C)	-272000	60575	268936	115908	-10592	115908	192422
	B/C Ratio		1.136607	1.097615155	1.03986	0.99651	1.03986	1.06796
	Rate of Return	**39%**						

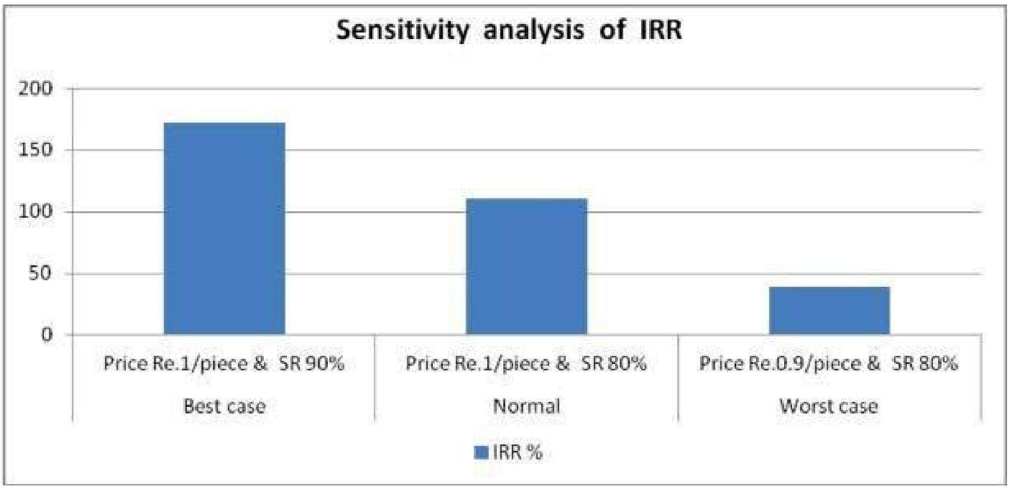

Fig.1. Sensitivity of Internal Rate of Return under optimistic, Normal and Pessimistic scenarios

Conclusion

In any aquaculture business, savings from efficient use of feed, time, energy, system stability and sustainability can improve profits. It seems biofloc technology has these properties. With emerging viral problems and rising costs for energy, biofloc technology with bio secure modular systems may be an answer for more efficient, sustainable, profitable aquaculture production. Related to biofloc meal and its perspectives, an earlier study detected initial estimates of cost for producing a metric ton of biofloc meal is approximately $400 to $1000. The same authors cited that global soymeal market varied approximately from $375 to $550/metric ton from January 2008 through May 2009. During the same time period, fish meal varied approximately from $1000 to $1225, suggesting feasibility on replacement of either soybean and/or fish meal by biofloc meal. Moreover, generated from a process that cleans aquaculture effluents biofloc meal production avoids discharge of waste water and excessive damage to natural habitats. This ingredient seems to be free of deleterious levels of mycotoxins, antinutritional factors and other constituents that limit its use in aqua feeds. Large-scale production of biofloc meal for use in aquaculture could result in environmental benefits to marine and coastal ecosystems, as the need for wild fish as an aqua feed ingredient is reduced. Sensorial quality of BFT products is also an important issue. BFT may bring higher profit if fresh non-frozen shrimp/fish is sold to near-by market, mainly at inland locations. These advantages certainly should be more explored and niche markets achieved, contributing to social sustainability.