Survey of disc chippers in roundwood chipping yards of southeastern United States

Alastair A. Twaddle and William F. Watson

ABSTRACT: A survey of roundwood chipping facilities throughout the southeastern United States was undertaken, and those results pertaining to information collected on disc chippers were summarized. The survey covered 76 roundwood chipping installations including both mill yard and satellite mills. Disc sizes, discharge types, and chip setup lengths are among the categories by which the chippers are summarized.

KEYWORDS: Chippers, chips, disc knives, logs, mills (factories), quality, southeastern USA, surveys, woodyards.

In 1990, the Department of Forestry at Mississippi State University completed an equipment survey of the major machinery components within roundwood chipping facilities throughout the southeastern United States. This paper covers the specific data relating to disc chippers and characterizes the chippers by various categories.

Response level

The survey covered both the mill yard facilities associated directly with a utilization plant and satellite chip mills. Fifty-three of the estimated 77 major mill yard facilities within the 12-state survey region participated in the project. The exact number of satellite roundwood chipping facilities operational at the time of the survey is unknown, but the survey covered 22 yards which is estimated to be about 1/4 of the satellite yards producing at least 90 billion kg of chips per year within the region.

Participating yards were distributed over 12 states, with the bulk of the responses from Mississippi, Georgia, Alabama, and Virginia as indicated in **Fig. 1**. A total of 101 chippers were recorded from the 76 survey respondents. These chippers produced an estimated 58 billion kg of chips in the survey period of one year beginning July 1, 1988. Each chipper therefore produced about 570 million kg of chips. In some mills, however, individual chippers produced about 113 million kg of roundwood chips in the 12-month period.

Chipper dimensions

The chipper disc dimensions varied from 190 cm to 330 cm with the number of knife sets in the discs ranging from 4 to 15. Bigger discs have more knife sets which allow higher throughput while avoiding the need for high disc speed.

The most common disc and knife combinations were a 285-cm disc with 15 knives and a 295-cm with 12 knives, although there were also a variety of other combinations found within the yards as seen in **Fig. 2**.

Powering

Over the range of disc sizes recorded, chippers with bigger discs had larger powered motors. For a given disc dimension, however, there was considerable variation. For example, 285-cm 15-knife discs ranged from 1865×10^3 W down to 600×10^3 W as shown in **Table I**. Similar variation was also found in the common 295-cm discs with 12 knives. Eighty-seven percent of the chipper motors greater than 1120×10^3 W were synchronous units. In contrast, 62% of the chippers below this level used wound rotor motors.

Operating speed

The speed of cutting of the wood during chipping affects chip quality. High disc speed boosts throughput at the expense of an increase in production of the fine material. An advisable target cutting speed of 20–25 m/s is therefore a compromise between production and quality.[1] The mid-disc operating speeds of the chippers in the survey were either in this operating range or just above it as seen in **Table II**. The highest operating speeds were 31 m/s by the smaller 244- and 264-cm discs operating above 450 rpm.

Twaddle and Watson are research assistant and professor, respectively, at Mississippi State University, P.O. Drawer FR, Starkville, MS 39762.

[1] Hartler, N., Tappi J. 69(10): 62(1986).

Disc revolutions of the chippers varied from 257 rpm to 512 rpm. As shown in **Fig. 3**, most of the chippers were operated at either approximately 300 rpm or 360 rpm. All of the chippers operating at 400 rpm or greater were those utilizing smaller disc sizes.

Feed method

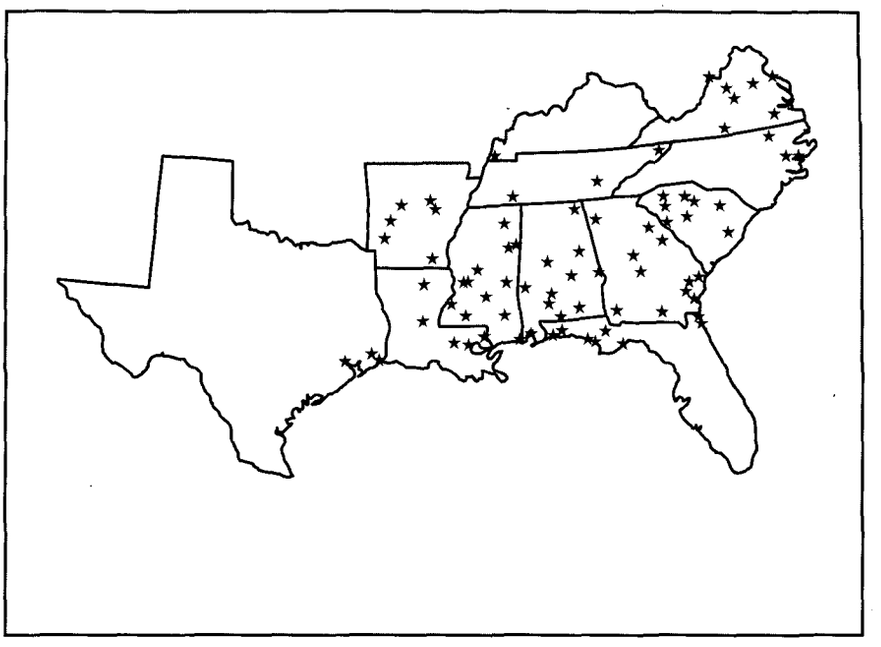
Disc chippers can be fed by either a horizontal or a drop method. The drop or gravity feed method where logs fall down a chute at an angle of 35° to 40° on to the disc surface is more appropriate for shortwood systems. In horizontal feed systems the logs are driven by belt, chain, or spike rollers to the chipper throat.

Horizontal feed systems chipping long length logs should produce the best chip quality since the log axis can be kept more easily positioned to the chipper spout axis. In addition log speed can be kept equal to the feeding speed of the chipper.[2] Furthermore, long logs present fewer ends to the chipper per unit volume of wood. Chip quality of log ends is generally regarded as being lower than that for the rest of the log. For this reason and a variety of material-handling advantages, virtually all new processing systems utilize horizontal chipping. Another factor is the diminished requirement for equipment needed to process longwood.

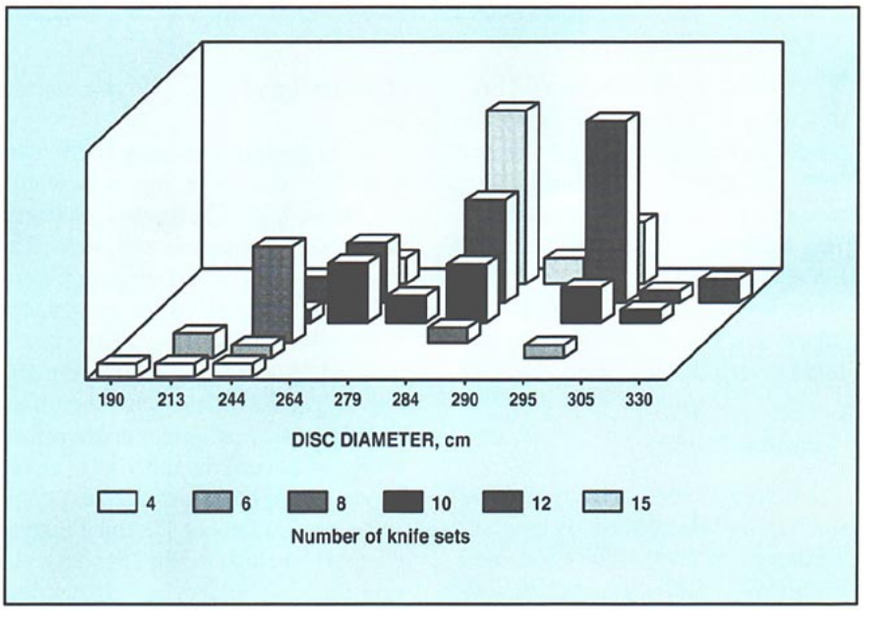
While horizonal chipping of long logs produces high chip quality, chipping of especially short logs in the 1.2-m length in a horizontally fed chipper produces poor quality chips because the short logs are not able to be stabilized sufficiently in the horizontal spout.[2]

Because of the dominance of tumble debarking systems in the woodyards surveyed, shortwood chipping systems of 1.2–3.0 m dominate. Fifty-seven percent of the 101 chippers in the survey are gravity fed. The remaining 44 are horizontally fed units. All of the 23 satellite yards used horizontal feed systems. Several mill yards chipping longer shortwood of 2.4–3.0 m also used horizontal feed. Some yards, however, were feeding horizontally with log length as short as 1.5 m.

1. Approximate location of participating woodyards



2. Numbers of various disc diameters/knife sets



Setup chip length

The length of chip that an individual disc chipper is set to make is primarily a function of the gap between the disc wear plate and the knife tip as well as the angle at which the log is presented to the disc. The former parameter is the Y-dimension, while the latter is the spout angle.

The choice of a particular chip length setup involves some degree of compromise. As the severed wood fractures and splits during cutting, the ratio of length to thickness created is about 5:1.

[2]Robinson, M. D., TAPPI 1989 Pulping Conference Proceedings, TAPPI PRESS, Atlanta, p. 325.

I. Applied power for two common disc sizes and varying number of knife sets, W x 10^3

Disc diameter	Number of knives 6	8	10	12	15
285 cm		1306	1492(2)	1828	1865(3)
			1119	1492	1492(4)
			746	1119(2)	1194(2)
			522	933	1119(6)
				895	746
					671
					597(2)
295 cm	1119		1492	2238	1679
			933(2)	1865(13)	1492(2)
				1492(2)	1306
				1492(2)	1119
				1119(5)	
				933	

Parenthetical expressions indicate the number of units having the particular combination of knives and disc diameter.

II. Mid-disc operating speeds for surveyed disc chippers

Operating speed (mid-disc)	% of chippers
<20 m/s	3
20–25	49
>25	48

Most kraft pulping processes usually require a thin chip with a significant proportion of the raw in-feed less than 8 mm. It is therefore desirable to cut short length chips. Formation of the chip, however, unavoidably requires severing of the fibers and causes some damage to the end fibers, resulting in lower pulp strength. A balance must therefore be struck between chip thickness and fiber length. Cutting shorter chips also produces more fines which are not desired in the pulping process.

Most pulping processes require a reasonably similar chip size. Kraft pulping is the dominant end process of the wood chips. Accordingly the variation in chip setup length from the surveyed yards was not expected to be great. Most chippers were set up to produce either 16-mm or 19-mm long chips, although some were set as low as 13 mm and a reasonable proportion at the upper level of 25 mm as seen in **Fig. 4**.

Effect of wood type on chip setup length

A hypothesis was made that yards with blowing discharge chippers may tend to use longer chip setup lengths to compensate for an expected increase in chip breakage caused by the blowing action. A summary of the available setup lengths split into bottom or blowing discharge did not reveal any major trends supporting this hypothesis, although the extreme ends of the data set showed fewer short setup lengths for blowing chippers and a greater proportion of longer lengths. These data are seen in **Fig. 5**. A statistical test (Contingency Table) confirmed this observation of no statistically significant trend (P = 0.05).

Effect of wood type on chip setup length

A further hypothesis associated with chip setup length was made that chippers handling only hardwoods would be set to produce a shorter chip than those handling only softwoods, because hardwoods tend to produce a thicker chip than softwoods for the same chip length. The results of summarizing the setup length based on whether the chipper was handling hardwoods only, softwoods only, or a mixture of the two are shown in **Fig. 6**. The data indicate a possible tendency for hardwood chippers to be configured to produce a shorter chip length. The Contingency Table statistical test indicated, however, that there was no definite pattern to chip setup length based on wood type (P = 0.05).

Knife systems

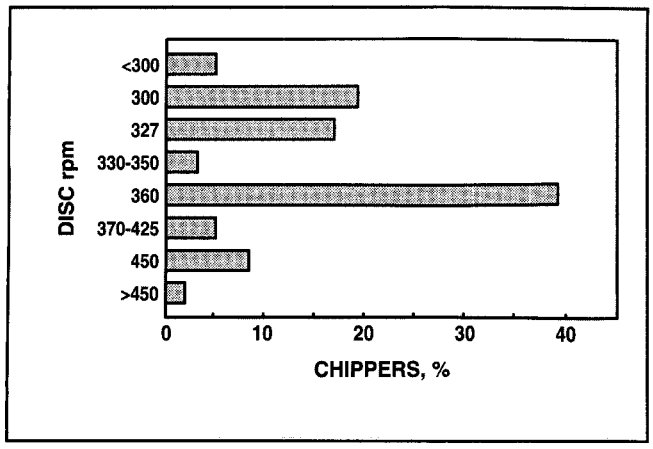
Table III indicates that 15% of the yards used disposable knife systems of one particular brand rather than regrindable knives. This accounted for 14% of the volume of roundwood chipped over the survey period.

Chip discharge

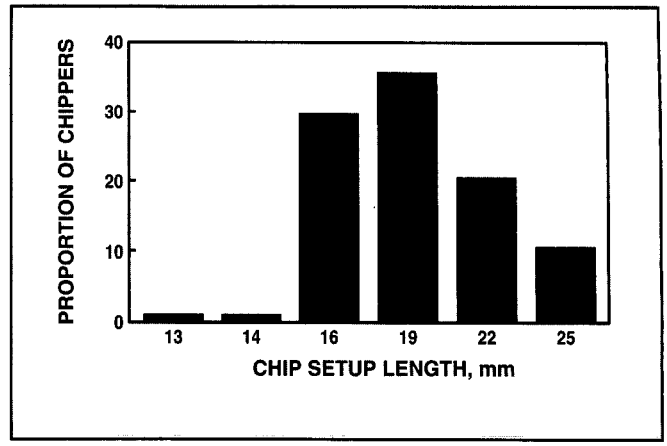
After being severed from the bole, chips passing through the disc slots are expelled from the chipper casing. The chips may be forced from the casing by blowing vanes mounted on the back of the disc and blown to a storage location. Alternately they may passively drop out of the bottom of the casing and be conveyed away from the chipper.

The blowing discharge method is a much more aggressive operation because the chips are forced from the chipper housing. The chips are likely to strike the vanes or be driven against surfaces along the discharge path causing additional breakage and the cre-

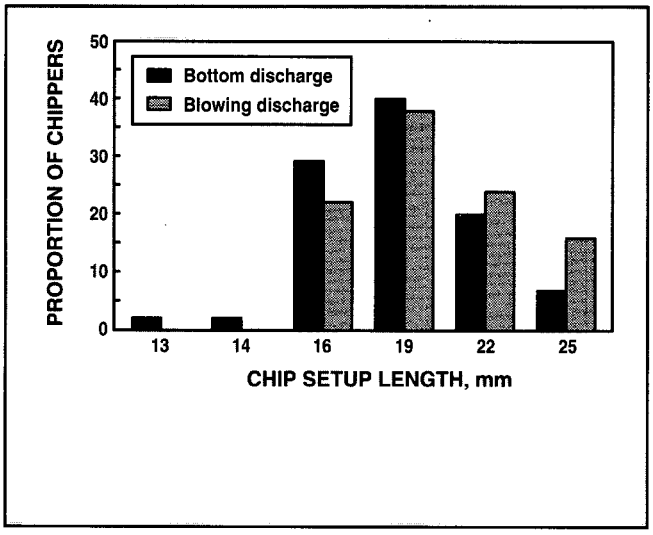
3. Variation in chipper disc revolutions



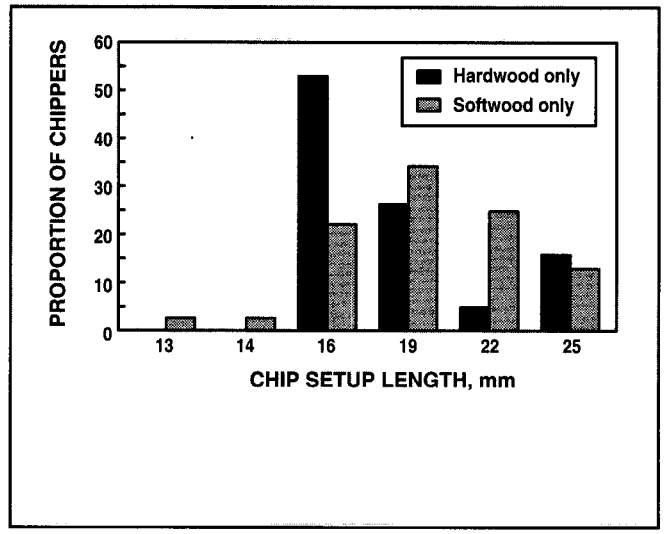
4. Variation in chip setup length



5. Variation between bottom and blowing discharge chippers



6. Variation between hardwood only and softwood only chippers



ation of pins and fine material. Because of the force required to move large volumes of air, blowing chippers also impose heavier power requirements even if the chipper is under conditions of no load.

The advantage of blowing chippers is that they can be situated lower to the ground level, negating the need for a conveying system under the chipping unit. The feed systems to the chipper can then be lower as well with a concomitant lower capital outlay.

Bottom discharge chippers were found to be more numerous than the blowing type, although a considerable proportion of blowing type chippers are used as shown in **Table IV**. One survey response indicated the use of a horizontal discharge chipper.

Disc chipper age

Various major components of a disc chipper are replaced during the service life of the unit. The responses to a questionnaire regarding the age of each chipper produced the results given in **Fig. 7**. Over 1/2 of the disc chippers included within the survey were less than 10 years old. The oldest unit recorded was 33 years old.

Chipper manufacturers

In the wood yards included within this survey, Carthage is the major chipper brand with 44% of the 101 chippers. Murray has about 1/4 of the chippers followed by Fulghum and Black Clawson with 10% for each. KMW, Kockums, Precision, Progress, and Soderhamn share the remaining 10% of installed chippers. This is depicted in **Fig. 8**.

Summary

A survey of equipment in southeastern United States roundwood chipping yards highlighted the considerable

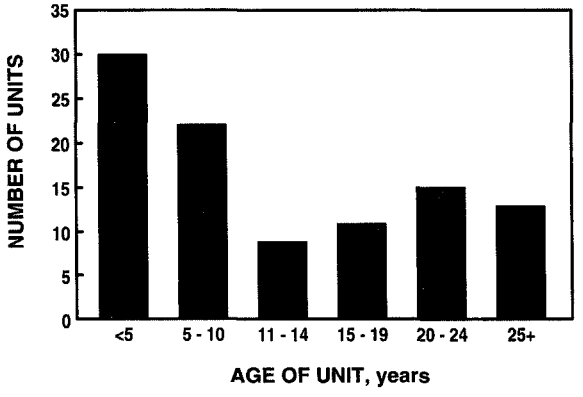
III. Proportion of yards with disposable or regrindable chipper knives

Knife system	*Yards*		*Yearly volume chipped*	
	Number	*%*	*KG*	*%*
Disposable	10	15	$7{,}800 \times 10^6$	14
Regrindable	50	85	$38{,}500 \times 10^6$	86

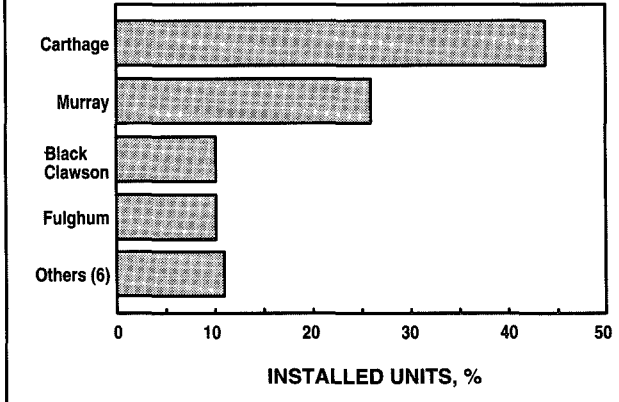
IV. Method of chip discharge from chipper housing

Discharge method	*% of chippers*
Bottom	62
Blowing	37
Horizontal	1

7. Variation in age of chipper installations



8. Roundwood chipper manufacturers in surveyed facilities



variability in the dimensions and operating features of disc chippers. Disc chippers also showed considerable variation in disc size, number of knife sets in the disc, and powering of the chipper. All of these factors are related to the production demands of the individual facilities.

The bulk of the chips produced at the surveyed yards were to be consumed using the kraft pulping process. The length of chips for which the chippers were configured varied from 13 mm to 25 mm, a wide range.

The information reported above should not be used as an overall indication of roundwood chipping in the southeastern United States. Because of the dominance of mill-associated yards in the survey returns, the results presented herein are more indicative of the larger mill associated woodyards than of smaller satellite operations. ■

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