

COST COMPARISON AT THE WOODYARD CHIP PILE OF
CLEAN WOODLAND CHIPS AND CHIPS PRODUCED IN THE
WOODYARD FROM ROUNDWOOD

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ABSTRACT

A cost comparison is made between a standard method of producing chips (i.e. chips produced from roundwood in a woodyard) and the production of clean chips in the woods with chain flail delimeter-debarkers and woodland chippers. The comparison considers:

- (1) Harvesting costs (to include chipping in the woods),
- (2) Transportation costs, and
- (3) Woodyard costs (handling and chipping).

The comparison is based on detailed field trials and extensive data collected on the quality of chips produced both in the woodyards and with woodland chippers. Cost estimates are based on typical harvesting, trucking, and woodyard operations and do not reflect the costs of any particular operation.

KEYWORDS

Woodland Chippers, Chain Flail Debarking, Woodyard Costs, Logging Costs, Transportation Costs

INTRODUCTION

More than 100 woodland chipping operations in North America are currently producing clean pulp quality chips with the use of chain flail delimeter-debarkers. These operations have the capacity of producing over 6,000,000 tonnes (metric tons) of chips for pulping facilities. At the 1990 TAPPI Pulping Conference, papers were presented which reported that these woodlands operations could, in certain situations, produce chips of equivalent quality to woodyards at the pulpmill and to better utilize the wood in the standing trees (1, 2).

A question arose as to the costs differential between producing chips with these woodlands operations as compared to conventional longwood operations and chipping at the mill woodyard. To answer this question, several studies were installed to gather comparative logging productivity information for longwood and woodlands chipping operations. Estimates of utilization at woodyards were derived from studies conducted in conjunction with the logging studies and from data collected at other locations. Woodyard costs were derived from a model prepared by Lou Flanders and Gerald Stoves and reported in another paper at this, the 1991 Pulping Conference.

METHODS

Studies of logging operations were conducted in a 23-year-old loblolly pine plantation near Ideal, Georgia, which was being clearcut and a 15-year-old loblolly pine plantation near Amory, Mississippi, which was being thinned. These studies were conducted in November 1990 and May 1991, respectively.

In the clearcut operations, four test blocks of approximately 15 acres were established and harvested by either a tree-length longwood operation or a woodlands chipper operation. The same woodlands chipping crew harvested two of the 15-acre blocks, and two different longwood crews harvested the other two blocks. The configurations of the logging operations used on each test block are reported in Table 1 as Longwood Clearcut 1, Longwood Clearcut 2, and Woodlands Chipping Clearcut. Total production observed was 1,682 tonnes of chips for the chipping crew and 893 tonnes of roundwood for Clearcut 1 and 1,231 tonnes for Clearcut 2.

Two thinning crews were observed for one week each to obtain productivity and machine utilization information. No test blocks were established since the crews were moving often during the study. The equipment in each crew is listed in Table 1 under Longwood Thinning and Woodlands Chipping Thinning. The longwood crew produced 970 tonnes of roundwood during the study period while the woodlands chipping crew produced 1,179 tonnes of chips.

The data collected during each study period consisted of the number of hours each machine, in the operation was utilized, the number of hours the crew members worked, and the tons of wood produced. Hours of utilization for the machines were obtained by mounting Servis recorders on each machine. A Servis recorder records the vibration of a machine on a disc by time of day; thus, operating time can be distinguished from idle time. Production information was gathered from trip tickets which were returned to the woods with the unloaded truck.

Estimates of cost per operating hour of the logging were obtained by updating the estimates reported in 1989 (3) using current costs of new machines, fuel, lubricants, etc. These current cost estimates are given in

Table 1. The hours each machine was utilized were multiplied by the estimated cost per operating hour to give the total cost of each machine during each study. A loaded labor cost of \$10.00 per crew hour for operators and mechanics and \$15.00 per crew hour for the foremen was assumed for all crews. The estimated cost of the operator for each machine was derived by multiplying his observed time on the job by the assumed labor cost. The total costs for the machines were summed by operation and divided by the total production. These cost estimates by study are summarized in Table 2. The costs are presented per tonne of roundwood in the longwood studies and per tonne of chips in the woodlands chipping studies. The data from the two longwood clearcut crews were combined in this study.

Transportation cost estimates were derived by updating costs presented in 1985 (4). The authors have periodically updated this information in bulletin form, and the latest data from a bulletin was updated using the producer price index. Thus, cost assumptions used for trucking were:

Cost of tractor per kilometer - \$0.65
Cost of longwood trailer per kilometer - \$0.075
Cost of chip van per kilometer - \$0.12

Other assumptions made to estimate transportation costs were:

Average travel speed - 75 kilometers per hour
Delay time in woods and unloading at wood yard - 1 hour per trip
Cost of driver - \$10.00 per hour worked

Using the assumptions listed above, cost estimates per trip for the truck and trailer at varying distances from the mill were developed and are presented in Table 3.

The transportation cost estimates per tonne at each distance from the mill were developed by dividing trip costs in Table 3 by observed net loads. The average net load for the woodlands chipping studies was 23.47 tonnes. The average net load in the longwood studies was 21.24 tonnes when hauling wood from the clearcut plantation and 23.07 tonnes when hauling from the plantation being thinned. The derived transportation cost per ton estimates are presented in Table 4. Table 5 gives the estimated cost in each form for each study based on a 60-kilometer haul from the woods operations to the mill.

The yield of clean chips from the clearcut studies was monitored for a subsample of the loads of logs delivered to the mill woodyard. The loads were processed separately through the drum, and all the drum rejects from these loads were collected and weighed. The rejects amounted to 10% of the delivered material. A study underway on woodyard utilization by diameter of the stems indicates that the drum rejects from thinned loblolly pine stems will

equal to 20% of the delivered material. By dividing the yield of chips into the delivered cost estimate, a logging and transportation cost estimate for the chip portion of the longwood is derived. Woodyard processing and handling costs were derived based on Flanders and Stoves models. A \$2.56 per tonne of chips conversion cost for longwood and \$0.55 per tonne for handling woodlands chips is assumed. The drum rejects from the longwood have a value for hog fuel and must be credited to this operation. The stems from the clearcut would yield 0.11 tonnes of rejects per tonne of chips while the thinnings would yield 0.25 tonnes of rejects per ton of chips. A \$10.00 per tonne value for hog fuel is assumed.

Thus, Table 5 gives a summary of the cost estimates into the chip pile for the chips produced by woodlands chippers and woodyard chippers for both thinning and clearcut operations based on a 60-kilometer distance from the woods operations to the mill woodyard. Figure 1 shows a plot of these costs into the pile at various distances to the mill for woodlands chippers and longwood operations harvesting thinnings. Figure 2 gives the same comparison for clearcut operations.

DISCUSSION

The size distribution of the woodlands chips produced in these studies was comparable to the chips produced at the woodyards receiving the longwood (1). The bark content was lower for chips produced at both woodyards than was observed for the woodlands chips produced in these studies. Still the woodlands chips averaged under 0.7% bark in all studies which is usually acceptable to most pulping facilities. Thus, the chips from the woodlands chippers would be of equivalent quality to the woodyard chips.

Earlier studies have indicated that woodland chipping operations better utilize the above-ground biomass available to harvest (2) and should receive a credit for this improved utilization. Utilization studies in the clearcut operations were inconclusive on this utilization advantage. Subsequent studies are underway to hone in on utilization of above-ground biomass by stem diameter for both the woodlands chips and chips produced from longwood at the woodyard. Early results indicate that woodlands chippers more efficiently utilize small stems (such as those harvested in thinnings) while this advantage is diminished or disappears for the larger stems.

The results of this study imply that chips produced from thinnings using flails and woodlands chippers can be cost competitive with chips produced at woodyards from thinnings. If utilization gains are considered for the flail-woodland chipper combination, then woodland chips would be in a more favorable status. However, when processing the larger stems from a more mature stand, the costs favor harvesting the stems as

longwood and manufacturing the chips at a woodyard. Thus, the niche in thinnings that these woodlands chipping operations are assuming is justified based on the enhanced utilization of the above-ground biomass.

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Table 1. Logging equipment utilized in studies and the estimated cost of the machines per operating hour.

Machine Type	Make & Model	Estimated Cost Per Operating Hour ^{1/}	Situation Utilized				
			Longwood		Woodland Chipping		
			Thinning	Clearcut 1	Clearcut 2	Thinning	Clearcut
			number of machines				
Crawler Tractor	Caterpillar D6D	\$73.87				1	
Chainsaw	Generic	3.66	2				
Feller-buncher	John Deere 643D (Shear Head)	44.73					1
	John Deere 643D (Koehring 16" Head)	51.60				2	
	John Deere 643D (Koehring 20" Head)	53.32	2				
Grapple Log Skidders	Caterpillar 518	47.45				1	
	Bell	20.74		1			
	Case W14B	28.07		1			
	VME 666-DGS	42.48		1			
	John Deere 548-D	36.50	2				
	John Deere 648-D	40.90					1
	Timberjack 380-A	40.15		1	1		
	Timberjack 450-A	43.80			2	3	
Knuckle-boom Log Loaders	Barko 160-A	23.15		1			1
	Barko 250	31.69				1	
	Prentice 180C	21.39	1				
	Prentice 210C	24.36				1	
Wheel Loader	John Deere 544D	40.21					1
Chain Flail	Manitowoc VFDD	83.53					1
Delimber-Debarkers	ForestPRO	85.73				1	
Woodlands Chippers	Trelan 23L	56.43				1	
	Morbark 23	94.86					1

^{1/} These cost estimates are updates of costs published by Brinker, Miller, Stokes and Lanford (3) using current costs for equipment, fuel, etc.

Table 2. Estimated stump-to-truck logging costs.

Operation	Longwood		Woodland Chipping	
	Thinning	Clearcut	Thinning	Clearcut
	cost per tonne of roundwood		cost per tonne of chips	
Felling	2.57	1.15	2.97	1.89
Skidding	4.33	2.95	4.65	1.98
Loading	1.37	0.97	1.00	0.78
Delimiting and Debarking	0.99	¹	2.67	2.81
Chipping	--	--	1.53	1.94
Foreman and/or Mechanic	0.66	0.72	0.51	0.17
Total to-Truck Cost	9.92	5.79	13.33	9.57

¹All delimiting was carried out by the skidders using a delimiting gate.

Table 3. Estimated cost per trip of operating a truck hauling raw materials by kilometers from the mill.

Kilometers to Mill	Total Kilometers	Tractor Cost ¹	Labor Time ²	Labor Cost ³	Cost of Tractor & Labor	Longwood Trailer Cost ⁴	Total Longwood Cost	Chip Van Cost ⁵	Total Chip Cost
20	40	\$26.00	1.53	\$15.30	41.30	\$ 3.00	\$44.30	\$ 4.80	\$ 46.10
30	60	39.90	1.80	18.00	57.00	4.50	61.50	7.20	64.20
40	80	52.00	2.07	20.70	72.70	6.00	78.70	9.60	82.30
50	100	65.00	2.33	23.30	88.30	7.50	95.80	12.00	100.30
60	120	78.00	2.60	26.00	104.00	9.00	113.00	14.40	118.40
70	140	91.00	2.87	28.70	119.70	10.50	130.20	16.80	136.50
80	160	104.00	3.13	31.30	135.30	12.00	147.30	19.20	154.50
90	180	117.00	3.40	34.00	151.00	13.50	164.50	21.60	172.60
100	200	130.00	3.67	36.70	166.70	0.65	181.70	24.00	190.70

¹Tractor costs were estimated at \$0.65 per kilometer.

²Labor times were estimated at 75 kilometers per hour plus one hour.

³Labor costs were estimated at \$10.00 per hour.

⁴Longwood trailer costs were estimated at \$0.075 per kilometer.

⁵Chip van costs were estimated at \$0.12 per kilometer.

Table 4. Estimated transportation costs per tonne by kilometers to mill.

Kilometers to Mill	Longwood Costs		Chip Costs
	Clearcut @ 21.24	Thinning @ 23.07	@ 23.47
	Tonnes Per Trip	Tonnes Per Trip	Tonnes Per Trip
	cost per tonne		
20	2.09	1.92	1.96
30	2.90	2.67	2.74
40	3.71	3.41	3.51
50	4.51	4.15	4.27
60	5.32	4.90	5.04
70	6.13	5.64	5.82
80	6.94	6.38	6.58
90	7.74	7.13	7.35
100	8.55	7.88	8.13

Table 5. Estimated cost of producing chips into the chip pile at a woodyard with woodland operations 60 kilometers from the woodyard.

Operation	Longwood		Woodland Chipping	
	Thinning	Clearcut	Thinning	Clearcut
Stump-to-Truck Logging	\$9.92 ¹	\$5.79 ¹	\$13.33 ²	\$9.57 ²
Transport Cost @ 60 Kilometers	4.90 ¹	5.32 ¹	5.04 ²	5.04 ²
Delivered Cost to Woodyard	14.82 ¹	11.11 ¹	18.37 ²	14.61 ²
Yield of Clean Chips	80%	90%	100%	100%
Delivered Cost of Clean Chip Equivalent	18.53 ²	12.34 ²	18.37 ²	14.61 ²
Cost of Conversion to Chips at Woodyard	2.56 ²	2.56 ²	--	--
Dumping and Hauling Chips at Woodyard	--	--	0.55 ²	0.55 ²
Credit for Hog Fuel for Roundwood @ \$10.00/ton	2.50 ²	1.10 ²	--	--
Total Cost of Chips into Pile	18.59 ²	13.80 ²	18.92 ²	15.16 ²

¹Per tonne (wood and bark).

²Per tonne of chips.

ESTIMATED COST OF PRODUCING CHIPS

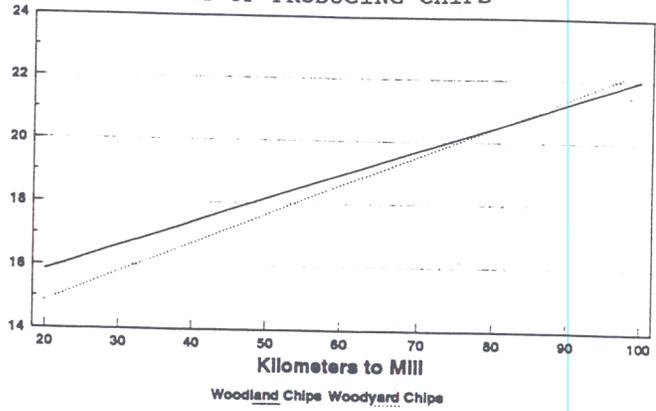


Figure 1. Cost of producing chips into the woodyard chip pile from thinnings.

ESTIMATED COST OF PRODUCING CHIPS

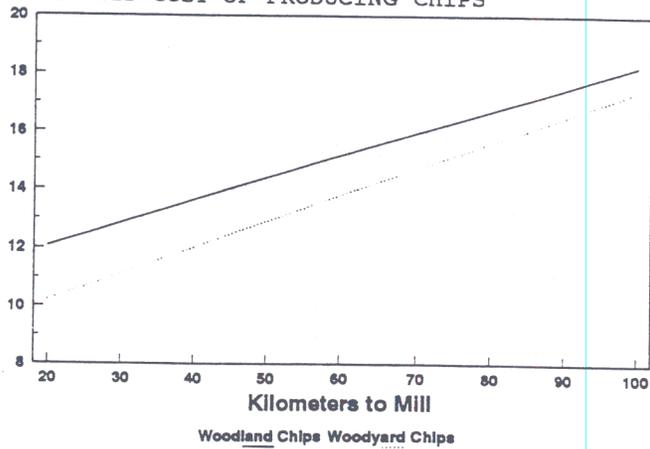


Figure 2. Cost of producing chips into the woodyard chip pile from clearcuts.