Utilization and Cost for Animal Logging Operations

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ABSTRACT - Forest harvesting with animals is a labor-intensive operation. Due to the development of efficient machines and high volume demands from the forest products industry, mechanization of logging developed very fast, leaving behind the traditional horse and mule logging. It is expensive to use machines on smaller woodlots, which require frequent moves if mechanically logged, so small logging systems using animals may be more cost effective. Highly sensitive areas such as around public recreation may be logged effectively with minimal disruption using animal crews. In this study, work sampling was used for five animal logging operations in Alabama to measure productive and non-productive time elements, to determine utilization with respect to operators, functions (felling and processing of trees, skidding, and loading and/or forwarding of logs), animals, and machines. Animals (horses and mules) were utilized less than 50 percent of the scheduled time. There appears to be an opportunity to reduce cost of log production by increasing scheduled work hours and utilization of machines and animals. Average onboard truck logging cost was estimated to be $28.12 per cord for the five crews.

INTRODUCTION

Logging in the United States began more than 200 years ago. The need for more lumber increased due to growing villages and later the booming towns of the eastern seaboard (Creighton, 1997). For a logging operation to be successful today, and in the future, it must produce the highest-value products in a safe, economical, steady-paced operation. Dykstra and Heinrich (1996) emphasized that proper forest harvesting operations must meet economic, silvicultural, environmental, and social objectives. Regardless of the size of a harvesting area or size of trees, a harvesting operation must be well organized.

Before the invention of the railways and automobiles, animal power was the main source of land transportation. Waterson (1994) pointed out that in the past, horses were one of the main sources of timber extraction. After the potential for higher outputs and cost reduction from mechanization was realized, horses were restricted to areas where machines had difficulty such as steep and broken ground.

In general, a logging operation can be divided into activities such as tree felling, limbing, bucking, bunching, skidding or forwarding, loading, and hauling to mills. Heinrich (1983) identified three levels of logging operations: 1) labor intensive, 2) intermediate technology, and 3) fully mechanized. Timber harvesting with animals is a labor intensive type of logging. Utilization of manpower, machines, and/or animals is a key factor to increasing overall system productivity and reducing cost of harvesting per unit of timber. Available literature reports very little information on the utilization of animal logging components and cost
of log production particularly when machines are combined with animals.

In Alabama most of the horse and mule loggers are located in the northern half of the state. These are hilly areas with oak-hickory and mixed pine-hardwood forests typically owned by non-industrial private forest (NIPF) landowners in small tracts. Most of these landowners do not want mechanical skidders on their land (Toms et. al. 1998). This indicates the potential for horse and mule logging in these small tracts of timber and in terrain with slopes. A typical horse logger is shown in Figure 1.

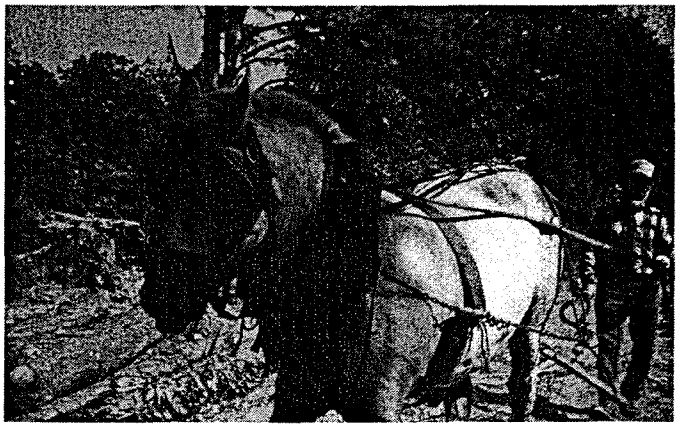


Figure 1. Animal logger with horse

OBJECTIVE

The goal of this study was to determine utilization, productivity, and costs within animal logging operations with respect to operators, functions (felling and processing of trees, skidding of logs, and loading and/or forwarding), animals, and machines.

METHODOLOGY

Field data were collected in the summer and fall 1999. Animal logging crews working in Alabama selected for this study were: 1) horses with forwarder (H/FWD), 2) mules with forwarder (M/FWD), 3) horses with side loading truck (H/SLT), 4) horses with knuckleboom loader (H/KBL), and 5) horse with long stick cable loader trucks (H/LSCLT). All were involved in partial cuts and used cut-to-length (CTL) saw logs and pulpwood. The functions observed were: 1) manual chainsaw felling and processing of trees, 2) animal skidding, and 3) loading and/or forwarding with forwarders, side loading trucks, knuckleboom loader, or long stick cable loader trucks.

Utilization

The proportion of time involved in each activity was obtained by taking a work sample of operators, functions, and animals/machines (Miyata et. al. 1981). Observations were recorded at five-minute intervals. Work activities varied slightly from crew to crew depending upon the management goals, crewmembers, and animals/machines used. Crewmembers often performed multiple functions. For instance, operators who primarily ran chainsaws might spend time skidding with horses. For each observation, activities for each operator, animal, and machine were recorded indicating whether the activity involved productive with the primary task, productive with a secondary task, servicing, repairing, or idle times. Utilization was defined as the ratio of productive time to total time. Estimation of utilization, which was calculated as binomial variables, used least squares regression analysis.

Cost

Ownership, operating, and labor costs were established from personal interviews with owners and crewmembers during the collection of field data using machine rate calculation methods discussed by Miyata (1986). Where possible, common cost factors were used for all crews. Eight percent annual interest rate was used for the alternative rate along with straight-line depreciation. The owners suggested an annual cost of 5 percent for insurance. Workman's compensation in Alabama for these operations was $3.00 per cord, and Social Security (FICA) and Federal Unemployment Insurance (FUTA) were 9.65 percent of labor cost.

RESULTS

General

For the five crews, the average scheduled hours per day ranged from 5.25 to 7.03 hours (excluding lunch breaks) (Table 3). Crew size ranged from one to five. The horse with knuckleboom loader operation had only one person who performed all tasks as compared to the mules with forwarder crew that had five persons. The other three animal operations had usually three persons. Many times, crew size varied for these operations from day to day. The horses with long stick cable loader truck crew used only one horse everyday while the other four animal operations had two horses/mules skidding logs. Generally, animal loggers worked less than 30 miles from their homes. With the exception of the mules with forwarder crew, who left their animals overnight in a fenced area near the logging site, crews moved their horses to the logging site each morning and home at the end of each workday.

Utilization

Animal logging operations were divided into three main functions: 1) felling and processing of trees, 2) skidding of logs, and 3) loading and/or forwarding. Utilization was calculated for operators, crews, functions, and animals/machines.

Table 1. Utilization and ownership status for individual operators of five animal logging operations

Operator (Ownership status)	Utilization (%)
Horses with forwarder crews	
Chainsaw operator (owner)	71***
Animal operator (family member)	57***
Forwarder operator (family member)	75^{NS}
Mules with forwarder crews	
Chainsaw operator (crew member)	43***
Assistant to chainsaw operator (crew member)	23***
Animal operator 1 (crew member)	40***
Animal operator 2 (crew member)	40***
Forwarder operator (Crew member)	68^{NS}
Horses with side loading truck crews	
Chainsaw operator (owner)	51***
Animal operator 1 (owner)	46***
Animal operator 2 (owner)	48***
Horses with knuckleboom loader crews	
Multifunction operator (owner)	68^{NS}
Horse with long stick cable loader trucks crews	
Chainsaw operator (owner)	79^{NS}
LSCL truck operator (owner)	100***
Assistant to LSCL truck operator (crew member)	64^{NS}
Average	58

^{NS} Not significantly different from average
*** Significantly different at 99% confidence interval

Utilization of operators

Altogether 15 operators were involved in the five animal logging operations. Table 1 gives the utilization of each operator. Operator productive time might include only his primary task but usually incorporated secondary tasks also. The productive time percentage contributed by both forwarder operators, chainsaw operators in long stick cable loader truck and horse with knuckleboom loader crews, and assistant to long stick cable loader truck were not significantly different from that of the chainsaw operator in horse with forwarder operation. Utilization of the long stick cable loader truck operator was significantly higher and the other nine operators were significantly lower. The long stick cable loader truck operator had 100 percent utilization because he spent much of his time driving outside of the woods area and when he was in the woods he was observed only being productive. When ownership status was compared, owners and family members were found to work significantly more than non - owners (Figure 2).

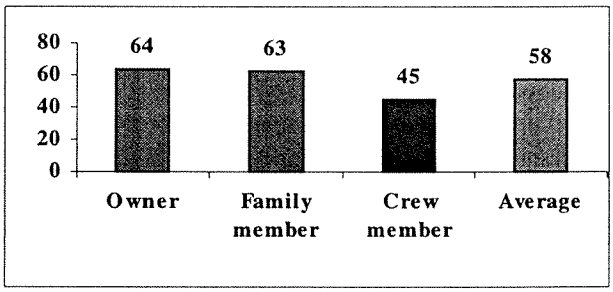


Figure 2. Utilization by ownership status (%)

Comparison of overall crew utilization

Crew utilization was determined by summing all productive time observations and dividing by total observations of all crewmembers. Utilization for the five animal operations were compared, and it was found that there was no significant difference among the knuckleboom loader, the long stick cable loader truck, and horses with forwarder operations. Mules

with forwarder and horses with side loading truck operations had significantly lower utilization (Figure 3). The long stick cable loader truck crew had highest overall utilization of 75 percent.

Tree felling and processing function

Utilization for felling and processing was calculated as the ratio of productive time to the total observations of the felling and processing function. This utilization was compared among crews and found to be similar for all crews except the mules with forwarder crew, which was significantly lower (Figure 4).

Log skidding function

Log skidding utilization was defined as the proportion of skidding observations spent doing productive activities. When comparing the five animal logging operations, there was no significant difference between skidding with mules or horses with forwarder crews or horses with long stick cable loader truck crews. However, skidding with horses with side loading trucks or knuckleboom loaders had significantly higher utilization (Figure 5).

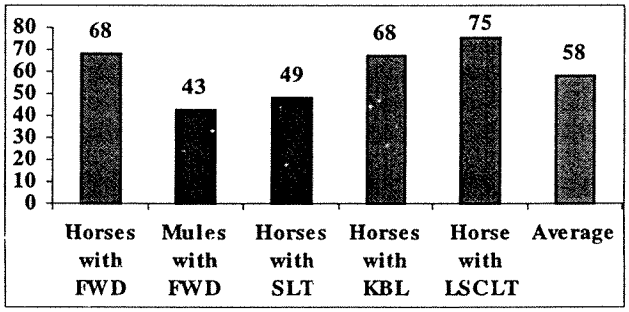


Figure 3. Utilization for five animal logging operations (%)

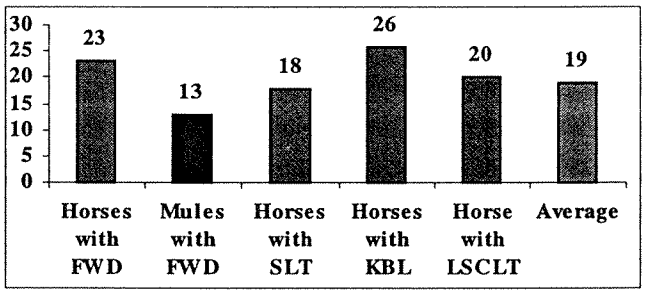


Figure 4. Utilization of felling and processing function in five animal logging operations

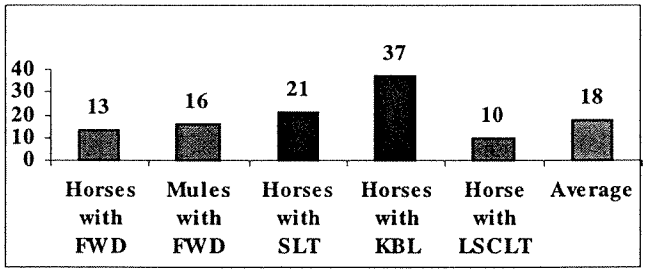


Figure 5. Utilization of log skidding function (%)

Log loading and forwarding function

When loaders or forwarders were examined, utilization was calculated as the ratio of productive time to total observations of that function. Utilization was compared for the five operations (Figure 6). Loading and/or forwarding for the horses with long stick cable loader truck operation was significantly higher than the horses with forwarder operation. Utilization for the other crews were significantly lower.

Utilization of animals and machines

Just as observations were made of operators, animals and machines were observed. Hand tools such as chainsaw and axes were not reported.

Utilization of horses and mules were calculated as the ratio of productive time observations to the total observations of animals. Figure 7 compares the ten animals in the study. The two horses used in horses with forwarder crew were used equally as were the horses used with the knuckleboom loader crew and the mules in the mules with forwarder crew. Only the horses with side loading truck crew were used a disproportional amount of time. On average, animals were utilized 22 percent of the work day.

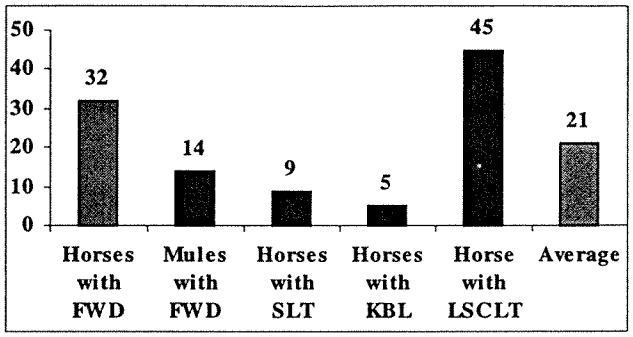


Figure 6. Utilization for loading and/or forwarding function (%)

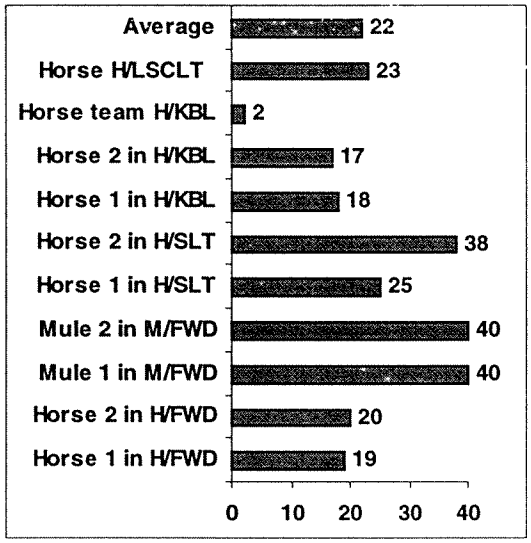
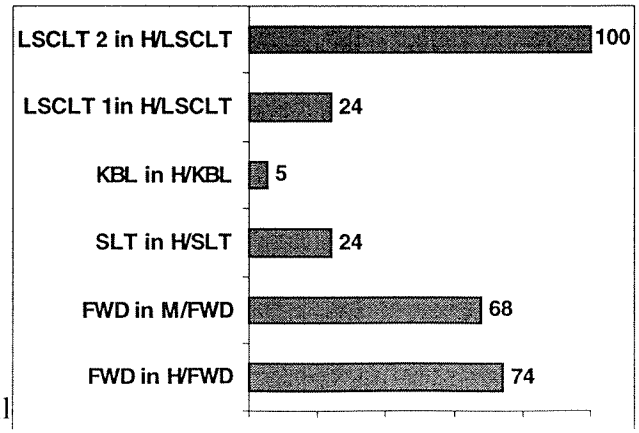


Figure 7. Utilization of animals (%)

When utilization of machines was compared, the forwarders had the highest utilization – 74 percent with horses and 68 percent with mules (Figure 8). The side loading truck and one of the trucks with long stick cable loader were used 24 percent. The knuckleboom loader was used the least. The other long stick cable loader truck was loaded immediately when it returned to the woods causing it to have 100 percent utilization.



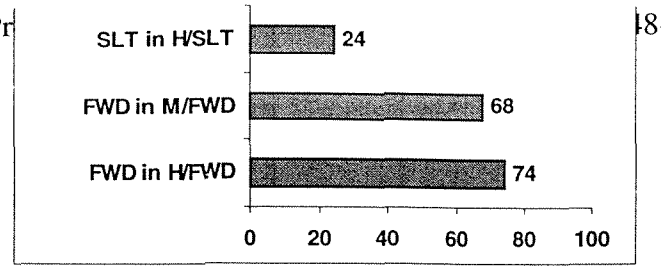


Figure 8. Utilization of loading and forwarding equipment (%)

COST AND PRODUCTIVITY

Fixed and variable costs were calculated for productive equipment like horses or mules, forwarders, side loading truck, knuckleboom loader, and long stick cable loader trucks. Animal accessories like harnesses also had fixed costs. Support equipment included pickup trucks and van for transporting animals. One crew had a dedicated office and a part time bookkeeper. Labor cost was based on an average rate of $10.09 per hour. Table 2 shows that fixed costs vary greatly by level of mechanization. Variable costs were more consistent. Labor cost was directly affected by the number of employees.

Cost for horses or mules ranged from $1,750 to $3,000 with an expected economic life of 12 to 15 years (Mules were more expensive than horses). Two sets of harnesses with tongs and chains were estimated to be $1,300 with an economic life of five years. Each crew had two sets of harnesses and 3 to 4 tongs.

The horses with forwarder crew had purchased a used forwarder for $28,000, a new pickup truck for $16,000, a van to carry the horses for $25,000, and had two Belgian horses for $5,000. The mules with forwarder crew purchased a new forwarder for $112,000, a pickup truck for $16,000, a van to transport crews for $25,000, and four mules for $21,000. This operation had an office and part time office assistant. The horses with side loading truck crew had a used side loading truck for $3,412, a used van to transport horses for $3,750, and two Belgian horses for $3,750. The horses with knuckleboom crew had purchased two horses for $5,000, a used knuckleboom loader for $5,000, and a used van to carry horses for $5,000. The horses with long stick cable loader crew purchased two long stick cable loader trucks for $15,000 each, two horses for $5,000, and a used pickup truck for $2,500.
Table 3 summarizes productivity and costs for the five crews. Daily production of logs ranged from 5.5 to 25 cords and from 0.78 to 4.41 cords per schedule hour (SMH). The mules with forwarder crew having 5 operators produced the most in both categories followed closely by the long stick cable loader crew. Not surprisingly, the one-man horse with knuckleboom loader crew was the least productive. When summarized by man-hour production, the long stick cable loader truck crew was more productive than the mules with forwarder and the side loading truck crew was the least productive. When paired with hourly costs given in Table 2, the lowest costs were with the long stick cable loader crew ($19.30 per cord) and highest with the side loading truck crew ($36.12 per cord). Average cost per cord for the five crews was $28.12 per cord for wood onboard truck.

CONCLUSION

Owners and family members performed productive work more than non-owners from this study of five animal logging operations. Utilization of horses or mules averaged about 22 percent as compared to machines that averaged 44 percent. Forwarders, the most expensive piece of equipment, had highest utilization. Operators for these mostly manual crews performed productively 58 percent of the time. Due to the low levels of utilization, it appears that productivity could be improved on these animal logging operations by working more of the scheduled workday. Also, this study showed that all five animal logging operations were working less than the normal 8-hour days (6.21 hours). By increasing daily scheduled work hours, cost of log production could be reduced by reducing fixed hourly costs.

It was found that the horses with side loading truck crew had the lowest hourly capital investment but highest unit cost for log production. The horses with long stick cable loader truck crew that had a moderate capital investment produced logs at the lowest cost rate. The next lowest logging cost was for the horses with knuckleboom loader crew. This study indicates that for animal logging operations high capital investments may not result in low costs for log production.

Table 2. Cost summary for five animal logging crews

Animal logging operations	Fixed ($/SMH)	Variable ($/SMH)	Labor ($/SMH)	Total ($/SMH)
Horses with FWD	10.37	9.70	33.18	53.25
Mules with FWD	31.74	14.94	61.90	108.58
Horses with SLT	2.52	5.37	33.18	41.07
Horses with KBL	2.66	5.00	11.06	18.72
Horse with LSCL truck	7.74	11.23	33.18	52.15

Table 3. Productivity and cost from five animal logging operations in Alabama

Animal logging operations	Crew members	Average scheduled work hours per day	Average daily log production (Cords)	Log production per schedule hour (Cords)	Cords per man - hour	Cost p cord ($)
Horses with FWD	3	6.83	13.20	1.93	0.64	30.55
Mules with FWD	5	5.67	25.00	4.41	0.88	27.62
Horses with SLT	3	5.25	6.50	1.24	0.41	36.12
Horses with KBL	1	7.03	5.50	0.78	0.78	27.00
Horse with LSCL truck	3	6.25	20.00	3.20	1.07	19.30
Average	3	6.21	14.04	2.31	0.76	28.12

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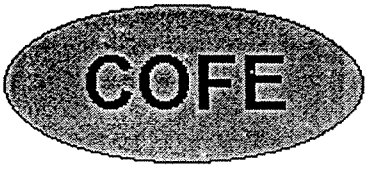

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