METHODS OF CALCULATING OPERATING COST OF AN AGRICULTURAL TRACTOR AND ITS EQUIPMENT

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IN arriving at an accurate evaluation of the cost of working an agricultural tractor and its ancillary equipment and in maintaining them in sound mechanical condition during the period of their working life, several factors have to be taken into account. In this article, an attempt is made to indicate the elements of cost that should be examined in such a computation.

All items of direct and indirect expenses that make up the operating cost of an agricultural tractor and its equipment are set out in the following pages.

For the purpose of this article only one item of operation has been considered, viz., disc ploughing by tractor. Any other operation may be treated in the manner discussed.

It has to be mentioned that, unlike in the case of a private individual who operates one or two tractors on hire, where a large organization maintains a fleet of tractors, there is bound to be substantial overhead expenditure involved in the general establishment but we have not attempted in this article to evaluate such overheads. They will vary with the size of the organization and, indeed, are not material to the discussion in this article as they are best treated under "management expenses" of the undertaking.

The authors also wish to state that in regard to certain items of expenses, e.g., indirect labour, indirect materials and lost time some generalization is made as it would be somewhat difficult to arrive at exact costs in such cases. But if it is remembered that costing can never be an exactly accurate computation under any circumstances, the data furnished will suffice to serve as an indication to those concerned with operating agricultural tractors of how the cost of running their machines is made up.

(A). TRACTOR.

The greatest single factor affecting the cost of operation of a tractor is the amount of hours of use per year. The total cost, on no loss no profit basis, is made up of two major items, viz :—

1. Fixed costs These include :

   (*a*) Depreciation and obsolescence.

   (*b*) Interest on investment.

   (*c*) Housing.

   (*d*) Taxes.

   (*e*) Insurance.

2. Running costs. These include :

   (*a*) Direct labour.

   (*b*) Indirect labour.

   (*c*) Direct materials.

   (*d*) Indirect materials.

   (*e*) Lost time.

   (*f*) Repair costs.

(B). EQUIPMENT.

In the case of equipment the total operating cost is made up of :

(*a*) Depreciation.

(*b*) Interest on investment.

(*c*) Housing

(*d*) Taxes.

(*e*) Insurance.

(*f*) Repair cost.

(A) TRACTOR

Description	Cost per Hour	Example
1. (*a*) Depreciation and obsolescene. Depreciation is the loss in capital value and service capacity of the tractor through use, natural wear and tear, physical decay, rust, corrosion and accidental damage. The total service life of a tractor must be known or assumed in order to determine depreciation. It is not possible to wait until a machine is worn out to determine how long it should last. Out of the three most useful methods, i.e., "Straight-Line" method, "Reducing-balance" or "Constant-ratio" method, and the "Sinking fund" method, the first one is the simplest for calculating the depreciation of this type of plant. Obsolescence is the reduction in value of the existing machine, due to the machine becoming old fashioned and out moded. There is continuous progress in the development of better machines. Obsolescence may lead to plant being replaced while it is still capable of production. Though it still has physical life, its economic life is at an end.	Purchase price of the Tractor—Estimated salvage value of the tractor at the end of its total service life ——————————— Total service life of the tractor in hours.	Suppose: The purchase price of the Tractor is Rs. 10,000. (ii) The estimated salvage value of the tractor at the end of its total service life is Rs. 200 (iii) And the total service life of the Tractor is 10,000 hours Then the depreciation will be :— $= \frac{\text{Rs. } 10{,}000 - \text{Rs. } 200}{10{,}000 \text{ hours}}$ $= \frac{\text{Rs. } 9800}{10000}$ or Rs. 0.98 per hour

Description	Cost per Hour	Example
1. (*b*) Interest on investment. This is a fixed item i.e., it is independent of annual use. The amount invested in a tractor is greater during its early life than during the later years, since an amount is written off each year for depreciation. Interest charges are desired when operating costs are being determined but not when depreciated values are being determined for resale. It is desirable to calculate interest charges by a method that results in constant or equal yearly charges throughout the machine's life, where operating costs are concerned. The sum of the interest charge and the depreciation should be constant. The rate of interest itself is affected by the amount of risk involved. For Farm Machinery it varies from 3 to 6 per cent. per annum.	$\frac{\text{Annual interest charge} \times \text{total service life of the tractor in years}}{\text{Total service life of the tractor in hours}}$ $\text{(Annual interest charge} = \frac{\text{Tractor purchase price} + \text{Estimated salvage value of the tractor}}{2} \times \text{rate of interest}$	Suppose the total service of the Tractor is 10 years and the rate of interest in this case is 5 per cent., then the interest on investment will be :— $= \frac{10{,}000 + 200}{2} \times \frac{5}{100} \times \frac{10}{10{,}000}$ $= \frac{51}{200}$ or Rs. 0·25 per hour
1. (*c*), 1. (*d*) and 1. (*e*) Housing, Taxes and Insurance. Annual charges for housing, taxes and insurance may usually be determined best by considering the specific case. If better estimates are not available, the following charges may be used as typical for Farm Machines in general : Housing 1·60 per cent., Taxes 2 per cent. and Insurance 0·40 per cent. per annum	$\frac{\text{Annual charges} \times \text{total service life of the Tractor in years}}{\text{Total service life of the Tractor in hours}}$ $\text{(Annual charges} = \frac{\text{Tractor purchase price} + \text{Estimated salvage value of the Tractor}}{2} \times \frac{\text{Sum of rates}}{100}$	Taking the same rates as given in the description, then these charges will be :— $= \frac{10{,}200}{2} \times \frac{1{\cdot}60 + 2 + 0{\cdot}40}{100} \times \frac{10}{10{,}000}$ $= \frac{51}{250}$ or Rs. 0·20 per hour

2. (*a*) Direct Labour. The wages, salaries and allowances of the operator directly engaged to operate the tractor	$\frac{\text{Total annual emoluments of the operator}}{\text{operating hours per year}}$	Suppose the total annual emoluments of the operator is Rs. 2,700, and the operating hours per year are 1,000 then the direct labour charges will be :— $= \frac{2,700}{1,000}$ or Rs. 2.70 per hour
2. (*b*) Indirect Labour. This includes the cost of the staff engaged in the supervision and management of the machine. It varies from department to department, organisation to organisation and depends upon the number of tractors a department or organisation has to work and look after. Further it depends upon the size of the area within which a given number of tractors are required to be worked and supervised. In a small area it may be possible to manage and supervise the work of a given number of tractors with less supervisory staff than it would be necessary with the same number of tractors in a larger or scattered area. In this case more staff is needed to ensure efficient supervision of field operations. It is directly proportional to the direct labour. But in general it may be taken as 25 per cent. of the direct labour-	25 per cent. of the direct labour charges per hour	$= \frac{25}{100} \times \frac{270}{100}$ $= \frac{27}{40}$ or Rs. 0·67 per hour
2. (*c*) Direct materials. Costs of fuel and lubricating oils. It is the largest single item of expense in operating a tractor.	(i) Consumption of fuel :— Average consumption of fuel per hour in gallons × cost of one gallon of fuel	Assuming the average consumption of fuel (diesel) of the tractor per hour is 1·5 gallons and cost of one gallon of fuel is Re. 1·20 then :— $= \frac{3}{2} \times \frac{120}{100}$ $= \frac{9}{5}$ or Re. 1·80 per hour

Description	Cost per Hour	Example
	(ii) Consumption of Engine Oil :— Air Cleaner capacity in gallons / Frequency of change in hours × Engine Sump capacity in gallons / Frequency of change in hours × Compensating oil for topping up in gallons / No. of hours in which topping is done × Cost of one gallon of oil	Suppose the Air Cleaner capacity is $\frac{1}{8}$ gallon and its frequency of change is after every 10 hours, engine sump capacity is $1\frac{1}{2}$ gallons and its frequency of change is after every 120 hours, and after every 10 hours working 1/20 gallon is needed for topping up, then :— $= \frac{1}{8} \times \frac{1}{10} + \frac{3}{2} \times \frac{1}{120} + \frac{1}{20} \times \frac{1}{10}$ $= \frac{3}{100}$ Gallon per hour $= \frac{3}{100} \times$ Cost of one gallon of engine oil (say Rs. 8) $= \frac{3}{100} \times \frac{8}{1}$ $= \frac{6}{25}$ or Rs. 0·24 per hour
	(iii) Consumption of gear oil :— Capacity of gear box, differential and hydraulic system, &c., in gallons +	Suppose the capacity is 6·5 gallons and the frequency of change is after every 60 hours working 1/16 gallon is needed for topping up then :—

	Frequency of change in hours / Compensating oil for topping up in gallons	$= \frac{13}{2} \times \left[\frac{1}{720} + \frac{1}{16}\right] \times \frac{1}{60}$
2. (*d*) Indirect Materials. Cost of materials such as flushing oil, cotton waste, grease, radiator cleaners, and other rust removing and washing materials used in the upkeep of the tractor. In general it may be taken as 10 per cent. of the direct materials.	No. of hours in which topping is done × Cost of one gallon of gear oil 10 per cent. of the direct material charges per hour.	$= \frac{29}{2280}$ Gallon per hour
2. (*e*) Lost time. It is the most difficult variable to evaluate in relation to field capacity. Field time may be lost in adjusting or lubricating machine, adding fuel, minor breakdowns, clogging and idle travel such as travelling to field and turning at ends &c. Loss of time affects directly on the direct labour and direct material and in any case it should not exceed more than 20 per cent. of these charges.	20 per cent. of the direct labour and direct material charges per hour	$= \frac{29}{2280} \times$ Cost of one gallon of gear oil (say Rs. 10) $= \frac{29}{228}$ or Rs. 0·10 per hour
2. (*f*) Repair cost. The total repair cost to maintain a tractor during its full service life includes the cost of the tools and appliances, spare parts, wages, salaries and allowances of the mechanics and other staff engaged in the overhaul of the machine, the cost of transport in taking the tractor to the workshops for repairs and back to its work site after repairs, and the transport charges of the staff sent out to attend to field repairs, &c. The total repair cost, as given in the A. S. A. E. 1959 edition year book is, for a tractor, 120 per cent. of the new cost with 12,000 hours to wear out and 15 years until	100 per cent. of the purchase price of Tractor / Total service life of Tractor in hours	$= \frac{10}{100} \times \frac{214}{100}$ $= \frac{107}{500}$ or Rs. 0·21 per hour $= \frac{(20)}{100} \times (2{\cdot}70 + 2{\cdot}14)$

Description	Cost of Hour	Example
obsolete. In this case it may be taken as 100 per cent. of the purchase price with 10,000 hours (to wear out) as its total service life in hours and 10 years (until obsolete) total service life in years.		$= \frac{121}{125}$ or Rs. 0·96 per hour $= \frac{100 \times \text{Rs. } 10{,}000}{100 \times 10{,}000 \text{ hours}}$ = 1 or Rs. 1.00 per hour
	TOTAL OPERATING COST OF THE TRACTOR PER HOUR (Sum of 1 and 2)	Rs. 9·11
(*a*) Depreciation	$\frac{\text{Estimated purchase price of the equipment—salvage value}}{\text{Total service life of the equipment in hours}}$	Suppose: The equipment is a 3/Furrow disc plough and its purchase price is Rs. 2,220 (ii) Its estimated salvage value is Rs. 50 (iii) And its total service life is 2,000 hours Then the depreciation will be :— $= \frac{2220-50}{2000}$ $= \frac{217}{200}$ or Rs. 1·08 per hour
(*b*) Interest on investment, Housing, Taxes, and Insurance. 9 per cent. per annum.	$\frac{\text{Annual charges} \times \text{Total service life of the equipment in years}}{\text{Total service life of the equipment in hours}}$	$= \frac{2220 + 50}{2} \times \frac{9}{100} \times \frac{10}{2000}$

		$= \frac{2043}{4000}$ or Rs. 0.51 per hour
(c) Repair cost. Total repair cost 30 per cent. of the purchase price of the equipment	30 per cent. of the purchase price of the equipment / Total service life of the equipment in hours.	$\frac{30}{100} \times \frac{2220}{2000}$ $= \frac{333}{1000}$ or Rs. 0.33 per hour

TOTAL OPERATING COST OF THE EQUIPMENT PER HOUR SUM OF B. (*a*), B. (*b*) and B. (*c*) Rs. 1.92

GRAND TOTAL OF OPERATING COSTS OF THE TRACTOR AND THE EQUIPMENT PER HOUR (SUM OF A AND B) Rs. 11.03

COST OF DISC PLOUGHING PER ACRE (WITHOUT PROFITS)

= Operating cost of the tractor and equipment per hour × hours required to plough and Acre

= Rs. 11·03 × 2·3 hours (assuming 2·3 hours are required to do one acre)

= Rs. 25·37 per acre.