THE POTENTIAL OF WOOD RESIDUES AS RAW MATERIAL FOR PULP IN ALBERTA

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INTRODUCTION

Integration of the wood-using industries offers several advantages toward efficient use of timber resources, chief among which is maximum conversion of logs to industrial use. Probably the most common benefit from integration in the wood industries of North America is the production of chips for pulping from wood residues in sawmills. Sources of chips include sawmills, veneer and plywood plants, planing mills and miscellaneous wood-using industries. The main products made from such residues are woodpulp, fibreboard and particle board.

With sufficient demand for forest products relative to accessible supplies of timber, integration and wood residue utilization are requisites for an efficient and profitable forest industry. However, in some regions of North America the advantages of intensive utilization either have not been immediately obvious or have been negated by local economic conditions (Lewis, 1965).

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[1]Forestry Economist and Forest Products Research Officer, respectively, Department of Fisheries and Forestry, Calgary.

Generally, where forest industries are highly developed wood residues are used or little residue is created.

The purpose of this study has been to investigate possible advantages of more complete utilization of the timber cut in Alberta and the relationship of intensive utilization of wood residues to the development of forest industry in the Province. Factors considered are demand for forest products, structure of the forest industries, transportation, forest resources and plant facilities needed for more complete utilization.

ADVANTAGES AND LIMITATIONS IN RESIDUE USE

Potential Advantages

Two basic advantages are inherent in intensive utilization of timber cut for raw material, viz., less waste of timber and more efficient use of labor and equipment. Other advantages follow from one or both of these.

Reduction of timber waste seems the most obvious advantage of intensive utilization. Where only lumber is made from logs, the loss of wood volume in slabs, edgings and trim may equal about one-fourth of the volume of sound wood in the logs of timber of the average size cut in Alberta (Dobie and Parry, 1967). An additional 16 per cent of the log is converted to sawdust in conventional sawmills.

Where wood is cut only for pulp, there is a loss of the difference between the value of the lumber that could have been obtained from the logs and the value of the pulpwood having the same cubic content as that lumber. Thus in the conversion of wood by pulping only, the product may not yield the highest value that could have been obtained from the logs. The actual economic loss depends on the size and quality of the timber, lumber and pulp values and the costs of separating logs and processing them for different products.

In many cases the highest value can be obtained from timber either by combining the production of lumber or plywood with that of pulp or building board, or by using residues from the former as raw material for the latter. Losses of sound wood may then be reduced to the sawdust, and with modern chipping headrigs this may be as little as 5 per cent of the log volume.

Perhaps less obvious is the increase in productivity of management, labor and equipment that can result from more complete use of the felled tree. Costs of roundwood are continually rising as the better timber in more accessible stands is depleted and labor costs increase. Costs rise in spite of mechanization as logging proceeds into rougher terrain and poorer stands at greater distances from markets. Use of logs for both lumber and pulp may nearly double the volume of wood yield from small sawlogs, and may yield higher value per unit of volume than use only for pulpwood. Utilization for both products should result in maximum returns from the efforts of woods labor and equipment.

In most regions of North America where the lumber industry is significant in the economy, sawmilling has become largely centralized, mechanized and even automated. This has occurred in many cases even without local markets for residues because of advantages in efficiency and proximity to transport lines and communities. Proximity to communities generally not only enhances communications and supply, but also enables the firm to attract and hold more capable and productive management and labor.

The possibility of producing chips from the large volume of wood that would otherwise be wasted, and selling them at any price greater than the cost of their production, is an additional incentive to centralization of the lumber industry. A major factor contributing to the survival of the bush sawmill is the saving in transport cost resulting from leaving residues in the woods and removing only the lumber. Since this saves hauling about half the volume of the log out of the woods, the saving in transport cost compensates at least partially for the inefficiency of the bush sawmill. Any margin between the price received for residues and the cost of processing them would make log-hauling to a central sawmill more economical. This, added to their greater efficiency, should encourage investment in central sawmills.

Figure 1 shows the relative advantages of bush and central sawmilling if the cost of sawing one thousand board feet (Mbf.) of lumber is $16 at the bush mill and $8 at the central mill. The cost per Mbf. of moving lumber to rail is assumed to be 6 cents per mile, the cost of hauling logs to a central mill 20 cents per mile. Line "A" represents the relationship between distance from the bush mill to rail and its total cost of producing lumber and hauling it to rail. Line "B" represents a similar relationship for the central mill, but log haul cost is substituted for lumber haul cost. The central sawmill is assumed to be on a rail siding and to include planing and drying facilities, so no lumber haul to planer would be needed.

With these assumptions it would appear economically preferable to haul logs for an average distance of up to 57 miles rather than to saw them at a bush mill. However, if chips can be produced and sold by the central mill, but not by the bush mill, any margin above the cost of producing these chips could be considered a further reduction in the cost of transporting logs and sawing lumber. For example, if the chips made as a by-product of one Mbf. of lumber cost $2 to make and could be sold for $6, the effect could be to compensate for $4 additional log hauling cost. In Figure 2, line "B1" represents the cost-distance relationship wherein a $4 chip return is subtracted from log hauling and lumber production costs. Similarly, line "B2" shows the effect on log hauling distance when chips return a margin of $8 above production costs. Figure 2 thus indicates that returns of $4 or $8 for chips could economically justify extending average log hauling distances from 57 to 86 or 115 miles, respectively.

Value of Wood Residue

In Alberta the average delivered cost of pulpwood in 1964 was $23 per cunit (Anon., 1967), probably at least $25 per cunit in 1968, and can be expected to rise further[2]. The cost of debarking and chipping at the pulp mill is about $2 per cunit. Thus the total value of pulpwood processed to the chip stage is currently about $27 per cunit. If chips made from sawmill residues were of similar quality to those made from pulpwood, their value should also be about the same, i.e., $27 per cunit. The economics of chip production should depend on two variables, given the value of chips as determined by that of pulpwood, viz., the cost of chipping residues at the sawmill and the cost of transporting chips to the pulp mill.

A major advantage to the pulp or building board manufacturer in using residues is that this provides either an additional or alternative source of raw material which tends to expand the supply of raw material and minimize its rate of price increase. Where the supply of residues is

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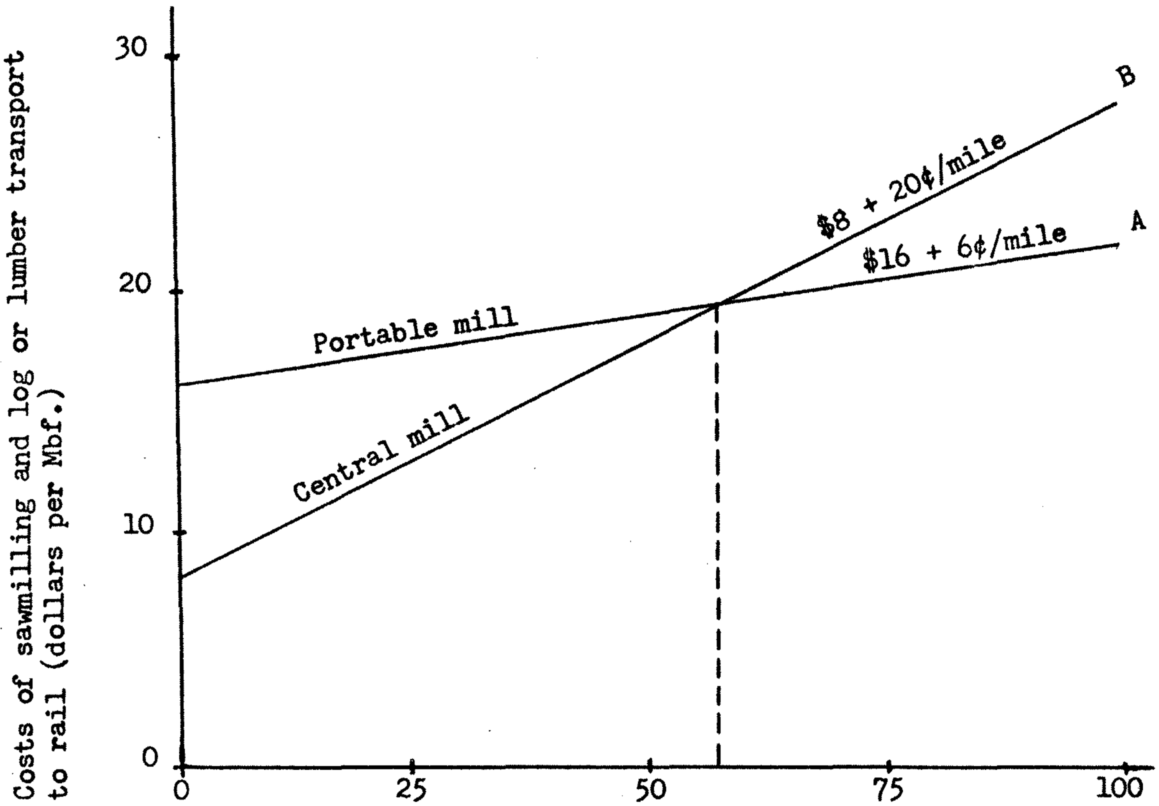
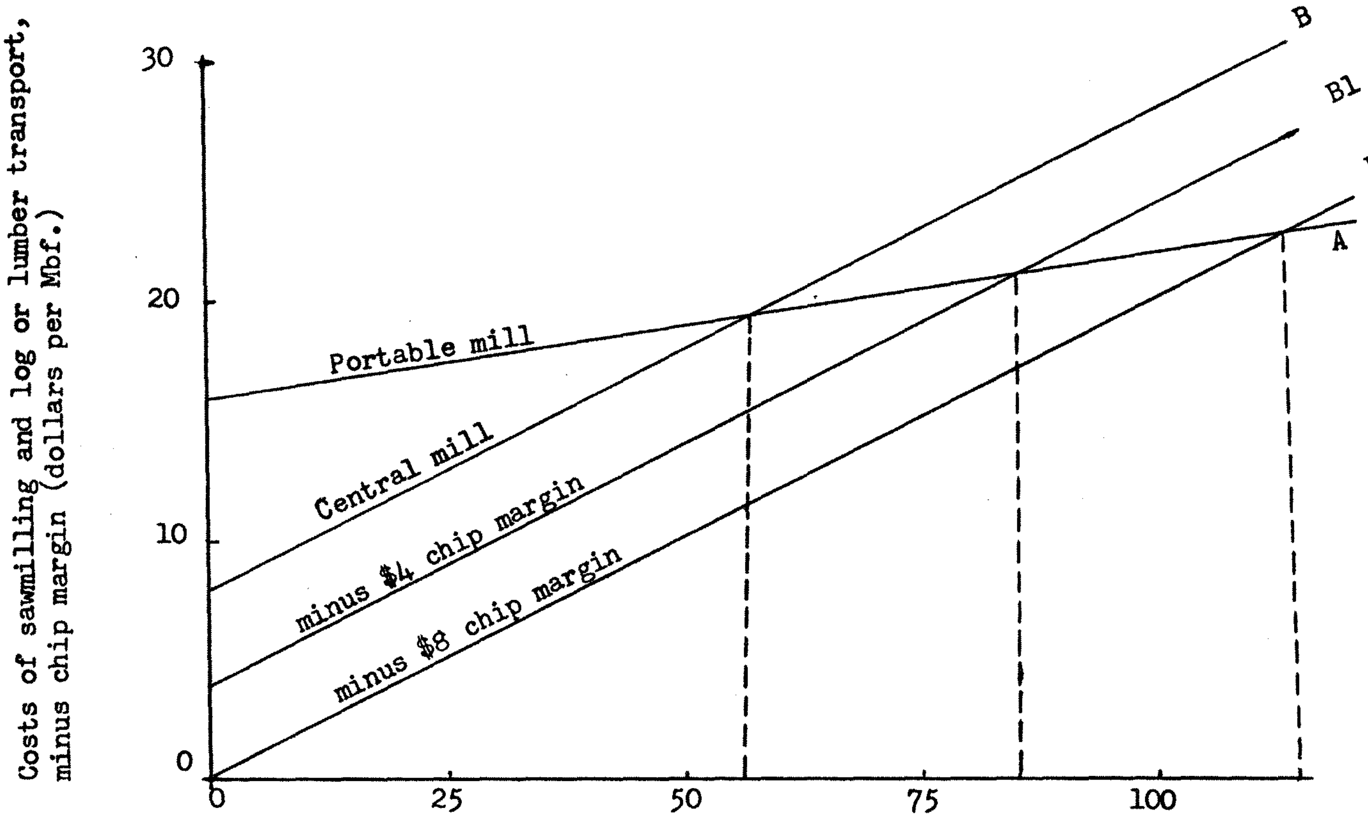
[2] A cunit contains 100 cubic feet of wood.



Average hauling distance to rail or central sawmill for logs or lumber (miles)

Figure 1. The effect of hauling distance on the relative economics of central and portable sawmills.



Average hauling distance to rail for lumber, or to central sawmill for logs (miles)

Figure 2. The effect of chip margin in offsetting hauling costs to central sawmills.

large relative to demand, the price at the sawmill should remain only slightly above the cost of production, but where the supply is small relative to demand, the price of residue F.O.B. sawmill should approach or equal the cost of debarked and chipped pulpwood minus the cost of transport from sawmill to pulp mill.

Where a pulp mill has an alternative to sawmill residues as a raw material supply, such as either cutting pulpwood on its own land or buying it, factors such as stability of supply, chip storage and handling, chip quality and forest management objectives will influence the price that will be paid for chips. However, as these factors will vary with conditions within the pulp and sawmill industries, the $27 alternate cost of pulpwood seems the best current estimate of the value of chips delivered at a pulp mill in Alberta.

Limitations

In spite of the theoretical advantages of utilizing wood residues, several factors limit the possibilities, viz., the distance to markets for Alberta wood and pulp products relative to competing producers, the structure of the sawmill industry in Alberta, and problems of water supply and pollution.

Distance to markets

Relative to British Columbia and eastern Canada, Alberta's wood and pulp products are at a disadvantage in national and world markets because of transportation costs. Even the interior of British Columbia generally has better transport connections with markets than northern Alberta. Most of the forest industries of eastern Canada are near the major population centers of the United States and Canada, and many have ready access to foreign markets by sea. However, the current raw material supplies in British Columbia and eastern Canada are becoming progressively remote from advantageous shipping points. It would appear, then, that if the demand for wood and pulp products grows as predicted, Alberta's timber resources will become increasingly attractive to industry in spite of transportation disadvantages.

Present structure of the sawmill industry

Although Alberta's sawmill industry includes several large mills about half of the total volume of lumber is produced by mills sawing less than 8 MMbf. per year, many of which are portable bush mills that are far from highways and railways. This limits the availability of their wood residues. In fact portable mills are designed expressly to produce lumber without bringing the remaining wood in the logs out of the forest. It seems unlikely that any extensive residue utilization will take place at portable bush mills except under local circumstances of scarcity of raw material for pulping and consequent high prices for chips. Such prices, if continued, would also exert considerable pressure to centralize sawmilling, thereby changing the structure of the industry from bush mills to central mills in a few years. The existing large mills can readily produce chips as soon as markets develop for this material, but at present the only major pulp manufacturer in Alberta does not use substantial quantities of wood residues. However, this could change as roundwood costs rise.

Production of lumber in Alberta in 1966 was 290 MMbf. (Anon., 1968). If 45 cubic feet of usable residues were produced per Mbf. of lumber[3], the 1966 production could have created 130,000 cunits of usable

[3]The quantity of coarse residues (slabs, edgings, and trim) produced in connection with the production of one Mbf. of lumber varies widely. Factors affecting the coarse residue yield are log size and quality, lumber dimensions and grades, and sawmill equipment and practice.

residues from all sawmills in the Province. Alberta forest inventory statistics indicate that under present utilization standards and allowable cut the lumber production could be more than doubled. The resultant residue would supply two-thirds of the wood requirements of 200,000 ton-per-year pulp mill.

At present about 160 MMbf. of lumber per year is produced in Alberta by 14 mills making more than 5 MMbf. per year[4]. Altogether these mills create about 100,000 cunits of usable residues, enough to supply more than one-fourth of the wood requirement of a 200,000 ton-per-year pulp mill. However, these sawmills are widely distributed, and until pulpwood prices increase much of their residue may be economically unavailable to the pulpmills that are likely to exist in the next decade.

Chip production in the sawmilling industry is largely dependent on the development of the pulp and paper industry and the building board industry. If the latter industries can pay sufficiently high prices for residues, the sawmill industry could develop the means to provide them, and with a sufficient demand for wood residues and lumber an efficient centralized sawmill industry should develop. Some integration of sawmills with pulp mills can be expected. As the pulp and paper and building board industries develop in Alberta, lumber could be produced by these industries as an incidental product to pulpwood. This could enable the pulpwood user to obtain maximum returns from woods operations while supplying its pulpwood needs. A minimum efficient sawmill with chipper headrig added to a pulp and paper mill should add less than one million dollars to the $50 million cost of a 200,000 ton-per-year pulp mill.

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[4]Unpublished data from a 1967 survey of the wood-using industry of Alberta by T. Szabo, Research Officer, Forestry Branch, Calgary.

Water supplies and water and air pollution

Alberta's water supplies seem to be well distributed for pulp production, since the major portion of the forest is in the North where streams flow in largely uninhabited areas. However, in areas south and west of Edmonton the values of unpolluted water and air to agriculture and human environment are so high that any significant pollution by the pulp and paper industry would seem to be intolerable.

Building board plants usually produce less pollution than pulp and paper mills. Hardboard and insulating board plants need not be heavy polluters, compared with pulp and paper mills, and pollution by particle board plants can be negligible. These, then, may be acceptable where pulp and paper mills are not.

Use of coarse residues will reduce the quantity of waste to be burned by about half, leaving mainly sawdust and bark. Bark disposal presents problems because of resistance to burning in its usual wet condition, and special burning arrangements or hauling and dumping may be required for effective disposal.

PROCESSES, EQUIPMENT, AND COSTS

General Considerations

Under present market conditions chip production is probably uneconomical for most sawmills in Alberta because of the general small size of mills, the distance to existing chip markets and the low value of chips in most of these markets. New pulp mill construction and higher pulpwood costs can be expected to raise the value of chips by increasing the total demand for raw materials and by bringing part of the market closer to the Alberta sawmill industry.

The volume of production that is required to provide for depreciation and for an adequate return on investment in a complete chipping plant has been estimated at about 5 MMbf. per year in eastern Canada, and about 8 MMbf. per year in B.C. However, the minimum sawmill production required to return a margin over costs of chip production will vary with the costs of producing chips, chip values at pulp mills and transport costs. These are affected by nearly all the conditions under which the mill operates, but especially by the distance from sawmill to pulp mill. For example, Flann (1963) described the operation of a sawmill producing 1 MMbf. per year and 10 Mbf. per day which produced chips profitably. Probably more important than mill size is the stability of the mill operation and of the market for chips. If a mill is to invest profitably in a chipping plant it must remain in business at least long enough to recoup its investment in the plant, along with its alternate rate of return. Furthermore, it must be certain that the price of chips will not fall below the level at which an acceptable return on the investment is possible.

There are three principal systems for producing chips, albeit many modifications, viz., central chipping for several sawmills, individual chipping by sawmills, and chipping headrigs in large-volume mills. Since about half the lumber produced in Alberta comes from mills sawing less than 8 MMbf. per year and only about a dozen sawmills produce more than this, the first alternative may be of interest. This is the least expensive of the three in terms of capital investment, but the most expensive in operating costs. The central chipping plant involves investment of a minimum of about $40,000 for the chipper, screens, conveying and loading equipment. In addition, sawmills will incur the costs of accumulating slabs and edgings in racks and banding them for shipment. Some loss of residue volume may result from the loss of trim owing to the difficulty of packing trim pieces. These costs are not incurred when residues are sent directly to a chipper by conveyor, and can be much less when residues are accumulated at the sawmill and chipped there. For this reason it may be economically preferrable in some cases for even small sawmills to have their own chipping plants. A comparison of costs of chipping at the sawmill and at a central plant is as follows for a mill sawing 4 MMbf. of lumber per year at a rate of 40 Mbf. per day:

Operation -	Cost per cunit of producing chips	
	Central plant	Sawmill
Debarking	$2.50	$2.50
Bundling residues	5.00	0.00
Chipping	1.13	5.12
Total	$8.63	$7.62

(See Tables 1 and 2 for basis of costs).

The estimated cost of producing chips from residues is $1.01 less when the sawmill has its own chipping plant even though the chipping cost is more than four times that of the central plant. Unless the central chipping plant is at a pulp mill, an additional cost would be incurred for transporation of slabs and edgings to the plant. A mill sawing only 4 MMbf. per year could produce chips for $7.62 per cunit. If the value of chips delivered at pulp mills is $27 per cunit, considerable margin is left for the cost of moving them from sawmill to pulp mill and for profit to the producer. With this cost-price structure mills sawing much less than 4 MMbf. could afford to install complete debarking and chipping equipment if they were close enough to chip users.

Table 2 shows the estimated costs of chipping debarked residues at a mill sawing 4 MMbf. of lumber per year to be $5.12 per cunit. The cost of chipping at a central plant is estimated at $1.13 per cunit to which must be added $5 for preparation of slabs and edgings for transport. The total cost of chip production therefore is $6.13, compared with a total cost of $5.12 for chipping at a 4 MMbf. per year sawmill. Thus it would appear in comparing central chipping and chipping at individual sawmills that the critical production level is somewhat lower than 4 MMbf. per year, if the sawmill operates one shift per day about 100 days per year. This would vary with the location of the sawmill relative to the chipping plant, pulp mills and other residue users.

The preceding analysis has little bearing on the minimum production at which a sawmill can afford to chip residues if no central chipper is available. In a situation where the cost of transporting chips to the pulp mill is small, chip production can be economical in small sawmills. For example, the estimated cost of chipping at a mill sawing 1 MMbf. of lumber per year is $16.01 per cunit (Table 3). Debarking at a mill of this size would add about $5 per cunit for a total chip production cost of $21.01. Assuming a value of $27 per cunit at pulp mill, $5.99 remains for transport and profit even though it might be more economical to produce these chips at a central plant if one were close enough. The limiting factors for small sawmills in chip production are distance to pulp mill and location relative to transportation lines. In Alberta, where most small sawmills are far from pulp mills and often not on rail lines or even good highways, the opportunity for profitable chip production

TABLE I. ESTIMATED COSTS[1] OF DEBARKING LOGS AT A SAWMILL WITH A DAILY PRODUCTION OF 40 MBF AND 18 CUNITS OF COARSE RESIDUES.

	Cost, dollars per: year	Mbf.	cunit
Depreciation on equipment[2] $30,000 over 10 years (salvage value assumed nil)	3,000	0.75	1.67
Interest at 6% on average investment of $15,000	900	0.23	0.50
Insurance at 1% of average investment	150	0.04	0.08
Labor, one man at $30 per day	3,000	0.75	1.67
Repairs and maintenance	400	0.10	0.22
Power	1,000	0.25	0.56
Total Cost	8,450	2.12	4.70
Saving in sawing cost resulting from sawing debarked logs[3]		1.00	2.20
Debarking cost charged to chip production		1.12	2.50

[1] Based on an operating year of 100 days.

[2] Rosser debarker and feed works, installed.

[3] Estimate based on information in Flann (1963).

TABLE II. CHIPPING COST COMPARISON OF A MINIMAL CHIPPING PLANT OPERATING AT 80 PER CENT OF CAPACITY AND AT THE CAPACITY OF ONE ROSSER DEBARKER, 100 DAYS PER YEAR, ONE (8 HOUR) SHIFT PER DAY.

Cost Item	Plant operating at 80% of capacity, chipping 13,000 cunits per year, or 130 cunits per day[1]		Plant operating at capacity of one rosser debarker, chipping 1,800 cunits per year, or 18 cunits per day[2]	
	Cost, dollars per: year	cunit	Cost, dollars per: year	cunit
Depreciation[3]	4,000	0.31	4,000	2.22
Interest[4]	1,200	0.09	1,200	0.67
Labor[5]	6,000	0.46	3,000	1.67
Maintenance	1,500	0.12	500	0.28
Power	2,000	0.15	500	0.28
Total	14,700	1.13	9,200	5.12

[1]Assuming 45 cubic feet of chippable residues are produced per Mbf. of lumber, this is equal to the residue produced by a mill sawing 30 MMbf. per year or 300 Mbf. per day.

[2]Assuming 45 cu. ft. of residues per Mbf. of lumber, this is equal to the residue produced by a mill sawing 4 MMbf. per year, or 40 Mbf. per day.

[3]$40,000 over 10 years, assuming no salvage value.

[4]At 6% of average investment of $20,000.

[5]At $30.00 per man-day.

TABLE III. CHIPPING COSTS OF MINIMAL PLANTS CHIPPING THE RESIDUES FROM LUMBER PRODUCTION OF 1 MMBF AND 2MMBF PER YEAR, OPERATING 100 DAYS PER YEAR, ONE (8 HOUR) SHIFT PER DAY.

Cost Item	Plant chipping residue from 1 MMbf. lumber production, or 450 cunits, per year		Plant chipping residue from 2 MMbf. lumber production, or 900 cunits per year	
	Cost, dollars per:		Cost, dollars per:	
	year	cunit	year	cunit
Depreciation[1]	4,000	8.89	4,000	4.45
Interest[2]	1,200	2.67	1,200	1.34
Labor[3]	1,500	3.34	2,250	2.50
Maintenance	200	0.44	300	0.33
Power	300	0.67	400	0.44
Total	7,200	16.01	8,150	9.06

[1] $40,000 over 10 years, assuming no salvage value

[2] At 6% of average investment of $20,000

[3] At $30 per man day; 100 days per year

seems limited until the industry develops further.

Small sawmill operations may have difficulty in obtaining capital to install chipping plants for a variety of reasons, but cooperation in financing and managing a jointly-owned chipping plant could prove feasible. A possible arrangement would be for a large sawmill to install a chipping plant primarily for its own use and to supplement its supply of chippable residues by purchase from other mills. Another alternative would be for sawmills to send wood residues directly to a pulp or board mill for chipping. For certain products, such as building boards, there seems to be some possibility of using residues containing limited quantities of bark, removing some of the bark from the chips in the screening process. This could eliminate the need for even a debarker at the sawmill, thereby reducing the investment for residue processing to the cost of racks and banding equipment at about $100.

For the large sawmill chip production can be very inexpensive. For example, a mill sawing 300 Mbf. per day for 100 days per year could chip its residue for about $1.13 per cunit (Table 2). This implies annual production of 30 MMbf. on the 100 days-per-year basis, a production level attained by few sawmills in Alberta. Furthermore, a sawmill capable of this daily production would presumably attempt to maximize the return on its investment by operating at least 200 days per year and would therefore produce 60 MMbf. of lumber per year. It is unlikely in the near future that many sawmills will be able to approach full use of even minimal chipping installations.

Large sawmills can make use of higher production debarkers at some saving in cost. For mills sawing more than about 40 Mbf. per shift, ring debarkers seem to be indicated rather than the rosser type. A minimal ring debarker installation requires investment of about $60,000 and can debark about 70 Mbf. per 8 hours of logs of the species and average size found in Alberta. Fixed costs per Mbf. are about the same as with rosser debarkers, assuming both types are used with equal intensity. However, total costs appear to decrease by about 15 per cent if production of the ring debarker is about 70 Mbf. per shift, as one operator is needed in either case. This would reduce debarking cost from $4.70 per cunit for a mill sawing 40 Mbf. per day to $4.00 per cunit for one sawing 70 Mbf. per day. Deducting the $2.20 per cunit saving in sawing cost resulting from debarking would reduce debarking cost chargeable to chip production from $2.50 per cunit to $1.80.

The cost of operating the chipping plant would be reduced from $5.12 per cunit for the 40 Mbf.-per-day mill to $3.38 per cunit for the 70 Mbf.-per-day mill. Thus the total cost of debarking and chipping one cunit at the 70 Mbf.-per-day mill would be $1.80 plus $3.38 or $5.18 on a 100-days-per-year operating basis compared to $7.62 at the 40 Mbf.-per-day mill. If chips are valued at $27 per cunit at the pulp mill, this would leave $21.82 per cunit for transportation and profit.

Chipping Headrigs

The foregoing has dealt with the costs of producing chips from wood residues produced by conventional sawmills such as now exist in Alberta. A recent study indicates that mills using chipping headrigs can produce lumber and chips from small logs at less than half the cost of sawing them at a conventional fixed sawmill. The cost of installing a chipper headrig, debarker and chip-handling equipment in an existing conventional sawmill has been estimated at $250,000 for an additional capacity of 52 Mbf. per 8 hours (Dobie, 1967).

The cost of installing an entire new sawmill complete with planing and chipping plants is estimated at more than $800,000. Such an installation would include either a circular or band headsaw as well as a chipping headrig. The chipping headrig would process small logs, while the conventional headrig would saw the large ones. A chipping plant in addition to the chipping headrig would be included to chip residues from the conventional sawmill section of the mill as well as cull lumber and logs and trim. Less complete facilities could be used with resultant smaller investment, but to produce lumber and chips at minimum cost it appears necessary to integrate the entire lumber and chip production operation including chipping, drying and planing, in order to eliminate the costs of transporting products from place to place during the course of production. Such integration is made feasible by intensive utilization of logs of all sizes which economically justifies their transport over long distances to central processing plants. In many cases long-distance transport of logs would be necessary to supply an integrated wood processing complex. A minimal lumber and chip plant with chipping headrig would have a capacity of about 70 Mbf. of lumber and 54 cunits of chips per 8 hours (Dobie et al., 1967). Because of the size of investment required for such an installation it would be desirable to operate it intensively. If operated 250 days per year at one shift per day, the production of such a plant would be 17.5 MMbf. of lumber and 13,500 cunits of chips per year, and with two shifts per day the production would be nearly doubled. Such an establishment would be large by Alberta standards and would have to obtain its wood from a large area.

Further economies could result from either increasing the capacity of the complex or from integrating it with a pulp mill to eliminate the cost of shipping chips. The urge to acquire these economies, the desirability of controlling raw material sources, and the capital required to establish efficient lumber and chip production complexes could result in the lumber industry eventually becoming largely owned by the pulp and paper industry in Alberta.

Summary

The economics of chipping sawmill residues have been examined for three main systems, viz., central chipping for several sawmills, individual chipping by sawmills, and chipping headrigs in large-volume mills. Production costs are affected by the economies of scale peculiar to each system. Costs drop sharply as certain levels are reached which permit the effective use of more efficient equipment. No definite production can be indicated below which it is uneconomical for a sawmill to install debarking and chipping equipment, except that it seems to be below 1 MMbf. per year. This level will vary with the individual sawmill, particularly with regard to its proximity to a chip-using plant, its expectations for the future and the price of chips.

Operators of mills sawing less than 4 MMbf. per year should in general consider sending slabs and edgings to a central plant for chipping. For mills sawing more than 4 MMbf. per year, chipping at the mill appears most economical in most cases. This presupposes that chip prices are at least sufficient to cover costs of transportation and production, and will remain so, and that the mill has a promising future for at least ten years.

Chip production costs decrease as sawmill production levels rise. For example, costs are estimated at $21.01 per cunit for sawmills producing 1 MMbf. per year, $7.62 for mills sawing 4 MMbf. per year and $3.63

for those sawing 30 MMbf. per year, assuming one shift per day and 100 days per year operation in each case. For production greater than 70 Mbf. per day, chipping headrigs offer still further economies, although large investment is required for such equipment. The cost of processing small logs with chipping headrigs can be less than half that of sawing them with conventional headrigs.

With the intensive utilization of logs implied by the use of sawmill residues for wood pulp, the most economical means of producing lumber and chips would be large, integrated, sawmill-chipping-planing complexes. If development of the pulp and paper industry in Alberta makes residue utilization common, economic forces can be expected to eventually cause the lumber industry to become centralized in such complexes.

TRANSPORTATION

Transport costs can be a substantial share of the delivered cost of wood residues, often exceeding all other costs combined. Furthermore, transport lines, particularly rail, strongly influence the location of industries using wood and wood-residues. Rail should be the most economical means available of transporting forest products for long distances in Alberta. A highly-developed and integrated wood-using industry would probably be so situated that all transport of lumber, chips, pulp, paper and building board for distances greater than 50 miles would be by rail. At shorter distances the advantages of truck transport, and possibly pipeline transport of chips, may make these more economical than rail.

Although lumber is now often trucked from bush sawmills to planers located on rail lines, the centralization of the sawmill industry required for efficient intensive utilization would seem to require sawmills to be located at rail sidings. This would make possible the lowest-cost long-distance shipment of wood residues from these sawmills. For long-distance transport the published rail rates for wood residues are generally slightly lower than the costs of truck hauling. For short distances truck hauling costs may be slightly lower than published rail rates. However, rail rates can be negotiated by large-volume shippers on a point-to-point basis, which can result in actual charges being much lower than published rates.

Published rates are usually intended to divide the total cost of railway operation among all shippers. However, the railway can increase its net revenue by carrying freight at any rate exceeding the direct cost of moving the commodity. Savings in costs also result from regular large-volume shipments. Direct costs therefore determine the minimum rate which can be negotiated. The actual rate arrived at will normally depend on "what the traffic will bear" - the difference between delivered value and cost of production, allowing the producer a "reasonable profit" - as long as the rate exceeds the direct cost of transport. As fixed costs are a large part of railway total costs, negotiated rates that will permit economical transport of wood chips can be to the advantage of the railway as well as to sawmills and pulp mills.

Preliminary economic studies indicate that for distances less than about 50 miles pipelines may be more economical than rail for moving chips (Hunt, 1967 and Tabor, 1968). However physical problems remain to be solved before pipelines can become operational for moving chips. Also, to be competitive with rail, large volumes must be moved because of the high cost of installing the pipe. Pipeline transport creates no economies of scale in the use of existing facilities, as does rail transport, unless perhaps chips could be moved in pipelines installed for other materials such as petroleum and minerals.

There is an apparent advantage in establishing a residue-using plant near Edmonton which is the rail hub of northern Alberta. A plant at this location could obtain wood residues from most of the large sawmills in the Province with minimum transport cost. However, it could be subject to competition on unfavourable terms from any plant closer to some of its suppliers. Unless such a plant could contract for a long-term chip supply or be assured of an alternative, it would risk loss of its raw material supply.

The users and producers of wood residues will likely depend mainly on rail transport if rail rates can be negotiated to levels making wood residues competitive with roundwood, although pipelines are a potential alternative.

SUMMARY AND CONCLUSIONS

Alberta's forest resources are now used to only a small extent of their potential, but these resources are well-suited to pulp production and to the integrated production of lumber and pulp chips. Because of the inherent economic advantages of integration, pulp mills may be expected to either obtain much of their raw material in the form of wood residues from the lumber industry or to establish their own sawmills to maximize returns from woods operations. Because of the relative scarcity of wood residues that can be expected soon after pulp mills create the demand, the price of chips delivered at the pulp mill should closely approach the cost of obtaining roundwood and debarking and chipping it. At present this cost is about $27 per cunit which should provide the incentive for the sawmill industry to become centralized in large lumber and chip producing complexes.

Centralization of sawmilling including chip production has economic and utilization advantages wherein waste would be reduced to bark and sawdust. Sawdust volume would also be reduced if chipping headrigs were used, possibly to as little as 5 per cent of log volume. Several social benefits should follow this development, including increased contribution of the forest industries to stable communities, better working conditions for labor and management, more efficient location of people relative to schools, roads, and communities, and more efficient use of railways.

The main deterrent to intensive utilization at present is the distance between most of Alberta's large sawmills and the markets for chips. Most chip users outside Alberta have access to plentiful chip supplies nearby, which keeps the price low and excludes Alberta sawmills from the market. Furthermore, most sawmills in Alberta have difficulty justifying investment in chip production equipment and obtaining the necessary capital because of their size. These obstacles should be largely overcome with the expansion of the pulp and paper industry and development of the sawmill industry in the Province.

Large sawmills, especially those with chipping headrigs, can produce chips at much lower cost than small mills, leaving a large margin between production cost and delivered value to cover profit and transport cost. The minimum lumber production below which chip manufacture at the sawmill is uneconomical appears to be at about 1 MMbf. per year, but chipping at such small mills costs several times as much per cunit as chipping at the large mills and leaves little margin for transport and profit. The feasibility of chipping at small mills will depend on their proximity to the pulp mill and on transportation arrangements.

The critical production level below which shipment of residues to central plants for chipping should be considered is about 4 MMbf. per year. At higher production levels the costs of preparing residues for movement to the central chipping plant are likely to exceed the costs of the inefficiency resulting from only partial use of a chipping plant at the sawmill. However, any uncertainty about the future of the sawmill or of the market for chips within economical shipping distance of the sawmill would favor a decision for central chipping, with its lower capital requirement, in spite of the higher costs. Chipping headrigs produce both lumber and chips more economically than circular or band mills.

It appears likely that integrated wood-using industries will develop in Alberta during the next decade, and will reach an advanced stage of development by the end of this period. Their exact organization, product mix and extent of development will depend largely on markets, but if forecasts of demand for forest products are good indicators, progress should be rapid during the late 1970's.

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