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ESTIMATING FARM MACHINERY COST

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1.0 Introduction

The scope of future development in agriculture is limited only by the necessity for mechanization to be economic. One of the objectives of farm management of which mechanization management forms a part, is to plan for maximum profit. This can only be achieved by minimizing unit cost of production. Calculating operation costs of farm machines will give insight on how to control unit cost of production. A farmer often needs to know what it will cost him to use a particular machine. In some cases he may be considering changing from one type of machine in hand, to an improved and more productive one, or at times he may wish to know what the costs of using his own machine will be in comparison with the cost of contract work. Operation costs are needed to gain information in which to base the different decisions.

As a farmer's investment in machinery and equipment is a major capital input in the farm business, he should know how to estimate the costs of owning and operating a machine before investing his capital. As farms and machines increase in size, as energy prices increase, and as inflation causes repair parts, fuel, and new machinery to increase in cost, machinery and power costs per unit of production will continue to rise but a good farmer or machinery manager will have a smaller increase in machinery and power cost per unit of production by making decision that will improve productivity per person and machine through keeping good information on operating costs. This bulletin is put together to assist farm machinery owners and agricultural mechanization extension agents on how to determine the various costs involved in owning and operating farm machines.

2.0 Costing of farm machinery

At this point, it becomes necessary to distinguish between cost accounting and the estimation of costs. Cost accounting deals with the recording and summarizing of incomes and expenses of an enterprise while estimation of costs is calculation of actual costs of performing a certain job. The costs of owning and operating farm machinery can be divided into two categories, viz:

a) Annual fixed costs, which occur regardless of machine use; and
b) Variable costs, which are related to the amount of machine use.

Fixed (Ownership) Costs.

Fixed costs are often called ownership costs because they are charged regardless of machine productivity. Fixed costs of a machine include those incurred due to depreciation, interest (opportunity costs), taxes, insurance, housing, and maintenance facilities.

Depreciation

Depreciation is a cost resulting from wear, obsolescence, and age of machinery. It is the gradual and permanent decrease in the value of a machine due to any of the reasons mentioned above and is not affected by the number of hours of machine use. Two informations are needed to estimate annual depreciation costs: an economic life for the machine and a salvage value for machine at the end of its economic life. The economic life of a machine is the number of years for which costs are to be estimated. It is usually less than the machine's service life because most farmers

trade in a machine for a new one before it is worn-out. But the economic life for the purchaser of a used machine is the period between purchase and wear-out.

A good rule of thumb for our conditions is to use an economic life of 5 to 6 years for most farm machines (Implements) and a 8-years economic life for tractors unless you know when you will trade in. Salvage value is an estimate of the value of the machine at the end of its economic life. It is the amount an owner expects to receive for a trade in, or an estimate of the used market value if you expect to sell the machine out -right, or scrap value if you plan to use the machine till it is worn out, or zero if you plan to retire and keep the machine on the farm. Table 1, gives the estimates of remaining value of farm machines at the end of the economic life selected as used in other countries. The average annual depreciation can be calculated from equation 1 below:-]

$$\text{Depreciation} = \frac{\text{Purchase price-Salvage Value}}{\text{Economic life.}} \quad (1)$$

Interest/Opportunity Cost

If you borrow money to purchase a farm machine the lender or bank from which you borrow will determine the interest rate to charge. But if you use your own capital, the rate to charge will depend on the opportunity cost for that capital elsewhere in your own farm business. Inflation reduces the real cost of investing capital in farm machinery. The interest rate can be adjusted for inflation by subtracting the expected rate of inflation from the initial interest rate. Interest is calculated as follows:

$$\text{Interest} = \text{Rate} \times \frac{(\text{Purchase Price} + \text{Salvage Value})}{2} \quad (2)$$

Taxes, Insurance and Housing (TIH)

These costs need to be considered as part of the fixed costs of owning an agricultural machinery. Machinery is normally insured against loss or other hazards. Current local survey of banks and insurance companies indicate an average insurance rate of 5 percent (of purchase price of machine) for agricultural machines in the country can be estimated at about 1 percent of the initial cost of the machine. As there is no tax on agricultural machinery in the country tax should be considered as zero percent of the purchase price of any machine.

To simplify calculating TIH costs, they can be lumped together as 6 percent of the current list price (equation 3).

$$\text{TIH} = 0.06 \times \text{Current cost price} \quad (3)$$

Total Fixed Costs:

The estimated costs of depreciation, interest, taxes, insurance and housing are added together to find total fixed costs.

Variable (Operating) Costs:

Variable costs increase proportionally with the amount of use of the machine. They include repair and maintenance, fuel, lubrication, operator labour, and tractor cost (if machine is not self-propelled).

The true values of these costs will not be known until the machine has been disposed of and then only if accurate records of expenses incurred were kept throughout the machines life. But the costs can be estimated if a few assumptions about machine life, annual use, and the future rate of

inflation are reasonably accurate. The information in this bulletin will be useful for estimating farm machinery costs. A worksheet is designed as in appendix A to summarize the information needed to estimate farm machinery costs and to actually calculate cost estimates for a sample problem.

Repairs and Maintenance

These are necessary to keep a machine operable. The cost of repairs and maintenance is closely related to the amount of use, the manner of operation and the type of farm. Repairs and maintenance costs for a particular type of machine vary widely from the geographic region to another because of soil type, terrain, climate, etc. Even within a local area, these costs vary from farm to farm because of different management practices and operator care.

The best data for estimating costs are records of past repair expenses. If you are not keeping these cost records, you should start doing so now. Records indicate whether a machine has had above or below average repair costs and when major overhauls may be needed. They also provide good information about your maintenance programme and your mechanical ability.

The best way to estimate these costs (herenow referred to as repair costs) if you do not keep your own records is from standard data available in the literature. The graphs in figure 1, 2 3 and 4 will help you estimate average repair costs. The graphs show the relationship between the sum of all repair costs for a machine and the total hour of use during its life time. The total accumulated repair costs are a percent of the current list price of the machine as were the on farm remaining value estimates listed

in Table 1. Notice the shape of each graph. The slope of all curves increases as the number of hours of use increases. This indicates that repair costs per hour are small in the early life of a machine and increase as the machines have more hours of operation. The curves for some machines have much lower slopes than the curves for other machines, indicating a slow, continous increase in repair costs throughout the life of the machine. The steep curves, such as for a planter, indicate a rapid increase in repair cost per hour early in the life of the machine, and then almost a constant high rate after that.

Fuel

Fuel costs can be estimated by two methods. First if you have a knowledge of the fuel consumption rate in gallons or litres per hectare for all the field operations you wish to perform, then those figures can be multiplied by the fuel cost per gallon or per litre to obtain the average fuel cost per hectare. And fuel cost per hectare can be multiplied by the hourly work rate of the machine in hectares por hour to calculate fuel cost per hour. For example, if average fuel required to harvest corn (maize) is 10 litres of diesel fuel per hectare and fuel cost is 45 kobo per litre then:

Average fuel cost per hectare = 10 litres/hectare x N0.45/lt = N4.50/hectare.

If 1.2 hectares of crop are harvested per hour, average fuel cost per hour = 4.50/hectare x 1.2 hectares/hour = N5.40/hour.

average fuel consumption for farm tractor on a year round basis without reference to any specific implement can also be estimated using the equations below.

Average gasoline, gallons/hour = 0.06 x maximum pto horsepower
Average gasoline, litres/hour = 0.306 x max PTO Kilowatt
Average diesel, gallons/hour = 0.044 x maximum PTO horsepower.

or

Average LP-gas, litres/hour = 0.367 x max, PTO Kilowatt.

Lubrication:

Oils and grease for lubrication are also to be costed. Surveys indicate that total lubrication costs on most farms average about 15 per cent of fuel costs. Therefore once the fuel costs per hour are known you can multiply it by 0.15 to estimate total lubrication costs (equation).

Labour:

Labour costs vary from farm to farm and from one location to another. Its costs also depends on type of operation to be performed. Labour cost is an important consideration in comparing ownership to custom hiring of machines.

Because of the time required to lubricate and service machines before starting work as well as time delays in getting to and from the place of work, actual hours of labour usually exceed field machine time by 10 to 20 percent. Consequently, labour costs can be estimated by multiplying the labour wage rate by 110 to 120 per cent of the machine hours used for a particular operation.

Total Variable Costs:

Repair, fuel, lubrication and labour cost are added together to calculate total variable costs.

Total Costs:

After all costs have been estimated the total fixed cost per year can be divided by the total hours of operation per year to calculate fixed cost per hour.

3.0 Step-By-Step solution to a sample problem -Tractor.

Calculate the cost of using a 70kw (kilowatt) power diesel tractor which had a list price of N200,000 but dealer discounts reduced the actual purchase price by 10 percent of the list price (N180,000). An economic life of 3 years and an interest rate on the investment of 12 per cent is selected. The tractor was used 500 hour per year, diesel fuel costs 45k per litre, and the operator was paid N4.00 per hour.

Solution

Fixed Costs:

Depreciation:

Current list price = N200,000, purchase price = N180,000 and economic life 8 years. From table 1, a salvage value of 34.9 percent of the list price, or N69,800 is predicted at the end of 8 years. This figure is entered at life 1 on the worksheet (Appendix A). Then using the formula for depreciation, (Equation (1) above); we have:

$$\text{Depreciation} = \frac{\text{N180,000 - 69,800}}{\text{8 years.}} = \text{N13,775/year.}$$

This value is entered at line 2 on the worksheet.

Interest

Lets assume for our example an annual inflation rate of 2 percent. The initial interest rate given was 12 percent, so that the adjusted or real interest rate is 10 percent (i.e. 12 -2 percent). After you have determined the interest rate to charge, the average annual interest cost is determined by multiplying your average investment in the machine over its economic life by the interest rate (equation 2):

$$\text{Interest} = \frac{0.1 \times (\text{N}180.000 + \text{N}69,800)}{2}$$
$$= \text{N}12,490/\text{year}.$$

These calculations are entered at lines 3 and 4 of worksheet.

Taxes, Insurance and Housing (TIH)

From equation (3):

$$\text{TIH} = 0.06 \times \text{N}200,000 = \text{N}12,000/\text{year}.$$

Total Fixed Costs:

The estimated costs of depreciation, interest, taxes, insurance and housing are added to obtain the total fixed cost. This was done for our tractor example on line 6 or the work sheet, resulting in a total fixed cost

of N38,265/year. This is over 20 percent of the original cost of the tractor. If the tractor is used 500 hours per year.

$$\text{Fixed cost/hour} = \frac{\text{N58,265}}{\text{500 hours}} = \text{N76.53/hour}$$

But, if the tractor is used only 300 hours per year.

$$\text{Fixed cost/hour} = \frac{\text{N38,265}}{\text{300 hours}} = \text{N127.55/hour}$$

The total annual fixed cost of N38,265 per year does not change. But fixed cost per hour increase when annual use is decreased. A wise machinery owner should therefore aim at high annual usage of his machines.

Variable Costs:

Repairs and Maintenance

Two examples will illustrate how to calculate the repair cost per hour for the N200,000 tractor. Because the tractor will be used about 500 hrs per year, it will have accumulated about 4000 hrs. of operation by the end of its 8 year economic life (see line 7 on the worksheet). Follow the line from the bottom axis at 4000 hours up to the curve for 2 -wheel drive tractors, then follow the horizontal line to the left axis, intersecting at 19 percent. So, total accumulated repair = 0.19 x N2000,000 = N38000 for 4000 hours.

This is entered in line 8 of the worksheet of Appendix A.

Average repair cost per hour can be calculated by dividing total accumulated repair by the total accumulated hours (line 9 of the worksheet).

$$\text{Average repair cost/hour} = \frac{\text{N38,000}}{\text{4,000 hours}} = \text{N9.50/hour}$$

For our second example use a N600,000 combine harvester (self propelled unit only) that will harvest at a rate of 1.2 hectares of maize crop per hour, what is the average repair cost per hectare of using the self-propelled unit if 250 hectares of maize will be harvested each year for 8 years.

$$\text{Total hours of use} = \frac{\text{250 hectares x 8 years}}{\text{1.0 hectares/hour}}$$

$$= \text{1667 hours.}$$

Follow the line vertically at 1,667 hour to the curve for self - propelled combine and then horizontally to inter-sect the left axis at 34 percent. Total accumulated repair cost = 0.34 x N600,000

$$= \text{N204,000 for 2000 hectares}$$

$$\text{(1,667 hours)}$$

$$\text{Average repair cost per hectare} = \frac{\text{N204,000}}{\text{2,000 hectares}}$$

$$= \text{N102.00/hectare.}$$

Repair costs increase as a machine accumulates hours of use, so the average repair cost per hectare for the last 100 hectares harvested should be higher than N102,00/hectares, proceed as follows:

Accumulated hours for 2,000 -400 hectares at 1.2 hectares/hour

$$= \frac{2000,400 \text{ hectares}}{1.2 \text{ hectares/hour}} = 1,333 \text{ hours}$$

Total accumulated repair costs for 1,333 hours = 24 percent of list price.

Total accumulated repair costs for 1600 hectares = 0.24 x N600.00= N144,000.

Total accumulated repair cost for 200 hectares was N204,000. Therefore the expected repair cost per hectare for the last 400 hectares harvested would be

$$= \frac{204,000 - 144,000}{400 \text{ hectares}} = \text{N150,00/hectare}$$

Fuel:

Average diesel fuel consumption (litres/hour) = 0.223 x 70= 15.61 litres/hour.

Average fuel cost per hour = 15.61 litres/hour x N0.45/litre = N7.03/hour

This figure is entered in line 10 of the worksheet.

Lubrication:

Average fuel cost was 7.03/hour, so average lubrication cost is:

0.15 x N7.03/hour

= N1.06/hour

This figure is entered in line 11 of the worksheet.

Labour:

A labour charge of N4,00/hour is assumed for example: Therefore, average labour cost per hour = N4.00/hour x 1.10 = N4.40.

This cost is entered in line 12 of the worksheet.

v) Total Variable Cost:

Repair, fuel, lubrication and labour costs are added together to calculate total variable costs (line 13).

vi) Total Costs:

After all costs have been estimated the total fixed cost per year can be divided by the total hour of operation per year to calculate fixed cost per hour.

In line 14 of the worksheet, for the tractor example, fixed cost per hour is N76,53 per hour. The fixed cost per hour can be added to variable cost per hour to calculate the total cost per hour to own and operate the tractor or machine (line 15 on the worksheet). Total cost per hour for our tractor example was N98,52.

4.0 Step-By-Step solution to a sample problem-Implement

Costs for implements or attachments that depend on tractor power are estimated in the same way as in the tractor example except that there are no fuel, lubrication, or labor costs. Tractor costs must be added to the implement costs to determine the total cost per hour of operating the machine. Total costs are added together at line 16 of the worksheet to give a combined cost per hour of N14.85.

Finally, total cost per hour can be divided by the hourly work rate in hectares per hour or tonnes per hour to calculate total cost per hectare or per tonne (line 17 on the worksheet). In the example, this value is N140.85 per hour divided by 2.8 hectares per hour to obtain N65.34 per hectare.

Costs for operations involving self-propelled machines can be calculated by entering values for the self-propelled unit in the first column of the worksheet, and values for the harvesting head or other attachment in the second column.

5.0 Step-By-Step Soluton to a sample problem -Used machinery

Many agricultural machines are bought second-hand. Costs of owning and using such machines can be estimated by using equations and tables already given in the same manner as for new machinery. The fixed costs of used machinery will usually be lower because the original cost of the machine will be lower. Repair costs will usually be higher per hour because of the initial hours of accumulated use by the previous owner. The secret

of success of used machinery is to balance higher hourly repair costs against lower hourly fixed costs. As an example of estimating cost for a used machine, suppose you just bought a 4.0 metre Rome disk harrow that was 4 years old for N10,000. You do not know its hours of accumulated use. What is the estimated total cost of owning and operating the disk harrow for another additional 4 years if it will be used for about 50 hours per year at 2.89 hectares per hour?

Since you do not know for sure the total hours of accumulated use, you can estimate it by multiplying its age (4 years) by your own expected annual use (50 hour per year), or 200 hours. From table 1, estimated solvage value at the end of 8 years (4 + 4 years) is 22.6 percent of the current list price. Current list price for a new Rome disk harrow is estimated at N30,000.

Salvage value = 0.226 x N30,000 = N6,780

$$\text{Depreciation} = \frac{\text{N10,000 - 6,780}}{4} = \text{N805,00}$$

$$\text{Interest} = 0.10 \times \frac{(\text{N10,000} + 6780)}{2} = \text{N839.00}$$

Taxes, Insurance and Shelter (TIH) = 0.01 x N30,000 = N300,00

Total fixed costs per year = N1944.00

If the disk harrow is used an average of 50 hour per year then.

$$\text{Fixed cost per hour} = \frac{\text{N1944}}{\text{50 hours}} = \text{N38.88/hour}$$

To estimate average repair and maintenance costs, termed as repair costs, use Figure 2. On the "hour" axis locate 200 hour, the estimated

accumulated hour of use on the disk when you bough tit. Follow the line up to the heavy or tandem disk curve (Since example disk is heavy Rome Harrow) and over to a total accumulated repair cost of 2 percent. Now, if you use the disk for 50 hour per year for 4 years you will accumulate 200 additional hours, for a total use at the end of 8 year of 400 hours. From 400 hour follow the lines up and over to an accumulated repair cost of 4.3 per cent. Accumulated repair cost during the next 4 years.

$$= \quad (0.43 - 0.02) \times N30{,}000$$

$$= \quad 0.023 \times N30{,}000 = N690.00$$

$$\text{Average repair cost/hour} = \frac{N690.00}{200 \text{ hours}}$$

$$= \quad N3.45.$$

As other variable costs, such as fuel, lubrication, and labour, have already been included in the variable cost for our tractor example, the total cost per hour for owning and operating the disk is simply the sum of fixed costs per hour and the repair cost per hour, or N42.33 for this example.

When estimating future costs for a machine that you have already owned for several years, enter your best estimate of the current market value of the machine in line (b) of the worksheet instead of its original purchase price.

6.0 ADjusting For INflation:

When inflation exists in an economy, costs of owning and using farm machinery must be adjusted for inflation. The figures obtained and summarized from surveys and Research data elsewhere are presented to help a farm manager estimate machinery costs for future years with inflation.

Several inflation rates are listed in the table to allow any farm manager to select the rate that he believes is most likely to occur. Simply estimate costs as before, then multiply by the adjustment factor..

An example will illustrate how to use the figures. In our tractor example, an estimated total cost of N98.52 per hour was obtained. If we expect an inflation rate of 7 percent/year, then the adjustment factor for the sixth year is 1.50. The total cost for the tractor in 6 years will be equal to 1.50 x N98.52/hour or N147,78/hour. Remember, this is still the average cost per hour over the economic life of the average cost per hour over the economic life of the tractor. It has simply been inflated at a rate of 7 per cent per year for 6 years.

Adjusting machinery costs for inflation can help predict what custom rate to charge each year to cover total costs and much capital will be needed to replace a machine in the future.

Note: Negligible or no change in machinery costs may be assumed for 1, 2, 3 and 4 percent inflation rates not given.

Repair costs can also be adjusted for inflation rates. In our combine harvester example (self propelled unit only) a total repair costs during the eight years of ownership of N204,000 or N102.00 per hectare was obtained. If a 5 percent rate of inflation is assumed for repair parts and

labour over the next 8 years an adjustment factor of 1.48 is obtained. The expected repair costs during the eighth year would be 1.48 x N102.00/ hectare or N150.96 per hectare.

Appendix A
Worksheet for estimating farm machinery costs

Note: If annual use in hr is not know, it can be calculated by dividing total ha or tonnes per year by the hourly work rate of the machine in ha/hr or tonnes/hr. The hourly work rate is also needed in line 17 to convert cost/hr to either cost/ha or cost/ton.

** The values so obtained from figures 1-4 and the table contained may be lower or higher under Nigerian conditions but are generally used as averages for estimating farm machinery costs.

7.0 CONCLUSION

The need to improve farm productivity and person and machine through keeping good information on operating costs is stressed. Detailed determination (Step-by-Step procedure) of costs involved in the use of tractor, implement and used machinery is given. It is hoped that such information will assist farm machinery owners and agricultural mechanization extension agents on how to determine the various costs involved in owing and operating farm machinery.

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