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ECONOMICAL BASIS FOR FINGERLING PRODUCTION IN CAGE CULTURE IN SRI LANKA

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ABSTR ACT

The objective of the study is the evaluation of the fingerling production system of cage culture in perennial reservoirs in Sri Lanka. More precisely, to estimate the suitability of the cage culture system as a fingerling production system before expanding it. Data from the research trial that was carried out in Muthukandiya reservoir in Sri Lanka under ACIAR project (No. 9440) 1997-2000 were used in this study. Production cost analysis was done considering an imaginary cage culture project. It consisted of 3 phases with 40 cages (Phase 1), 60 cages (Phase 2) and 80 cages (Phase 3). The model used the details Investment, Operation, Cash flow and Balance Sheet of the project. The funding of this project is proposed to be provided mainly by a bank loan (Rs. 4.36 million with an interest rate of 12%) and also by Rs. 500,000 funding from a non-governmental organisation (NGO). No funding is proposed by shareholders. The amount of the bank loan was estimated considering the investment and first year operational cost. From the year 2009 the project is profitable and gradually builds up the total equity. In the 5th operational year of the project (2013) the total equity has become positive (Rs. 89,192). The operating surplus (EBIDTA) is Rs. -881080 in the year 2008. From the production start in 2009, the revenue will increase and the EBIDTA will become positive and increase from 32.97% to 41.47% in 2017. The income tax in Sri Lanka is 35%. The loss incurred in 2008 is subtracted from the taxable profit of the following years until 2013 when the taxable loss transfer is fully used up. The project shows a net present worth of Rs. 105,601 at the rate of 12.6% return not considering the method of funding. Accordingly the project will be profitable. Fingerling of rohu (*Labeo rohita*) and common carp (*Cyprinus carpio*) production through cage culture using locally available feed stuff, rice bran and commercial feed in Muthukandiya reservoir in Sri Lanka looks to be an economically profitable activity.

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1 INTRODUCTION

Sri Lanka is an island located in the Indian Ocean, in Southern Asia, southeast of India. It is in the tropics just near the equator (5.5°-9.5°N). Sri Lanka has a mild climate without extremes. The average yearly temperature for the country as a whole ranges from 28 to 30°C (82-86 °F). Day and night temperature may vary by 4 to 7 °C (7-13 °F).

It has a total area of 65,610 km^2 (25,332 sq. miles), with 64,740 km^2 of land and 870 km^2 of water. The coastal area (coastline) is 1,340 km long and studded with bays, lagoons and estuaries (approximately 158,000 ha).

Sri Lanka is the 53rd most populated island in the world. The population is 20,064,776 (2005 census) and the annual population growth rate is about 0.79%. The literacy rate is the highest in the region at 92% (estimated in 2003).

Sri Lanka has rich water resources emanating from the central highlands that receive rain during the monsoons i.e. the northeast monsoon (December-March) and southwest monsoon (June-October). The rainfall pattern is influenced by the monsoon winds of the Indian Ocean and Bay of Bengal. The mean annual rainfall ranges from 900 mm to 6000 mm, with an average of about 1,900 mm, which is about two and a half times more than the world annual mean of 750 mm. The country can be divided into wet and dry zones with a mean annual rainfall of 2424 mm and 1450 mm respectively. The mountains (central part of the island) and the south-western part of the country known as the wet zone receive ample rainfall (an average of 2500 mm) from the southwest monsoon. Most of the southeast, east and northern parts of the country comprise the "dry zone" which receives between 1200 mm and 1900 mm of rainfall annually. The dry zone is affected by the northeast monsoon. Much of the rain in these areas falls from October to January, the rest of the year there is very little precipitation (Anon. 2001) (Figure 1).

Figure 1: The main climatic zones, the dry zone and the wet zone and the location of Muthukandiya reservoir in the dry zone of Sri Lanka.

There are 169,941 ha of inland waters available in Sri Lanka including large, medium and minor irrigation reservoirs, non-perennial small reservoirs, Mahaweli reservoirs, upland hydroelectric reservoirs and natural floodplain lakes (Table 1).

Table 1: Inland water resources in Sri Lanka and their extents (Anon. 2006)

Water Resources	Number	Area (ha)
Large irrigation reservoirs	73	70,850
Medium irrigation reservoirs	160	17,001
Minor irrigation reservoirs	(>10000)	39,271
Non-perennial small reservoirs (seasonal tanks)		100,000
Minor irrigation reservoirs	(>10000)	39,271
Floodplain lakes (natural)		4,049
Upland hydroelectric reservoirs (recent)	7	8,097
Mahaweli multipurpose system of reservoirs (recent), Victoria, Kothmale, Randenigala, Ulhitiya, Rathkinda		13,650
Freshwater resources (total)		169,941

Inland fisheries in the irrigation perennial reservoirs started with the introduction of African cichlid tilapia (*Oreochromis mosambicus*) in 1950. The production of inland fish has been increased from 8000 tons to 40,000 MT from 1970 to 1989 (Murray and Little 2000).

However, aquaculture is not practiced traditionally in Sri Lanka. It is a relatively recent development, with interest in fish culture first appearing during the 1950s. Although, the potential of culture-based fisheries in non-perennial reservoirs (seasonal tanks) as an aquaculture practice is increasingly recognised. There are nearly 10,000 ha of non-perennial small reservoirs, which could have the potential for culture-based fisheries in addition to being used for irrigating paddy fields, bathing, watering cattle and domestic uses. They are small in size <80 ha, filled with rain water through northeast monsoonal rains from October to January and dry up for 3-4 months of the year and are highly productive. For fishing purposes they have to be stocked at the beginning of each farming cycle which will take between 6 and 9 months, depending on the species selected and prevailing weather conditions. However, the main problem in popularising this aquaculture activity is the limited availability of fingerling stock at the required time (De Silva 1988).

The species commonly used in culture-based fisheries in non-perennial reservoirs are Chinese major carps (bighead carp, *Aristichthys nobilis*, silver carp, *Hypophthalamichthys molitrix*, grass carp *Ctenopharyngodon idellus*), Indian major carps (rohu, *Labeo rohita*, mirigal *Cirrhinus mrigala* and common carp *Cyprinus carpio*) in various combinations and ratios (Chakrabarty and Samaranayake 1983). The production of fingerlings is carried out by NAQDA (National Aquaculture Development Authority), private pond owners and community organisations through cages and mini-nurseries (Appendix 1).

The produced fingerlings are mainly used for the stocking of non-perennial reservoirs. Nevertheless, the production is not sufficient and therefore increased fingerling production is required. Production systems should, however, be evaluated to know their potential profitability before expanding fingerling production.

Cage culture in perennial reservoirs is one of the most interesting fingerling production systems with community participation in Sri Lanka.

The objective of the present study is to determine whether cage based fingerling production is an economically viable option.

2 MATERIALS AND METHOD

Trials on fingerling production through cage culture were carried out under the ACIAR (Australian Centre for International Agricultural Research) project (No. 9440) 1997-2000 in Sri Lanka. These were carried out in three perennial reservoirs i.e. Chandrikawewa (Ratnapura District), Muthukandiyawewa (Figure 1) and Kiri-Ibbbanwewa (Moneragala District) that are located in the dry zone in the southern part of Sri Lanka.

The research trial was carried out with *L. rohita* and *C. carpio* respectively. The study is based on the growth of fish in four feed types within the culture period of 45 days (Table 2).

Table 2: The research trial on fry rearing up to fingerling of rohu (*Labeo rohita*) and common carp (*Cyprinus carpio*) in cages in Muthukandiya reservoir

	Rohu (*Labeo rohita*)	**Common carp (*Cyprinus carpio*)**
Stocking density (fry/m^3)	150-200	150-200
Age of the fry (days)	28	28
Used feed	Rb (rice bran)	Rb
	Cf (commercial feed)	Cf
	Af (aqua-feed)	Af
	Nf (non-fed)	Nf
Growth considered	2.5-5-7 cm	2.5-5-7 cm
Purchasing price (Rs.)	0.25	0.10
***Sale price (Rs.)**	2.00	1.50
Duration	45 days	45 days

*sale price of rohu and common carp is Rs. 2 and Rs. 1.50 in 1996-2000 in the area

Rohu and common carp are important species in culture based fisheries in Sri Lanka (Appendix 2).

Stocking fry, feeding, sampling and adjusting the feed amount, cleaning cages and thinning out fast growing fish were the activities carried out during the 45 day culture period (Appendix 3). During stocking and harvesting feed is not provided. The other days in the culture period feed is provided twice per day once in the morning and once in the evening according to 10% of body weight considering the wastage of feed through the wave action of the reservoir. The random sampling of fish in each cage should be carried out biweekly to adjust the feeding amount. The outside of the cages should be cleaned every 10th day after stocking in the culture period to allow exchange water. The fish in cages is thinned out between 21 and 35 days to separate fast growing fish to reduce competition. The cages were imported from India. Technical specification of the cages is given in Table 3.

Table 3: Details on cages that were used in cage culture trials in Muthukandiya reservoir.

Description	
Webbing material-	HDPE (High Density Poly Ethylene)
Webbing thickness	0.5-1.5 mm
Mesh size-	4 mm, knotless
Dimension-	2 m (W) x4 m (L) x 2.5 m (H)
Capacity-	20 m^3
Cost of cage	Rs. 12,000

A rafter was made of low-cost materials such as bamboo (*Bamboo spinosa*) tree, wood, empty plastic cans (130 L), coir, nylon, kuralon and poly propoline ropes. The rafter could be used for 4-6 months and two rearing cycles (Figure 2).

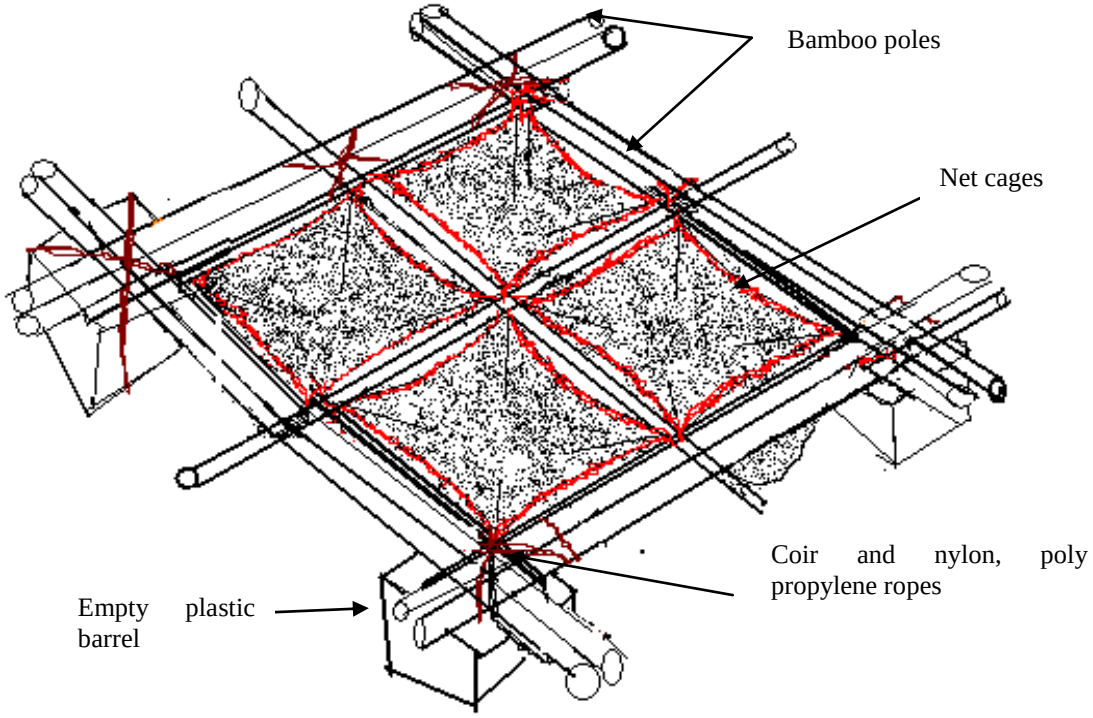

Figure 2: The rafter made using low cost raw materials

Both fish species showed significantly higher survival in the rice bran and commercial feed types in both trials. The income was also higher in these two feed types. Average daily growth did not vary significantly among the feed types. Accordingly, the data on *L. rohita* and *C. carpio* fingerling production using Rb and Cf feed types are used in the production cost analysis (Table 4).

Table 4: Average daily growth (ADG) and percentage survival of rohu (*Labeo rohita*) and common carp (*Cyprinus carpio*) fry rearing in cages with four different feed types in Muthukandiya reservoir under ACIAR project

Fish species	Feed used	ADG (g/day)	Survival (%)	No. of fingerlings produced	Income (Rs.)
L. rohita	Rice bran	0.0102	55.1	2204	4408
	Commercial feed	0.0113	51.4	2056	4112
	Aqua-feed	0.0198	39.95	1600	3200
	Non-fed	0.0133	37.1	1480	2960
C. carpio	Rice bran	0.0067	78.45	3120	6240
	Commercial feed	0.0062	70.65	2800	5600
	Aqua-feed	0.0116	41.9	1680	2520
	Non-fed	0.0015	36.6	1480	2220

2.1 Production cost analysis

For the production cost analysis, a cage culture project was designed to produce 1.92 million fingerlings per year in Muthukandiya reservoir. An illustration of the project site and set up is given in Figure 3.

Figure 3: Project site and set up for fingerling production through cage culture in Muthukandiya reservoir.

The project duration is 10 years. The first year (January-December 2008) is for the preliminary development activities, and purchase of necessary equipment and preparation of necessary documentation. It will be a priority to reconstruct the road from Muthukandiya reservoir to Dambewela (14 km).

- Watch house

A watch house can be constructed in the reservoir as a floating hut. Investment in construction will be kept to a minimum using tar sheets for roof, empty barrels for floating and low cost wood for walls. Pouching as well as protecting fish from predatory birds and preventing damage to cages through floating debris could be prevented as the watch house is near to the cages (Figure 4).

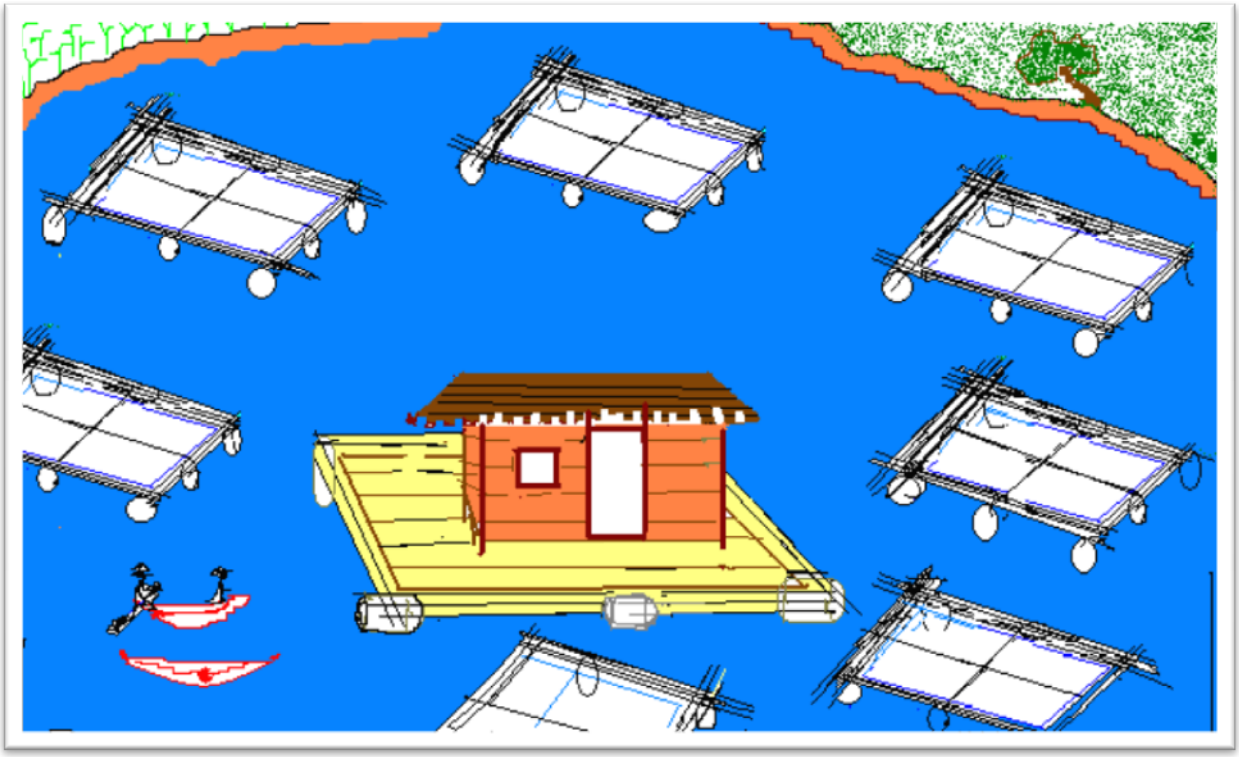

Figure 4: The floating watch hut in Muthukandiya reservoir

- Vehicle(van)

The vehicle should be an "ISUSU ELF" van which is convenient for fish transportation and cages, bamboo trees etc.

- Small boat and engine (15 Hp)

- Construction a building with office, stores, garage and rest room

A building should be constructed with an office, stores and garage together. The garage could be used as a rest room for labourers as well. The office should be simple but open to ensure good ventilation and take advantage of sunlight as there is no electricity.

- Import cages

The cages for trials in Muthukandiya reservoir were purchased from India in 1996. Such cages could also be purchased with a competitive price from Thailand, China and Japan.

Prepare paper documents for getting approval for cutting and transport of bamboo according to the rules and regulations of the Forest Department in Sri Lanka.

The project has three phases beginning in the second year (2009):

Phase 1 (2009-2011) start with 40 cages
Phase 2 (2012-2014) with 60 cages
Phase 3 (2015-2017) with 80 cages

It is not practical to have all the cages as one block. If the 40 cages are set together in the same raft, water exchange through cages could be inadequate to ensure good ventilation. It may cause mass fish deaths due to lack of oxygen. Natural food organisms entering the cages will also be reduced. Therefore, 40 cages could be arranged in 10 rafters, in each rafter with 4 cages (cage block). These 10 rafters could be set up in different places in reservoir (a). It is more practical than the 40 cages set up in one rafter (b) (Figure 5).

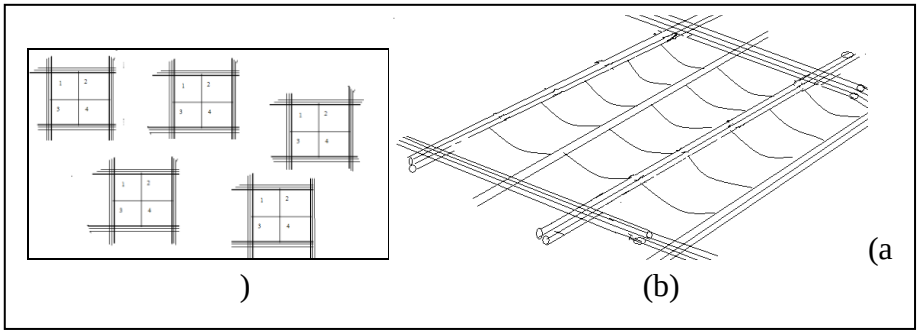

Figure 5: Separate cage blocks (a) are more practical than all cages together (b). In phases 2 and 3 the number of cages will be increased to 60 and 80 respectively. Then production costs (operational costs), as well as revenue/income through sales will change accordingly (Table 5).

Table 5: Primary project plan for fingerling production through cage culture in Muthukandiya reservoir

	2008	**Phase 1**			**Phase 2**			**Phase 3**		
		2009	2010	2011	2012	2013	2014	2015	2016	2017
No. of cages installed		40	40	40	60	60	60	80	80	80
*Reservoir area hired (m^2)		50,500			75,500			100,500		
Rohu fry/year (million)		0.96	0.96	0.96	1.44	1.44	1.44	1.92	1.92	1.92
Common carp fry /year (million)		0.96	0.96	0.96	1.44	1.44	1.44	1.92	1.92	1.92
Total fry requirement/year (million)		1.92	1.92	1.92	2.88	2.88	2.88	3.84	3.84	3.84
Bank loan required (Rs. million)	4.36									
Constructions	Buildings*									
Renovations	Road									
Purchasing	Van									

*See Figure 6.

The project staff should be increased with the increasing number of cages in Phase 2 and Phase 3. Casual labourers will be used during peak times such as during harvesting and emergency cage cleaning. One manager is enough for the three phases of the project. The suggested staff consists of aquaculture assistants, watchers, driver, skilled labours and casual labours. In the new recruitment of the casual labourers, the skilfulness and the ability to drive vehicles are considered. Accordingly, these persons could be used for driving vehicle when the driver is on leave. Two aquaculture assistants are needed as the project expands with more cages.

2.1.1 Apply loan

The capital expenditure for the project was calculated to be Rs. 4.36 million considering investment and production costs for the project. The ADB funded project ARDQIP (Aquatic Resources and Quality Improvement Project) has commenced a special loan scheme for entrepreneurs who are willing to take part in aquaculture enterprises. The interest rate is 7% per annum on a reducing basis. Nevertheless, the project will be over in 2009. The loan, therefore, will have to be obtained from the Peoples' Bank in Sri Lanka as a loan for a 10 year period with an annual interest rate of 12% (Appendix 4).

2.1.2 Determination of investment costs and production costs

Two types of data are required for the production cost analysis. These are investment costs and production costs. The data for variable costs is calculated for the project using the data from a research trial under ACIAR project (No. 9440) in Muthukandiya reservoir.

Investment costs:

The items that are durable for the whole project duration are considered as investments. These are buildings, vehicle, boat and engine, oxygen cylinders (08) and floating watch house. Re-construction of roads is also considered in investment as infrastructure development as necessary for running the project properly.

A small boat and 15 Hp engine is necessary to use in particularly windy times during the monsoon. It will also help to stock fish in cages in a short time period.

Fry sale should be done in double polythene bags with oxygen. Accordingly, 8 oxygen cylinders are necessary to purchase for fish packing. The empty cylinders could be re-filled in "Ceylon Oxygen (Pvt) Ltd" in Colombo, Sri Lanka.

Production costs:
The production costs should be considered as two components, variable costs and fixed costs. Items that will have to be replaced within the culture cycles during the project period and salary for the staff have been considered as variable costs. Accordingly, the costs for the following items in this project are considered as variable costs under operational costs.

- Accessories for bamboo rafters
- Cages (cages are durable for 3 years maximum)

- reservoir water (the area for the cages and watch house should be included)
- Fry included with the transport and packing costs
- Salary for the staff (the payments for the labourers in 1996 have been converted into 2008 using the index numbers of minimum wages, 1998-2006 that are gazetted by the Labour Department of Sri Lanka).
- Minor equipments needed such as coir brushes, plastic buckets, small size cages (1 m x1m x 0.9 m), feeding platforms, jugs and basins for feed preparation, battery operated field balance for fish sampling and weights of the feed, polythene and rubber bands and scissors for making polythene bags.
- Fish feed rice bran could be collected from the area near by the project as it is locally available. Commercial feed should be purchased from Grain Elevators (PVT) limited in Colombo and it should be transported to the site as it is not available locally. The proximate composition of the rice bran and commercial feed is in Appendix 5.

The salary for the Manager is considered as a fixed cost.

2.1.3 Calculated revenue/income of the project

The income of the project will be earned from the selling of produced fingerlings. The number of rohu (*L. rohita)* and common carp (*C. carpio)* fingerling produced through Rb and Cf feed types in cage culture trials in Muthukandiya reservoir were used in the calculation of revenue/income through the project as follows.

No. of rohu fingerlings produced with Rb feed type =2204/cage
No. of rohu fingerlings produced with Cf feed type =2056/cage
No. of common carp fingerlings produced with Rb feed type =3120/cage
No. of common carp fingerlings produced with Cf feed type =2800/cage

The number of fingerlings that could be produced through cages 40, 60 and 80 were calculated in Table 6.

Table 6: The production of rohu and common carp fingerlings and income through selling fingerlings in the proposed project

	Rohu		**Common carp**		**Total**
Feed type	Rb	Cf	Rb	Cf	
Production per one cage	2204	2056	3120	2800	10180
No. of cages used	15	15	15	15	60
Production through 15 cages per cycle	33060	30840	46800	42000	152700
No. of production cycles per year	6	6	6	6	
Production through 15 cages per year	198360	185040	280800	252000	916200
Price for fingerling (Rs.)	5.00	5.00	4.00	4.00	
***Annual income (Rs.)**	991800	925200	1123200	1008000	4048200

*Annual income has to be changed with "No. of cages used in two feed types as 10, 15, 20 etc"

2.1.4 Cost of reservoir water

The cost of reservoir water for inland fisheries in Muthukandiya reservoir was not calculated earlier. Nevertheless, Renwick (2001) has calculated the cost of reservoir water for rice farming and inland fisheries in the Kirindi Oya Irrigation and Settlement Project (KOISP) in Sri Lanka. The cost of reservoir water for inland fisheries in Muthukandiya reservoir was calculated according to Renwick (2001) (Table 7). The required data on inland fisheries in Muthukandiya reservoir were obtained from published data (Amarasinghe and De Silva 1999).

Table 7: Calculation of the economic return through inland fisheries in Muthukandiya reservoir

Per boat	
Catch per trip (CPUE)	=9.3 kg boat day^{-1}
Annual yield per boat	=77841 kg
Per reservoir	
Annual production	=77841 kg
Value of production (Rs.)	=7784100.00
Cost of production (Rs.)	=2511000.00
Economic returns (Rs.)	=5273100.00

Retail price of fish in the area =Rs. 100.00; Labour costs are estimated at the rate of Rs. 200/day

The necessary following data from Amarasinghe and De Silva (1999) were used in this calculation:

Area of Muthukandiya reservoir	= 844 ha
Fish yield for the period of 1993-1996	= 42.1 kg ha^{-1} year^{-1}
CPUE (Catch Per Unit Effort)	= 9.3 kg boat day^{-1}
No. of days fishing per year	=270
Annual yield	=25.11 MT
No. of fishermen in the reservoir	=31
No. of net pieces used per boat	=20

The cost for the area that was required for cage culture is calculated as follows (Table 8).

Cost for water in Muthukandiya reservoir considering inland fisheries= Rs.B/year/m^3
The area of reservoir necessary for cage culture = V
The worth of this area considering inland fisheries = B x V

Table 8: Value of reservoir water for cage culture project in Muthukandiya reservoir

Value of reservoir (Rs.)=		0.62/m^2
Accordingly the cost for reservoir water for the cage culture project		
For Phase-1 (Rs.)	=	31310.00/year
Phase-2 (Rs.)	=	46810.00/year
Phase-3 (Rs.)	=	62310.00/year

Reservoir water is not only used for the paddy cultivation and inland fisheries. Economically important activities and several social activities (non-profit) also carried out using the reservoir water by the villagers.

Renwick (2001) has not considered these activities for costing reservoir water in the KOISP area. However, the cost for reservoir water should be determined considering all these income generating activities and social activities (Table 9).

Table 9: Cost for reservoir water considering income generating and social activities

Activity		Cost /m^3 (Rs.)
Economic activities		
Rice farming	=	N1
Inland fisheries	=	N2
Chena cultivation	=	N3
Aquaculture such as cage culture	=	N4
Social activities		
Livestock activities	=	N5
Bathing	=	N6
Washing cloths	=	N7
Drinking water purpose	=	N8
Cost for the reservoir water	=	N1+N2+N3+N4+N5+N6+N7+N8 $\sum_{1....}^{8} N$

Nevertheless, the above data on Muthukandiya reservoir could not be found and therefore it couldn't be calculated accordingly.

2.1.5 Reservoir area for cage culture project

The whole reservoir could not be hired or purchased for the project according to the rules and regulations of the Department of Irrigation in Sri Lanka that is responsible for reservoirs irrigation water. Nevertheless, some areas of reservoir could be hired for the cage culture project. The Irrigation Department of the Government has given high priority for the development of rural aquaculture projects in the country. The necessary area has to be considered a minimum area required for the cages and watch house.

The cage culture trials (four cages with the capacity of 20 m^3) needed around the area of 5000 m^2 from the reservoir. It is calculated as follows (Figure 6).

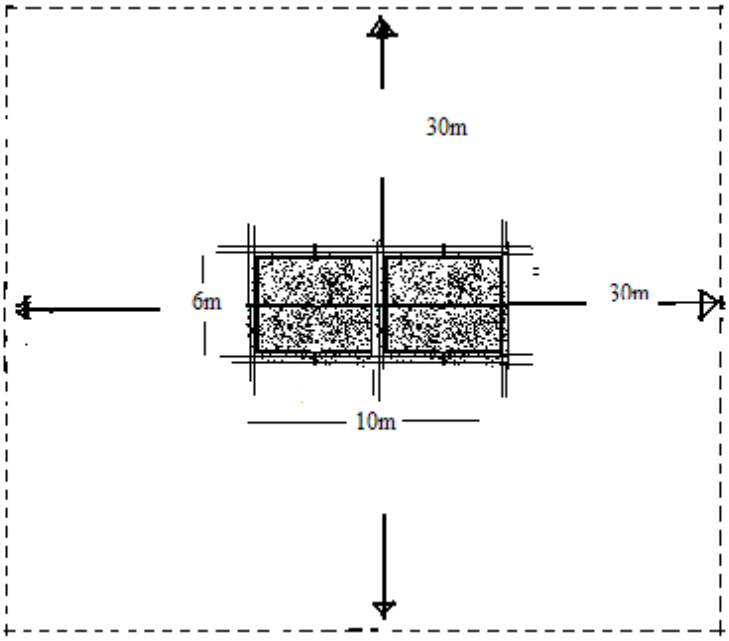

Figure 6: Reservoir area for cage culture project in the Muthukandiya reservoir

The necessary area for cage block (for raft with four cages with the capacity of 20 m^3 in each) was calculated and the area of the reservoir is determined for the 10 cage blocks (40 cages), 15 cage blocks (60 cages) and 20 cage blocks (80 cages) as follows.

The reservoir area needed for one cage block with four cages =70 m x 66 m=4620 m^2 ≈5000 m^2
Accordingly, the reservoir area for 10 cage blocks =5000 x 10=50000 m^2
Reservoir area for watch hut =10 m x10 m=100 m^2
(Figure7)

Considering outer space the area should be increased up to 500 m^2
Then the reservoir area that is needed for:

1st phase of project=50000 m^2+500 m^2 =50500 m^2
2nd phase=5000x15 =75000 m^2+500 m^2
=75500 m^2
3rd phase=5000x20 =100000 m^2 +500 m^2
=100500 m^2

2.1.6 Reservoir area for floating hut

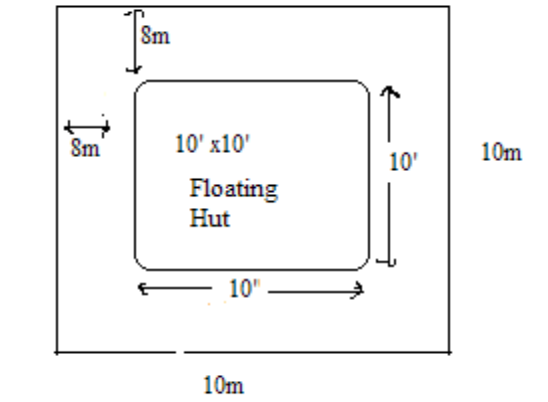

Figure 7: The reservoir area that is needed for the watch house

The size of the watch house =10' x 10'. Considering the floating platform and some space for the outside 10 m x 10 m considered for the space.

2.1.7 Calculation of cost of fry including transport cost and packing fee

Fry production in the Aquaculture Development Centre (under NAQDA) in Udawalawe is around 300 km away from the Muthukandiya reservoir. Accordingly, the cost of fry should be included with transport costs. As such, double polythene bags with O_2 (oxygen) are charged and it is also necessary to include them (Table10).

Table 10: The cost of fry including transport and packing fee.

	Total cost for fry including transport and packing fee-cage culture project in Muthukandiya reservoir								
	Phase 1			Phase 2			Phase 3		
	2009	2010	2011	2012	2013	2014	2015	2016	2017
No. of rearing cycles/year	6	6	6	6	6	6	6	6	6
Fry requirement /cycle	320000	320000	320000	480000	480000	480000	640000	640000	640000
L. rohita fry/cycle	160000	160000	160000	240000	240000	240000	320000	320000	320000
C. carpio fry/cycle	160000	160000	160000	240000	240000	240000	320000	320000	320000
Fry requirement /year	1920000	1920000	1920000	2880000	2880000	2880000	3840000	3840000	3840000
L. rohita fry/year	960000	960000	960000	1440000	1440000	1440000	1920000	1920000	1920000
C. carpio fry/year	960000	960000	960000	1440000	1440000	1440000	1920000	1920000	1920000
Cost for *L. rohita* fry/year (Rs.)	240000	240000	240000	360000	360000	360000	480000	480000	480000
Cost for *C. carpio* fry/year (Rs.)	96000	96000	96000	144000	144000	144000	192000	192000	192000
Total cost for fry/year	336000	336000	336000	504000	504000	504000	672000	672000	672000
No. of fry/bag	1000	1000	1000	1000	1000	1000	1000	1000	1000
No. of bags (*L. rohita*) need/cycle	160	160	160	240	240	240	320	320	320
Cost for each double polythene bag with O_2 (Rs.)	10	10	10	10	10	10	10	10	10
Cost for polythene bags with O_2 (for *L. rohita*)	1600	1600	1600	2400	2400	2400	3200	3200	3200
No. of bags (*C. carpio*) need/cycle	160	160	160	240	240	240	320	320	320
Cost for polythene bags with O_2 (for *C. carpio*)	1600	1600	1600	2400	2400	2400	3200	3200	3200
No. of bags at once/vehicle	80	80	80	80	80	80	80	80	80
No. of trips for *L. rohita* transport/cycle	2	2	2	3	3	3	4	4	4
No. of trips for *C. carpio* transport/cycle	2	2	2	3	3	3	4	4	4
Total trips for fry transport/cycle	4	4	4	6	6	6	8	8	8
Cost for vehicle/trip (Rs.)	2500	2500	2500	2500	2500	2500	2500	2500	2500
Total cost for vehicle/year (Rs.)	60000	60000	60000	90000	90000	90000	120000	120000	120000
Total cost for fry including transport cost/year	399200	399200	399200	598800	598800	598800	798400	798400	798400

2.1.8 Calculating the cost of feed

The selected feed types were rice bran (Rb) and commercial feed (Cf) through the research trial in Muthukandiya reservoir. Rb is available locally as the area is mainly based on paddy cultivation. Accordingly, it could be transported by bicycle with low transport costs.

The commercial feed is manufactured in Grain Elevators (PVT) Ltd in Colombo. It should be transported from Colombo (around 300 km distance) as it is not available locally. Then transport cost is necessary to be included and feed cost was calculated accordingly (Table.11).

Table 11: Cost for used feed rice bran (Rb) and commercial feed (Cf) in cage culture project in Muthukandiya reservoir

Necessary details for cost calculations	Feed	
	Rb	Cf
Used feed amount/cage (kg)	6	3
Price /kg (Rs.)	20	85
Feed price/cage(Rs.)/culture period	120	255
†Feed price for 40 cages(Rs.)/culture period	2400	5100
No. of cycles per year	6	6
Total price for feed (Rs.)/year	14400	30600

†no. of cages could be changed as 30 and 20

3 RESULTS

The major investments were made in the year 2008 (preparatory year) for a book value of Rs. 2,846,000.The investments were made for buildings, cages with transport fee, watch house, re-construction of a damaged road, boat and engine (15 Hp), vehicle, oxygen cylinders and other expenses. The investment for cages falls in the years 2008, 2012 and 2015 respectively as the durability of the cages is 3 years. Accordingly, the investment for the years 2012 and 2015 will be Rs. 732,000 and Rs. 976,000 (Table 12).

The depreciations for buildings and cages are 10% and 33.3% respectively. The other depreciations for road, vehicle, boat and engine and oxygen cylinders are 9% in each. Watch house and others are 16.6% and 14% (Table 12).

The financing of the project is proposed to be provided by a loan of Rs. 4.36 million and NGO funding of Rs. 500,000. No shareholders' equity is proposed for the project (Table12). The loan will be obtained from the Peoples' Bank of Sri Lanka with 12% interest and a 2% loan management fee (Appendix 4). The revenue of the project is based on the sale of the fingerlings produced through cage culture (Table 13).

The variable cost will include cost for reservoir water, for bamboo, nylon and poly propolene rope and empty plastic cans, for fish feed (rice bran and commercial feed), for fry, for minor equipment and salary for the staff. Under maintenance and road repairs, watch house and re-filling of oxygen cylinders is considered (Table 13).
The salary for the Manager is considered as fixed cost under operational cost (Table 13).

The EBIDTA is -881,080 in the preparatory year. A Rs. 1,715,389 operating loss is projected for the preparatory year of 2008 but from the 1st operating year with the production a profit of Rs. 32,434 is projected increasing almost yearly until 2017. Then it is estimated at Rs. 1,074,013 (Table 13).

The income tax rate is 35% for the company in Sri Lanka. As the loss transfer up to 2012 the income tax should not be paid but the taxable profit has been incurred. In the year 2013 the taxable profit is much higher and the remaining loss transfer is fully paid. Accordingly, the payment of income tax started 2013 (Table 13).

The cash flow statement of the project is showing the projects (company) incoming and out going money (sources and uses of cash) during the 11 years period beginning from 2008 up to 2017. Furthermore it is showing how changes in balance sheet and income accounts affected cash and cash equivalent (Table 14).

Funds from operations is Rs. -1,491,480 in the preparatory year (2008).It is because the loss before tax is Rs. -1,715,389 in this year as there is no income/revenue (Table 14).

As the production will start in the 1st year of operating of the project (2009), profit before tax increases positively with the increasing number of cages in Phase-2 and Phase -3 of the project (Table 14).

Funding is scheduled by expected funds from NGOs (Rs. 500,000) from the 1st operating year (2009) of the project up to 2012. A bank loan for Rs. 4,360,000 is proposed to secure funding for the investments and the preparatory year's negative operating loss (Table 14).

The petty cash of Rs. 22,520 should be maintained from the beginning until end as it is necessary to have some amount of allocation in hand (Table 14).

The net present worth of the project not considering the way of funding is Rs. 105,601 at a 12.6% rate of return and it has shown the project is profitable (Table 14).

No paid dividends are proposed in this project as there are no share-holders (Table 15).

Income tax will be paid from the year 2014 (6th year of production). Until then the project is earning profits but is using its loss balance from the preparatory year (Table 15).

The balance sheet is a quantitative summary of a company's financial condition at a specific point in time, including assets, liabilities and net worth. In the balance sheet total equity is Rs. -1,715,389 in the preparatory year as there is no production and then no income/revenue. Nevertheless, when production will start and when the number of cages increases, increasing the production (in Phases 2 and 3) the total equity has increased up to a positive value showing Rs. 83,192, Rs. 638,097, Rs. 1,582,565 and Rs. 2,620,620 for the years 2014, 2015, 2016 and 2017 respectively (Table 15). The increasing positive values highlight the attractive profitability of the project.

Table 12: Investment for the project

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Investment and financing			1	2	3	4	5	6	7	8	9
Investment:											
Buildings		400.000	0	0	0	0	0	0	0	0	0
Cages with transport fee		488,000	0	0	0	732,000	0	0	976,000	0	0
Watch house		30,000	0	0	0	0	0	0	0	0	0
Road (re-construction)		500,000	0	0	0	0	0	0	0	0	0
Boat and engine		130,000	0	0	0	0	0	0	0	0	0
Vehicle		1,100,000	0	0	0	0	0	0	0	0	0
Oxygen cylinders		128,000	0	0	0	0	0	0	0	0	0
Other		70,000									
Book - Value		**2,846,000**				**732,000**			**976,000**		
Depreciation:											
For buildings	10%	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
For cages	33.3%	0	162,667	162,667	162,667	244,000	244,000	244,000	325,333	325,333	325,333
For watch house	16.6%	5,000	5,000	5,000	5,000	5,000	5,000	0	0	0	0
For road	9%	45,455	45,455	45,455	45,455	45,455	45,455	45,455	45,455	45,455	45,455
For vehicle	9%	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
For boat and engine	9%	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818	11,818
For oxygen cylinders	9%	11,636	11,636	11,636	11,636	11,636	11,636	11,636	11,636	11,636	11,636
Other	14%	10,000	10,000	10,000	10,000	10,000	10,000	10,000	0	0	
Total depreciation		**223,909**	**386,576**	**386,576**	**386,576**	**386,576**	**386,576**	**462,909**	**534,242**	**534,242**	**534,242**
Financing:											
NGO funding		0	150,000	150,000	100,000	100,000	0	0	0	0	0
Loans		4,360,000									
Repayment											
Principal		4,360,000	3,924,000	3,488,000	3,052,000	2,616,000	2,180,000	1,744,000	1,308,000	872,000	436,000
Interest	**12%**	523,200	470,880	418,560	366,240	313,920	261,600	209,280	156,960	104,640	52,320
Loan management fees	**2%**	**87,200**									

Table 13: Operations for the project

Operations			**Phase 1**			**Phase 2**			**Phase 3**		
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Operations statement											
Sales (quantity)		0	610,800	610,800	610,800	916,200	916,200	916,200	1,221,600	1,221,600	1,221,600
Sales price		0	2,698,800	2,698,800	2,698,800	4,048,200	4,048,200	4,048,200	5,397,600	5,397,600	5,397,600
Revenue		0	2,698,800	2,698,800	2,698,800	4,048,200	4,048,200	4,048,200	5,397,600	5,397,600	5,397,600
Variable cost											
Cost for reservoir water			31,310	31,310	31,310	46,810	46,810	46,810	62,310	62,310	62,310
Bamboo		25,330	0	10,000	10,000	37,995	15,000	15,000	50,660	25,000	25,000
Coir, poly-propolene and nylon rope			8,000	8,000	8,000	12,000	12,000	12,000	16,000	16,000	16,000
Empty plastic cans		10,000		1,000	1,000	15,000	1,000	1,000	20,000	1,000	1,000
Rice bran (including transport fee)			14,400	14,400	14,400	21,600	21,600	21,600	28,800	28,800	28,800
Commercial feed (including transport fee)			30,600	30,600	30,600	45,900	45,900	45,900	61,200	61,200	61,200
Fry (including transport and packing fee)			399,200	399,200	399,200	598,800	598,800	598,800	798,400	798,400	798,400
Minor equipments		50,000	0	5,000	0	5,000	0	5,000	0	3,000	0
Salary for other staff											
For aquaculture assistant			216,000	216,000	216,000	444,000	444,000	444,000	468,000	468,000	468,000
For driver		156,000	156,000	156,000	156,000	168,000	168,000	168,000	180,000	180,000	180,000
For watchers		144,000	288,000	288,000	288,000	288,000	288,000	288,000	432,000	432,000	432,000
For labours		132,000	264,000	264,000	264,000	396,000	396,000	396,000	528,000	528,000	528,000
Casual labours		3,750	27,000	27,000	27,000	36,000	36,000	36,000	54,000	54,000	54,000
Maintenance and repairs											

Road		0	0	0	0	50,000	0	0	50,000	0	0
Re-filling O_2 cylinders			14,400	14,400	14,400	19,200	19,200	19,200	24,000	24,000	24,000
Watch house		0	0	0	5,000	5,000	5,000	5,000	0	0	0
Fixed Cost											
Salary for manager		360,000	360,000	360,000	360,000	420,000	420,000	420,000	480,000	480,000	480,000
Total expenditure		881,080	1,808,910	1,824,910	1,824,910	2,609,305	2,517,310	2,522,310	3,253,370	3,161,710	3,158,710
Operating surplus (EBITDA)		-881,080	889,890	873,890	873,890	1,438,895	1,530,890	1,525,890	2,144,230	2,235,890	2,238,890
Depreciation		223,909	386,576	386,576	386,576	386,576	386,576	462,909	534,242	534,242	534,242
Operating gain/loss		-1,104,989	503,31	487,314	487,314	1,052,319	1,144,314	1,062,981	1,609,988	1,701,648	1,704,648
Interest and loan management fee		610,400	470,880	418,560	366,240	313,920	261,600	209,280	156,960	104,640	52,320
Profit before tax		-1,715,389	32,434	68,754	121,074	738,399	882,714	853,701	1,453,028	1,597,008	1,652,328
Loss transfer			-1,715,389	-1,682,955	-1,614,201	-1,493,126	-754,727	0	0	0	0
Taxable profit		0	32,434	68,754	121,074	738,399	882,714	853,701	1,453,028	1,597,008	1,652,328
Income tax	35%	0	0	0	0	0	44,795	298,795	508,560	558,953	578,315
Net profit/loss		-1,715,389	32,434	68,754	121,074	738,399	837,919	554,906	944,468	1,038,055	1,074,013

Table 14: Cash flow (source and allocation of funds)

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Source of funds												
Profit before tax		-1,715,389	32,434	68,754	121,074	738,399	882,714	853,701	1,453,028	1,597,008	1,652,328	
Depreciation		223,909	386,576	386,576	386,576	386,576	386,576	462,909	534,242	534,242	534,242	
Funds from operations		**-1,491,480**	**419,010**	**455,330**	**507,650**	**1,124,975**	**1,269,290**	**1,316,610**	**1,987,270**	**2,131,250**	**2,186,570**	
Loan drawdown		4,360,000										
Equity drawdown		0	150,000	150,000	100,000	100,000	0	0	0	0	0	
Funds for allocation		**2,868,520**	**569,010**	**605,330**	**607,650**	**1,224,975**	**1,269,290**	**1,316,610**	**1,987,270**	**2,131,250**	**2,186,570**	
Allocation of funds												
Investment		2,846,000	0	0	0	732,000	0	0	976,000	0	0	
Petty cash		22,520	0	0	0	0	0	0	0	0	0	
Repayment		0	436,000	436,000	436,000	436,000	436,000	436,000	436,000	436,000	436,000	
Paid taxes		0	0	0	0	0	0	44,795	298,795	508,560	558,953	
Paid dividend			0	0	0	0	0	0	0	0	0	
Total allocation		**2,868,520**	**436,000**	**436,000**	**436,000**	**1,168,000**	**436,000**	**480,795**	**1,710,795**	**944,560**	**994,953**	
Changes net curr. assets		**0**	**133,010**	**169,330**	**171,650**	**56,975**	**833,290**	**835,815**	**276,475**	**1,186,690**	**1,191,617**	
Cash flow for NPV calculation												
Investments		-2,846,000	0	0	0	-732,000	0	0	-976,000	0	0	
Investment in petty cash		-22,520	0	0	0	0	0	0	0	0	0	
Total investments		-2,868,520	0	0	0	-732,000	0	0	-976,000	0	0	
Profit/loss												
Funds from operations		-1,491,480	419,010	455,330	507,650	1,124,975	1,269,290	1,316,610	1,987,270	2,131,250	2,186,570	
Adding interests and loan fees		610,400	470,880	418,560	366,240	313,920	261,600	209,280	156,960	104,640	52,320	
Less tax subtraction of interest		-305,200	-235,440	-209,280	-183,120	-156,960	-130,800	-104,640	-78,480	-52,320	-26,160	
Payment of taxes	35%	0	0	0	-46,473	-241,770	-448,677	-490,032	-497,438	-723,013	-764,250	-774,456
Total profit/loss		-1,186,280	654,450	664,610	644,297	1,040,166	951,413	931,219	1,568,313	1,460,558	1,448,481	-774,456
Total cash flow		-4,054,800	654,450	664,610	644,297	308,166	951,413	931,219	592,313	1,460,558	1,448,481	-774,456
Net present worth of project	**12%**	**105,601**										
IRR		**12.6%**										

Table 15: Balance sheet

		Phase-1			Phase-2			Phase-3		
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Assets										
Cash account	22,520	133,010	169,330	171,650	56,975	833,290	835,815	276,475	1,186,690	1,191,617
Debtors (acc. receivable)	0	0	0	0	0	0	0	0	0	0
Stock inventory	0	0	0	0	0	0	0	0	0	0
Current assets	**22,520**	**133,010**	**169,330**	**171,650**	**56,975**	**833,290**	**835,815**	**276,475**	**1,186,690**	**1,191,617**
Fixed assets book value	2,622,091	2,235,515	1,848,939	1,462,364	1,807,788	1,421,212	958,303	1,400,061	865,818	331,576
Fixed assets	**2,622,091**	**2,235,515**	**1,848,939**	**1,462,364**	**1,807,788**	**1,421,212**	**958,303**	**1,400,061**	**865,818**	**331,576**
Total assets	**2,644,611**	**2,368,525**	**2,018,269**	**1,634,014**	**1,864,763**	**2,254,502**	**1,794,118**	**1,676,535**	**2,052,509**	**1,523,193**
Debts										
Dividend payable	0									
Taxes payable	0	0	0	0	0	0	44,795	298,795	508,560	558,953
Creditors (acc. payable)	0									
Next year repayment	436,000	436,000	436,000	436,000	436,000	436,000	436,000	436,000	436,000	0
Current liabilities	**436,000**	**436,000**	**436,000**	**436,000**	**436,000**	**436,000**	**480,795**	**734,795**	**944,560**	**558,953**
Long term loans	3,924,000	3,488,000	3,052,000	2,616,000	2,180,000	1,744,000	1,308,000	872,000	436,000	0
Long term liabilities	**3,924,000**	**3,488,000**	**3,052,000**	**2,616,000**	**2,180,000**	**1,744,000**	**1,308,000**	**872,000**	**436,000**	**0**
Total debt	**4,360,000**	**3,924,000**	**3,488,000**	**3,052,000**	**2,616,000**	**2,180,000**	**1,788,795**	**1,606,795**	**1,380,560**	**558,953**
Equity	0	-1,715,389	-1,682,955	-1,614,201	-1,493,126	-754,727	83,192	638,097	1,582,565	2,620,620
Profit and loss balance	-1,715,389	32,434	68,754	121,074	738,399	837,919	554,906	944,468	1,038,055	1,074,013
Total equity	-1,715,389	-1,682,955	-1,614,201	-1,493,126	-754,727	83,192	638,097	1,582,565	2,620,620	3,694,633
Total liabilities and equity	**2,644,611**	**3,956,434**	**3,556,754**	**3,173,074**	**3,354,399**	**3,017,919**	**2,343,701**	**2,551,263**	**2,418,615**	**1,632,966**
Debts and capital	**0**	**-1,587,909**	**-1,538,485**	**-1,539,061**	**-1,489,636**	**-763,417**	**-549,584**	**-874,728**	**-366,106**	**-109,772**
Balance	**2,644,611**	**2,368,525**	**2,018,269**	**1,634,014**	**1,864,763**	**2,254,502**	**1,794,118**	**1,676,535**	**2,052,509**	**1,523,193**

4 DISCUSSION

Fingerling of rohu (*Labeo rohita*) and common carp (*Cyprinus carpio*) production through cage culture using locally available feed stuff, rice bran and commercial feed could be done in Muthukandiya reservoir successfully.

The funding of this project is provided by a bank loan and Rs. 500,000 from non-governmental organisations (NGOs). No funding is proposed by shareholders. Therefore, the equity of the project is zero in the beginning from 2008. In a situation like this some banks refuse to grant the loan. If shareholders put forward 1 million at the beginning the equity is not zero and bank could rely on that to grant the loan. The problem with zero equity is that if the company has losses due to unavoidable circumstances there is no way to repay the loan.

However, from the year 2009 the project earns a profit and builds up the total equity gradually. In year 2013 (7^{th} year of the project) the total equity has become positive (Rs. 89,192) value. It has indicated that the project is profitable.

If shareholders join the project several advantages could be gained. Firstly, the bank is likely to be willing to grant the loan. Secondly, the loan amount could be reduced and finally the interest and loan management fee could be reduced accordingly. Then the total investment and depreciation is decreased and the profit of the project has increased.

Likely shareholders could be some prospect person, businessman or an organisation such as a fisheries co-operative society. The fisheries co-operative society in Muthukandiya reservoir is currently functioning with a considerable amount of deposit. They could join as shareholders in this project. Then the project will be very strong. The operating surplus (EBIDTA) is Rs. –881,080 in the preparatory year 2008 (1^{st} year of the project) as there is not any production in the first year of the project. Nevertheless, starting with the production in year 2009, the revenue will increase the EBIDTA and will become positive and increase from 32.97% to 41.47% (Figure 8). Accordingly, the project will be highly profitable.

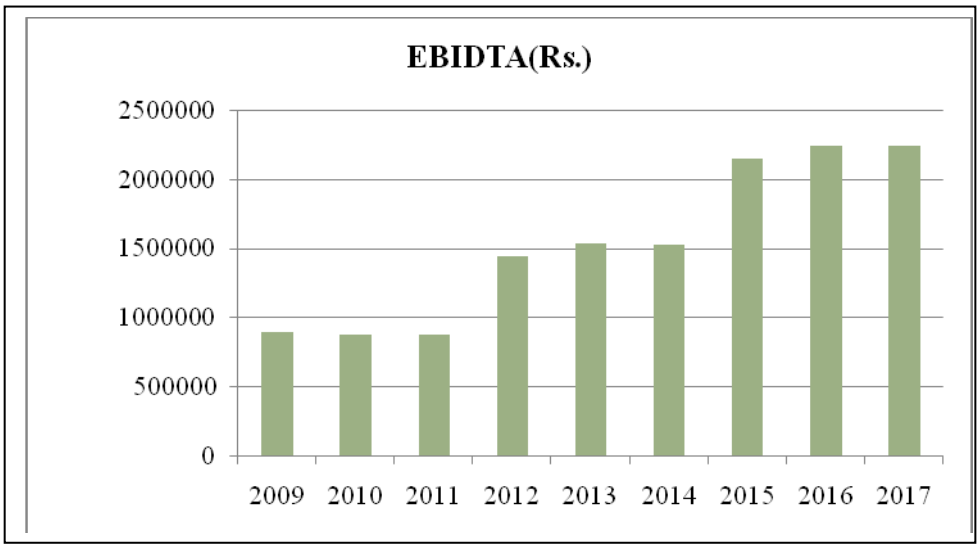

Figure 8: Increasing EBIDTA (Rs.) of project with time

There is a loss for the project in 2008, as there is no revenue (no production). However, with the production of the fingerlings in 2009 a substantial net profit is realised and it increases up to year 2017. The income tax rate for the company in Sri Lanka is 35%. Nevertheless, income tax couldn't be subtracted from the project as the taxable profit used in the loss balance (loss transfer). However, in 2013 the earning taxable profit is high and could be able to pay all loss transfer and will be paid as income tax. Until then (2008-2012) paying income tax is not necessary but the project will earn profit.

Most of the non-governmental organisations (NGOs) and foreign funded development projects are currently involved in rural aquaculture development activities in Sri Lanka. They are willing to support this type of aquaculture development activity. Accordingly, the NGOs and development organisations are invited to support the project with a financial allocation of Rs. 500, 000 for a 4 year period beginning in 2009 (personal experience).

5 CONCLUSION

Fingerlings of rohu (*Labeo rohita*) and common carp (*Cyprinus carpio*) production through cage culture using locally available feed stuff, rice bran and commercial feed in Muthukandiya reservoir in Sri Lanka looks to be an economically profitable activity.

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DCS 2007. General Wage rate (minimum) index numbers (base 1978 =100) for tea and rubber estate labourers and unskilled workers in government employment, 1998-2006, Department of Labour, Sri Lanka

Appendix 1 The fingerling production system in Sri Lanka

The Chinese and Indian major carp species do not reproduce naturally in Sri Lankan waters. The seed production of these species, therefore mainly depend on the induced breeding. The State sector (NAQDA) is involved in the induced breeding of fish and production of post-larvae in Aquaculture Development Centres in Udawalawe and Dambulla. Rearing of post-larvae up to fry stage is carried out in the Aquacculture Development Centres (ADC) including Udawalawe and Dambulla.

The private sector, community organizations and mini nurseries (under Aquatic Resources and Quality Improvement Project- ARDQIP) are not involved in the induced breeding of freshwater fish or PL rearing up to fry stage. Fry rearing up to fingerling is carried out by NAQDA, private pond owners, community organizations in mini-nurseries (under ARDQIP project) and in cages in perennial reservoirs (Figure9).Fry rearing up to fingerling in cages in perennial reservoirs by the community is only considered in this study.

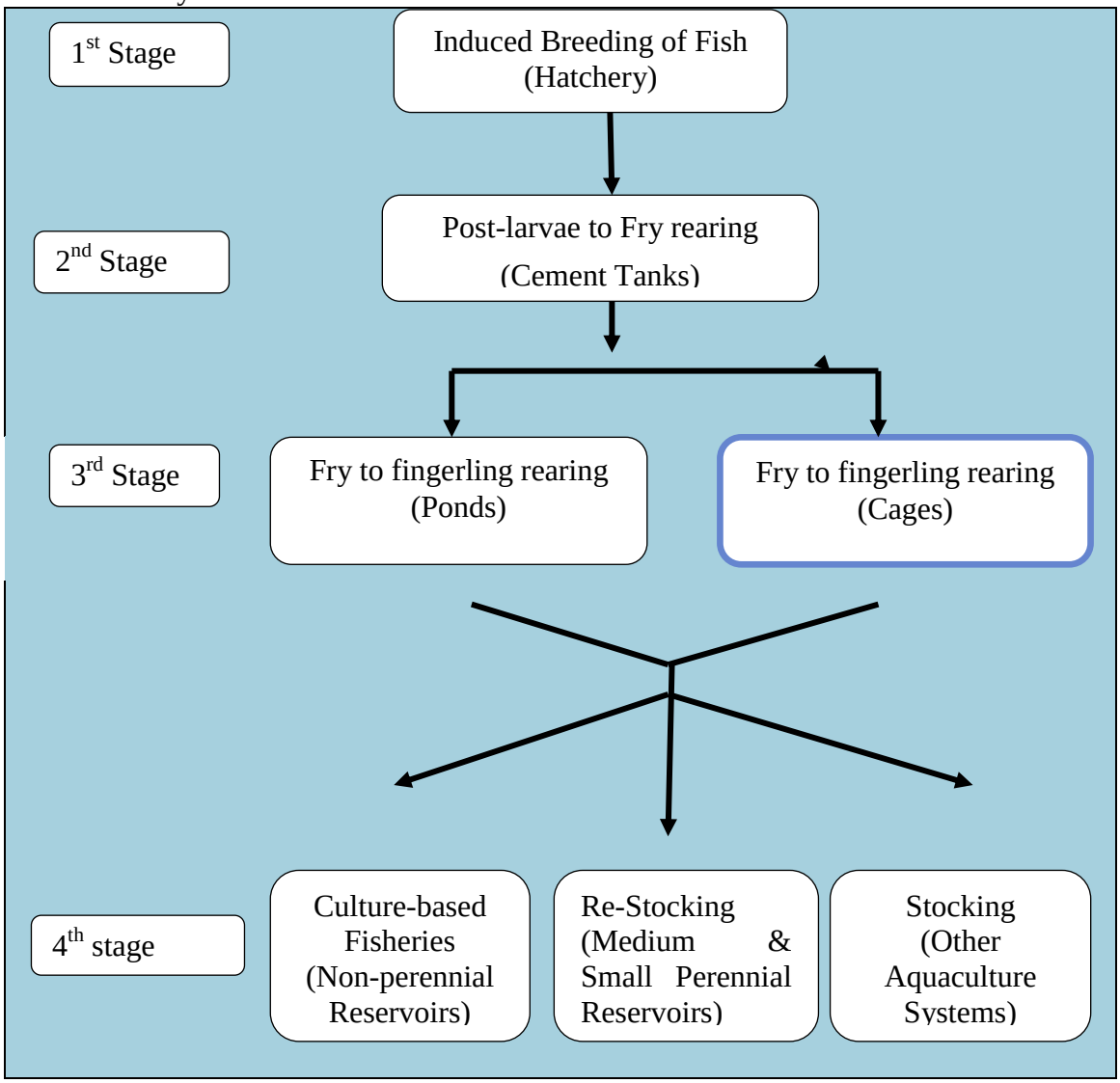


Figure 9: The fingerling production system on Chinese and Indian carps in Sri Lanka.

Appendix 2 Used Fish Species

The fish species involved are rohu (*Labeo rohita),* and common carp (*Cyprinus carpio*). Both fish species are exotic but adapted to Sri Lankan waters. common carp naturally breeds in Sri Lankan waters but rohu does not. However, currently evidence have been found that natural breeding of rohu (*L. rohita*) in Udawalawe reservoir (unpublished).These two species are the important fish species that used with other Indian major carps, Chinese major carps and Tilapias (*Oreochromis niloticus* and *Oreochromis mosambicus*) in poly culture system in culture-based fisheries in non-perennial reservoirs (Thayaparen, 1982).

L. rohita, vacum naturally in freshwater sections of the rivers of North India was introduced to Sri Lanka in 1981 (Jinghran and Pullin, 1985). It has become an important species in the fishery of perennial reservoirs (Illukkumbura 1986) and in poly culture systems (Chandrasoma 1986) in Sri Lanka. It is one of the best candidates for stocking in perennial and seasonal reservoirs (Chandrasoma 1992). Accordingly, there is a considerable need for the production of *L. rohita* fingerlings to be used in stocking seasonal and medium sized perennial reservoirs in Sri Lanka.

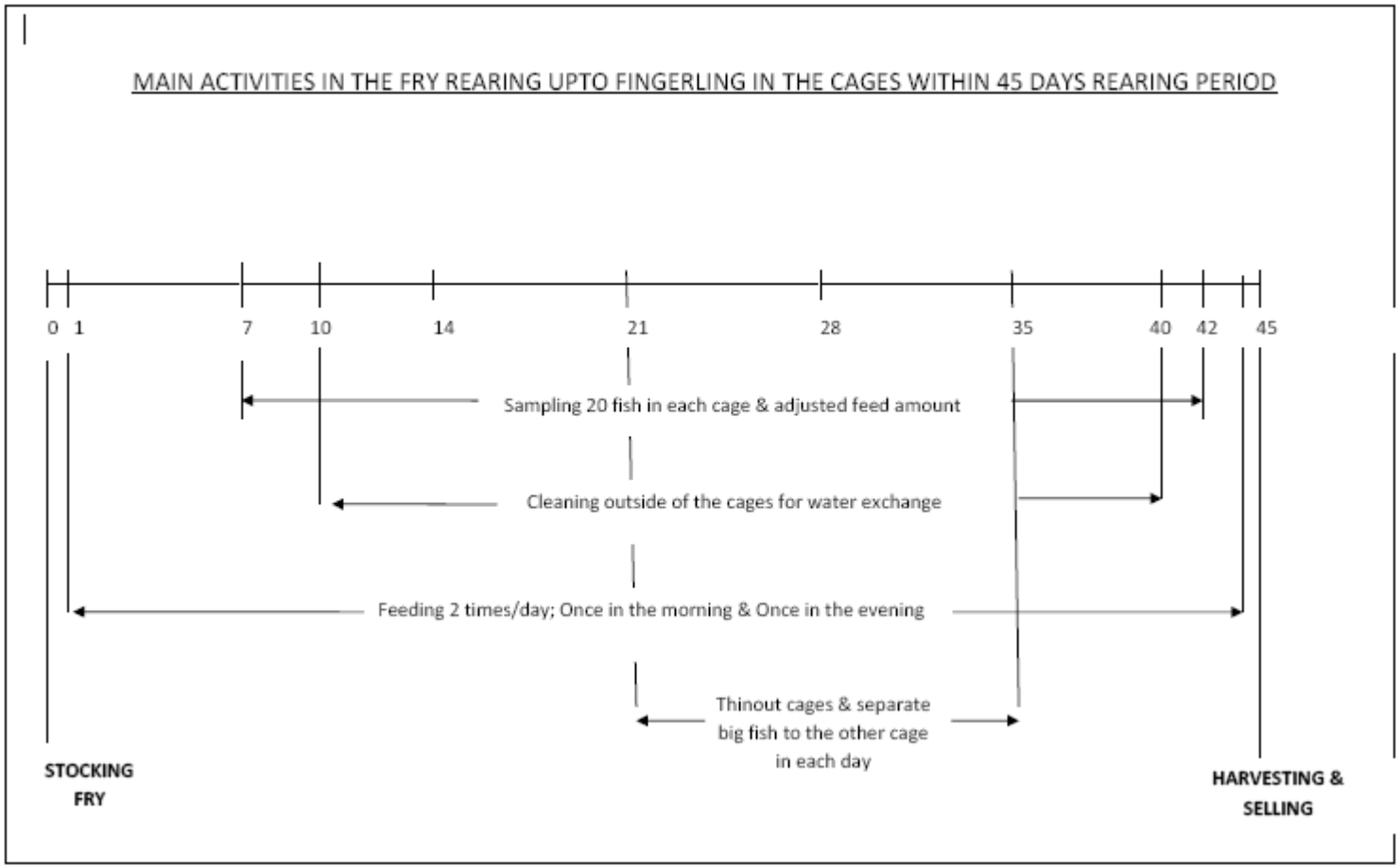
Family: Cyprinidae
Order: Cypriniformes
Class: Actinopterygii
Species: *Labeo rohita*
Common name:rohu

Family: Cyprinidae
Order: Cypriniformes
Class: Actinopterygii
Species: *Cyprinus carpio*
Common name:common carp

Figure 11: Rohu fingerling

Figure 10: Common carp fingerling

Appendix 3 Main Activities in the 45 days fry rearing period in cages



Appendix 4 Bank Loan

Bank Loan from Peoples' Bank, Sri Lanka

Interest rate=12% **Time period for the loan=10 years (matured date=01.01.2018)**

	1st year 2008	2nd year 2009	3rd year 2010	4th year 2011	5th year 2012	6th year 2013	7th year 2014	8th year 2015	9th year 2016	10th year 2017
Loan	4.360.000	3.924.000	3.488.000	3.052.000	2.616.000	2.180.000	1.744.000	1.308.000	872.000	436.000
Monthly instalment	36.333	36.333	36.333	36.333	36.333	36.333	36.333	36.333	36.333	36.333
Total deduction per year	436.000	436.000	436.000	436.000	436.000	436.000	436.000	436.000	436.000	436.000
Interest/year	523.200	470.880	418.560	366.240	313.920	261.600	209.280	156.960	104.640	52.320
Balance end of the year	3.924.000	3.488.000	3.052.000	2.616.000	2.180.000	1.744.000	1.308.000	872.000	436.000	0

87200

610.400

Appendix 5 Proximate Composition of 2 feed types, rice bran and commercial feed

Table 16: Proximate composition (%) of commercial feed (Cf) and Rice bran (Rb) that used in the fingerling production trials in Muthukandiya reservoir

Feed	Dry matter	Moisture	Ash	Protein	Fat
Commercial	97.7	7.2	9.5	37.1	6.6
feed	±0.02	±0.2	±0.0	±2.2	±1.7
Rice bran	85.2	14.9	10.7	13.2	2.8
	±3.9	±3.8	±4.6	±0.4	±0.1

(Source: Ariyaratne, 2001)