

LOGGING PRACTICES IN TANZANIAN NATURAL FORESTS

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Abstract

Miombo woodland forests and Tropical High forests (THF) are the two major types of natural forests in Tanzania. These forests are characterized by low harvestable volume per unit area, un-even aged trees and inaccessible most of the year round due to difficult terrain and poor road networks.

Most of the logging operations in natural forests are performed on piece work basis. Cutting tasks vary from 1 tree/day in THF to 50 trees/day in Miombo woodland forests depending on the size, stocking and the cutting tool. For instance in the THF where an axe was used as a cutting tool, productivity was $9.1\text{m}^3/\text{day}$ while in Miombo woodland forests where 2-man crosscut saw and a chainsaw were used for cutting, productivities were $4.2\text{m}^3/\text{day}$ and $29.2\text{m}^3/\text{day}$ respectively.

Skidding production depended on the skidding method, means, distance and volume per trip. Exponential growth curve relationships were observed when skidding time as a function of distance were plotted for both skidding means. The estimated skidding productions for the County tractor and D7 Cat. were $31.8\text{m}^3/\text{day}$ and $26.1\text{m}^3/\text{day}$, respectively.

Loading of logs into the trucks was done both manually and by use of machines. Where done manually, loading time varied from $5.7\text{min}/\text{m}^3$ to $10.9\text{min}/\text{m}^3$ depending on the loading site and the size of the landing. Loading times when using a Grapple loader and a Skidder plate were $1.5\text{min}/\text{m}^3$ and $1.7\text{min}/\text{m}^3$, respectively.

Introduction

Of the total land of Tanzania ($945,000\text{ km}^2$), about half of it is classified as forest land. The natural forests which cover about 99.8% of the total forest and are grouped into two major forest types namely Miombo woodland forests and Tropical High forests (THF). Miombo forests are characterized by low stocking and low annual volume increment ($2.3\text{m}^3/\text{ha}$), while THF confined mainly to high altitude mountain areas are being extensively exploited or cleared for agricultural purposes (Abeli, 1985, Abeli and Dykstra 1981). Important timber trees harvested in Miombo forests include *Pterocarpus angolensis*, *Azelia quanzensis* and species of the genera *Julbernardia* and *Brachystegia*. In THF, valuable trees harvested are *Ocotea usambavensis*, *Chlorophora excelsa*, *Olea capensis* and *Khaya nyasica* (Dykstra 1983).

At present most of the natural forests being exploited are far from wood processing centers and inaccessible most of the year due to difficult terrain and poor roads (Abeli 1979).

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Because of these factors, logging productions and practices in the natural forest differ from plantation forests. This paper analyses the logging methods and logging productions based on the logging studies conducted in the Miombo woodland forests and THF.

The study areas

The logging methods and production data presented in this paper are based on studies carried out in Tabora and Tanga regions. The logging operations studied were those of Tabora Misitu Sawmill Ltd. and Ugalla Sawmill (logging in Miombo forests in Tabora region) (Abeli 1979) and Kwamkoro Sikh Sawmill (logging in THF in the Usambara Mts. near Tanga) (Issara, 1986; Malilah, 1986, and Mrosso, 1986).

The Miombo area under study lies at 32.5°E longitude and 5.5°S latitude while THF area lies at 38.5°E longitude and 4.9°S latitude.

Temperatures in Miombo forests ranged from 15°C at night to 35°C during the day time while in THF, temperatures ranged from 10°C to 32°C, respectively. In the THF, the ground was covered with thick creeping climbers while in Miombo forests, the undergrowth consisted mainly of hyparrhenia grasses and shrubs. The average ground slope in the Miombo area was about 5% and tree stocking varied from 20–80m³/ha. In THF, the ground slope was steep varying from 30–80%, while the average tree stocking was 55m³/ha (Abeli 1979, Issara 1986).

Materials and Methods

In each logging area, data on the logging methods, equipment and other factors considered to influence logging production like climate, terrain and forest conditions were measured and recorded. For the time study data, the flyback timing method was used with stop watches graduated in minutes and centiminutes.

To determine logging volumes, trees and logs were measured over-bark and log volumes computed by use a Smalian formula. Skidding distances were measured in meters by use of a measuring tape.

In this text, logging operation was divided into three component operations; cutting, skidding and log loading. To facilitate data collection, analysis and interpretation, each component operation was divided into work elements. Cutting operation was segregated into the following work element: site preparation, felling, bucking and walking while skidding operation into; travelling empty, choking, log skidding and unchoking work elements. Preparation, actual loading, moving from one log to another or from one landing to another and load tightening were the work elements associated with log loading operation. For each work element, effective time, necessary and unnecessary delay times were recorded. These work element times were statistically analysed to find their relationship with the various independent variables.

Results and discussion

Results presented, analysed and discussed in this text are mainly physical production values. No cost evaluations and comparisons are made due to a significant time lapse between the time the operations were undertaken in Miombo forests and THF. Logging operations in Miombo forests were undertaken in 1978 while in THF, in 1986. A difference of 7 years for example resulted to a rise in labour costs by about two times, fuel costs by about four times and machine costs by about six times in Tanzania. Thus before comparing the production costs of the two forests, it would therefore require adjusting the 1978 prices if any comparison is to be realistic.

Cutting

Table 1 shows cutting tools, crew size and tasks in the three sawmills.

Table 1: Cutting summary data for the three sawmills

Type of forest	Sawmill	Cutting tool	Crew size	Cutting time (h/day)	Average dbh (cm)	Diam range (cm)	Daily task (trees)	Merch vol/tree (m ³)	Vol. cut per day (m ³)
Miombo forest	Tabora Misitu	Chain-saw	2	2.50	45	35—53	50	0.57	29.2
Miombo forest	Ugalla sawmill	2man-cross cut	2	3.20	44	37—53	7	0.60	4.2
THF	Kwamkoro sawmill	Axe	2	1.83	94	72—128	1	1.82	9.1

Cutting in both forests was done on task work basis. The tasks which were arbitrarily set varied from one area to another depending on the type of the cutting tools, the stock density and the size of trees. Since these tasks were not based on any scientific research findings, they were rarely fulfilled or adhered to. For instance in Ugalla sawmill, sometimes the crew cut 14 trees per day while in Tabora sawmill, due to low tree stocking and machine breakdowns, the daily task of 50 trees was rarely achieved. (Abeli 1979). In THF, sometimes a single tree (because of buttresses) took two days to fell and buck it into logs (Malilah, 1986).

In both forests, the first branch set the limit of the bole length. Since no limbing was undertaken, in Miombo forests for example, the average number of logs per tree was 1 log (Abeli 1979) while in THF, it was 5 logs (Malilah, 1986). The payment system which was based on the number of trees felled rather than the volume of logs, encouraged the cutting crews in both forests to cut small size trees and buck one or few logs per tree. This system resulted in

only 33% of the tree's volume in Miombo forests being utilized and the rest being left in the forest to rot (Abeli 1979).

Analysis of the cutting production data revealed that cutting production depended on the tree size and the type of the cutting equipment. For the three cutting tools non-linear relationships were observed when production rate as a function of tree size were plotted on a graph. Using the second degree polynomial equations to fit the best curves on these data, exponential growth curve and asymptotic curves resulted (Figure 1)

Figure 1 shows that when using a chainsaw, cutting production increases up to a dbh of 43cm and beyond this diameter, it starts decreasing. The chainsaw asymptotic curve indicates that chainsaw is more efficient for cutting small to medium size trees rather than big size trees. In case of two man crosscut saw, cutting production decreases and then increases with increase in tree size. The exponential growth curve (beyond 43 cm) indicates that big size trees even beyond 53 cm can be handled efficiently with two man crosscut saws. Comparing the production rates for the two cutting tools, production rate for the chainsaw appears to be higher than that of a two man crosscut saw for the entire dbh range. The optimal tree size when using an axe was about 110 cm. Like in chainsaw production, axe production rate increases up to the optimal diameter and then stands decreasing with increasing diameters.

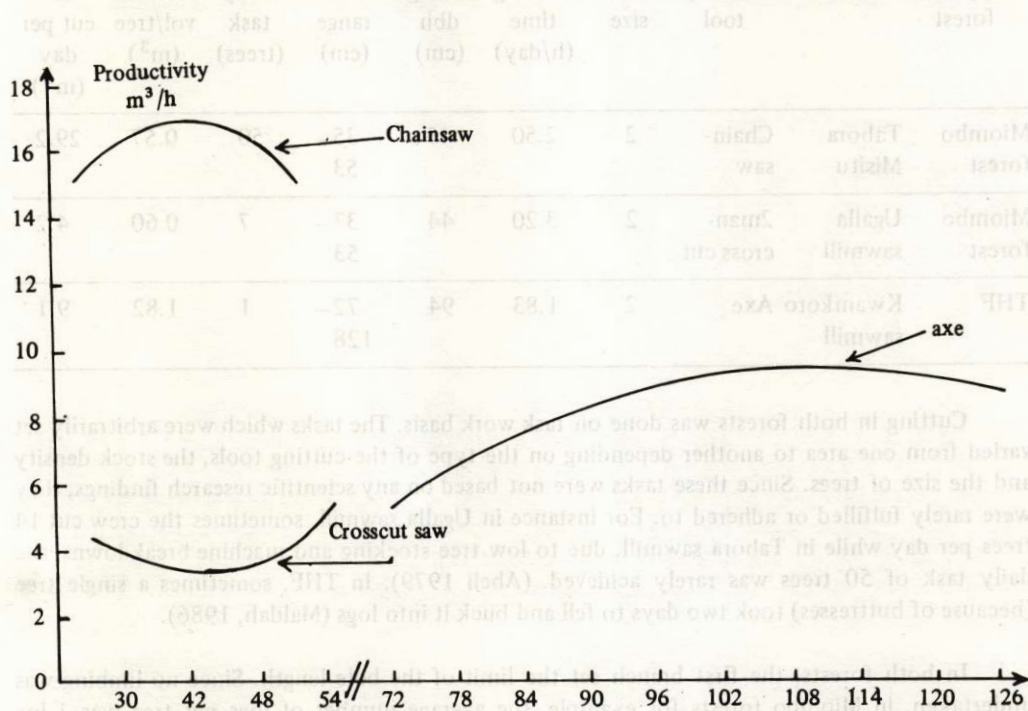


Figure 1. Cutting production rates for the three cutting tools as a function of tree diameter at breast height.

Skidding

Logs were ground skidded in both Kwamkoro sawmill and Tabora Mimitu sawmill. The former used a D7 Caterpillar while the later used a 754 County tractor. Since these tractors were old i.e., crawler (over 10 years) and County (5 years), the rate of machine breakdowns was high. No skidding was done in Ugalla sawmill since logs were loaded directly onto trucks at the stump sites. Table 2 shows skidding productions for the two sawmills.

Table 2. Skidding productions on the two sawmills

Sawmill	Type of machine	Machine power (kw)	Skidd. dist. (m)	Vol/trip (m ³)	Tasks/day (trips)	Task/day (m ³)	Estimated Task/h (m ³)
Kwamkoro Sikh saw mill	D7 cat. Crawler	149	127	3.26	8	26.08	7.87
Tabora Mimitu sawmill	754—Country	54	64	0.53	60	31.80	8.50

Due to machine breakdowns and lack of logs to skid, rarely were the skidding tasks in Tabora Mimitu fulfilled. Worse still, since the tractor was not fitted with a winch, it resulted to only one log being skidded or dragged per trip. (Abeli 1979). In this sawmill there was only one working shift unlike in Kwamkoro sawmill where there were two working shifts each skidding 8 loads per shift (Issara, 1986).

To find the relationship between skidding work cycle time and the skidding distance, skidding data for the two tractors were plotted on a graph. Using the second degree polynomial equations to fit the best curves, curvi-linear relationships as shown by the two exponential growth curves in Figure 2 were observed.

Besides the skidding distance varying, volume of logs skidded per work cycle also varied. To find the influence of these variables on the tractor production, multiple linear regression equations were used. Equations (1) and (2) are used in estimating skidding production rates for the Crawler tractor and the County tractor respectively as a function of distance and volume.

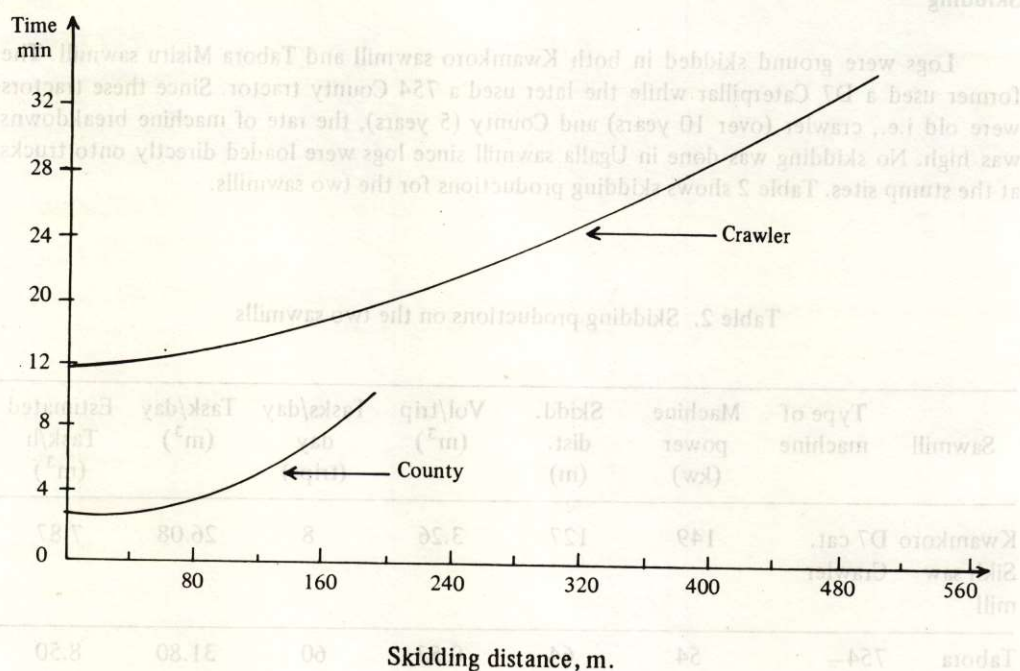


Figure 2. The relationship between the skidding work cycle time and the skidding distance.

$$\text{Crawler: } Y = 2.969 + 0.038 \text{ DIST.} + 2.421 \text{ VOL} \quad (1)$$

$$R^2 = 0.464 \quad n = 91$$

$$\text{County: } Y = -0.661 + 0.024 \text{ DIST.} + 4.650 \text{ VOL} \quad (2)$$

$$R^2 = 0.733 \quad n = 33$$

where y = volume of logs skidded per hour, in m^3/h

DIST. = skidding distance (one way), in m

VOL. = volume of logs skidded per trip, in m^3

R^2 = the coefficient of determination

n = the number of observations.

Since the R^2 value in equation (2) is higher than in equation (1), it indicates that variations in total volumes skidded per hour by the County tractor are more influenced or explained by variations in distance and volume than in the case of Crawler tractor. Also for both equations (1) and (2), the coefficients of distance and volume were found to be significant different from zero at 1 percent level of statistical probability.

Comparing the two skidding tractors, it is clear that given the same load and distance, the skidding production for the County tractor was higher than that of a Crawler tractor. This was mainly due to high moving speed and the easiness of the terrain which the County tractor was working on. When the County tractor production rates are compared with the production rates when using the County tractor in plantation forests (Ole-Meuludie and Dykstra 1982), the production rates in Miombo forests were lower in the entire distance range due to small load volumes skidded per trip. Therefore by fitting the County tractor with a winch, butt plate and chokers, it would increase load volume per trip and consequently skidding production rate.

The high percentage of delay time (45%) arising from machine breakdowns, logs getting stuck and frequent cable breakages (Issara, 1986) plus low moving speed resulted to Crawler tractor production rate being low despite the relatively big size loads per trip. To improve production rate, it would require repairing and maintaining properly the Crawler tractor, replacing the worn out skidding cables and clearing the skidding tracks.

Loading

In all three sawmills, hauling of logs from the forests to the mills was done by means of trucks. Hauling started by loading trucks either at the stump site or at landings established along the forest roads. In Ugalla sawmill, "terrain" trucks were loaded at the stump sites and unloaded at the roadside landings. From these roadside landings, "long distance" trucks were used to haul logs to the mills. In the cases of Tabora Misitu and Kwamkaro sawmills, trucks were loaded at landings established either in the forest or along the forest roads.

Log loading in the two miombo sawmills was done manually by use of cross-haul method i.e. rolling or pushing the logs up a ramp constructed of logs onto the truck decks. Where the landings were small, trucks had to move from one landing to another in order to get a full load. The loading crew size fluctuated between 7–12 persons in Ugalla sawmill and from 8–10 people in Tabora Misitu sawmill depending on the size and the length of the log to be loaded. (Abeli, 1979).

Logs in Kwamkoro sawmill were big and heavy. Instead of using manual labour, logs were either rolled onto truck decks by means of roll-way method (using the skidder's plate) or loaded by means of a grapple loader. Loading in this sawmill took place at landings established along the forest roads (Mrosso 1986). Table 3 shows loading productions on the three sawmills.

Table 3: Loading productions when using different loading means at different loading sites.

Sawmill	Loading means	Loading site	Log size(m ³)	Truck load(m ³)	Loading time (min/m ³)
Ugalla	manual	stump	0.53	2.7	10.87
Ugalla	manual	landing	0.53	4.7	7.70
Tabora Minitu	manual	landing	0.54	4.9	5.73
Kwamkoro	Grapple loader	landing	1.80	9.8	1.50
Sikh	Skidder plate	landing	1.84	10.3	1.67

Loading productions depended on the loading site and the loading means. Loading at stump sites took more time due to movements from one stump to another before a full load could be obtained. Again, besides mechanical loading being four times faster, it was also found to be less hazardous than manual method especially when handling big size logs.

The loading means and methods in the two Miombo sawmills resulted to under-utilization of trucks carrying capacities. With the existing loading methods and trucks lacking side stakes, it was difficult to make up a full truck load. Erection of side stakes and mounting of manually operated loading winches on the hauling trucks or construction of A-loading frames at landings would effectively increase the number or the volume of logs loaded and hauled per truck.

Conclusion

The results of these studies show that most of the logging equipment used in the natural forests are old and not specifically designed for logging in these forests. As a result the production efficiency is low, the rate of breakdowns is high and there is a gross under-utilization of the equipment. This calls for the replacement of the aging equipment, modification and mounting of the necessary logging accessories on the logging machines.

The logging methods and the payment systems encouraged the cutting crews to cut small size trees, tractor drivers to skid short distances and form small landings, and the loading crews to load small truck loads. Improving the logging methods and changing the payment system so that tasks are based on volumes rather than the number of logs would definitely increase logging productions.

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