
Economics of Tractorization for Tillage Operations in Agricultural Productions: Case Study of Kwara, Oyo, Kogi, and Niger States.

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Abstract

A field survey was conducted to determine the appropriateness of the existing tractors in agricultural production in Nigeria in the following locations: Kwara, Oyo, Kogi and Niger states. Results indicate that the average size of the tractors in use is 74.44 hp (55.5 kW) on an average of 156 ha of arable crops per annum with an average of 0.67 hp/ha (0.5 kW/ha) as power input per hectare. Results also revealed that no small sized tractors are currently in use, an indication that the tractors of 45 hp (33.5 kW) and less are fast disappearing from Nigeria agricultural productions. Contrary to expectations, heavy tractors of more than 86 hp (63.3 kW) are gradually becoming popular. The result also indicates that the tractors were used for average of 523.51 hours annually. The results indicated that the tractors have low annual usage, with high overhead costs. Study also showed that only tillage and haulage operations are tractorized.

1. Introduction

Nigeria is located between latitude 4°N and 14°N and longitude 2.5°E and 14.5°E in West Africa. It has a land area of about 923,769km² (Musa and Choudhury, 1984). With its six different vegetation zones, Nigeria produces several diverse crops and has a great potential for agricultural improvement through mechanization which can lead not only to self-sufficiency but exportation of several of crops as well. There is a continuous widening of the gap between food demand and production. This is the most significant and disturbing feature of Nigeria's agricultural sector although it is a prime sector of the country's economy, second only to the petroleum sector. The key to the nation's economy or economic growth, therefore, should be to raise the productivity of the agricultural sector irrespective of how viable any or all other sectors of the economy may be in order to conserve foreign exchange.

The agricultural revolution that is taking place in most developing countries including Nigeria calls for considerable change in agricultural production technology. Over 80% of the cultivated area in Nigeria is tilled and farmed using hand-tool and traditional implements. The area a farmer can cultivate annually is inherently limited to about 2ha to produce what barely suffices to feed his family. Advocations of hand-tool technology for agriculture amounts to virtual enslavement that condemns a large group of Nigerians to perpetual poverty (Odigboh, 1991). Animal-draught power in the form of a pair or team of work bull; oxen or even donkey is used to some extent by farmers in the northern parts of Nigeria. There, it certainly provides some relief, albeit marginally, from toilage inherent in field operations. Animal-draught technology is becoming increasingly unrealistic in Nigeria where it is faced with many serious limitations (Odigboh, 1991).

Considering all the factors involved, power mechanization will most likely be the appropriate technology package for agricultural intensification programmes in Nigeria. All real stake holders genuinely interested in the welfare of Nigeria and Nigerians, must acknowledge that the war against hunger and scarcity of agro-industrial raw materials is too complex and too sophisticated for the armament of hoes and diggers in the hands of the army of aged and ageing peasant farmers or yoked behind malnourished mules, oxen and donkeys (Odigboh, 1991).

According to Hunt (1973) and William Edwards (2009), machinery costs are divided into two categories, fixed costs and variable costs. Fixed costs include the cost of interest on the machinery investment, taxes, housing and insurance that are dependent on calendar year time and independent of use. Variable costs include cost of fuel, lubricants, daily service and maintenance, power and labour ; they are clearly costs associated with use. Hunt (1973) also reported that costs relating to farm machinery operations can only be estimated and therefore, time should not be spent in using complex depreciation methods. He suggests that the straight line depreciation method is most reliable for cost approximations. Kolawole (1972) reported that the tractors' average annual working time was 535h each which was quite low compared to 1,400 hours in Ethiopia during 1967 and 1,500hours in Kenya during 1965-66. Low annual use resulted in high cost per unit of work. The tractors usually remained idle due to frequent breakdown, lack of spare parts and trained mechanics. Kolawole (1974) also reported an increase of 64% in area cultivated after the introduction of tractors from 1970 to 1973. Some 66% of all the tractor owners did custom work due to the small size of their farms seasonability of the work and for earning additional income. Chaudhry (1976) reviewing the situation of mechanization reported that big

tractor of 40 to 60hp have benefited only the big farmers owning farms 50acres and above. He suggests the introduction of multipurpose power tillers on a massive scale for benefiting 98% of the small sizes of 2 to 25 acres. Power tillers can be used effectively and efficiently for all field operations and transportation. Chancellor (1968) concluded that small tractors are more appropriate for small size of farm. However, considering the cost on the basis of work done, the big tractor was more economical than the smaller tractor as cost per rated horse power hour for the later was higher. He suggested that the contractors doing custom hire work should own large tractors and that small farmers requiring relatively little annual tractor work should get it done through custom hiring as it would be more economical than owning even a small tractor.

Moses and Frost (1965) concluded from survey of 358 tractors that the largest tractors were the most expensive to operate on the basis of cost per hour. They were the cheapest to operate, however, from the stand point of cost per horse power; hence it is economical to use a large tractor where sufficient work is available. Babatunde (1995) concluded that full mechanization of grain production in Nigeria is only profitable under machinery ownership for minimum farm size of about 50ha. Farms under 50ha should only be fully mechanized using custom hire of machineries. While custom hire should aim for an output of over 100ha per year for minimum operational costs of machinery. He also found that unless intensive use of tractors for purposes other than field work, transporting and processing are encouraged, the over head cost of tractor use will remain very high for both machinery ownership and custom hire.

1.1 Objectives

The objectives of the work reported in this paper were to study the existing mechanization structures in Nigeria based on machines and implements used for land preparation; analyze the economy of imported mechanization equipment; and to select appropriate machines and implement for agricultural productions based on the existing mechanization structures in Nigeria. Such information would be useful in making management decisions.

2. Materials and Methods

For the purpose of determining the appropriate tractorization for the mechanization of tillage operations of Nigeria Agricultural Productions, a questionnaire was designed to collect data from the available farm records and information from tractor owners, farm managers and the tractor operators from Kwara and parts of neighbouring states of Oyo, Kogi and Niger. The questionnaire was designed to collect data such as; Name and Address of establishment that own farm tractors; year of purchase and purchase price of such tractors; the origin models and makes of the tractors; total hectare covered by each tractor annually; the rate of fuel consumption per hectare by the tractor; the costs of lubricants, repair and maintenance per annum; the implements commonly used with the tractors (their origin, cost of purchase, number of bottom and width of each bottom); and the average size of individual farm. A copy of the questionnaire is as shown in Appendix 1.

The straight-line depreciation method was used to calculate annual fixed cost assuming ten years life and ten percent (10%) salvage value. Annual interest rate of 11 percent, which is commonly chargeable for Agricultural purposes and taxes and shelter charges at 1 percent(1%) of purchase price are added to depreciation, to make a single percentage of purchase price as annual ownership cost.

$$D = \frac{P - S}{L} = \frac{P - 0.1P}{L} = 0.09P \quad (1)$$

$$I = \frac{P + S}{2} \times 0.11 = \frac{P + 0.01P}{2} \times 0.11 = 0.06P \quad (2)$$

$$\text{Taxes and Shelter} = 0.01P \quad (3)$$

where,

P = purchase price

S = salvage value (0.1P)

D = Annual depreciation

L = Life of machine (10 years for tractor).

I = Annual interest

Therefore, total fixed cost or ownership cost per annum is equal to 0.16P or 16 percent of the purchase price. The cost of fuel consumption was calculated based on N64.00 per liter of diesel in the year 2004 and added to lubricants, repair and maintenance costs.

The annual hours of usage of tractors was calculated as shown below:

Effective field capacity of a machine, which is the actual field coverage achieved by a machine is given by:

$$C = \frac{Swe}{10} \left(\frac{ha}{hr} \right) \quad (4)$$

where,

s = Speed of operation, km/hr

w = Width of implement, m

e = Field efficiency

Time, T, to cover one hectare is the reciprocal of C: i.e.

$$T = \frac{1}{C} = \frac{10}{Swe} \quad (5)$$

Equation 5 was multiplied by a given number of hectares to obtain time in hours to cover a given number of hectares. The width of the implement commonly used with the tractors in the surveyed area is as shown below:

Plough	=	0.9 m
Harrow	=	1.7 m
Ridger	=	2.3 m (2 rows)

ASAE D230.4 (ASAE, 1986) were used for calculating field capacity and hence time to cover one hectare by the tractors for each operation.

3. Results and Discussion

3.1 Results

Table 1 shows the tillage operations commonly performed in the study area; width of implements used as measured and speed and field efficiency of each operation from ASAE data.

Using the data in Table 1 and substituting into equation 4, the hours of use for each operation was calculated as shown in the Table 2 and hence annual hours of usage.

Table 3 shows the distribution of tractors in the surveyed area by horse power, hectareage covered and average annual hours of usage. The average values were indicated in brackets.

3.2 Discussion

Results in Table 3 indicate that 81.25% of the tractors in use in the surveyed area have their power rating between 45 and 75 hp (33.5 - 55.9 kW). The tractors in the range of 45 – 65 hp (33.5 – 48.4 kW) highest modal classes covered 2091 hectares with an average annual hours of use of 483.82 hours. The tractors in the range of 86 hp (64.07 kW) and above covered 1546 hectares with an average annual hours of usage of 722.31 hours. The above results showed that the power rating of the tractors should be matched with job availability, thus smaller tractors are more economical when not much job is available.

Table 3 also revealed that no small sized tractors are currently in use, an indication that the tractors of 45 hp (33.5kW) and less are fast disappearing from Nigeria agricultural productions. Contrary to expectations, heavy tractors of more than 86 hp (63.3 kW) are gradually becoming popular. The results of table 3 also indicated that the average annual hours of usage is 523.51 with standard deviation of 264.85. The results indicate that the economy in mechanization had not been realized. It also revealed that the benefits of increased annual use and reduced annual costs had not been realized by the tractor owners and they were keeping their tractors idle unnecessarily, there has been limited tractorization of farm operations.

4. Conclusions

The following conclusions could be drawn from the study;

1. Big tractors of 47-126 hp of an average horse power of 74.44 hp (55.5kW) were in use on an average of 156.72 hectares with an average of 523.51 annual hours of usage per tractor.
2. The economy of mechanization which is assisted by uniform easy-working soils and good sized fields of regular shape had not been realized.
3. The benefits of increased annual use and reduced annual costs had not been realized by the tractor owners and they were keeping their tractors idle unnecessarily, because there had been limited tractorization of farm operations.
4. Majority of the tractors in Nigeria were imported from America, Asia and Europe. These tractors are suitable for use on large farm lands with uniform and easy-working soils, conditions that are very rare in Nigeria; hence Nigeria agriculture should try out smaller tractors for reasons of lower operating hours and farm holding sizes.

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Table 1: Operation type, width of implement, speed of operation and field efficiency.

Operation	Width of implement (m)	Speed of operation (km/hr)	Field efficiency (e)
Plowing	0.9	7.0	0.85
Harrow	1.7	8.0	0.85
Ridging	2.3	5.5	0.80

Table 2: Results of computation of field capacity

Farm operation	Time to cover one hectare (hr/ha)
Plowing	1.867
Harrow	0.865
Ridging	0.988

Table 3. Distribution of tractors in the surveyed area by horse power, hectareage covered and average annual hours of usage

Size (hp)	Number of Tractors	Distribution by Size (%)	Hectarage Covered (ha)	Annual Hour of Usage (hours)
< 45	0	0	-	-
45 - 55	3	9.375	230	855.60 (285.20)
56 - 65	14	43.750	1981	7369.15 (526.37)
66 - 75	9	28.125	1218	4769.04 (529.89)
76 - 85	1	3.125	40	148.80
> 85	5	15.625	1546	3609.51 (721.90)
Total	32	100	4765	16752.30 (523.51)

APPENDIX 1 QUESTIONNAIRE

This questionnaire was designed to obtain some information from you as part of post graduate research work in Agricultural Engineering Department of the University of Ilorin. The works are at studying the Economy of tractor usage and some basic tillage implements in Nigeria Agricultural Productions.

Full Name of organization/individual:

Address:

Qualification of personal responding:

Post held:

SECTION A GENERAL INFORMATION ABOUT TRACTORS

1. The Origin of the tractor is:
2. The model of the tractor is:.....and the make is.....
3. The horse power of the tractor is:
4. The year of purchase is:
5. The cost at purchase is:
6. Is the tractor still in use? Yes or No
 - a. If yes, what are the years of being in service:.....
 - b. If No, what was the life span of the tractor:.....

SECTION B TRACTOR PERFORMANCE PER ANNUM

1. Government owned tractors
 - a. The hectareage covered by the tractor per annum is:

- b. Cost of tillage per hectare is:
.....l/ha
 - c. The rate of fuel consumption is ;.....l/ha
 - d. The lubricant cost is :annum
 - e. The cost of repair and maintenance carried out on the tractor per annum
is:.....
 - f. Do you engage your tractor(s) in hired work? Yes or No (Tick appropriately).
 - g. If yes , what is the hectarage covered on hired work per annum
:.....
 - h. What is the cost of tillage operation per
hectare:.....N/ha
 - i. You may wish to give detail and amount of other expenses incurred in the tractor per annum:
2. **INDIVIDUAL/COOPERATIVE OWNERSHIP HIRING SERVICES**
- a. The size of your farm land is :ha
 - b. How many tractors are at your disposal?.....
 - c. The cost of tillage operation(s) per hectare is:
.....
 - d. The rate of fuel consumption is:annum
 - e. Lubricant cost is:annum
 - f. Cost of repair and maintenance per annum is:
.....
 - g. Do you engage the tractor (s) on hire work? Yes or No (Tick appropriately)
 - h. If yes, what is the hectarage covered on hired work per annum :
.....ha
 - i. What is the cost of tillage operation per
hectare:.....N/ha
 - j. What is the average size of individual farm?
.....ha

SECTION C

IMPLEMENTS USED WITH THE TRACTOR

1. Which of the following three basic implements do you use on the farm?
A. **PLOUGH** (B) **HARROW** (C) **RIDGER**
(Tick appropriately)
- A. **PLOUGH**
 1. The origin is:
 2. The cost of purchase is:.....m
 3. Number of bottoms is:
 4. Which of each bottom is.....m
- B. **HARROW**
 1. The origin is:
 2. The cost of purchase is:.....m
 3. the width of the harrow ism
- C. **RIDGER**
 1. The origin is:
 2. The cost of purchase is:.....m
 3. The width of the harrow ism
4. Give the list any other implement(s) you use and not mentioned above and quantity of job done per annum
in N.....
5. You may wish to give any other relevant information that can assist the
researcher.....