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## **RESEARCH ARTICLE**

## DEVELOPMENT OF SUBSTRATE BASED AQUACULTURE FOR RESOURCE POOR FARMERS IN ASSAM

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ARTICLE INFO	ABSTRACT		
Article History: Received 27 <sup>th</sup> March, 2019 Received in revised form 26 <sup>th</sup> April, 2019 Accepted 20 <sup>th</sup> May, 2019 Published online 28 <sup>th</sup> June, 2019	Productivity of a fish pond can be enhanced without increasing nutrient inputs through heterotrophic food production. Individual farmers' pond is limited to the rearing of fry to fingerlings over a period of three months. Most of the individual farmers who practiced fish seed rearing in their seasonal ponds are unable to carry out grow out practices in their ponds because of unavailability of water throughout the year. Besides, the higher consumptive need of resource poor farmers have been a major hurdle in sustaining the operations for successive years. Farmers use advance fish fry of size 20-40mm to stock in		
Key words:	fish ponds from local hatchery. Survival of fish seed were ranged from 50-60%. Fish culture was		
Productivity, Palmyra leaf, Advanced Fingerlings, Substrate based Aquaculture. *Corresponding author:	undertaken for 3 months duration. Farmers were trained to use locally available substrate like Palmyra leaf. Survival of fish seed were ranged from 90-95%. Advanced fingerlings of 100-175 gm on an average size harvested and sold to stocking units in the locality to enhance fish production from low productive ponds. Ecologically sustainable: external/ chemical inputs reduced to the great extent. The substrate aquaculture may be considered as organic aquaculture practices. Tiny organisms that live on the surface of objects under waters is an excellent food for browsers. The gross income from sale of 1000 No. of advance fingerlings of 250 kg @ Rs.60 per kg works out to Rs.15000 on a conservative scale. The Internal Rate of Return (IRR) of this technology is more than 50 % with Benefit Cost Ratio of Ratio (BCR) 2 : 1. As such, this technology is technically feasible and economically viable. Hence, a community based project for developing substrate based aquaculture is an income generation activities. A pilot scale trial in an extended number of household ponds, distributed over different agro-ecological		
Vinayak V. Parab	means of poverty alleviation in Assam and elsewhere in the region.		

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## **INTRODUCTION**

The state of Assam is also full of wetlands, derelict water bodies and ponds and tanks with rich fish biodiversity. Fish is an integral part in the diet of the people of Assam. Pond production systems in all the states of India are becoming increasingly reliant on external resources (feed, fertilizers) to supplement or stimulate autochthonous food production for pond fish. In most pond production systems, only about 15-30% of nutrient inputs is converted into harvestable products, the remainder being lost to the sediments, effluent water and the atmosphere (Acosta-Nassar et al., 1994; Gross et al., 2000). Improving the conversion of nutrients into harvestable products, through adoption of periphyton-based production into existing pond systems, is one solution worth exploring. Substrate based aquaculture is an environment friendly culture technology. The concept of substrate based aquaculture is derived from Acadja in West Africa, Kathas of Bangladesh, Samarah of Cambodia, Athkotus of Sri Lanka, Katal and Jeng of Assam, Jack of Tripura and Phoomdis of Manipur.

**Katal and Jeng of Assam:** The principle of substrate based aquaculture is periphyton. Periphyton which is the total

assemblages of sessile or attached organisms on any substrate, tiny organisms that live on the surface of objects under waters which is called as biofilm bacteria. Biofilm bacteria is an excellent food for browsers. Periphyton is defined here as the entire complex of all sessile biota attached to the substratum, plus associated detritus and micro-organisms. Bacteria provide a significant source of carbon through extra-cellular polymer (Pearl 1979; Hobbie and Lee 1980), besides providing essential amino acids and vitamins (D'Agostino and Pravasoli 1970). However, the particle-bound sessile bacterial aggregates (biofilm) are preferred to their planktonic free cells by zooplankton and fish because of easy and economic exploitation (Ferguson and Ruble 1976). Bacteria are known to colonize on substrate and to develop into micro-colonies with extra-cellular polymeric substance anaerobic cells to form biofilm (Costerton 1984). Usually, bacterial biofilm cell density is 100 to 1000 times greater than the planktonic population per unit weight. A fourfold increase in the density and biomass of Daphnia magna through increased biofilm on a glass surface has been demonstrated by Langis et al. (1988). Agricultural wastes and aquatic weeds are easily available and biodegradable and seem to be more ideal for colonization of bacteria than inert glass and plastic surfaces.



The idea is originally derived from traditional fishing methods, such as the 'acadjas' of Côte d'Ivoire (Welcomme, 1972), the 'samarahs' of Cambodia (Shankar et al., 1998) and the 'katha' fisheries of Bangladesh (Wahab and Kibria, 1994), where tree branches are placed in shallow open waters to attract fish and enhance productivity. Preliminary data reported by Hem and Avit (1994) suggested that fish yields in an 'acadja-enclos' could be up to 8 tons ha/ year, eight times higher than in control areas without artificial substrate. Increased food availability and better protection from predators may explain the high yields. The results from experiments in aquaculture ponds, where stocking and predation are more controlled, vary from no effect (Shrestha and Knud Hansen, 1994; Faruk-ul-Islam, 1996; Azim et al., 2001a) to a 40-80% increase in fish yield in ponds with artificial substrates compared to control ponds (Ramesh et al., 1999; Wahab et al., 1999; Keshavanath et al., 2001). Since carp polyculture system mostly depends on organic manure, due to insufficient and inadequate application of the same, fish production remains at sub optimal level in farmer's field condition. Thus it is suggested to undertake substrate based aquaculture practices with the use of palm leaves could be effectively utilised for rearing of advance fish fry to advance fingerlings from such low productive fish ponds. Development of such a viable and low cost technology and its application to current farming practices will definitely help increase fish yield in farmer's field and help secure food security.



#### **MATERIALS AND METHODS**

There are 5035 Nos. of individual fish ponds covering about 634.42 ha out of which only 10 ha of fish ponds have been selected to carry out field trial in Vill: Dhanbari, PO: Bagdoba, Rangjuli Tribal Development Block, Dist: Goalpara, Assam. 12 earthen ponds ( $10 \times 7.5$  m, mean water depth 1.2 m and water spread area : 0.2 ha) in the Goalpara district of Assam have been studied, in depth, for assessing their financial viability. Fisheries official of Government of Assam and NGO were associated in the field trial during November, 2008. Secondary data available on fresh water aquaculture sector has been collected from District Fisheries Development Office, Goalpara. Primary information has been collected from fish

farmers, fish farmers groups, traders, godown owners, and commission agents through personal interviews, based on a structured questionnaire. Information collected included, status of availability of inputs required for fresh water aquaculture, composition and changing trends in aquaculture technology, composition of fish catch, seasonal variations in fish catch, design and cost of various artificial fish food, operational costs, income, credit availability, marketing channels, postharvest management etc., Financial viability has been assessed by the discounted cash flow technique using financial parameters like NPW, BC Ratio, IRR and Return on Investment (%).

Pond facilities and design: The primary occupation of the people in this field project area is largely agriculture and labour work. All farmers in this area considered as small and marginal fish farmers. They are cultivating rice, vegetables, Potato and Pineapple. >30% of the people are scheduled tribes. They are the major tribal groups viz, Rabha and Boro. The other sources of livelihood for the tribal are Fishery, Piggery, Goatary and Poultry. Mostly 0.1ha to 0.2 ha larger water bodies are located in the field trial area. Such water bodies could be effectively utilised for rearing of advance fish fry to advance fingerlings with the substrate aquaculture technique is found to be very suitable in the visited field area. Because of the following hurdles, farmers in this area are undertaking unscientific fish culture although water bodies are very conducive for scientific fish culture technology. The Farmers are found to be stocking the fish with heavy density and repeated harvesting methodology as per the market demand but without application of manures/fertilizers or artificial feeding as also in absence of aeration provision. As a result, they are getting fish production hardly 500 kg per ha per year. Moreover, the necessary inputs required for fish rearing/culture operations are not readily available in the local area such as Single Super Phosphate and Vitamins except urea. Whereas, Lime is being supplied from Guwahati. Not only that, but, Raw Cow Dung is not readily available, since all RCD is not sufficiently available for application in fish pond in villages as very little amount are left after application of the same in their homestead gardens and agricultural fields and Mustard Oil Cake is being supplied from Barpeta, Mangalduri, Darrang which are 250 to 300 km away from the field trial area. However, seed is available from the eco-hatchery located in the Dhupdhara village of the project area is supplying the required quantity of seed to the needy fish farmers of entire project area.

Substrate selection and pond preparation: Farmers are traditionally using tree branches and bamboo poles coupled with floating aquatic weed as FAD (Fish Aggregating Device) which serves to promote the growth of fish by increasing natural food availability through production of periphyton on these substrates. This practise is being locally called as Kathal Fisheries. Locally available Palmyra Leaves were selected as substrates because of its wide availability and low price. Of the several types of locally available bamboos, Bambusa sp. was also chosen as it is less useful for house building purposes. However, Palymera leaves were found to be most suitable for substrate aquaculture. All the ponds are nothing but the existing water bodies, reclamation of the same by dewatering and excavation was not possible and also not necessary. Weed eradication as also removal of predators is being done by engaging labourers. It is the only requirement towards capital expenditure. Whereas, input cost will be consisting of basic

raw material and its requirements. The basic raw material requirement for the unit is Substrate. The proposed 220 Palmyra Leaves having diameter of 60 cm per sq.mtr for 1000 sq.mtr will be the most suitable to be used as Substrates.



The requirement of other inputs/raw material mainly includes, inter alia, Lime and Advanced Fry. 80 kg of Lime @ 800 Kg/ Ha will be used to make the water body conducive for rearing operation. Seed and laborers also are the other basic requirement towards the input cost. Seed cost consists of 1200 Advanced Fry of 3.5 cm size @ 12000 per Ha will be stocked to rear further to attain advance size of 250 gm each with rearing period of 4 months. Labour cost will be minimal. Watch & ward and Marketing will be taken care of by fish farmer himself. Only for harvesting of advanced fingerlings requires TWO labours.



Water supply and fertilization: Starting one week after substrate installation the periphyton biomass growing on the substrates. After the substrates were installed, the ponds were filled with the water from a nearby source if requires. The water depth in each pond was monitored daily (fluctuating from 1.15 to 1.35 m) and maintained by adding water to replace losses at weekly intervals.



## RESULTS

A schedule of fortnightly fertilization required for traditional (control) fish seed rearing ponds with semi-decomposed cattle manure, urea and triple super phosphate (TSP) at the rates of 3000, 100 and 100 kg/ha, respectively, was started immediately after pond filling and maintained throughout the period. However, in substrate aquaculture pond, in the field

trail area is found to be not possible because of the non availability of the mentioned inputs. Even though, stocking of 1200 Advanced Fry of 3.5 cm size @ 12000 per ha per crop with the 90% survival rate, production of advance fingerlings1000 No.of 250 gm each per crop of 4 months was achieved. Two such crops per year is found to be more feasible.

Techno-Economic feasibility vis-a-vis Financial Analysis: Total outlay of the substrate aquaculture taking into consideration the operating cost of one cycle in the first year works out to Rs. 7450. Out of two recommended crops/cycles in a year, operational cost of only one cycle at Rs. 5450 in the first year has been envisaged in the project. Hence, operational cost for only one crop as also income from only one crop has taken into consideration for estimation of economics. The gross income from sale of 1000 No. of advance fingerlings of 250 kg @ Rs.60 per kg works out to Rs.15000 on a conservative scale. The internal rate of return of the scheme is more than 50 % with (BCR) Benefit Cost of Ratio at 15% 2: 1 and N P W at 15% is 11679. As such, the substrate aquaculture is technically feasible and economically viable. The economic analysis as also details of income and expenditure from the unit is given in the annexure II. The net surplus works out to Rs. 30,000 from second year onwards on a conservative scale. Even if any fish farmer avail the bank loan assistance, since, the scheme is economically viable and bankable as well, and the repayment schedule indicates that the principal amount of bank loan with interest can be repaid in one year.

# The summary of the same along with other general lending terms is given below

#### Techno-Economic feasibility vis-a-vis Financial Analysis

Unit size	: 0.1WSA	
Crop/cycles	: 2	
Stocking density : 1200 A 12000 per ha per crop	Advanced	Fry of 3.5 cm size @
Rearing period	: 4 months pe	er crop

Survival rate	: 90 %

Production of advance fingerlings: 1000 No. of 250 gm each per crop

Total project outlay taking into consideration the operating cost of one cycle in the first year works out to Rs. 7450. Out of two recommended crops/cycles in a year, operational cost of only one cycle at Rs. 5450 in the first year has been envisaged in the project. Hence, operational cost for only one crop as also income from only one crop has taken into consideration for estimation of economics. Total project outlay taking into consideration the operating cost of one cycle in the first year works out to Rs. 7450. The gross income from sale of 1000 No. of advance fingerlings of 250 kg @ Rs.60 per kg works out to Rs.15000 on a conservative scale. The internal rate of return of the scheme is more than 50 % with (BCR) Benefit Cost Ratio of 2: 1. As such, the scheme is technically feasible and economically viable. The repayment schedule indicates that the interest and the principal amount of bank loan can be repaid in a year.

#### The Financial analysis of both Substrate and Controlled Aquaculture system is as follows

	Substrate Aquaculture	<b>Controlled Aquaculture</b>	Percentage increase
Capital cost	2000	2000	
Operational cost of one crop	5450	9750	78 %
Total Project Out Lay	7450	11750	
Production of Advance Fingerlings	1000 Nos.	600 No	60 %
Survival rate of Stocked advance fry	90%	50 %	
NPW at 15% DF	11679	15763	
BCR at 15% DF	2:1	1.57 :1	
I R R	500 %	297%	

#### A detailed economics of the said bankable model is given below

No.         Item         Item         Cost of scalaminion         Cost of scalaminion <thcost of="" scalaminion<="" th=""> <t< th=""><th>Unit</th><th colspan="5">Unit cost of substrate aquaculture in 0.1ha i.e. 1000 m<sup>2</sup> Water Spread Area(WSA)</th></t<></thcost>	Unit	Unit cost of substrate aquaculture in 0.1ha i.e. 1000 m <sup>2</sup> Water Spread Area(WSA)				
A         Capital Cost         Capital Cost         Capital Cost         Mound (Ks.)           a         Cost of excavation for 1000 m3 for 1 m excavation less. 20% i.e. for 800 m3         800         Cum         45         Not required           b         Weed rediction by 3 bloburs         3         day         75         675           c         Removal of prediators by neiting by 2 bloburs         3         day         75         900           d         Dowatering by one pump for 12 hrs         12         heur         73         900           d         Dowatering by one pump for 12 hrs         12         heur         73         800           d         Cost of Substrates Palm Lad Diameter.         220         pices         4         800         80           d         Cost of Substrates Palm Lad Diameter.         200         pices         4         800	No.	Item				
1Cost of exclanationnumber of the second of the sec	Α	Capital Cost	Qty	Unit	Cost (Rs.) per unit	Amount (Rs.)
a         Cost of exacuation for 1000 m3 for 1 m excavation less 20% i.e. for 800 m         800         Lum         75         875           6         Removal of predators by netting by 2 labours         3         day         75         875           7         Devationing by anopump for 12 hrs         3         day         75         900           8         Operational cost one crop         -         -         -         200         2000           8         Operational cost one crop         -	1	Cost of reclamation				
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c         Removal of prediators by netting by 2 labours         3         day         75         450           I         Devarting by one pump for 12 hrs         12         hour         75         900           I         Cost of Substrates Plan Lear Diameter:         -         -         -         -         -         2025           I         Cost of Substrates Plan Lear Diameter:         -         <	b	Weed eradication by 3 labours	3	day	75	675
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2       The fish seed shall be procured by the farmers through the Implementing Agency (NGO) form nearby Hatchery.         3       The farmers shall be advised to undertake culture with a species ratio of Catla, Roburt and Cabasu 134:52:14.         C       Repayment Schedule       6700       1         Bank loan       6700       0       1         Repayment Period       One year       1       1         E.       INCOME EXPENDITURE STATEMENT AND REPAYMENT       1       1       1         Particulars       1       1       1       1       1         1.       Gross Income       1       1       1       1       1         2.       Gross Surplus : (1 - 2)       7450       1		will not be allowed to continue the culture operations to rear upto table size for a	year.		-	
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Image: constraint of the second se	Partic	culars		Years		
1. Gross Income       15000       Income       Income         2. Gross expenditure       7450       Income       Income         3. Gross Surplus : $(1-2)$ 7450       Income       Income         4. Add recurring cost capitalised for term loan       5450       Income       Income         5. Amount available for repayment $(3+4)$ 13000       Income       Income         6. Repayment Instalment of Bank Loan Rs.6705 @12%       Rate of Interest x C.R.F :       7510       Income       Income         7. Net surplus $(5-6)$ 5490       Income       Income <t< td=""><td></td><td></td><td></td><td>Ι</td><td></td><td></td></t<>				Ι		
2. Gross expenditure       7450       1         3. Gross Surplus : (1 - 2)       7450       1         4. Add recurring cost capitalised for term loan       5450       1         5. Amount available for repayment (3+4)       1       13000       1         6. Repayment Instalment of Bank Loan Rs.6705 @12%       Rate of Interest x C.R.F :       7510       1         7. Net surplus (5 - 6)       5490       1       1       1         7. Net surplus (5 - 6)       1       2       3       1         Cost       7450       10900       10990       1         Benefit       15000       30000       30000       1         PWC       21887       1       1       1         PWB       33566       1       1       1         NPW@15 %       11679       2       1       1         BCR at 15 %       2       1       1       1       1	1. G	bross Income		15000		
3. Gross Surplus : $(1 - 2)$ 7450       1         4. Add recurring cost capitalised for term loan       5450       1         5. Amount available for repayment (3+4)       13000       1         6. Repayment Instalment of Bank Loan Rs.6705 @12%       Rate of Interest x C.R.F :       7510       1         7. Net surplus (5 - 6)       5490       1       1       1         7. Net surplus (5 - 6)       1       2       3       1         Cost       7450       10900       10990       1       1         Benefit       15000       30000       30000       1       1         PWC       21887       1	2. G	bross expenditure		7450		
4. Add recurring cost capitalised for term loan5450Image: control of the sequence of the se	3. G	bross Surplus : (1 -2)		7450		
5. Amount available for repayment (3+4)       13000         6. Repayment Instalment of Bank Loan Rs.6705 @12%       Rate of Interest x C.R.F :       7510         1.120000       5490       5490         7. Net surplus (5 - 6)       5490       6         Years       1       2       3         Cost       7450       10900       10990         Benefit       15000       30000       30000         Vet benefit       7550       19100       19100         PWC       21887       6       6         PWB       33566       6       6         NPW@15 %       11679       2       6       6         BCR at 15 %       2       0       0       0	4. A	dd recurring cost capitalised for term loan		5450		
6. Repayment Instalment of Bank Loan Rs.6705 @12%       Rate of Interest x C.R.F :       7510       7510         7. Net surplus (5 - 6)       5490       5490         Years       1       2       3         Cost       7450       10900       10990         Benefit       15000       30000       30000         Net benefit       7550       19100       19100         PWC       21887       1       1         PWB       33566       1       1         NPW@15 %       11679       2       1       1         BCR at 15 %       2       1       1       1       1	5. A	mount available for repayment (3+4)		13000		
1.12000       Image: Second s	6. Re	epayment Instalment of Bank Loan Rs.6705 @12% Rate of Interest x C.R.F :		7510		
7. Net surplus (5 - 6)       5490       1         Years       1       2       3         Cost       7450       10900       10990         Benefit       15000       30000       30000         Net benefit       7550       19100       19100         PWC       21887       1       1         PWB       33566       1       1         NPW@15 %       11679       2       1       1	1.120	000				
Years         1         2         3           Cost         7450         10900         10990           Benefit         15000         30000         30000           Net benefit         7550         19100         19100           PWC         21887         1000         1000           PWB         33566         11679         11679           BCR at 15 %         2         1000         1000	7. Ne	et surplus (5 - 6)		5490		
Cost         7450         10900         10990           Benefit         15000         30000         30000           Net benefit         7550         19100         19100           PWC         21887         1000         1000           PWB         33566         1000         1000           NPW@15 %         11679         11679         1000           BCR at 15 %         2         1000         1000		Years	1	2	<u>3</u>	
Benefit         1500         3000         30000         30000           Net benefit         7550         19100         19100         19100           PWC         21887         1         1           PWB         33566         1         1           NPW@15 %         11679         1         1           BCR at 15 %         2         1         1		Cost	7450	10900	10990	
Net benefit         7550         19100         19100           PWC         21887             PWB         33566             NPW@15 %         11679             BCR at 15 %         2		Benefit	15000	30000	30000	
Net benefit         7550         19100         19100           PWC         21887             PWB         33566             NPW@15 %         11679             BCR at 15 %         2		NT . 1		10100	10100	
PWC         21887         6           PWB         33566            NPW@15 %         11679            BCR at 15 %         2		Net benefit	7550	19100	19100	
PWB         33566           NPW@15 %         11679           BCR at 15 %         2		PWC	21887			
NPW@15 %         11679           BCR at 15 %         2		PWB	33566			
BCR at 15 % 2		NPW@15 %	11679			
		BCR at 15 %	2			

**Cash flow and Economic analysis:** The economic analysis as also details of income and expenditure from the unit is given in the annexure II. The summary is as under:

N P W	at 15% DF	:	11679
BCR	at 15% DF	:	2:1
IRR		:	500 %

Unit	Unit cost of rearing of Advance Fingerlings by controlled scientific method in 0 the i a 1000 m <sup>2</sup> Water Surged Area (W(A)				
III 0.1	na na 1900 m. mata opicau Aita (moA)				
SI	Item				
Α	Capital Cost	Quantity	Unit	Cost (Rs.) per unit	Cost
1	Cost of reclamation				
a	Cost of excavation for 1000 m <sup>3</sup> for 1 m excavation less 20% i.e. for	800	Cum	45	Not
	800 m <sup>3</sup>				required
b	Weed eradication by 3 labours	3	day	75	675
с	Removal of predators by netting by 2 labours	3	day	75	450
d	Dewatering by one pump for 12 hrs	12	hour	75	900
	Total Capital Cost			C	2025
				Say	2000
В	Operational cost one crop				
1	Advanced $Fry (1200 \textcircled{a} Rs 3.0/Fry)$	1200	No	3	3600
2	Lime @ 800 Kg/Ha	80	ka	10	800
3	SSP @ 500 kg. /ha	50	ng.	8	400
4	Urea $(a)$ 350 kg. /ha.	35		10	350
5	RCD @ 10000 kg. /ha.	1000		0.5	500
6	Micronutrients	L.S.	1		750
	Supplementary feed				
7	MOC (Mustard Oil Cake)@2000 kg/ha	200	kg	15	3000
8	Rice Bran (polish)@3750/kg	375	kg	0.5	187.5
9	Miscellaneous Expenditure including insurance of asset and farmer	Not available			0
10	Watch & ward	Self			0
11	Harvesting by 2 labours	1	day	75	150
	Operational Cost for one crop		1	1	9737.5
				Say	9750
С	Total Cost /Total Financial Outlay				11738
D	(Capital cost + Operational cost)	100/	11720		1174
D	Farmer's contribution @10%	10%	11/38		11/4
E	Loan Amount			Sau	10304
F	Cross Incomo			Say	13000
г	From Sale of advance fingerling of 250gm each (600 Fish@50%	150	Ka	60	9000
	survival)	150	кg	00	2000
	(a)Rs. 60.00/Kg) per crop				
G	Repayment Schedule				
	Repayment Period	Three years with	th one year gr	ace period	
	Repayment instalments (12% int.)	I year	II year	III year	IV year
	(Annual equated instalments-4 years	4939	3864	3864	3864
	Capital Recovery Factor- 0.329234				
	Net surplus (after repayment)	-6602	4398	4398	4398
Н	Income expenditure statement and repayment			1	
			V		
<u> </u>	Particulars	т	Years		W
.	Total Grass Income from fish	1	18000	111	18000
1 ;;	Gross expenditure	11738	0738	0738	0738
11 111	Gross Surplus · (1 - 2)	_2738	8263	8263	8263
iv	Add recurring cost capitalised for term loan	0	0	0	0
v	Amount available for repayment (3+4)	-2738	8263	8263	8263
vi	Repayment Instalment of Bank Loan Rs.15000 @12% x C R F	3864	3864	3864	3864
	0.329234	5001	2001	2001	2001
vii	Net surplus (5 - 6)	-6602	4398	4398	4398
Ι	Financial analysis:				
1	NPW at 15% DF		15763		
2	BCR at 15% DF		1.57		
3	IRR		297.00	%	
	Years	1	2	3	4
i	Capital Cost	2000			
ii	Recurring cost	9738	9738	9738	9738
iii	Total Cost	11738	9738	9738	9738
iv	Benefits	9000	18000	18000	18000
v	Gross surplus	-2738	8263	8263	8263
V1	PWC at 15% DF	27800			
V11	PWB at 15% DF	43563.52			

The net surplus works out to Rs. 30,000 from second year onwards on a conservative scale. The internal rate of return of the scheme is more than 50% with Benefit Cost Ratio (BCR) of 2 :1. Thus, the scheme is economically viable and bankable as well. (The repayment schedule indicates that the principal amount of bank loan with interest can be repaid in one year).

## DISCUSSION

The field area is socio-economically highly vulnerable and dependent solely on fishery as vocation. Ecological safety and economic sustainability issues affect these sections most. Mainly, most of the small and marginal farmers having homestead fishponds, farmers lack appropriate technology, institutional finance and proper extension support. Farmers using traditional method for fish aggregation and feed supplements which have low productivity. Moreover, necessary inputs required for culture practices viz., lime, RCD, MOC are not available at farms located at remote places and have to be brought from 250-300km. Substrate based aquaculture as an income generation activities, productivity of a fish pond can be enhanced without increasing nutrient inputs through heterotrophic food production. In aquatic environments, bacterial biofilm includes a complex community of other organisms such as algae, protozoa and fungi embedded in the extracellular matrix secreted by bacteria. The role of bacteria as food for both zooplankton and planktophagus fish needs no further emphasis (Kuznestov 1977; Moav et al. 1990). Worldwide several substrate-based fish prodcution practices exist, of which Acadja, Athkotu, Samarah, Phum, Aj gnuii assonii, Xeng fishery are popular. These substrate-based fisheries reported higher productivity then conventional supplemental feed-based aquaculture. Herbivorous fish, in general, have natural tendency to graze on periphyton fed environment (Surjya K. Saikia, Debangshu N. Das 2014). In an aquatic system, micro-floral community living attached to the surface of submerged objects which includes bacteria, fungi, protozoa, phytoplankton, zooplankton, benthic organisms, organic detritus, and range of other invertebrates and their larvae is collectively defined as periphyton (1) It may dwell either on a degradable or nondegradable substrates present in an aquatic system (2) Word 'lentic' refers to standing water which includes lakes, ponds, marshes, and ditches. Availability of light, nutrient, substrate and less physical disturbances makes lentic ecosystem as an ideal habitat for periphyton. Usefulness of periphyton in fresh water includes primary productivity, nutrient cycling and food web interaction. (3) In recent years periphyton is of great interest in monitoring water quality and sustainable aquaculture practices. (H.Ganesh, K.C.Pushpalatha. B. Gangadhar 2017).

However, current fertilization practices have little potential to promote sessile biofilm micro-organism. Hence, boosting fish production by promoting bacterial biofilm on suitable substrates in fertilized ponds is possible. Development of an effective food production by submerging locally available and cheap substrate assures the upliftment of resource poor fish farmers. Individual farmers' pond is limited to the rearing of fry to fingerlings over a period of three months. Most of the individual farmers who practiced fish seed rearing in their seasonal ponds are unable to carry out grow out practices in their ponds because of unavailability of water throughout the year. Besides, the higher consumptive need of resource poor farmers have been a major hurdle in sustaining the operations for successive years. Farmers use advance fish fry of size 20-40mm to stock in fish ponds from local hatchery. Survival ability of fish seed were ranged from 50-60%. Fish culture was undertaken for 3 months duration.

#### Conclusion

Since carp polyculture system mostly depends on organic manure, due to insufficient and inadequate application of the same, fish production remains at sub optimal level in farmer's field condition. However, the farmers when start practicing substrate based aquaculture, there shall least dependence of artificial feed and exogenous fertilization which will reduce input cost to a significant level. Thus, the net profit of the farmer shall increase which will lead to increased income from the unit area. The application of this technology evolved by farmers have resulted in the generation of new technologies that are likely to benefit the resource poor who always have difficulty in obtaining pond input resources. Thus it is possible to undertake substrate based aquaculture practices with the use of palm leaves could be effectively utilized for rearing of advance fish fry to advance fingerlings from such low productive fish ponds. Development of such a viable and low cost technology and its application to current farming practices will definitely help increase fish yield in farmer's field and help secure food security.

The application of this technology evolved by farmers have resulted in the generation of new technologies that are likely to benefit the poor who always have difficulty in obtaining pond input resources. The farmers when start practicing substrate based aquaculture, there shall least dependence of artificial feed and exogenous fertilization which will reduce input cost to a significant level. Thus, the net profit of the farmer shall increase which will lead to increased income from the unit area. It is possible to obtain 46% higher profit just by the addition of palmyra as substrate, as compared with the control treatment. Fertilization and supplementary feeding are important in increasing production. This will add up to 40% to 70% of the production cost, depending on the intensity of feeding.

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