

COMPARISON OF REPAIR COSTS OF TWO WHEEL DRIVE TRACTORS UNDER TANZANIAN CONDITIONS

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The repair costs of 2WD tractors were investigated in order to provide important information, which lacks in the scope of agricultural mechanization in Tanzania. Previously repair cost functions established for tractors in developed countries were used for both theoretical and practical purposes. The findings of this study have revealed that repair costs of tractors vary substantially from one make to another. The prediction functions developed in this study indicated that the magnitudes of repair costs in Tanzania are higher than the repair costs established in Europe and North America. The reason for this could be either due to high cost of imported spare parts or due to high frequency of failure resulting from the use of untrained tractor operators or probably the repair and maintenance manuals provided by manufacturers are not appropriate to some of the operating conditions.

Keywords: Tractor, Repair, Comparison, Cost, Mechanization

INTRODUCTION

Agriculture in Tanzania has been the major source of the country export earnings. It provides the local industries with raw materials and supplies food for the growing population. However agricultural production is still very low. Over the past 30 years, the growth in agricultural production has averaged to 2%, whilst during the same period the country imports food at a rate of 7% per year (IBRD, 1989). In order to reverse this situation agricultural production in Tanzania needs to be increased. This can be achieved by either increasing the area under cultivation or by use of modern technologies that are geared to increase the output per unit area. Although the use of modern technologies is still low in Tanzania, the adoption rates of these technologies have been reported to be higher than that of increasing the area under-cultivation (MALD, 1991). On other hand the

overall agricultural production depends greatly on bringing more land under cultivation.

Tanzania has a big potential in agriculture as reflected in its favourable man to arable land ratio, diverse agro-climates, and substantial untapped and under-utilised resources in crop and livestock production. There are 45 million hectares of arable land in Tanzania, but only 10% of these are currently under cultivation (MALD, 1991). Suppose that the area under cultivation is tripled and the use of modern technologies is maintained, then the country should be able to feed her-self and produce enough food and cash crops for export.

To use this enormous potential, the country needs to expand and improve mechanised agriculture at all levels of power sources. However tractorization (mechanical power) has been observed to be limited due to a number of problems. Among them the frequency of repairs have been observed to be one of the

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crucial problem. UNIDO (1983) and FAO (1995) reported that about 45 to 60% of the total tractor population in the country were out of use due to repair problems.

This could be due to lack of any approved management information package suitable for the country conditions. As a result machinery has been operated blindly resulting in heavy losses of high investment costs. Provision of information on prediction of the frequency of repairs and repair costs could be one of the important measures to assist farmers in reducing the existing problems. This has also been aggravated by the lack of literature published on the subject in Tanzania. Better understanding of repair pattern is very crucial for a farmer owning a tractor because it can be easier for the farmer to budget before hand and even schedule repair operation in order to reduce the time taken out of field. Bohm (1993) reported that large saving of machinery costs could be made in repair costs than in costs of fuel and lubricants if unnecessary break down can be avoided or if the extent of breakdowns can be reduced by repairing primary damage at an early stage.

This work was therefore undertaken to provide this missing information that could also be used for estimation of the annual costs of using tractors and determination of the optimum replacement period of tractors in Tanzania. The major objectives were:

1. To investigate skills of tractor operators in Tanzania.
2. To develop repair cost prediction functions for different makes and groups of 2WD tractors.
3. To compare the magnitude of repair costs of these tractors and those established in other countries.

MATERIALS AND METHODS

Data were collected from 12 large-scale farms and 19 small-to-medium scale farmers in Morogoro, Iringa, Tanga, Kilimanjaro and Arusha regions in Tanzania. The data collected include tractor makes and models, year of purchase, purchase price, power ratings, repair history and its costs, hours of use and operator's information. The recorded data from large-scale farms were collected from the past records, whilst data from small-to-medium scale farmers were collected by interviewing the respondents, who relied mainly on recalling because none of them keep records. Operator information was obtained by interviewing the tractor drivers, but sometimes the person in-charge or tractor owners were consulted to countercheck for the correctness of the given information.

In total, data for 96 2WD tractors were collected from large-scale farms, whereas data for 25 2WD tractors were collected from small-to-medium scale farmers. The data for the 2WD tractors owned by large-scale farms were categorised into 4 groups based on tractor makes, namely Massey Ferguson, Case International, Ford and Same. Tractors owned by small-to-medium scale farmers were not categorised because the number of tractors in this group was too small to permit a meaningful statistical analysis. The number and the average power rating of tractors for each group considered in this study are shown in Table 1. All costs involved in the analysis were adjusted to the base year 1996 in order to take care of the effect of inflation (Blank and Tarquin, 1976; Hunt, 1983; Morris 1988). The year 1996 was chosen as a base year because this research work was initiated in that year.

Table 1: Tractor groups

| Tractor group | Units | Average power (kW) | Average annual use (h) |
|--------------------|-------|--------------------|------------------------|
| Massey Ferguson | 42 | 62 | 920 |
| Case International | 19 | 64 | 730 |
| Ford | 22 | 58 | 860 |
| Same | 13 | 52 | 1020 |
| 2WD - SMSF | 25 | 52 | 660 |

Repair costs are defined as those expenses necessary to restore or maintain technical soundness and reliability of the machine (Morris, 1988; Wendl, 1991). They include the sum of spare parts and labour costs. However data collected in this study was for the costs of spare parts only because data on labour costs was not available. However during data collection most of farmers estimated labour costs to be about 6% of the spare part costs. This value was reasonably close to the value of 4% established in Burkina Faso (Kando and Larson, 1990).

Repair costs of tractors could be best established by studying each tractor over a period of time. But using such a method it would require observing each tractor for a number of years to obtain the historical data before the repair cost functions are established. Since the repair costs of tractors were to be determined within a time limit, the method used by Ward et al., (1985) and Wendl (1991) was used in data processing. This is because the method has an advantage of establishing the repair cost information within a short time period.

The method involves the following steps. First, tractors are grouped accordingly (in this case, 2WD tractors owned by large-scale farms to include a group of Massey Ferguson, Case International, Ford and Same and the other group of 2WD tractors owned by small-to-medium scale farmers). Secondly tractors in each group are classified into different tractor age. Then for each age the average annual hours of use and average repair costs are

computed. Thereafter the series of average accumulated hours of usage and the accumulated repair costs for each group of tractors are determined. In the end, curves indicating the relationship between the average accumulated repair costs as the percentage of the purchase price versus the average cumulated hours are plotted. The repairs cost prediction functions are then determined from the plotted curves.

RESULTS AND DISCUSSION

Repair operations for agricultural tractors are carried out when failure occurs. There are numerous different reasons, which results to failure. Some of the factors that influence failure are: the type of operation and machine loading, hours of use, and age of the tractor. Other factors include badly matched tractor in terms of make and power, operator's error, accidents, environment, etc.

In this study however not all factors influencing repair costs were studied because of time and financial limitation. In that case the study concentrated only on the skills of tractor operators and on how the repair costs change with the increase of cumulative hours of use.

Tractor operators are the most important people as far as controlling and management of tractors is concern. In other word, these are the people trusted to manage an investment worth millions of Tanzanian shillings. One of their major responsibilities is to carry out normal routine maintenance that prevents tractors from

frequent breakdowns and unnecessary major repairs. Therefore when one decides to invest money into tractor business like in all other expensive investments he/she needs to employ competent operator in terms of education and training (skill) on operation and maintenance of the tractor so as to realise adequate profit.

In Tanzania however the situation is different because most of the tractor operators employed have never undergone any formal training in tractor operation and maintenance. Figure 1 shows only 15% of the interviewed operators in Tanzania had the opportunity to attend a

training course of not more than 2 weeks in tractor operation. In terms of education the result in figure 2 showed that most of the tractor operators (74%) have the basic primary school education. Therefore they can read and write in Swahili without any problem. However it was also found that, some of the operators, about 23% did not have the basic education and in this group 50% were not able to read and write. Only 3% of the operators interviewed had completed form four. However all of them indicated that they were not very good in English both in writing and understanding when reading.

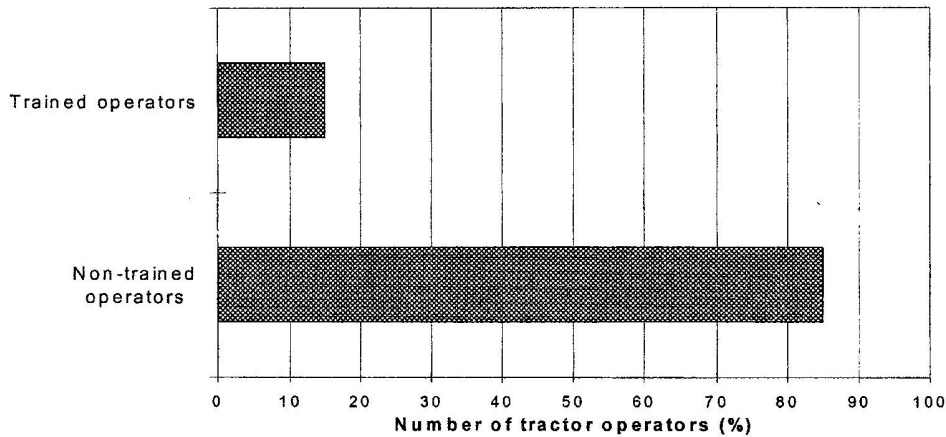


Figure 1. The number of trained and non-trained tractor operators

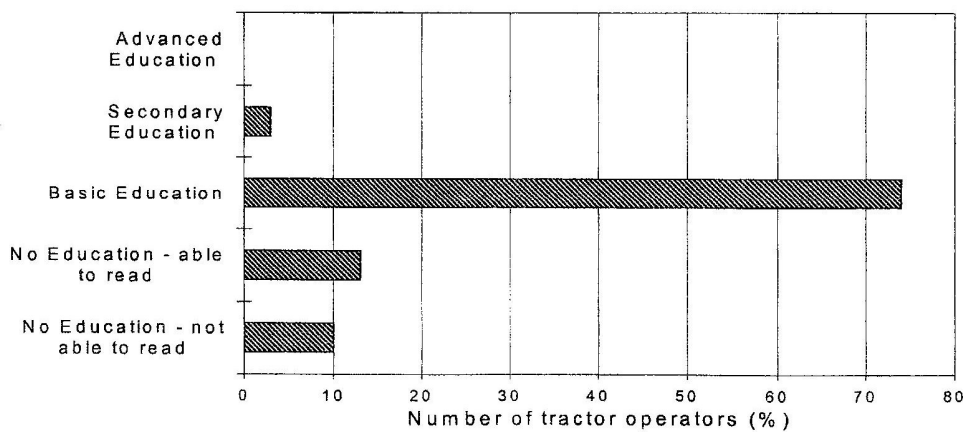


Figure 2. The level of education of tractor operators

Although this study did not establish whether the use of untrained operators result into higher repair costs, there is no doubt about undesirable performance from untrained operators as compared to educated and trained ones. This shows that, farmers investing into tractors in Tanzania lack adequate information on the importance of trained operators. If operators do not have adequate training then it is obvious that the operators would not be able to use the available instruction manuals. To make the situation worse, all instruction manuals available on tractor operations and maintenance in Tanzania are written only in English, which is not the commanding language for most of the operators as established in this study.

Table 2 shows the results of the repair cost function models of different tractor groups. The

coefficients of determination (R^2) for all tractor groups were found to be more than 90%. These functions agree well with the previous functions developed elsewhere (Kando and Larson, 1990; Morris, 1988; Ward et al., 1985; Wend, 1991). The functions derived from this study however cannot be generalised to all tractors in Tanzania because as observed during data analysis, large variations in repair costs occur from one tractor group or make to another. The variations are acknowledged due to the difference in other factors that are not included in the modelled functions as mentioned above. Nevertheless the developed functions provide an important analytical tool that can be used to compute magnitude of the repair costs in Tanzania.

Table 2: Repair cost functions for different groups of tractors

| Tractor make/group | Repair cost function | R^2 |
|------------------------|---|--------|
| Massey Ferguson | $TAR = 2.6517 \left(\frac{X}{1000} \right)^{1.4574}$ | 0.988 |
| Case International | $TAR = 3.0536 \left(\frac{X}{1000} \right)^{1.6694}$ | 0.9969 |
| Ford | $TAR = 3.9613 \left(\frac{X}{1000} \right)^{1.4853}$ | 0.9957 |
| Same | $TAR = 5.0813 \left(\frac{X}{1000} \right)^{1.4206}$ | 0.9911 |
| Four Wheel Drive | $TAR = 0.157 \left(\frac{X}{1000} \right)^{3.049}$ | 0.8078 |
| Two wheel drive (SMSF) | $TAR = 0.4639 \left(\frac{X}{1000} \right)^{2.3775}$ | 0.9297 |

TAR = Total accumulated repair costs (% of initial price)

X = Cumulated hours of use

The comparison of repair costs of different groups of 2WD tractors in this study showed that the magnitudes of repair costs of tractors

varied from one group to another (Figure 3). The group of 2WD tractors owned by small-to-medium scale farmers have lower repair costs

at early stage up to cumulated use of about 6500 hours than tractors owned by large scale farms. This fact could be partially explained by the number of different tractor drivers assigned to operate a tractor. In large-scale farms it was observed that different tractor operators are assigned to operate one tractor. Therefore this effect makes them more exposed to abuse at the early stages than those owned by small-to-medium scale farmers, which have the advantage of being strictly operated by one person. However above 6500 hours the repair costs of these tractors increase at a higher rate than the 2WD tractors owned by large-scale farms. This could be partially explained by the fact that at high accumulated usage the tractors owned by the small-to-medium scale farmers are too old in comparison to those owned by large scale farms at the same accumulated

hours. During data analysis it was found out that 2WD owned by small-to-medium scale farmers operate annually at an average of about 660 hours, while those owned by large-scale farms operate at about 1000 hours per year. In that case the higher failure rates of the 2WD tractors owned by small-to-medium scale farmers is due to the old age of the tractors.

Massey Ferguson tractors under large-scale farms were found to have lower repair costs when compared to other tractor makes under the same ownership. The reason for this could be due to the fact that the Massey Ferguson tractors experience less frequency of failures as compared to other tractor makes. It should be noted that the prices of most of the spare parts for different tractors do not differ very much from one make to another.

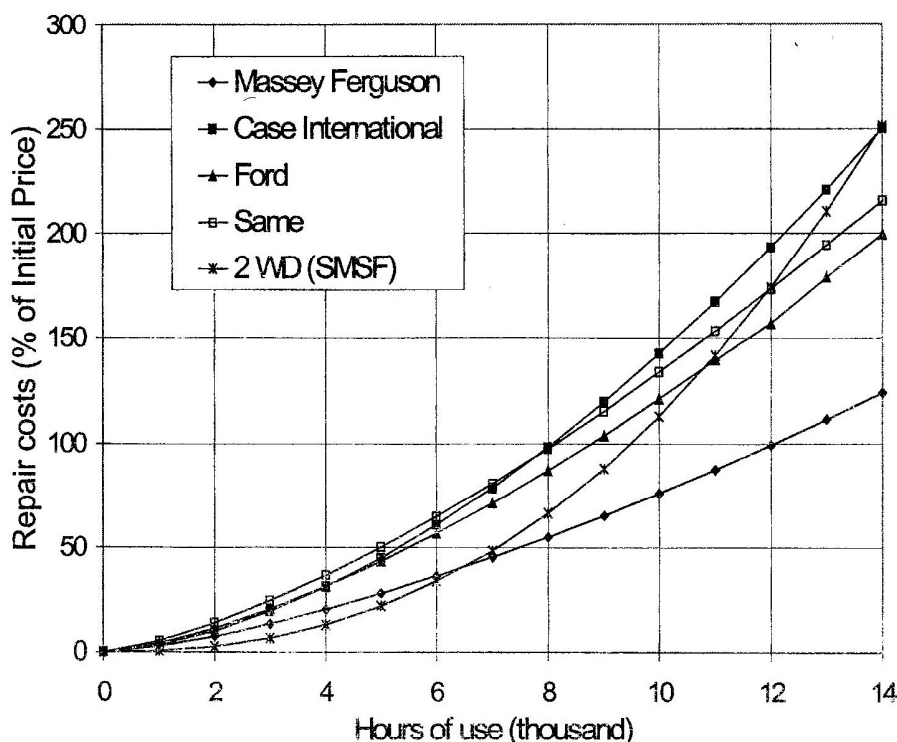


Figure 3 Comparison of repair costs of 2WD tractors (this study)

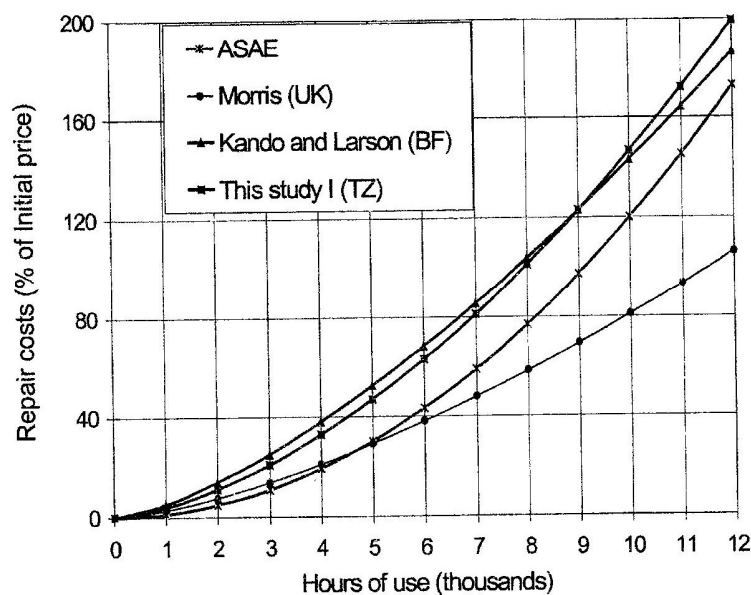


Figure 4 Comparison of repair costs of 2WD tractors with other sources

Figure 4 shows the results of the comparison of this study with other similar studies. The average magnitudes of the accumulated repair costs of 2WD tractors in Tanzania are higher than those published in North America and Europe. But on the other hand the magnitudes of repair costs of 2WD tractors in Tanzania are almost equal to the result documented in other African country, Burkina Faso for that matter (Kando and Larson, 1990).

The reason for high repair costs in Tanzania could either be explained by the high costs of the imported spare parts (as the labour cost in Tanzania is lower than that of Europe, which ranges between 25% and 35% of the spare part costs as per Ward, et al., 1985 and Wendl, 1991) or could be due to the use of untrained tractor operators, who do not carry out routine maintenance as specified in manufacturers manuals. The resulting effects are higher frequencies of breakdowns and therefore higher repair costs. During data collection however almost all tractor operators indicated that they do perform routine maintenance as scheduled in tractor service manuals but the truth of it remains questionable. On the other hand, if tractor operators truly perform maintenance as

scheduled in tractor manuals then the problem might be due to the specifications provided by tractor manufacturers. Probably the repair and maintenance specifications provided by the manufacturers are not very appropriate to some of the operating conditions in which tractors are used. Although the service manuals provided by manufacturers for tractors in Europe and Africa are the same. Therefore this necessitates a further investigation. Another reason could be related to the quality of the spare parts imported in Tanzania. They could be of inferior quality than those used in Europe and America.

CONCLUSIONS

The survey data indicated that most of tractor owners use untrained tractor operators. About 10% of these operators are not able to read and write. It was the opinion of this study that training course for operators is very important because the training programme will expose the drivers to the facts regarding proper caring of tractors. Otherwise it is very difficult for operators to carry out for example routine maintenance by relying on tractor manuals that

are written in English language, whereas English is not a commanding language for most of operators. The repair costs of tractors can possibly be reduced if trained operators will be used.

Different mathematical functions as presented in table 2 were developed in order to predict repair costs of different groups of tractors in Tanzania. The prediction models were found to be similar to those developed elsewhere. The magnitudes of repair costs of tractors vary widely from one tractor group to another. However the repair costs of tractors increased with increased frequency of use.

The group of Massey Ferguson tractors was found to have generally low magnitude of repair costs when compared to other groups of tractors in Tanzania. The combined result of 2WD tractors owned by large scale and small-to-medium scale farmers was found to be consistence in magnitude with the result of Burkina Faso.

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NOMECLATURE

| | |
|----------------|---|
| 2WD | Two wheel drive tractor |
| ASAE | American Society of Agricultural Engineers |
| DAAD | Deutscher Akademischer Austauschdienst (German Academic Exchange Service) |
| FAO | Food and Agriculture Organization |
| R ² | Coefficient of determination |
| SMSF | Small-Medium Scale Farmer |
| TAR | Total Accumulated Repair costs |
| UNIDO | United Nation Development Organization |
| X | Cumulated hours of use |

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