1

ECONOMICS OF FISHING OPERATIONS, FINANCIAL FEASIBILITY AND SENSITIVITY ANALYSIS

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Concept

Economics is the basis for life. Every one of us is a practicing economist in himself/herself in life. The principle of economics, when applied to fields like agriculture, animal husbandry, fisheries, poultry and other enterprises becomes more valuable. Initially fisheries did not consider economics as a component. But later in course of time, the fishery biologists realized that economics is a vital component of fisheries management.

The economic principle says that wants are unlimited but the means to satisfy them are limited. This is the basis of scarcity definition of Economics. In the wider sense, the resources at our disposal to meet our requirements are limited. We have to allocate the resources among the competing alternatives, for which the economic theory helps us. Optimization of resource use to obtain maximum profit is one of the aims for applying economic principle in entrepreneurship. In fisheries also, the economic principles are allocated for formulating fisheries management measures.

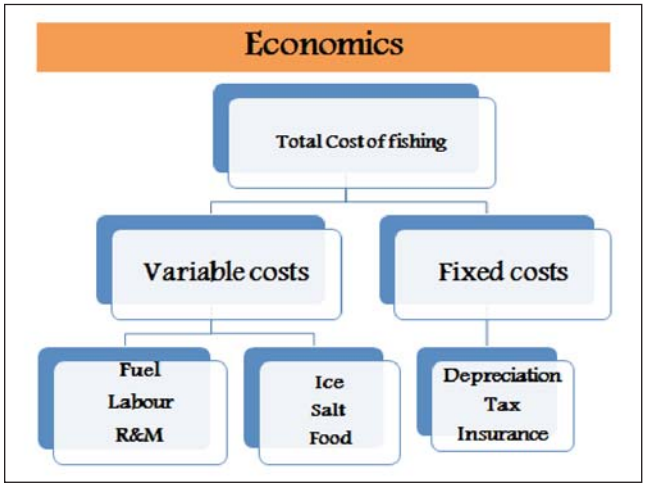
Costs of fishing operations

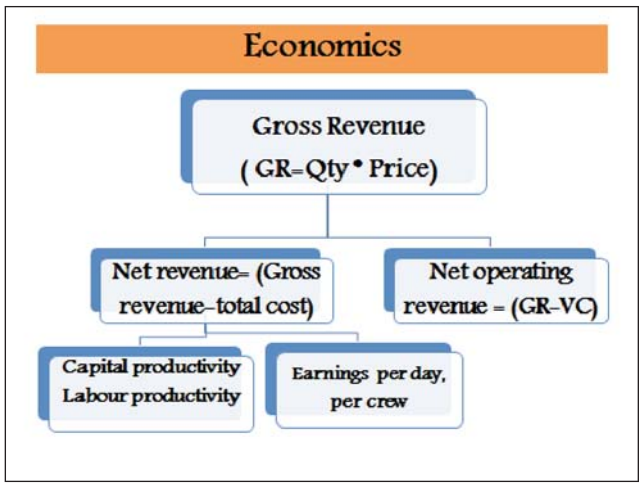
The costs of fishing operations are divided into fixed costs and operating costs.

Fixed cost

Fixed costs (normally referred as annual fixed costs) refer to the expenses that are met even if there is no fishing and are recurring in nature. Example: taxes, insurance premium, permanent labour (if any). In addition to the above, the annual fixed costs include, depreciation, interest on fixed capital (as an opportunity cost of capital).

The depreciation of all the components of fishing craft and gear are worked out based on their economic life. The relevant details are collected from the detailed questionnaire designed for this purpose. (See Annexure-1). The normal rates of depreciation followed are 8 per cent per annum for mechanised crafts, 10





per cent for motorized and traditional crafts (hull alone). The gears depreciate at 33 per cent and the minor equipments which are replaced every year is depreciated at 50 per cent. The engines, winch motors, iron ropes are depreciated at 10 per cent assuming an economic life of 10 years. The electronic gadgets like GPS are subjected to a depreciation rate of 20 per cent. The interest on fixed capital is normally worked out based on the interest rate charged for long term loans by Nationalised banks, which are refinanced by National Bank for Agricultural and Rural Development (NABARD).

Variable Costs (VC)

Variable costs refer to the out of pocket expenses and also the actual expenses incurred in the process of production (Figure 1). The variable costs include the labour wage, daily *bata,* fuel cost, cost of ice, expenses on food, repair and maintenance charges and other incidental costs.

In mechanised fishing, the labourers normally are paid the wages per week which can be converted into per trip. The labourers will also be paid daily *bata* as a proportion of the gross revenue, which will be included in the operating costs. In case of motorized and traditional and traditional units, the labourers normally share the catch in lieu of wages. In such cases the crew share can be computed after deducting the expenses from the gross revenue. Of the remaining amount, a certain proportion (ranging from 35 to 50 per cent depending upon the craft and gear used) will be allocated as the craft's share to meet the expenses and the remaining amount is equally shared among all the crew members including the owner. The imputed value of family labour should be computed based on the wages for hired labour. The wages for the family labour so derived should be added to the total wages while calculating the operating costs

The fuel cost per trip should be calculated by multiplying the quantity of diesel/ kerosene consumed per trip with the price per litre. The expenses on lubricating oil which normally will be incurred weekly, should be converted to expenses per trip. The repair and maintenance charges, normally expressed per annum, which included the maintenance charges of crafts, engines and gears, should be apportioned per trip. It is customary to consider the interest on working capital in agricultural enterprises as there will be a substantial time lag between use of variable inputs and the time of realization of output. However, in case of marine fishing, the expenditure on variable inputs like fuel, food, lubricating oil and other expenses is incurred and the returns realized on the same day. Hence, the interest on working capital need not be included.

Gross returns(GR)

The return per trip can be calculated by multiplying the species-wise quantity collected per trip with the corresponding landing center price of the species (Figure 2). The gross returns per trip can be converted to gross returns per season by multiplying gross returns per trip with the number of trips per season. Later this can be scaled up to annual value by adding the values of all the seasons.

The gross returns per trip can be calculated using the formula

$$\text{Gross return per trip} = \sum_{i=1}^{n}(P_i X_i)$$

Where,
Pi is the landing center price of the i^{th} species,
X_i is the quantity of the i^{th} species caught and
'n' is the number of species caught per trip.

Net returns (NR)

The annual net return is worked out by subtracting the annual total cost from annual gross returns.

Annual Net Return (Profit/Loss) = [Gross revenue-(Annual Fixed cost +Annual Variable cost)]

The calculation of cost and returns are given in the following table. This is based on the work done in Ramanathapurpam district of Tamilnadu.

Table 1 Annual Fixed cost of mechanised fishing unit (*in Rupees)*

Components of fixed cost	Value	Per cent to total
1. Depreciation		
a. Craft	37,064	55.31
b. Engine	6,958	10.38
c. Gears	10,587	15.8
d. Major accessories	9,803	14.63
e. Minor accessories	2,598	3.88
Total depreciation	**67,010**	**45.15**
2. Interest on initial investment @ 18 % per annum	81,410	54.85
3. Total annual fixed cost	**1,48,420**	**100**

Table 2 Annual Operating cost of a mechanized fishing unit *(in Rupees)*

Particulars	Mechanized craft	
	Value	Per cent to total
1. Number of fishing days	229	
2. Number of fishing trips	125	
Operating Cost		
1. Wages	78,704	14.08
2. Fuel	3,68,110	65.88
3. Food & daily bata	40,005	7.16
4. Ice	17,471	3.13
5. Lubricating oil	7,989	1.43'
6. Auction	-	-
7. Repairs and maintenance	46,271	8.28
8. Berthing	198	0.04
9. Others	-	-
10. Annual operating cost	5,58,748	100

Table 3 Annual cost and returns of a mechanized trawl fishing unit *(in Rupees)*

Particulars	Mechanized crafts	
	Cost /return	Per cent to total
1. Annual fixed cost	1,48,420	20.99
2. Annual operating cost	5,58,748	79.01
3. Annual total cost	**7,07,168**	**100**
4. Annual catch (in kg.)	56,326	
5. Annual gross revenue	7,91,159	
6. Annual net operating income (5-2)	2,32,411	
7. Annual net income (5-3)	83,991	

Productivity of fishing units

Productivity measures the economic efficiency of a particular system. This is a measure of how different inputs are utilized efficiently. To estimate the productivity of major fishing units, different economic indicators like rate of return, returns to labour and capital, break-even harvest and price, pay-back period and related indicators can be worked out sector-wise for mechanised, motorised and traditional fishing units

Operating ratio = [Annual operating cost / Gross return]
Fixed ratio = (Annual fixed cost /Gross Return)
Gross ratio = (Annual total cost /Gross return)
Capital turnover ratio = (Gross return/ Initial investment)
Break-even harvest (tonnes/annum) = Fixed cost/ (Price per kg -variable cost per kg)
Break-even price (rupees/kg) = [Total cost of harvest (in rupees)/Annual harvest (in kg)]

This will also help to analyse the comparative economic efficiency of different types of fishing units.

The productivity of mechanised fishing unit based on our studies conducted in Tamil Nadu is given below.

Table 4 Comparative productivity of fishing units, Tamil Nadu

Economic indicators	Traditional crafts	Motorized crafts	Mechanized crafts
A. Input-Output Efficiency			
1.Operating ratio	0.812	0.805	0.706
2. Fixed ratio	0.232	0.182	0.188
3. Gross ratio	1.044	0.987	0.894
B. Capital Efficiency			
1. Capital turn-over ratio	1.586	2.062	1.749
2. Rate of return on capital (%)	21.75	30.26	49.61
3. Pay-back period (years)	4.6	3.31	2.02
C. Labour Efficiency			
1. Number of crew employed	2	4	5
2. Average production per manday (kg.)	9.86	32.74	163.98
3. Value of production per manday (Rs.)	255.54	770.48	2303.23
4. Average wages per manday(Rs.)	113.55	279.67	229.12
D. Break-even Analysis			
1. Break-even harvest (tonnes)	2.82	14.36	35.92
2. Break-even price (Rs.)	27.04	23.23	12.55
3. Average price realised (Rs./kg.)	25.91	23.54	14.05
E. Other Measures			
1. Average annual fishing days	234	235	229
2. Average catch per day (kg.)	9.86	65.47	245.97
3.Gross revenue per day(Rs.}	255.54	1540.96	3454.84
4.Net operating income per day (Rs.)	48.05	300.55	1014.89
5. Net profit per day(Rs.}	-11.18	20.01	366.76

Financial feasibility of fishing units

The financial feasibility of fishing units is an important analytical tool that determines the financial worthiness of the crafts. Hence the financial institutions are interested to see the economic viability of any enterprise before advancing loans to them. The financial feasibility of fishing units can be studied through investment evaluation using both discounted cash flow techniques and undiscounted cash flow techniques.

The undiscounted cash flow measures include:

Rate of return on capital = (Average annual cash flow/ Initial investment) x 100

Pay-back period (years) = (Initial Investment / Average annual cash flows)

Discounted cash flow techniques

These techniques have a relative advantage since the expected future cash flows are reduced to a single sum at a point of time by incorporating the time value of money. The different criteria that were employed to evaluate the investments are:

(i) Net present Value (NPV),

(ii) Benefit-Cost ratio (BCR)

(iii) Internal Rate of Return (IRR)

The feasibility analysis of fishing methods is based on a few assumptions, which include, the following assumptions:

1. The rate of interest on fixed capital is 12 percent per annum.
2. Costs and benefits are assumed to remain at the level obtained in the initial year since the effect of inflation on cost will be offset by the inflation in the output prices over years.
3. The annual number of fishing days are assumed to be 220 for mechanized crafts, 240 for motorized and 260 for traditional crafts.
4. The additional expenses on nets is added to the investment every third year.
5. The economic life of the mechanized crafts can be assumed to be 10 years and that of traditional and motorized crafts to be 15 years.
6. The salvage value was assumed to be 10 per cent of the initial investment.

Net Present Worth (NPV)

This criterion helps to determine the present net worth of the stream of cash inflows over cash outflows. The streams of cash flow should be discounted at the selected interest rate. This discount rate can be selected based on some criteria like the World Bank suggested interest rate for evaluating the projects related to agriculture and allied sectors. NPW is calculated using the following formula:

$$NPW = \sum_{n=0}^{T} B_n (1+d)^{-n} - \sum_{n=0}^{T} C_n (1+d)^{-n} + V_T (1+d)^{-T} - \sum_{n=0}^{T} I_n (1+d)^{-n}$$

Where,

B_n = Cash inflows in period n

C_n = Cash outflows in period n

V_T = The salvage value realized in the terminal year of the investment
I_n = Investment made in year n
d = Discount rate
n = Number of years of economic of investment
T = Terminal year

The ranking guideline is that, for an investment to be feasible, the NPW should be positive.

Benefit Cost Ratio (BCR)

The ratio of the sum total of annual discounted net cash flows over the economic life of the investment indicates the benefit-cost ratio. This ratio should be equal to or greater than unity for the investment to be considered feasible. The BCR is computed as follows;

$$BCR = \frac{\sum_{n=0}^{T} B_n (1+d)^{-n} - \sum_{n=0}^{T} C_n (1+d)^{-n} + V_T(1+d)^T}{\sum_{n=0}^{T} I_n (1+d)^{-n}}$$

Internal Rate of Return (IRR)

IRR is that discount rate which makes the NPW equal to zero. It can be said that, IRR is that discount rate which equates the net cash flows during its economic life with the initial investment. This represents the average earning capacity are the compound rate of earning of the investment. The mathematical form of IRR is written as:

$$IRR = \sum_{n=0}^{T} B_n (1+r)^{-n} - \sum_{n=0}^{T} C_n (1+r)^{-n} + V_T(1+r)^T - \sum I_n (1+r)^{-n} = 0$$

Where, r = internal rate of return

The actual procedure to calculate IRR is by linear interpolation.

$$IRR = \text{Lower discount rates} + \text{Difference between the two rates} - \frac{\text{NPW at lower discount rate}}{\text{Absolute difference between the NPWat the two}}$$

Here the lower discount rate (LDR) is that rate at which NPW is positive and higher discount rate (HDR) is that rate at which NPW is negative. Care has been taken to minimize the effect of linearity by choosing the LDR and HDR which are as close as possible so that the calculated IRR should be greater than the investor's required rate of return or opportunity cost.

The financial analysis can be done using MS Excel sheet itself. The factors for year-wise discount rates can be arrived at using the formula $1/(1+r)^n$.. (Please refer the excel sheets for actual calculations (A model table is given below).

Table 5 Financial Feasibility Analysis of a mechanized craft

Year	Investment	Cash out flow	Total cash out flow*	Discount factor (20%)	Discounted cash outflow (DCOF)	Cash inflow**	Discount factor (20%)	Discounted cash inflow (DCIF)	Discounted Net cash flow	
0	37710.86	0	37711	1.0000	37711	0	1.0000	0	-37711	
1		48553	48553	0.8333	40461	59796	0.8333	49830	9369	
2	1387.99	48553	49941	0.6944	34681	59796	0.6944	41525	6844	
3	7890.11	48553	56443	0.5787	32664	59796	0.5787	34604	1940	
4	1387.99	48553	49941	0.4823	24084	59796	0.4823	28837	4753	
5		48553	48553	0.4019	19512	59796	0.4019	24031	4518	
6	9278.1	48553	57831	0.3349	19368	59796	0.3349	20026	658	
7		48553	48553	0.2791	13550	59796	0.2791	16688	3138	
8	1387.99	48553	49941	0.2326	11615	59796	0.2326	13907	2292	
9	9278.1	48553	57831	0.1938	11208	59796	0.1938	11589	381	
10	1387.99	48553	49941	0.1615	8066	59796	0.1615	9657	1592	
11		48553	48553	0.1346	6535	59796	0.1346	8048	1513	
12	9278.1	48553	57831	0.1122	6486	59796	0.1122	6707	220	
13		48553	48553	0.0935	4538	59796	0.0935	5589	1051	
14	1387.99	48553	49941	0.0779	3890	59796	0.0779	4657	768	
15		48553	48553	0.0649	3151	62937	0.0649	4085	934	
					277519			**279778**	2259	
								NPV at 20% discount rate	4518	2259
								BCR at 20% discount rate		
								Discounted cash inflow		279778
								Discounted cash outflow		277519
								BCR (DCIF/DCOF)		**1.01**

Sensitivity Analysis

Sensitivity analysis is a simple technique to assess the effects of adverse changes on a project. It involves changing the value of one or more selected variables and calculating the resulting change in the NPV or IRR. The extent of change in the selected variable to test can be derived from post evaluation and other studies of similar projects.

Changes in variables can be assessed one at a time to identify the key variables. Possible combinations can also be assessed.

Sensitivity analysis should be applied to project items that are numerically large or for which there is considerable uncertainty.

The results can be presented together with recommendations on what actions to take or which variables to monitor during implementation and operation.

Practical Utility

- It forces management to identify the underlying variables and their relationships.
- It shows how robust or vulnerable a project is to change in underlying variables.
- It indicates the need for further work in terms of gathering information in NPV or IRR is highly sensitive to changes in some variables.

Limitations:

1. It may fail to provide leads - if sensitivity analysis merely presents complicated set of switching values it may not shed light on the characteristics of the project.
2. The study of impact of variation in one factor at a time, holds other factors constant, may not be very meaningful when underlying factors are likely to be inter-related.

Data requirement

Cost and benefit stream across the project time period anticipated is required.

Methodology:

Sensitivity analysis can be done to ascertain the project feasibility at three different stages.

(i) ***Increasing cost of capital or interest rate increases***

The increasing cost of capital or the interest rate increases can be accounted in the sensitivity analysis by computing the NPV and BCR at different discount rates and thereafter checking the profitability of the changes.

(ii) ***Escalation of cost of the project due to different risks involved***

The cost of the projects gets escalated due to the various risk factors involved in the business which include the prophylactic measures needed to control and prevent the disease outcome, application of more fertilizers than the expected, more number of irrigations, more number of man days increase due to the inefficiency of human labour, etc. This increase in the cost of the project can be accounted by the ex-ante approach of increasing the project cost by 10 percent and 20 percent and later working the NPV and BCR with the benefit stream keeping unchanged.

(iii) ***Uncertainties resulting due to differences in the price receivables***

The uncertainties in the project benefit stream arise due to the uncertain nature of the prices that are expected in the market after the harvests. The uncertainties are basically due to the reason that the factors determining prices itself are subjected to changes. The other uncertainties include the yield uncertainty, technological uncertainty and institutional uncertainty. In countering the uncertainties, the anticipated benefit stream in the project can be reduced by 10,20,30 percentages and the NPV and BCR are computed accordingly, keeping the project cost unchanged.

Example :

For the following fisheries project data set on the perform the sensitivity analysis for the three different cases of :

(i) Increasing cost of capital.

(ii) Increased cost of project due to risks involved at 10 and 20 percent cost like.

(iii) Uncertainties due to the differences in the price receivables at 10, 20 and 30 percent reduction for the yield.

Table 6 Case -I : Increasing Cost of Capitals

Year	Cost	Benefit	d.f. at 12%	d.c. at 12%	d.b. at 12%	d.f. at 20%	dc at 20%	d.b at 20%	df at 25%	d.c. at 25%	db. At 25%
0	250000	0	1	250000	0	1	250000	0	1	250000	0
1	50000	200000	0.893	44650	178600	0.833	41650	166600	0.800	40000	160000
2	50000	200000	0.797	39850	159400	0.694	34700	138800	0.640	32000	128000
3	50000	200000	0.712	35600	142400	0.579	28950	115800	0.512	25600	102400
4	50000	200000	0.636	31800	127200	0.482	24100	96400	0.410	20500	82000
5	50000	250000	0.567	28350	141750	0.402	20100	100500	0.328	16400	82000
				430250	749350		399500	618100		384500	554400
				NPV	319100		NPV	218600		NPV	169900
				BCR	1.714		BCR	1.5471		BCR	1.4418

Inference:

The computation of the NPV and BCR at different cost of capital indicates that the project is feasible and profitable even at 25 per cent discount rate. At 25 percentage discount rate also there exists a positive NPV and BCR of more than one. The exercise indicates the high yielding capacity of the project even at higher discount rates.

Table 7 Case II : Escalation of the cost of the project due to the different risks involved

Year	Cost	Bene-fit	d.f at 12%	d.c. at 12%	d.b. at 12%	Cost increase by 10%	d.c. at 12%	d.b. at 12%	Cost increase by 20%	d.c. at 12%	db. at 12%
0	250000	0	1	250000	0	275000	275000	0	300000	300000	0
1	50000	200000	0.893	44650	178600	55000	49115	178600	60000	53580	178600
2	50000	200000	0.797	39850	159400	55000	43835	159400	60000	47820	159400
3	50000	200000	0.712	35600	142400	55000	39160	142400	60000	42720	142400
4	50000	200000	0.636	31800	127200	55000	34980	127200	60000	38160	127200
5	50000	250000	0.567	28350	141750	55000	31185	141750	60000	34020	141750
				430250	749350		473275	749350		516300	749350
				NPV	319100		NPV	218600		NPV	169900
				BCR	1.742		BCR	1.547		BCR	1.442

Inference:

On increasing the cost of the project taking into consideration the different risks involved the computed NPV and the BCR values indicate that the project is feasible and economical to a discount level rate of even when there is an increase of 20 percentage cost increase.

Table 8 Case III : Uncertainties resulting due to the differences in the price receivables

Year	Cost	Benefit	d.f at 12%	d.c. at 12%	d.b. at 12%	Reduction in benefit of 10%	Discounted benefit	Reduction in benefit of 20%	Dis-counted benefit	Reduction in benefit of30%	Dis-counted benefit
0	250000	0	1	250000	0	0	0	0	0	0	0
1	50000	200000	0.893	44650	178600	180000	160740	160000	142880	140000	125020
2	50000	200000	0.797	39850	159400	180000	143460	160000	127520	140000	111580
3	50000	200000	0.712	35600	142400	180000	128160	160000	113920	140000	99680
4	50000	200000	0.636	31800	127200	180000	114480	160000	101760	140000	89040
5	50000	250000	0.567	28350	141750	225000	127575	200000	113400	175000	99225
	500000	1050000		430250	749350	945000	674415	840000	599480	735000	524545
				NPV	319100	NPV	244165	NPV	169230	NPV	94295
				BCR	1.742	BCR	1.567	BCR	1.393	BCR	1.219

Inference:

The uncertainties in the project benefit stream can be sensitised by the exante approach of reducing the anticipated project benefit stream at 10,20, 30 percentages. The computed NPV and BCR ratios indicate that the project can withstand uncertainties to the tune of even 30 per cent reduction in the yield due to the different uncertainties. The NPV and BCR at 30 percentage reduction in the yield in the project benefit stream was found to be Rs. 9,4295 and 1.21 respectively.

Annexure-I

Socio Economic Evaluation and Technology Transfer Division
Central Marine Fisheries Research Institute, Cochin-682 018
Schedule 1: Fixed cost and fishing pattern

1. Type of Fishing Unit : Mechanized

Primary gear: Secondary gear:

2. Reg. No. :

3. Landing Centre :

4. Location ***Mandal /Taluk*:** **District:** **State:**

5. Ownership information

a) Name and address of the owner :

b) Type of ownership : Sole/Partnership/Family/Others

c) Source of Finance : Self/Bank/Coop society/Private. Source/ Others (specify)

Amount (Rs.): Subsidy if any(Rs):

d) Year of Purchase :

e) New one or second hand :

f) If second hand, age of the craft at the time of purchase:

6. Technical information

Sl.No.	Components	Specifications			
1	Hull (Craft)	OAL (ft):	Wood/ Steel	Breadth(ft):	Draft (ft) :
2	Engine	Make:		Hp:	Fuel : (Lit/hr):
3	Gear	Head rope (m):		Cod end mesh:	
4	Fish holding capacity (tonnes):				

7. Fishing Pattern details

Seasons	Pre- monsoon	Monsoon	Post- monsoon
Mention Period			
Type of fishing:(SDF/MDF)			
No. of trips/Year			
Fishing days / week			
Voyage hours/ trip			
Actual fishing hours/trip			
Fishing Holidays			
Closed seasons			
Dry docking for Repairs & Maintenance. (no. of days)			
Major fishing ground(Lat/ long. position)			

Note: SDF: Single Day Fishing; MDF: Multi Day Fishing

8. Investment details (in Rupees)*

Sl.No.	Components	Specifications	Purchase value	Year of Purchase	Economic Life	Subsidy(Rs.)
1.	Hull (Craft)					
2.	Cost of fiber coating					
3.	Engine					
4.	Winch set					
5.	Otter board					
6.	Fish hold (cold storage units)					
7.	Ropes					
8.	Wireless sets					
9.	Eco sounders					
10.	GPS set					
11.	Batteries					
12.	Wire rope					
13.	Propeller					
14.	Gears/ Net (1)					
	Gears (2)					
	Gears (3)					
	Gears (4)					
	Gears (5)					
	Gears (6)					
	Gears (7)					
	Gears (8)					
	Gears (9)					
15.	Other accessories (Specify)					
	Total					

Note: * Whichever item is applicable for a particular craft, please fill in the respective column.

9. Other fixed cost components

a) Insurance premium

b) Taxes (if any)

c) Others

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