Costing of fishery technologies developed through research for commercialization

Chandrasekar.V, Geethlakshmi.V & Nikita Gopal*

ICAR-Central Institute of Fisheries Technology, Kochi-682029, Kerala
vcsecon@gmail.com

A producer or a firm acquires different inputs like labour, machines, land, raw materials, etc. Combining these inputs, it produces output. This is called the process of production. In order to acquire inputs, it has to pay for them. That is the cost of production. Once the output has been produced, the firm sells it in the market and earns revenue. The revenue that it earns net of cost is the profit of the firm. We assume here that the objective of a firm is to maximise its profit. A firm looking at its cost structure and the market price of output decides to produce an amount of output such that its profit reaches the maximum.

A production function is defined for a given technology. It is the technological knowledge that determines the maximum levels of output that can be produced using different combinations of inputs. If the technology improves, the maximum levels of output obtainable for different input combinations increase. We then have a new production function.

The inputs that a firm uses in the production process are called factors of production. In order to produce output, a firm may require any number of different inputs. However, for the time being, here we consider a firm that produces output using only two factors of production – factor 1 and factor 2. Our production function, therefore, tells us what maximum quantity of output can be produced by using different combinations of these two factors. We may write the production function as q = f (x1, x2)

isoquant is just an alternative way of representing the production function. Consider a production function with two inputs factor 1 and factor 2. An isoquant is the set of all possible combinations of the two inputs that yield the same maximum possible level of output. Each isoquant represents a particular level of output and is labeled with that amount of output.

Cost of Production:

Business decisions are generally taken based on the monetary values of inputs and outputs. The quantity of inputs multiplied by their respective unit prices will give the monetary value or the cost of production.

Importance of Production cost:

In all business decisions, especially those decisions concerning:

- Location of the weak points in production management;
- Cost minimisation
- Finding the optimal level of output;
- Determination of price and dealers' margin; and,
- Estimation of the costs of business operation.

The cost of producing goods includes both explicit and implicit cost.

Explicit Costs:

These are costs falling under business costs and are those entered in the books of accounts. Payments for wages and salaries, materials, insurance premium, depreciation charges are examples of explicit costs. These costs involve cash payments and are recorded in accounting practices.

Implicit/Imputed Costs:

Those costs that do not involve cash outlays or payments and do not appear in the business accountin system are referred to as implicit or imputed costs. It is not taken into account while calculating the loss c gains of the business. The explicit and implicit costs together (explicit +implicit costs) form the economi cost.

Analytical Cost Concepts Used in Economic Analysis of Business Activities.

1. Fixed and Variable Costs
2. Total, Average, and Marginal Costs
3. Short-Run and Long-Run Costs
4. Incremental Costs and Sunk Costs
5. Historical and Replacement Costs
6. Private and Social Costs

Fixed and Variable Costs

Costs that are fixed in volume for a certain level of output. They do not vary with output. The remain constant regardless of the level of output.

Fixed costs include:

(i) Cost of managerial and administrative staff;
(ii) Depreciation of machinery;
(iii) Land, maintenance.

Fixed costs are normally short-term concepts because, in the longrun, all costs must vary.

Variable Costs are those that vary with variations in output. It includes: (i) Cost of raw materials; (i Running costs of fixed capital, such as fuel, repairs, routine maintenance expenditure, direct labo charges associated with output levels; and (iii) The Costs of all other inputs that may vary with the level output.

Total, Average, and Marginal Costs:

a) The Total Cost (TC) refers to the total expenditure on the production of goods and services.
b) It includes both explicit and implicit costs.
c) The explicit costs themselves are made up of fixed and variable costs.

The Average cost (AC) is obtained by dividing total cost (TC) by total output (Q).

$$AC = TC/Q$$

Marginal Cost (MC) is the addition to total cost on account of producing one additional unit of a product. is the cost of the marginal unit produced.

$$MC = \text{Change in } TC / \text{Change in } Q$$
$$= \Delta TC / \Delta Q$$

Short-Run and Long-Run Costs:

a) Short-Run Costs are costs which change as desired output changes, size of the firm remainir constant. These costs are often referred to as variable costs.

b) Long-Run costs, on the other hand are costs incurred on the firm's fixed assets, such as plant, machinery, building, and the like.

Incremental Costs: it refers to the total additional cost associated with the decision to expand output or to add a new variety of product. The concept of incremental cost is based on the fact that, in the real world, it is not practicable to employ factors for each unit of output separately due to lack of perfect divisibility of inputs. It also arise as a result of change in product line, addition or introduction of a new product, replacement of worn out plant and machinery, replacement of old technique of production with a new one, and the like

Sunk costs: it refers to those costs that cannot be altered, increased or decreased, by varying the rate of output. once management decides to make incremental investment expenditure and the funds are allocated and spent, all preceding costs are considered to be the sunk costs since they accord to the prior commitment and cannot be reversed or recovered when there is a change in market conditions or a change in business decisions.

Historical and Replacement Costs:
Historical cost refers to the cost an asset acquired in the past, whereas, replacement cost refers to the outlay made for replacing an old asset. These concepts derive from the unstable nature of price behaviour. When prices become stable over time, other things being equal, historical and replacement costs will be at par with each other.

Private and social costs are those costs which arise as a result of the functioning of a firm, but neither are normally reflected in the business decisions nor are explicitly borne by the firm. Costs in this category are borne by the society. Total cost generated in the course of doing business may be divided into two categories:

(i) Those paid out by the firm; and,
(ii) Those not paid or borne by the firm, including the use of resources that are freely available plus the disutility created in the process of production.

Costs under the first category are known as private costs. Those of the second category are known as external or social costs. Examples of such social costs include water pollution from oil refineries, air pollution costs by mills and factories located near a city etc. From a firm's point of view, such costs are classified as external costs, and from the society's point of view, they are classified as social costs.

The theory of costs basically deals with cost-output relations. The basic economic principle states that total cost increases with increase in output. However, focus is not the absolute increase in total cost, but the direction of change in the average cost (AC) and the marginal cost (MC). The direction of changes in AC and MC will depend on the nature of the cost function.

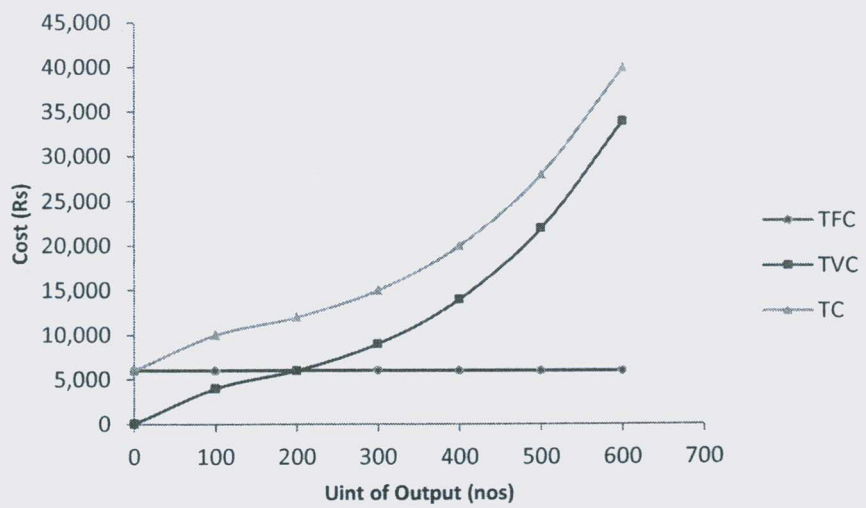
Cost – Output Relationship:
A cost function is a symbolic statement of the technological relationship between the cost and output. $C = TC = f(Q)$, and $\Delta Q > 0$, The specific form of the cost function depends on the time framework for cost analysis: short-or long-run.

Short Run Costs:

- Total Variable cost (TVC) is the total amount paid for variable inputs and it Increases as output increases
- Total Fixed Cost (TFC) is the total amount paid for fixed inputs and does not vary with output
- Total Cost (TC) = TVC + TFC

Table: Short-Run Total Cost Schedules:

Output (Q)	Total Fixed cost (TFC)	Total Variable cost (TVC)	Total Cost (TC=TFC+TVC)
0	6,000	0	6000
100	6,000	4000	10000
200	6,000	6000	12000
300	6,000	9000	15000
400	6,000	14000	20000
500	6,000	22000	28000
600	6,000	34000	40000



Average Costs

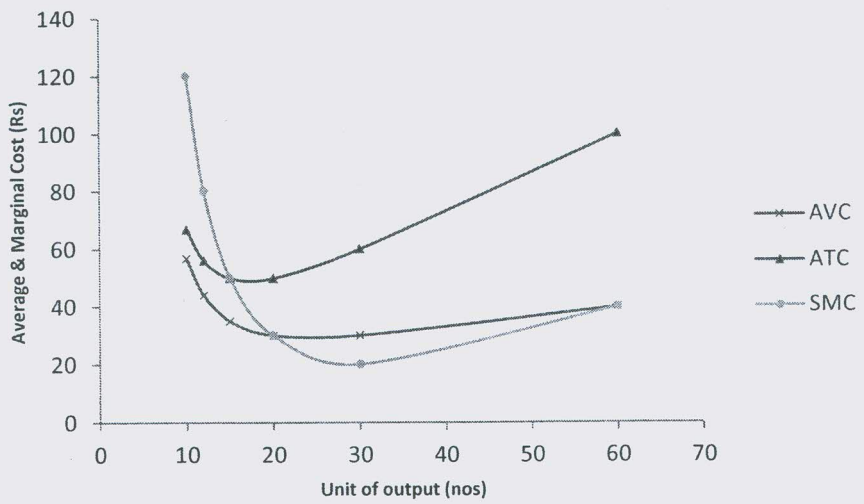
AVC = TVC/Q ; AFC = TFC/Q ; ATC = TC/Q = AVC + AFC

Short run marginal cost (SMC) measures rate of change in total cost (TC) as output varies

$$SMC = \Delta TC/\Delta Q = \Delta TVC/\Delta Q$$

Table: Average & Marginal Cost Schedules:

Output (Q)	Average fixed cost (AFC=TFC/Q)	Average variable cost (AVC=TVC/Q)	Average total cost (ATC=TC/Q =AFC+AVC)	Short-run marginal cost (SMC=ΔTC/ΔQ)
0	0	0	0	0
100	60	40	100	40
200	30	30	60	20
300	20	30	50	30
400	15	35	50	50
500	12	44	56	80
600	10	56.7	66.7	120



Relations Between Short-Run Costs & Production

When marginal product (average product) is increasing, marginal cost (average cost) is decreasing • When marginal product (average product) is decreasing, marginal cost (average variable cost) is increasing and when marginal product = average product at maximum AP, marginal cost = average variable cost at minimum AVC

Short run Cost Function: Cost-output relations are normally determined by the cost function and are exhibited by cost curves. The shape of cost curves depends on the nature of the cost function which are derived from actual cost data

Linear Cost Function. TC = C = a + bQ where a = Total Fix Cost (TFC),bQ = Total Variable Cost (TVC)
The Average and Marginal cost functions can be obtained from the Total Cost Function as follows:

Average Cost (AC) = TC = a + bQ
= a/Q + b Q / Q
Marginal Cost (MC) = dTC/dQ = b

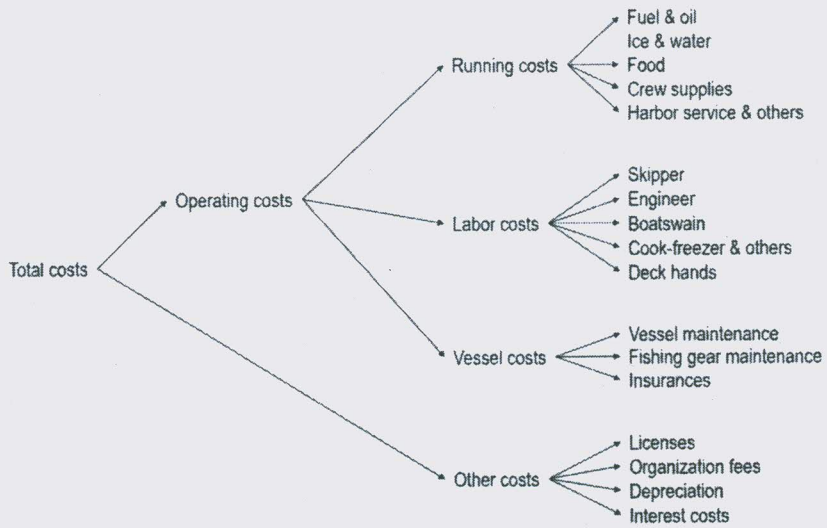
Quadratic Cost Function.

TC = C = a + bQ + Q2
AC = TC = a + bQ + Q 2 = a/Q + bQ/Q + Q
MC = dTC/dQ = b + 2Q
Example, if TC = C = 150 + 10Q + Q2
Then, AC = 150/Q + 10Q + Q 2
= 150/Q + 10 + Q
MC = dTC/dQ = 10 + 2Q

Short Run Cost

In order to produce output, the firm needs to employ inputs. But a given level of output, typically, can be produced in many ways. There can be more than one input combinations with which a firm can produce a desired level of output. The question is which input combination will the firm choose? With the input prices given, it will choose that combination of inputs which is least expensive. So, for every level of output, the firm chooses the least cost input combination.

Example: Fishing trawler operation cost structure



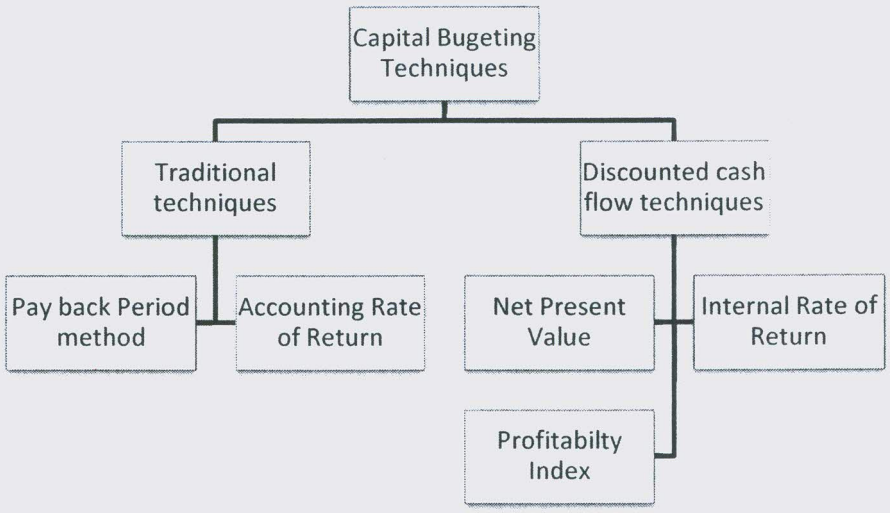
TECHNIQUES OF CAPITAL BUDGETING

Capital budgeting is mathematical in nature which means that there are certain techniques related to quantitative investment and are employed to determine the worth of an opportunity of investment. Following are the important techniques of capital budgeting.

- Pay Back Period

- Return on Investment
- Net Present Value (NPV)
- Profitability Index (PI)
- Internal Rate of Return (IRR)

A number of capital budgeting techniques that are used in practice are



1. Pay Back Period Method:

The payback period is the length of time required to recover the initial cash outlay of the project. It can be calculated as follows:

Payback Period = Cash Outlay/Annual cash inflow

The method can be understood as follows:

For example: A project which has an initial cash outlay of Rs. 10, 00,000 and a constant annual cash inflow of Rs. 3, 00,000 has a payback period of Rs. 1,000,000/ 3, 00,000 = 3½ years.

According to the pay back criterion, the shorter the payback period, the more desirable the project.

Advantages:

1. It is a ready method, both in concept and application. It does not use involved concepts and tedious calculations and has few hidden assumptions.
2. Since it emphasizes earlier cash inflows, it may be sensible criterion when the firm is facing the problem of liquidity.
3. It is a rough and ready method for dealing with risk. It favours projects which generate substantial cash inflows in earlier years and discriminates against projects which bring substantial cash inflows in later years but not in earlier years. Now, if risk tends to increase with futurity – in general this may be true. The pay back criterion may be helpful in weeding out risky projects.

Demerits:

1. A company can have more favourable short-run effects on earning per share by setting up a shorter payback period. It should, however, be remembered that this may not be a wise long term policy as the company may have to sacrifice its future growth for current earnings.

2. The emphasis in pay back is on the early recovery of the investment. Thus, it gives an insight to the liquidity of the project. The funds so released can be put to other uses.
3. The riskiness of the project can be tackled by having a shorter payback period as it may ensure guarantee against loss. Company has to invest in many such projects where the cash inflows and life expectancies are highly uncertain.
4. Under such circumstances, pay back may become important not so much as a measure of profitability but as a means of establishing an upper bound on the acceptable degree of risk.

Accounting Rate of Return Technique (ARR):

It is also called as Average Rate of Return method, is primarily based on accounting approach rather than cash flow approach. The accounting rate of return is find out by dividing the average income after taxes by average investment.

$$\text{ARR} = \frac{\text{Average income after taxes}}{\text{Average investment}}$$

$$\text{ARR} = \frac{\text{Average income after taxes}}{\frac{\text{Average investment} + \text{Salvage value}}{2}}$$

ARR method can be used as an accept or reject criteria. This method will accept all the projects which have ARR less than the minimum rate. The projects would be ranked one which has highest ARR.

Merits:

1. Net earnings after depreciation are considered under this method and this is of vital importance in the appraisal of investment proposals.
2. It is an easy method to adopt and simple to understand.
3. It considers the earnings over the life span of the project and as such is superior to pay back method.

Demerits:

1. This method, like the pay back method, does not consider the time value of money.
2. It does not differentiate between the sizes of investment required for investment proposals. Investment proposals may have the same ARR but may require different average investments. In such a situation the method is of no use for the firm and the firm cannot precisely decide on the implementation of any specific proposal.
3. ARR uses accounting approach in place of cash flow approach. For this reason, it does not truly reflect the proper timing of the benefits. Thus, it ignores the reinvestment potential of a project.

Net Present Value Method (NPV method):

This method is one of the discounted cash flow techniques that take into consideration the time value of money. It recognizes that cash flow streams at different time periods differ in value and can be compared only when they are expressed in terms of common denominator i.e. present values.

Procedure for calculating NPV:

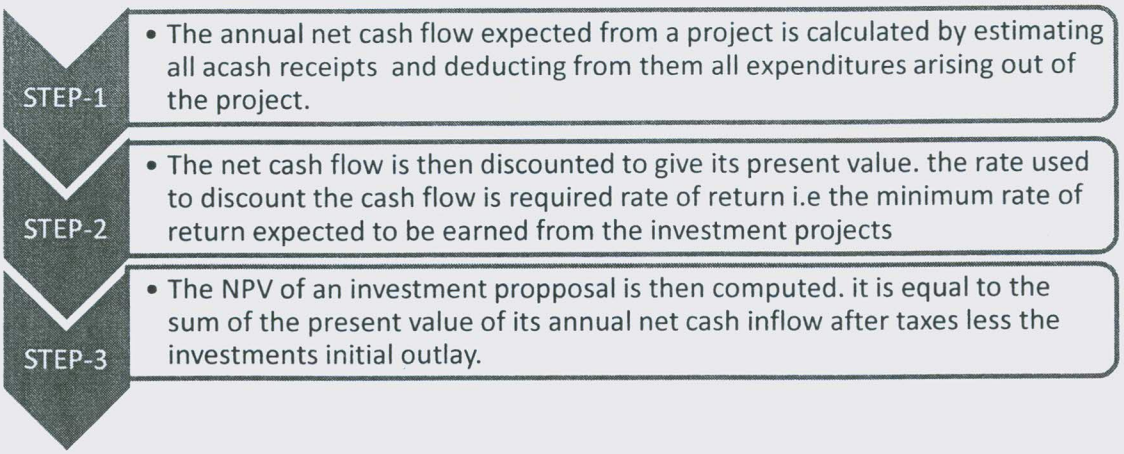
The process of calculating NPV is as follows

$$\text{NPV} = \sum_{t=1}^{n} \frac{\text{CF}_t}{(1+\text{r})^t} - \text{C}$$

Where, CF_t = net cash inflow in time period t

r = rate of discount

C = Initial cash outlay
n = Project's expected life.



Thus, the NPV method is the process of calculating the present value of cash flow (inflows and outflows) of an investment proposal, using the opportunity cost of capital as the appropriate discounting rate, and finding out the net present value by subtracting out the present value of cash outflows from the present value of cash inflows.

Features of NPV method:

1. The NPV of simple project decreases as the discount rate increases. The decrease in the NPV, however, is at a decreasing rate.
2. The NPV method is based on the assumption that the intermediate cash inflows of the project are re-invested at a rate of return equal to the firm's cost of capital.
1. NPV method can be used to accept/reject the project. The project would be accepted if the NPV is positive and reject if NPV is negative.

Merits:

1. It considers the cash flow streams in its entirety.
2. The net present value of various projects measured as they are in today's money value can be added. For example, the net present value of a package consisting of two projects, A and B will simply be the sum of the net present value.
3. It takes into account the time value of money.
4. It squares neatly with the financial objective of maximisation of the wealth of stockholders. The net present value represents the contribution of the wealth of stockholders.

Demerits:

1. The major limitation of this method is that it requires detailed long term forecasts (estimates) of the incremental benefits and costs. There may also arise difficulty in deciding the appropriate rate of discount for finding the values of the cash flows coming in over the project's life. The relative desirability of an investment proposal may change with a change in the discount rate.
2. Another shortcoming of this method is that it may not give dependable results in case of projects involving different outlays or having different effective lives. In spite of these limitations, NPV method is theoretically considered as the most correct criterion and is frequently used in practice.

Internal Rate of Return (IRR) Method:

It is another Discounted Cash Flow Technique which takes into account the time value of money. This technique is also known as Yield on Investment, Marginal Productivity of Capital, Time Adjusted Rate of Return, Marginal Efficiency of Capital, Rate of Return etc.

This internal rate of return is usually the rate of return that a project earns. It is defined as the discount rate (r) which equates the aggregate present value of net cash inflows with the aggregate present value of cash outflows of a project. It is the rate which gives the project NPV = 0.

$$\sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} = C$$

$$\sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - C = 0$$

CF_t = net cash inflow in time period t

C = cash outlay

n = The project's expected life

r = Internal rate of return

IRR for uneven cash flow is determined by a trial and error approach. We first determine the present value of the future net cash flows using an arbitrary discount rate. If the present value of future cash flows at this discount rate is larger than the initial outlay (i.e. NPV is positive), the discount rate is increased till the NPV results in a negative figure.

If at the first arbitrary rate of discount, the NPV happens to be a negative figure, then the discount rate is lowered till the NPV is a positive figure. Finally, the IRR is determined with the help of interpolation as under:

$$IRR = \left\{\begin{matrix} lower \\ discount \\ rate \end{matrix}\right\} + \left\{\begin{matrix} difference\ between \\ the\ two\ discount \\ rates \end{matrix}\right\} \times \left\{\frac{NPV\ at\ the\ lower\ discount\ rate}{sum\ of\ the\ absolute\ values\ of\ the\ NPVs}\right\}$$

$$IRR = R_L\left(\frac{NPV}{\Delta NPV}\right) X\ \Delta^r$$

Where,

RL = Lower of the two rates of discount

NPV = Net present value of project at RL

ΔNPV = Difference between NPV's at RL and RH

Δ = Difference between RH and RL

(RH being the higher of the two discount rates)

As an accept-reject criterion, a comparison of the actual IRR with the required rate of return that is cut off rate is to be made. The project would be accepted if the IRR exceeds the cut off rate and rejected if IRR is less than the cut off rate.

Merits:

1. It recognises the time value of money.
2. It is consistent with the objective of maximising shareholders' wealth.
3. It does not use the concept of the cost of capital but itself provides a rate of return which is indicative of the profitability of the investment proposal.

4. IRR method is easier to understand. Business executives and non-technical people will understand the investment proposal with relative ease if told that IRR of a given project is say 20% and the discount factor is 10% rather than being told about the NPV of the said project.
5. It takes into account the total cash inflows and outflows.

Demerits:

1. Possibility of multiple IRRs remains in same situation which reduces the utility of this method.
2. It requires detailed long term forecasts of incremental benefits and costs.
3. Underlying assumption of varying reinvestment rates is another limitation of IRR method. In other words, IRR method implies that reinvestment rates are contingent on the individual projects. This is very much unrealistic.
4. It involves tedious calculations.

Profitability Index (PI):

Also known as Benefit/Cost Ratio is the ratio of the present value of the future net cash flows to the initial cash outlay of the project. The index provides a relative measure for judging desirability and evaluating the worth of an investment proposal. It can be calculated as follows:

$$\text{Profitabilty Index} = \frac{\text{NPV of cash inflows}}{\text{Intial investment in the project}}$$

$$PI = \frac{\sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}}{C}$$

Where,

CF_t = net cash inflow in time period t

r = rate of discount

n = Project's expected life

C = Initial cash outlay.

It is used as an accept/reject criteria for the project. If PI > 1 then accept the project and if PI < 1, reject the project.

Merits:

1. It is consistent with the goal of maximising the shareholders wealth.
2. It uses cash flows. I
3. It recognizes the time value of money.

Demerit:

The main demerit of this method is that it requires detailed long term forecasts of the incremental benefits and costs. It also poses difficulty in determining appropriate discount rate.

Further readings:

Agricultural technology ready for commercialization Fisheries- Indian council of Agricultural Research, New Delhi. (2014) https://krishi.icar.gov.in/PDF/com_tech/Fisheries.pdf

Caesar B. Cororaton 2003, "Research and Development and Technology in the Philippines" PERSPECTIVE PAPER SERIES NO. 10 PHILIPPINE INSTITUTE FOR DEVELOPMENT STUDIES. https://dirp4.pids.gov.ph/ris/books/pidsbk03-ppstechnology.pdf

Harry F. Campbell, Richard P.C. Brown-"Cost-Benefit Analysis financial and economic appraisal using spreadsheet" second edition.
Raymond Toh Euston Quah Toh Quah – "Cost-Benefit Analysis: Cases and Materials".