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कृषि मशीनरी के संचालन की लागत का आकलन – दिशानिर्देश

(पहला पुनरीक्षण)

Draft **Indian Standard**

ESTIMATING THE COST OF FARM MACHINERY OPERATION — GUIDELINES

(*First Revision of IS 9164*)

ICS 65.060.10

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FOREWORD

Formal clauses will be added later

With the increase in use of farm machinery through custom hiring in the country, estimation of cost of operation by using a uniform method, assumed considerable significance. The custom hiring services are being organized so that every farmer can reap the advantages of mechanized farming practices, since it is practically neither possible for every farmer to own all farm machinery nor it would be economically viable. Moreover, by way of operating farm machinery on more than one farm, capital outlay and running cost can also be reduced considerably. Such services are being organized by individual farmers, commercial enterprises, agro-industry corporations, agro-service centres, custom hiring centres (CHCs), farmer producer organizations (FPOs), etc.

The objective of estimating cost of farm machinery operation is to serve as a basis for planning and management. Thus, for a contractor, the main objective may be to create a basis for establishing rates and for checking them from time to time. For this purpose, results from cost calculation can be used firstly to compare the income received from a job with the cost of its performance and to suitably adjust the rates; and secondly to pinpoint unreasonably high cost and their reasons, so that timely action can be taken to reduce their cost.

For a farmer, the main purpose of calculating cost may be to compare, for example, the cost of having his/her own machine with the cost of employing a contractor, or costs of different types or sizes of machines. It will also help to check the cost of production of a particular crop to ensure its profitability.

In view of the above a need was, therefore, felt, to prepare guidelines for estimating cost in a rational way. This standard was first published in 1979. In the preparation of this standard, assistance was taken from various agro-industry, corporations and different organizations using fleets of farm machinery for hiring purposes. Assistance was also derived from the following:

- Multi-farm use of agricultural machinery published by Food and Agriculture Organizations of United Nations, Rome.
- ASAE D - 230.2 Agricultural machinery management data. American Society of Agricultural Engineers, USA.

Based on the experience gained in the use of this standard by various stakeholders and technical inputs provided by the Central Farm Machinery Training and Testing Institute (CFMTTI), Budni, the standard has been taken up for revision. The revision of the standard includes following modifications:

a) Provision of calculating depreciation by various methods have been incorporated.
b) Inclusion of useful life of some modern farm machinery that are now being used in India, in Table 1.
c) Provision of condemnation of farm machinery

Draft Indian Standard
ESTIMATING THE COST OF FARM MACHINERY OPERATION — GUIDELINES
(*first revision*)

1 SCOPE

1.1 This standard recommends guidelines for estimating cost of farm machinery operation.

1.2 This standard also covers the conditions for declaration of condemnation of farm machinery.

2 COST FACTORS

2.1 The cost of using farm machinery consists of expenses for ownership and operation, and overhead charges. It may also include a margin for profit. Ownership costs are independent of use and are often called as fixed costs. Costs for operation vary directly with use and are referred to as variable costs. A summary of cost items is given below:

a) Fixed Costs:
   1. Depreciation;
   2. Interest on investment;
   3. Insurance and taxes (property, registration and road); and
   4. Housing.

b) Variable Costs:
   1. Fuel,
   2. Lubricating oil,
   3. Repair and maintenance, and
   4. Wages and labour charges.

c) Overheads

3 FIXED COSTS

3.1 Depreciation

This cost reflects the reduction in value of a machine with use (wear) and time (obsolescence). While actual depreciation would depend on the sale price of the machine after its use. Following are the different methods for calculating the value of depreciation-

3.1.1 *Straight-line Method*

In this method the annual depreciation rate is constant throughout the life of the machine. The amount of depreciation can be determined by-

$$D = \frac{P - S}{L}$$

D = depreciation cost, average per year;
P = purchase price of the machine;
S = residual value of the machine (*see* **3.1.1.1**); and
L = useful life of the machine in years (*see* **3.1.1.2**).

NOTE — The depreciation cost per hour can be calculated by dividing D with the number of hours the machine is expected to be utilized in a year.

3.1.1.1 Residual value of the machines may be taken as 10 percent of the purchase price.

3.1.1.2 Useful life of some of the commonly used machines under general conditions of usage is given in Table 1 for guidance.

3.1.2 *Sum of the Years Digit Method*

In this method the annual depreciation rate decreases as the machine gets older. The amount of depreciation in Rs./year can be determined by-

$$D_{n+1} = \frac{(L-n)(P-S)}{Y_d}$$

Where,

Y_d = Sum of the years digits = L (L + 1)/2
n = age of the machine in years at the beginning of year for which depreciation is to be calculated
L = life of machine (year)
P = purchase price (Rs)
S = residual value of the machine (Rs)

3.1.3 *Declining-balance Method* – In this method, the machine is depreciated at fixed percentage throughout the life of the machine.
Depreciation in Rs./year can be determined by-

$$D_{n+1} = P\left(1-\frac{X}{L}\right)^n\left(\frac{X}{L}\right)$$

Where,
D_{n+1} = amount of depreciation charged for year n+1,
P = purchase price, Rs.
n = age of machine in years at beginning of year for which depreciation is to be calculated
L = life of machine, years
X = ratio of depreciation rate.

NOTE — *X* may be any number between 1 and 2. For used machine *X* is taken as 1.5.

3.1.4 *Sinking-fund Method* – In this method a depreciation fund or sinking fund is created which is so calculated that the annual sum credited and accumulated throughout the life of machine may be equal to amount which would be required to replace the old machine. It is advantageous for use with a planned replacement policy. Depreciation in Rs./year can be determined by-

$$D = (P-S)\frac{i}{[(1+i)^L]-1}$$

where,
D = amount of annual depreciation i.e. sinking fund instalment
P = purchase price, Rs.
S = residual value of the machine, Rs.
i = Rate of interest (fraction) on saving
L = useful life of the machine in years

Total depreciation after 'm' years i.e. sinking fund to be set aside is determined by-

$$SF = D \text{ x } \frac{[(1+i)^m]-1}{i}$$

3.2 Interest

Annual charges of interest on the purchase price should be calculated on the basis of the actual rate of interest payable. If this information is not available, 10 percent of average purchase price should be taken. Average purchase price shall be calculated by the following formula:

$$A = \frac{(P+S)}{2}$$

where,
A = average purchase price, Rs.
P = purchase price of the machine, Rs. and
S = residual value of the machine, Rs.

3.3 Insurance and Taxes

Actual amount paid or to be paid annually for insurance and annual taxes, if any should be charged. If the information is not available, it may be calculated on the basis of 3 percent of the average purchase price (see A in **3.2**) of the machine.

3.4 Housing

It should be calculated on the basis of 1.5 percent of the average purchase price (see A in **3.2**) of the machine.

TABLE 1 USEFUL LIFE OF SOME OF THE COMMONLY USED FARM MACHINERY
(*Clause* **3.1.1, 4.3.2** *and* **4.3.3**)

Sl. No.	Name of Machine	Useful Life	
		Hours	Years
(1)	(2)	(3)	(4)
i)	Stationary engine	10 000	10
ii)	Electric motor	15 000	15
iii)	Power tiller	8 000	10
iv)	Tractor (wheeled and crawler)	10 000	10
v)	Combine (self-propelled)	3 000	6
vi)	Combine (mounted and drawn)	2 000	7
vii)	Seed drill	2 500	10
viii)	Seed-cum-fertilizer drill	2 000	8
ix)	Planter	2 000	10
x)	Plough	3 000	10
xi)	Disc harrow	3 000	10
xii)	Cultivator	4 000	10
xiii)	Front-mounted dozer attachment for wheeled Tractor	3 000	10
xiv)	Towed scraper for wheeled tractor	2 000	10
xv)	Power sprayer (knapsack and tractor mounted)	2 000	8
xvi)	Seed cleaner	2 500	5
xvii)	Agricultural trailer	3 600	12
xviii)	Power thresher	2 500	8
xix)	Centrifugal pump	10 000	10
xx)	Power chaff cutter	5 000	8
xxi)	Rotavator	2 400	8
xxii)	Ridger	1 500	12
xxiii)	Blade terrace	2 000	10
xxiv)	Puddler	2 500	10
xxv)	Cane crusher	10 000	10
xxvi)	Rice transplanter (walk behind)	6000	10
xxvii)	Rice transplanter (Ride-on)	6000	10
xxviii)	Hay rake	2500	8
xxix)	Baler	2000	7
xxx)	Rotary mulcher	2000	7
xxxi)	Tractor operated reaper/reaper binder	3000	15
xxxii)	Self-propelled reaper/reaper binder	2500	10
xxxiii)	Straw reaper/chopper	3000	7
xxxiv)	Laser land leveller	2500	10

4 VARIABLE COSTS

4.1 Fuel

Fuel consumption depends on the size of the power unit, load factor and operating conditions. The actual consumption can be observed while the machine is working or may be taken from the results obtained at official testing stations. It is common practice to consider average fuel consumption from the varying load test [*see* **4.10** of IS 5994] as approximately equal to fuel consumption on the farm. Average fuel consumption can also be estimated by the following formulae:

a) $A = 0.15 \times B$

where

A = average diesel consumption in 1/h,
B = rated power in kW.

b) $C = 0.25 \times B$

where

C = average petrol consumption in 1/h,
B = rated power in kW.

4.2 Oil

The actual oil consumption should be recorded while the machine is working. In case oil consumption data is not available, oil consumption may be taken as 2.5 to 3 percent of the fuel consumption on volume basis. The cost of filters, replacement of oil and other lubricants is included under repairs and maintenance (see 4.3).

4.3 Repair and Maintenance

4.3.1 Repair and maintenance expenditures are necessary to keep a machine operable due to wear, part failure renewal of tyres and tubes and accidents. The costs of restoring a machine are highly variable. Good machinery management may keep cost low. Normal wear deterioration is directly related to use, and restoration or repair costs are assumed to be typical variable costs. Maintenance costs, primarily those related to lubrication, are directly related to use also.

4.3.2 The accumulated repair and maintenance costs (TAR) in percent at any point in a machine's life can be estimated from the following formulae:

a) For four-wheeled and crawler tractors – TAR = $0.100X^{1.5}$
b) For stationary power unit and two-wheeled tractor – TAR = $0.120X^{1.5}$
c) For self-propelled combine, dozer and scraper – TAR = $0.096X^{1.4}$
d) For agricultural trailer – TAR = $0.127\,X^{1.4}$
e) For pto-driven combine, seed drill, seed-cum fertilizer drill and sprayer- TAR = $0.159X^{1.4}$
f) For seed cleaner – TAR = $0.191X^{1.4}$
g) For plough, planter, harrow, ridger and cultivator – TAR = $0.301\,X^{1.3}$

where,
TAR = Total accumulated repair cost divided by purchase price (P) of the machine expressed as percentage.
X = 100 times the ratio of accumulated hours of use to the wear out life given in Table 1.

4.3.3 The repair and maintenance cost in percentage of purchased price for whole usable life (see Table 1) of some of the machines calculated on the basis of formulae given in **4.3.1** is given in Table 2 for guidance.

4.4 Wages and Labour Charges

In performing custom work, the cost of at least one operator has to be included. Sometimes an assistant may also be engaged. One or both of them may be employed on a yearly basis, and the yearly cost of the operators is equal to the wages paid plus any allowances to which they may be entitled. Average cost per hour may be computed by dividing the total cost by the number of hours the operator has performed the work. This cost is, of course, higher than the average per hour work on the farm because part of the time will be used for travelling, interruptions and moving machines from one farm to another, and this is not paid for directly by the customers.

5 OVERHEAD CHARGES

This includes charges for supervision and establishment and interest on working capital if applicable. It should be assumed as 20 percent of the sum of fixed and variable costs.

6 TOTAL COST PER HOUR

6.1 The sum of fixed cost, variable cost and overheads per hour shall give the total cost.

7. TOTAL COST PER HECTARE

7.1 The total cost per hectare may be obtained on the basis of field capacity of the machine. The data regarding kind of machine, its working width, average speed of travel, size and shape of the fields and travel conditions should be recorded by the contractor since this kind of data would be very useful and would be sufficiently accurate. However, if no such data is available, the estimation of field capacity should be made by calculation on the basis of the following formula:

$$C = \frac{SW}{10} \text{x} \frac{E}{100}$$

where,

C = effective field capacity in hectare per hour,
S = speed of travel in km per hour,
W = theoretical width of the machine in m, and
E = field efficiency in percent at theoretical field capacity

7.2 Field Efficiency

7.2.1 Field efficiency is a measure of relative productivity of a machine under field conditions. It accounts for failure to utilize the theoretical operating width of the machine, operator's capability and habits, operating policy and field characteristics. The activities, such as turning and idle travel, materials (seed, fertilizer, chemicals, water, harvested material, etc) handling, cleaning clogged equipment, machine adjustment, lubrication and refuelling and waiting for other machines accounts for a majority of the time lost in the field. Travel to or from a field, major repairs, preventive maintenance and daily service activities are not included in field time or field efficiency.

7.2.2 Field efficiency is not a constant for a particular machine, but varies with the type of soil, size and shape of the field, pattern of field operation, crop yield, moisture and crop conditions. In absence of any data the field efficiency shall be selected from Table 3. Recommended speed of travel is also given in Table 3.

8 CONDEMNATION OF FARM MACHINERY

Condemnation is a process of conducting an evaluation to determine whether the machine or equipment should be removed from the service and sent for disposal. Equipment shall be considered for condemnation, if any of the following conditions is fulfilled-

a) If the machine or equipment has completed useful life as mentioned in Table 1, in hours of operation or years completed from the date of purchase, whichever is earlier, or

b) If the machine or equipment has been examined by the committee at Institute/ department level and has been declared to be irreparable/ unserviceable due to any reason including non-availability of spare parts or the cost of repair is not economical, or

c) If the machine/ model is obsolete due to technical advancements or changes in regulatory requirements including emissions and other provisions of CMVR or changes in government policies or manufacturer has stopped the production of the machine/model and its spare parts.

TABLE 2 PERCENTAGE OF ACCUMULATED REPAIR AND MAINTENANCE COST
(*Clause* **4.3.2**)

Sl. No.	Name of Machine	Cost in Percentage of Purchase Price for Usable Life in Years														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
i)	Stationary engine	3.8	10.7	19.7	30.4	42.4	55.8	70.3	85.9	102.5	120	-	-	-	-	-
ii)	Electric motor	2.1	5.8	10.7	16.5	23.1	30.4	38.3	46.7	55.8	65.3	75.4	85.9	96.8	108.2	120
iii)	Power tiller	3.8	10.7	19.7	30.4	42.4	55.8	70.3	85.9	102.5	120	-	-	-	-	-
iv)	Tractor (wheeled & crawler)	3.2	8.9	16.5	25.3	35.5	46.5	58.6	71.6	85.4	100	-	-	-	-	-
v)	Combine (Self Propelled)	4.9	13	23	34.3	46.9	60.6	-	-	-	-	-	-	-	-	-
vi)	Combine (mounted & drawn)	6.6	17.4	30.6	45.8	62.6	80.8	100.3	-	-	-	-	-	-	-	-
vii)	Seed drill	4	105	18.6	27.8	38.0	49.1	60.9	73.4	86.6	100.3	-	-	-	-	-
viii)	Seed cum fertilizer drill	5.5	14.4	25.4	38.0	52.0	67.1	83.2	100.3	-	-	-	-	-	-	-
ix)	Planter	6	14.8	25.1	36.4	48.7	61.7	75.4	89.7	104.5	119.8	-	-	-	-	-
x)	Plough	6		25.1	36.4	48.7	61.7	75.4	89.7	104.5	119.8	-	-	-	-	-
xi)	Disc harrow	6	14.8	25.1	36.4	48.7	61.7	75.4	89.7	104.5	119.8	-	-	-	-	-
xii)	Cultivator	6	14.8	25.1	36.4	48.7	61.7	75.4	89.7	104.5	119.8	-	-	-	-	-
xiii)	Dozer	2.4	6.4	11.2	16.8	23.0	29.6	36.8	44.3	52.3	60.6	-	-	-	-	-
xiv)	Scraper	2.4	6.4	11.2	16.8	23.0	29.6	36.8	44.3	52.3	60.6	-	-	-	-	-
xv)	Power sprayer	5.5	14.4	25.4	38	52.0	67.1	83.2	100.3	-	-	-	-	-	-	-
xvi)	Seed cleaner	12.7	33.4	58.9	88.2	120.5	-	-	-	-	-	-	-	-	-	-
xvii)	Agricultural trailor	2.5	6.5	11.5	17.2	23.5	30.4	37.7	45.4	53.6	62.1	70.9	80.1	-	-	-

TABLE 3 TYPICAL RANGES OF RECOMMENDED SPEED AND FIELD EFFICIENCIES FOR VARIOUS MACHINES
(*Clause* **7.2.1**)

Sl. No.	**Machine**	**Recommended Average Speed of Travel (km/h)**	**Recommended Average Field Efficiency (percent)**
(1)	(2)	(3)	(4)
i)	Plough	4.5	80
ii)	Disc Harrow	6.0	80
iii)	Cultivator	6.0	80
iv)	Seed Drill	5.0	70
v)	Seed cum fertilizer drill	5.0	70
vi)	Planter	5.0	70
vii)	Ridger	4.5	90
viii)	Puddler	5.0	75
ix)	Rotavator	2.5	80
x)	Combine (Self Propelled)		
	-For paddy	2.0	75
	-For wheat	3.5	75
xi)	Combine (mounted and drawn)		
	-For paddy	2.0	70
	-For wheat	3.0	70