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2.6 Plantation Thinning Systems in the Southern United States

Bryce J. Stokes, USDA Forest Service, Auburn, Alabama, USA,
William F. Watson, School of Forest Resources, Mississippi State University, Mississippi State, Mississippi, USA

Abstract

This paper reviews southern pine management and thinning practices, describes three harvesting systems for thinning, presents production and cost estimates, and utilization rates. The costs and product recoveries were developed from published sources using a spreadsheet analysis. Systems included tree-length, flail/chip, and cut-to-length. The estimated total harvesting, transport, and woodyard *cost* per m^3 of pulpable fiber at the digester was US$24.15 for tree-length and US$19.84 for flail/chip. The same costs for cut-to-length was USS27.66, 27.87, and 29.15 per m^3 for chainsaw, feller-buncher/ processor, and harvester systems, respectively when producing 2.3-m boltwood. When processing the trees into .5.3-m bolts, the cost for the harvester system was US$29.05. Fiber recovery to the digester was approximately 5 5 percent of standing biomass for all the systems.

Introduction

The United States has an increasing demand for all wood products, resulting in several forest management strategies for managing and utilizing vast holdings of southern pine plantations. There are 13 million hectares of plantations in the southern region of the U.S. By the year 2000, they will provide 43 percent of the South's total softwood supplies and are expected to provide 65 percent by 2030. Plantations constitute one in six of all forested hectares in this region (Kelly et al. 1996). Most of these plantations were established with *Pinus* species and the vast majority of these plantations are loblolly pine, *Pinus taeda.*

These pine plantations are usually established with fairly high stockings (1,700 trees per hectare) and the plantations are grown on either a pulpwood or sawlog rotation. As a fiber supply, plantations are either clear felled after a 17-25 year rotation, or provide the wood from thinnings. In longer rotations of 35-65 years, thinnings are usually used as a management tool to enhance the quality of timber grown to sawtimber maturity. To grow these plantations for more than 25 years, one or more thinnings are necessary to prevent stagnation. It is estimated that as many as 500,000 hectares are thinned advantages in second thinnings or in older, first-thinning stands. Each of these systems have inherit advantages and disadvantages as far as access, productivity, tree-size sensitivity, thinning quality, residual stand and site impacts, product recovery, and utilization.

As always, in our capitalistic society, costs often dictate the final selection of the type operations to be used. In this paper we will describe the role of thinning in southern pine plantations and the major types of thinning systems employed in the Southern United States: tree-length, in-woods flail delimbing/debarking with chipping, and cut-to-length. System production rates were developed from published sources using a spreadsheet analysis and current machine rates. Product recoveries were determined for a typical stand as a percentage of whole-tree biomass and converted to solid wood at the digester.

Thinning Guidelines

There has been much research and there are volumes of literature on the practice of thinning (Stokes 1992). Most of the literature has addressed improved growth rates and silviculture, some addressed methods and machinery. Tree growth potentiai is determined genetically, but actual growth is determined largely by the environment: light, water, nutrients, space and protection from insects and diseases (Nebeker et al. 1985). Growth increments of individual trees can be regulated through thinning practices by using known biological principles about height growth and late wood development.

Stand growth is influenced by site quality, age, species, stocking level, and forestry practices. In even-aged stands, a more advanced stage is reached earlier on the better quality sites, requiring earlier thinning. The natural process of competition concentrates the growth potential of the stand in the dominant and codominant trees. Proper stocking is the number of trees per unit area that fully utilizes the site's potential to grow trees. A high-quality site has a higher carrying capacity.

Timing and frequency of thinnings should be determined by site quality and length of rotation. Precommercial thinning is not justified unless there are more than 3,700 trees/ha such as in' natural stands or seeded plantations. The timing of the first commercial thinning is extremely important and should consider product objectives, site quality, stand density, operability, subsequent thinnings, and rotation length. For sawlog rotations, thinning should be delayed until after natural pruning has occurred. Corresponding ages would be about 12-14 years on land with a site index of 29 and 20 to 22 years on land with an index of 19m. Also, it is the typical strategy to postpone each year yielding 30 million m^3 of wood to be used by the pulp and paper industry for the most part.

Many of the pulp mills use plantation thinnings to constitute as much as 30 percent of their pine supply. This causes concern in mills producing liner board or other pulps demanding strength properties. Mills producing bleach grades of pulp are finding advantages in using pine thinnings since these juvenile wood fibers behave more like hardwood fibers and require less bleaching to achieve the desired whiteness.

Residual stand quality is always a major concern in thinning operations. Since thinning is an intermediate stand treatment, it is important to assemble an operation which leaves the stand in a condition to respond rapidly to the available sunlight and the reduction in competition. This usually means that the thinning system should have the ability to achieve the desired selectivity and should not cause damage to the roots and crowns. Another concern is that the operation not cause damage to the residual boles since these are the crop trees which were selected for their potential to develop into quality stems for solid wood products.

Different corporate objectives, management strategies, stand and site conditions, mill processing facilities, and final products dictate the prescription, method, schedule, and use of various harvesting systems to conduct thinning operations. In all cases, either ground skidding or forwarding is used for primary transport; therefore access and the establishments of corridors for primary transportation is a major task in first thinnings. Most often, this is accomplished by removing every third or fifth row, or by opening corridors at designated intervals.

In the past, motor manual crews were favored to achieve the desired selectivity and to minimize damage. However safety concerns and workman's compensation insurance premiums have reduced the cost competitiveness of these operations. In many states, affordable workman's compensation insurance is only available for completely mechanized crews. In early thinnings, in which all trees are used for fiber, woodlands chipping systems are very cost-effective, especially when using row/selection cuttings. High-speed feller-bunchers using felling saws or shears are combined with grapple skidders to supply stems to roadside flail delimber/debarkers and chippers. Tree-length systems are also very prevalent for early thinnings and do offer the opportunity for solid-wood product sorting. Again, the feller-bunchers and skidders are used to take the stems to roadside for mechanical processing and loading. Another option that is currently being introduced is cut-to-length systems using harvesters and forwarders. This particular option is best suit for multiple-product sorting and has thinnings until sufficient revenue is received from the harvested trees to cover the costs.

Heavy thinning promotes rapid diameter growth but under utilizes the site. Light thinnings increase site utilization and. volume increments but require numerous entries into the stand. Thinning guidelines suggest removing 30 to 45 percent of the stand basal area, or maintaining about 14 to 21 m^2/ha in the residual stand. The number of thinnings is determined by stand density at the time of first thinning. The interval of cutting is influenced by economic factors associated with operability, but the biological interval is frequently defined by the length of time for trees to grow 3 meters in height.

In the southern US, the decision to thin is based on management objectives. If pulpwood is the only objective, then the value of thinning is questionable (Bennett 1963). Most studies have shown that for pulpwood rotations, thinnings will have no influence on cubic volume yields except in extremely dense young stands. When sawlogs or multiple products are the objective, thinning should be an integral part of stand management. Thinnings can also be used to manage insect infestations, but if improperly appiied can contribute to increased insect and disease problems.

If pine plantation is being managed for solid wood products, thinnings must commence soon after the tenth growing season or diameter loss may occur. Stems harvested in a first thinning between 10 to 15 years are usually sufficiently large to be cost effective. Thinning intensities vary among landowners from leaving as few as 250 trees/ha to as many as 750 trees/ha. Thinning regimes may include only one entry into a stand with high removal intensities, or a series of entries before final cutting. In some cases, trees are pruned to avoid the development of limby bolewood after heavy thinnings are used. If less intensive first thinnings are used, one or more additional thinnings are required to reduce plantations to about 200 trees per ha which is the desired density to produce solid wood products.

Numerous studies have shown that tree heights arid total volume production are essentially independent of initial stocking. At close spacings, the carrying capacity is reached early. Once the carrying capacity is reached, the rate of volume production will be the same regardless of initial stocking. Initial spacing is determined primarily by the product objectives. For larger diameter timber, there are three alternatives:

1. wide spacings with no thinning and shorten rotation (approximately 1,000 trees/ha),
2. intermediate spacings (approximately 1,500 - 2,000 trees/ha), with no thinnings, and a lengthened rotation or
3. intermediate spacings with thinnings to shorten rotation.

Harvesting Methods and Systems

There are two important considerations for choosing a thinning method:
1. growth response and quality of residual trees, and
2. costs involved in making the thin.

The best choice will often represent a compromise between cost and quality, as well as the ability to recover more valuable products.

There are three basic thinning methods used in the South:
1. selective,
2. systematic (also known as mechanical), and
3. combination of systematic and selective.

In the selective method, trees are marked or removed primarily on their position in the stand structure and/or their quality. This method is also referred to as low, crown, and selection thinning. In the systematic method, trees are removed strictly based on spacing, either a row spacing or designated corridor width and interval. There is no regard for a particular tree's crown position or quality. In the past, every third row, i.e. approximately 11 m spaced corridors, was commonly used. Today, the cutting of every fifth row (approximately 18 m between corridors) is more common. Also, it is more preferable to used a combination of systematic and selective cutting. In this method, a row or corridor is removed and trees are selected for removal based on biological principles between the cut corridors. Although fifth row with selective cutting between rows is the most common method in use today, third row and ninth row removals with selective cutting are also being utilized.

Typical thinning systems cover a broad range of mechanization: from very labor intensive to fully mechanized. The simple labor-intensive methods use chainsaws for felling and processing. Mechanical intensity begins with feller-bunchers and progress through mechanical processors and harvesters to whole tree processing/chipping. The advantages of a labor-intensive system are low capital investments, high maneuverability, minimal soil disturbance, and the ability to work efficiently on small tracts. Disadvantages are low productivity rates, sensitivity to adverse weather and ground conditions, and relatively high harvesting costs. Also, the inherent dangers associated with manual work in the woods results in more accident and higher insurance premiums than for mechanical systems. Mechanical systems have advantages of higher production rates, lower harvesting costs, and less sensitivity to adverse weather and ground conditions. The disadvantages include high capital investment, need for extensive operator training, and potential extensive stand damage and soil disturbance.

In the more typical tree-length operations, the trees are delimbed and topped in the woods either using a chainsaw or delimbing gate with chainsaws at the deck. Grapple skidders are used to extract the trees and the stems are usually loaded tree-length onto trailers. Current modifications to these systems include the addition of mechanical processors and slashers. The high insurance rates, shortage of high-quality chainsaw operators; and improved production are driving the tree-length operations to full mechanization. In thinnings, the boles may be slashed into shorter lengths to increase highway haul payloads. It is difficult to reach maximum payloads with early thinnings when using tree-length wood, although efforts are made using drop-frame trailers, double- and cross-stacked wood, and alternating butts.

High speed feller-bunchers are usually used for felling in tree-length systems. Since residual stand quality is a major concern: smaller machines are usually used to make the selective cuts. A larger machine may be used to cut rows or corridors, and if the stand density is significantly reduced, may be used to perform the selective cutting. Some operators are using swing feller-bunchers on tracks to reduce residual soil and stem damage.

The use of in-woods chipping has usually been limited to energywood production because high bark content limits the use of whole-tree chips as a pulp furnish. Flail delimbing and debarking allows economical processing and chipping of whole trees in the woods to produce clean, acceptable chips (Stokes and Watson 1988, Watson and Stokes 1994). In-woods processing of whole trees has several advantages over tree-length operations. Flail processing and chipping is potentially more economical for small diameter trees than delimbing and hauling tree-length wood. Another advantage is increased biomass recovery, assuming that the limbs, top, and bark can be utilized as fuel. In-woods flailing and chipping allows the recovery of a higher-valued chip product for a larger portion of the whole tree and the smaller diameter stand components. A disadvantage is the high-capital investment and restricted product for the logger.

Historically, forwarders have had a significant role in pine plantation thinnings. They once replaced the old "bobtail" truck method in many areas. The forwarders were used with manual felling and processing. and were an extension of the purely manual system. During the 1970's and early 1980's, the tree-length systems became predominate. However, forwarders and cut-to-length systems are today being used for thinnings, especially second thinnings. There have been many improvements in machines for processing at the stump, especially in harvesters for combining the felling and processing. There are many inherent advantages of cut-to-length systems and the use of forwarders. They potentially reduce the residual site and stand damage, can work with fewer roads and landings, and require fewer workers (when fully mechanized). Such systems can improve value recovery using computer systems for processing. However: the harvester/forwarder system has a high capital cost and such systems are limited to markets that accept such wood lengths. There is still a range of mechanization of cut-to-length systems, which include manual felling and processing, up to harvesters. To reduce costs in early thinnings, options include the use of feller-bunchers and processors to get away from single stem processing. Drive-to-tree harvester are being used to reduce the capital investment for such machines.

Productivity and Cost Comparisons

A range of thinning systems were developed using production and cost information from published sources. For comparison, they were evaluated in a representative composite stand. The productivity cost comparisons were made with the use of a spreadsheet templet based on the Auburn Analyzer (Tufts et al. 1985) and modified by Stokes (1987). The comparison simulated the various systems operating on a typical stand receiving a first thinning, using a fifth-row with selective cutting method. The spreadsheet was used to estimate the productivity of the various components and the system as a whole working in this stand (Holtzscher 1995, Lanford and Stokes (In Press)). The cost of the components and the system cost were estimated using machine rates.

The systems evaluated included a tree-length and flail/chipping system that used feller-bunchers and grapple skidders. Three cut-to-length systems using a forwarder were also used in the analysis: one with manual felling, processing, and piling; one with mechanical felling and mechanical processing/piling with separate machines, and; a swing-to-tree harvester system. All of the forwarder systems were evaluated producing 2.3-m boltwood. Also, the forwarder/harvester system was evaluated producing 5.3-m boltwood. These systems are described in Table 2.6.1 as:

1. tree-length
2. flail/chip
3. forwarder/chainsaw
4. forwarder/processor
5. forwarder/harvester/2.3 m
6. forwarder/harvester/5.3 m.

Table 2.6. I. Thinning systems used in analysis.

System	Fell	Process	Extract	Production (Rcf. No.s)
Tree-length	Valmet 503 feller-buncher (72 kW)	CTR Slasher/ loader	Franklin 405 grapple skidder (87 kW)	7,12
Flail/chip	Valmet 503 feller-buncher (72 kW)	Peterson Pacific 5000 (522 kW)	Franklin 405 grapple skidder (S7 kW)	9,12,13
Forwarder Chainsaw	Chainsaw	Chainsaw	Valmet 546 forwarder (76 kW)	3,8
Processor	Valmet 503 feller-buncher	Grapple processor (70 kW)	Valmet 546 forwarder (76 kW)	3,8
Harvester	Valmet 546 harvester (93 kW)	Valmet 546 harvester	Valmet 546 forwarder (76 kW)	3,5,8

note: The use of trade names is for convenience of the reader and is not an endorsement by the USDA Forest Service or Mississippi State University.

Systems were balanced to minimize costs by using reasonable and representative equipment configurations. As an example, the flail/chip system was balanced to one flail and chip unit. Systems with harvesters were balanced to one harvester. System costs were based on the least productive function, after balancing. Machine owning and operating costs were based on a machine rate analysis (Miyata 1980). A standard labor rate of US$11.88 per scheduled machine hour (SMH), which included all fringes and compression coverage, was used for simplicity. In reality, there is a differential in labor rates depending on job tasks. Table 2.6.2 summarizes many of the assumptions used in the productivity and cost estimations.

Table 2.6.2. Assumptions used in production and cost analysis.

***General* Production:**
Tree-length and Flail/chip:
Average skidding distance - 183 m
Trees per cutting accumulation - 3
m^3 per skidder turn - 1.5
Average forwarding distance - 152 m Forwarders
m^3/load - 9.6
m^3/stop:
0.7 - chainsaw system
1.7 - processor system
0.5 harvester system, 2.3-m bolts
0.6 - harvester, 5.3-m bolts.

General Costs:
2,000 SMH (scheduled machine hours) per year
12 percent interest rate
20 percent salvage value

Machine Costs:			
Machine	Purchase Price US$	Life (yrs)	Maximum Utilization (%)
Chainsaw	520	1	50
Valmet 503 feller-buncher	100,000	5	65
CTR Slasher/loader	150,000	5	80
Franklin 405 skidder	94,424	5	65
Peterson Pacific flail/chipper	450,000	5	70
Valmet 546 forwarder	167,494	5	85
Grapple processor	180,000	5	65
Valmet 546 harvester	280,383	5	65

The representative stand was a loblolly stand with an initially density of 1468 trees/ha in which 727 trees/ha were harvested (Table 2.6.3). A fifth-row removal and selective harvest between rows was simulated to obtain the harvest and residual tree distribution (Stokes 1987). In the simulation, 46 percent of the trees were removed from the rows and 54 percent of the trees were selectively removed from between the rows The initial stand volume was almost 264 m^3/ha; harvested volume was about 11 lm^3/ha. Average dbh (diameter breast high) was 16.8 cm for all harvested trees; average dbh of the trees removed from the rows was 18.0 cm and average dbh for the selective cut trees was i 5 8 cm

Table 2.6.3. Representative pine plantation stand.

DBH class cm	Total height m	Initial trees no./ha	Harvested trees no./ha	Initial volume m^3/ha	Harvested volume m^3/ha
10	10	163	135	5.7	4.7
13	12	111	72	7.7	5.0
15	13	222	121	25.6	14.0
18	15	415	203	71.1	34.7
20	16	356	146	85.3	35.0
23	17	156	35	50.1	11.1
25	18	45	15	18.4	6.1
Total		**1468**	**727**	**263.9**	**110.6**

Table 2.6.4. Summary of products by harvest and process method.

	Harvest method			
Product/residues	Tree-length	Flail/chip	Cut-to-length 2.3 m	Cut-to-length 5.3 m
	Percent of standing biomass			
Acceptable chips	55.2	54.6	54.8	55.0
Mill residues:				
-Debarking drum	6.9		6.8	6.8
-Screening	6.6	6.0	6.6	6.6
-Total	13.5	6.0	13.4	13.4
Forest residues	31.3	39.4	31.8	31.6
Total	100.0	100.0	100.0	100.0

Recovery efficiencies were determined and compared for the four delivered products: tree-length wood, clean in-wood chips, 2.3-m boltwood, and 5.3-m boltwood. The quantity of clean chips at the digester and residues along the wood flow paths were estimated for each harvesting system. The recovery percentages (Table 2.6.4) were based on published information for the product recovery (Flowers et al. 1992, Watson and Stokes 1994, Watson et al. 1992, Watson et al. 1993). In the analysis, it was assumed that over-sized chips were resliced and put back into the woodflow. Actual recovery levels would depend on the actual merchandising limits and type of processing equipment, such as screens, at the mill.

The recovery efficiencies were applied to the unit cost of the "delivered products" to convert these costs to US$/$m^3$ of solid wood fiber to the digester. Transportation costs for a 100 km haul were estimated to be US$7.37 per delivered m^3 of tree-length and boltwood, and US$8.08 per delivered m^3 of clean, in-wood chips. These costs are based on the trucks attaining a full payload which can be difficult for tree-length operations in states with restrictive overhand laws.

Table 2.6.5. Production and cost summary based on delivered products

System/function	No. of machine/ workers	US$ per SMH	m^3 per SMH	US$ per m^3
Tree-length				
Feller-buncher	1	36.99	16.0	2.32
Skidder	1	33.94	16.0	2.13
Delimber/loader	1	44.31	19.3	2.81
Total system		115.74	16.0	7.26
Flail/chip				
Feller-buncher	3	104.37	51.[illegible]	2.63
Skidder	3	97.47	47.9	2.45
Flail/chipper	1	160.25	39.8	4.03
Total system		362.09	39.8	9.11
Forwarder/chainsaw 2.3				
Chainsaw fell	2	26.61	14.6	2.21
Chainsaw process	2	26.96	12.6	2.24
Manual pile	2	23.76	12.0	1.97
Forwarder	1	44.39	13.7	3.68
Total system		121.73	12.0	10.10
Forwarder/processor 2.3				
Feller-buncher	1	34.44	17.1	2.71
Processor	1	52.57	12.7	4.14
Forwarder	1	43.45	15.5	3.42
Total svstem		130.45	12.7	10.27
Forwarder/harvester 2.3				
Harvester	1	72.40	10.2	7.06
Forwarder	1	43.47	12.4	4.24
Total system		115.88	10.2	11.30
Forwarder/harvester 5.3				
Harvester	1	72.40	10.2	7.06
Forwarder	1	42.47	14.5	4.14
Total svstem		114.87	10.2	11.20

Results

Table 2.6.5 summarizes the individual function and total system productivity and cost to roadside for- each of the evaluated systems. These costs do not include hauling, but are for loading the wood onto trailers. There are no supervision, overhead, or profit as part of these costs. The more mech nized systems have significantly higher overhead and supervision costs and thus will be favored bv this analysis. The most productive system is the flail/chip, which produces almost 39.S m^3/SMH. This system is balanced with three feller-bunchers and three skidders. The tree-length system has the next highest production at over 16.0 m^3/SMH. Cut-to-length systems ranged from *IO.2* to 12.7 m^3/SMH. The forwarder/processor system had higher production than the other forwarder systems; this is indicative of the effect that small diameters have on system production. This system uses a feller-buncher to convert the harvest process from a single-stem process to a multiple-stem process, which improves production. The least productive system is the forwarder/harvester at about 10.2 m^3/SMH.

The least cost option to roadside, loaded onto trailers, was the tree-length system at US$7.26/$m^3$. Flail/chip system cost was the nest lowest at USS9.1 l/m^3. Forwarder system costs ranged from US$ 10.1 0/m^3 to USS 11.30/m^3. The forwarder/harvester had the highest cost of USS 11.30/m^3 when processing 2.2-m boltwood.

Table 2.6.6 summarizes the recovery and total cost for the different systems to the digester. Almost 81 percent of' all roundwood, either tree-length or bolts, delivered to the mill was recovered as acceptable chips. The mill residues were bark from drum debarking and fines from screening. Over 90 percent of the clean, inwoods chips that were delivered to the mill made it to the digester. Some additional bark and undersized chips were removed during the screening process.

Table 2.6.6. System **cost** ***for*** *fiber to the digester*

System	USS per delivered m^3			Percent to digester	USS per solid m^3 of acceptable chips at digester		
	Loaded on truck	Transport'	To mill		Harvest & transport	Woodyard	Total
Tree length	7.26	7.37	14.63	80.3	18.22	5.93	24.15
Flail-Chip	9.11	8.08	17.19	90.2	19.06	0.78	19.84
Forwarder/ chainsaw 2.3 m	10.10	7.37	17.47	80.4	21.72	5.93	27.56
Forwarder/ processor 2.3 m	10.27	7.37	17.64	80.4	21.94	5.93	27.87
Forwarder harvester 2.3 m	11.30	7.37	18.67	80.4	23.22	5.93	29.15
Forwarder harvester 5.3 m	II.20	7.37	18.57	80.4	23.12	5.93	29 05

'Transport cost based on 100 km one-way haul distance.

Total harvest and transport costs were determined for the delivered products, i.e. wood and bark in the roundwood and unscreened chips from the flail/chip system. These cost was lowest for the tree-length system and highest for the cut-to-length system when using the harvester. The total harvest and transport costs were converted to US$/m^3 of wood in the form of acceptable chips (chips to the digester) and the cost ranking remained the same. Woodyard handling: drum debarking (except flail/chip), and screening costs were added to the converted harvesting and transportation costs. The least cost system for providing chips to the digester was the flail/chip system at US$19.84/m^3. The highest cost system was the forwarder/harvester (2.3-m boltwood) at US$29.15/m^3 of acceptable chips to the digester. The other system costs per m^3 of chips to the digester were US$24.15, 27.66, 27.87, and 29.05, respectively, for the tree-length, forwarder/chainsaw, forwarder/processor, and forwarder/harvester with 5.3-m boltwood systems.

Summary and Conclusion

In this analytical comparison the flail/chip system had the least cost to the digester. In a case study (Watson and Stokes 1994), in which all cost could be accounted for, the flail/chip and tree-length systems had almost identical cost to the digester. The lower estimated cost verses the case-study cost of the flail/chip system is probably due to the perfect system balance used in the analytical process. This did not occur in the case study.

Also, in the analysis, the tree-length system had the greatest utilization as a percent of the whole trees. It is possible that the flail/chip system will have greater utilization when the roundwood systems can not handle the smaller stems. Usually the decision to use the flail/chip system is driven by the capacity of an existing wood yard being exhausted and the need for an additional chip source.

The cut-to-length systems had the highest cost of delivering wood *to* the digester. However, some land managers and particularly private nonindustrial landowners will. demand that this system be used so that residual site and stem damage is reduced. The forwarder/harvester system affords all weather capabilities in most topographic conditions. This is a great advantage for mills demanding fresh wood. As firms in the USA move to comply with their sustainable forestry initiative, the forwarder/harvester system might find greater favor.

In conclusion, all of these systems have a niche in which they can operate in the southeastern Unites States. More pressure will be placed on the systems with chainsaw operators as workmans's compensation insurance rates rise. Also most new wood yards are designed to handle longer bolts of wood the shorter (2.3 m) bolts do not feed through these systems as well. Thus, it is likely in the future that all cut-to-length pulpwood will be 5 meters or greater in length.

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