THE REAL COST OF EXTRACTING LOGGING RESIDUE STUDY

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Credits

Lumberjack RC&D is a 501(c) 3 rural/urban development council whose mission is to:

- Support and promote enhancement of the quality of the environment, thereby providing an attractive and satisfying place to live and work.
- Protect, preserve, restore, and where necessary, improve land, water, and related resources to assure the quality of the natural resource base for sustained use.
- Support and promote a better living standard and adequate income for area citizens through social, economic, and natural resource development.
- Foster relationships between public and private sectors to provide maximum benefit to area citizens.

As a part of this mission, Lumberjack RC&D obtained a Rural Community Assistance grant through the USDA Forest Service. The purpose of this study is to determine The Real Cost of Extracting Logging Residue in the Lake States (Michigan, Minnesota, and Wisconsin).

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The figures and percentages used throughout this document are subject to change depending on the conditions of existing energy markets, supply and demand, current dollar value, local, state, and national economic status, and other unforeseeable variables. All information provided hereafter is true to the best of our knowledge and any oversight or misrepresentation is unintentional. All information is presumed to be the most up-to-date information available as of September 2005. Direct research should be done for the most up-to-date information when looking for specific costs/prices in your area. New technology and innovative practices are being discovered constantly and the most efficient systems and methods today could be outdated in the near future. This study was written to give as accurate information as possible.

Real Cost of Extracting Logging Residue

Project Overview

This study looks at different types of logging operations and the variables within each logging operation that address the real cost of extracting logging residues. Logging residues, for the purpose of this study, refers to tops and branches that are smaller than pulpwood standards as well as any submerchantable/unmerchantable trees. A huge variable on how much biomass is available by site is dependent on the minimum top diameters that mills are accepting at the time. Typically, a four-inch top is the common utilization standard in the Lake States, but depending on market conditions, this has varied from five-inches down to three-inches, and even two-inches on occasion. Therefore, the utilization diameter standard will have a dramatic effect on the percentage of wood fiber that could potentially go into biomass from any given timber sale.

Results of the Study

Biomass Processing Variables
This study evaluates the cost involved with extracting logging residues from active logging operations. The areas of a logging operation that could involve cost for biomass production are:

- Stumpage
- Harvesting
- Forwarding/Skidding
- Chipping/Grinding
- Transportation to Biomass Plant

Cost of Stumpage
Stumpage costs for logging residue varies considerably in the Lake State Region. There are different policies in regards to stumpage payments for residue on individual National Forests, State Forests, County Forests, Industrial Ownerships, and Individual Private Ownerships. In many cases, agency or industrial ownerships do not have a policy that addresses this relatively new practice.

Harvesting
This is typically the least of any cost factors involved with biomass production in that most of the trees that are harvested for biomass will also have other products, such as sawlogs and pulpwood, taken out of them. Essentially, the trees would have been harvested anyway, just not as thoroughly utilized. One situation where additional costs would come in would be with harvesting submerchantable or otherwise unmerchantable trees on any type of operation.

Forwarding/Skidding
This will be a considerable cost for cut-to-length operations and typically a negligible cost for whole tree operations. The main variables are length of skid, soil type, weather conditions, and terrain. Additionally, operating cost of the machine and operator proficiency are factors to be considered.

Chipping/Grinding
(For ease of reference, chippers and chipping will be referenced to throughout this report; however, the description also includes grinders and grinding)

Chipping is fairly constant per specific operation. The variables that come into play are dirt on the wood to be chipped (which will dull the blades), any metal within the tree (nails, fence, etc.), and frozen conditions. The size of the material being chipped will have some impact as well, but on the timbersales looked at on this study, the variability is at a specific point in time, not usually throughout the entire job.

Another variable in regards to chipping costs is in the chipper being used, specifically: size (output), operating cost, and if it is owned or leased.

Transportation
Several factors come into effect in this area. The main one being distance from the chip site to the end-using facility. Most trucking rates are either by the mile or by the hour. A directly related factor is the cost of fuel, which will have a direct impact on rates whichever way the trucking costs are assessed.

Another factor directly affecting trucking costs is whether trailers can be left on site to be filled or whether the trucker needs to wait for the trailer to be filled. Time needed to fill a trailer (25 ton loads) can vary dramatically (20 – 90 minutes) depending on the. In the winter, leaving filled trailers that will not be handled immediately can result in the chips being frozen to the trailer, which will significantly affect the unloading process

Types of Harvesting Systems

The two most prevalent harvesting systems in the Lake States today are Cut-To-Length Mechanized and Whole Tree – Mechanized. These two harvesting systems will be discussed and costs will be put to each aspect of the operation in table form. Following these tables, other types of harvesting systems will be discussed and cost analogies made.

Cut-to-Length – Harvester (Mechanized)
Harvesting
The harvesting is done by a mechanized harvester, which fells the tree and processes it into usable products of varying lengths. Typically, when this process is completed, there is a pile of limbs and tops from several trees combined. Minimal adaptations have to be made to the harvesting process in order to make the collection of these residues more

efficient for the forwarding operation. Of all the factors involved in extracting and preparing biomass chips, this part of the process usually adds the least amount of expense in that the tops and branches are traditionally in distinct piles throughout the logging process anyway. Piling to make it more conducive to biomass extraction will generally add some time to this part of the operation.

Forwarding

This is done with a forwarder, which loads cut products into a bunk(s) attached to the forwarder. This will usually be the greatest expense out of any of the factors involved, due to the simple fact that residues cannot use up the full weight capacity of the forwarders. Other than the age of the equipment, the main variable is whether it is a single bunk or double bunk forwarder. A positive aspect of the forwarding process with logging residues is that the forwarder can operate at a faster speed because there is less weight; however, many more trips have to be made into the sale area. Other factors involved in the cost of forwarding are distance to the landing and weather (i.e. snow covering up residue piles between processing and forwarding).

Whole Tree – Mechanized

Harvesting:

The harvesting in this type of system can be done with either a chainsaw or a wide variety of mechanized equipment whose main purpose is tree felling and not processing it. The main variable on these operations will be limbing, which can be done by a mechanized delimber or chainsaw either in the woods or on the landing. For biomass production, it would typically be more effective to do the delimbing on the landing. The trees are typically processed on the landing with a chainsaw, delimber, slasher, or some combination thereof. Whether or not the residue is utilized, there is typically nothing different that would be done for this type of operation. The only difference would be with trees that might be considered unmerchantable, in regards to condition or species, for traditional forest products. These trees would then be cut where they typically would not be utilized for any other product.

Skidding

The skidding can be done with either a grapple or a cable skidder, and unless the situation mentioned above in regards to unmerchantable trees occurs, there is typically little additional cost for extracting the logging residue because the entire tree is processed on the landing, making residue extraction a natural fit to these logging operations.

Logging Residue Extraction Specifics

Harvesting Variables

All of the information found in the tables below is from specific timber sales. On any timber sale there will be a number of variables that will affect production rates and will ultimately affect the cost of residue extraction. These variables include, but are not limited to:

- Terrain (steepness, ease of skidding/forwarding)
- Distance to landing (average skid length)

- Volume per acre of biomass (will vary by stand density, tree species, and current utilization standards at primary mills)
- Soil moisture content and/or soil stability (in many instances, tops will be used to stabilize the soil and prevent rutting, in which case they would not be available for biomass production)
- Economics of individual logging operation (every logging operation has specific economic dynamics where the cost of producing biomass fuel can vary greatly depending on a number of factors such as:
    - Age and type of equipment
    - Workforce on site
    - Whether trucks are contracted or owned
- Trucking distance (distance from site to mill)

The following tables were compiled from numbers provided from actual logging operations. It should be understood that this is just a "snapshot" in time, and that these costs will vary widely, depending on a wide range of circumstances that are discussed throughout this study.

Whole Tree Removal (Hardwood Thinning) ~ Green Tons

Tree Length	Cords/Acre Merchantable	Tons/Acre Biomass	Harvesting	Skidding	$ to Chip/Ton	Transport to Mill	$/ton Stumpage	Total Price/Ton
Northern Hardwood (NH)	7	8.2	$0/ton	$0/ton	$4.27/ton	$8/ton	$ 2.14	$ 14.41
NH	10	11.7	$0/ton	$0/ton	$4.27/ton	$7/ton	$ 2.14	$ 13.41
NH (Aspen Removal)	10	3.5	$0/ton	$0/ton	$4.27/ton	$9/ton	$ 2.14	$15.41
Aspen (Submerchantable)	0		$6.41/ton	$2.14/ton	$4.27/ton	$8/ton	$0.43/ton	$21.25

In many instances, this type of harvesting is not allowed in selective cuts.

Cut-to-Length – Harvester ~ Green Tons

	Cords/Acre	Tons /Acre	Harvesting	Forwarding	$ to Chip /Ton	Transport to Mill	$/Ton Stumpage	Total Price/Ton
Selective Cut - Hardwood, small area of clearcut Aspen	14 cords/acre 75% - Hardwood 14% -Aspen 11% -Balsam	11 tons	$0/ton	$12.30/ton	$5/ton	$9/ton	$0/ton	$26.30/ton
Land Clearing, Mainly Hardwood	29 cords/acre 84% - Hardwood 16% -Pine/Fir	33 tons	$0/ton	$9.20/ton	$5/ton	$12/ton	$0/ton	$26.20/ton
Shelterwood Harvest - Oak and Red and White Pine Left, Hardwood, Aspen, and Jack Pine Cut	12 cords/acre 40% -Hardwood 41% -Aspen 19% -Jack Pine	8 tons	$0/ton	$14.80/ton	$5/ton	$12/ton	$0/ton	$31.80/ton
Clearcut - Aspen and Balsam Fir	15 cords/acre 75% -Aspen 18% –Balsam 7% -Misc.	10 tons	$0/ton	$14.80/ton	**	**	$0/ton	**

** Sold tops on the landing to a commercial chipping operation

This particular operation uses biomass chipping to market their harvesting services. The landowners take reduced stumpage in return for the harvest area being cleaned up giving it a "park like" appearance. In actuality, the cost of the biomass production exceeds price received per ton by a considerable margin. Therefore, the reduced stumpage actually subsidizes the chipping operation.

Whole Tree Removal (Aspen Clearcut) ~ Green Tons

Tree Length	Cords/Acre Merchantable	Tons/Acre Biomass	Harvesting	Skidding	$ to Chip/Ton	Transport to Mill	$/ton Stumpage	Total Price/Ton
Aspen	25	10	$0/ton	$2.14/ton	$4.27/ton	$11/ton	$ 3.00	$20.41

There are added costs for skidding due to removal of submerchantable trees, which would typically not be processed in a normal harvesting operation.

Other Harvesting Systems

These systems are some variation of the two systems aforementioned; though they are not as prevalent, each of them are used to varying extents. There can also be some adaptations of these systems, but for the most part, the systems listed here account for a vast majority of the wood harvested in the Lake States. What will be discussed is how they are similar or different from the two main systems previously discussed.

Cut-to-Length– Feller Buncher/Chainsaw/Forwarder

Harvesting

In these operations, trees are felled and bunched by the feller buncher and then cut up into products by a chainsaw operator. The tops and branches would typically be in a more concentrated area than on a manual cut-to-length operation, however less concentrated than in a processor cut-to-length operation.

Forwarding

Forwarders are used in this harvesting situation as well; however, the cost per ton is typically more than a mechanized cut-to-length operation. This higher price is a result of the logging residue typically not being as concentrated as in the mechanized cut-to-length system; however, this method would concentrate logging residue more than the cut-to-length manual system.

Cost Comparison

Typically, forwarding costs for biomass extraction would be 30-40% higher than on a harvester cut-to-length system. Other costs would typically be about the same.

Cut-to-Length– Manual (Chainsaw)

Harvesting

Harvesting is done with a chainsaw and the operator typically cuts and leaves the products where they are felled. The tops and residue are usually left where they are, so in this scenario, no additional expense would be involved. Potentially, a greater effort could be made to directionally fell trees in a way that would provide greater concentration of tops to make the forwarding operation at least somewhat more efficient.

Forwarding

There would be considerable expense involved with gathering residue in this type of operation because there typically are not any concentrated piles other than where several tops would be lying together. As a result, there will be a lot more stopping and loading as compared to the cut-to-length mechanized operations. However, the utilization is typically not as good as the mechanized cut-to-length operations, therefore there would be more mass in the tops.

Cost Comparison

Typically, forwarding costs for biomass extraction would be 50-60% higher than on a harvester cut-to-length system. Other costs would typically be about the same.

Whole Tree – Manual (Chainsaw)

In regards to biomass extraction, there should typically be no difference between this and the whole tree mechanized; the costs should be relatively the same.

Whole Tree – Chipping

Due to the cost of stumpage, whole tree chips are not typically used for biomass fuel. Otherwise, the price to extract would be essentially the same as whole tree mechanized with the exception of the stumpage cost.

Other Residue Processing Options

The Swedish Experience

Sweden has been utilizing fuel chips from logging slash for over 30 years. The amount of utilization is increasing annually and is predicted to continue growing over the next ten years. Bioenergy from forest residue is an important part of the Swedish energy system and Sweden is a world leader in this field. Over the years, many different production systems have been tested, such as:

- Chipping of logging slash at the logging site
- Baling of logging slash for processing at the end user facility
- Bundling of logging slash and parts of trees for processing at terminals or heating plants
- Compression of logging slash on trucks and processing at heating plants
- Forwarding of logging slash to landings and processing it there

In Sweden, as is the case in the Lake States, the decisive factor for successful biomass energy production systems is the cost for the biomass fuel supplied to the heating plant. This has resulted in the evolution of two main ways of processing biomass fuel in Sweden; one being the bundler system (which will be discussed in detail in the next section) and the other being the forwarding of logging residue to landings where it is chipped (chipping may follow months after delivery to the landings). These two systems

seem to work the best with mechanized cut-to-length operations, which is the predominant harvesting method employed today in Sweden.

To address the inefficiencies of forwarding logging residue, in many cases, a forwarder that has been specially adapted to carry more residue is used (the forwarder bunk is longer and wider).

Forest Residue Bundling

Recently, a logging contractor in Michigan purchased a forest residue bundler. Due to its relative newness and it being used in applications (hardwood thinnings) that it has not been traditionally used for in Scandinavia, the contractor was not ready to share any production information at this point because there are still a lot of unknowns in regards to operating in the different timber types and timber harvesting systems found in this area. There is, however, data available from tests done with this equipment in the Western United States. Even though the applications and operating environment in that region are completely different from those in the northeastern United States, it gives an example of operating costs.

Additionally, a trip was made to Minnesota to view a residue bundler demonstration. This demonstration was done in a timber sale area that had been closed out for nearly a year. Results from this demonstration were not definitive.

For many years, it has been understood that finding an effective method of densifying residues would be a key development to reduce the costs of biomass collection systems. The following are excerpts from a study done in the Western United States in 2004.

Biomass Bundling Operations

Skogforsk, the Swedish Forest Research Institute, described field evaluations of these systems[i] based on "composite residue logs" (CRL's), or biomass bundles approximately 24 inches in diameter and 10 feet long. Biomass handling is greatly simplified by compacting loose slash into a form that resembles a log. CRL's can be loaded, transported, forwarded, stacked to dry, and processed with conventional log-handling equipment. This process has been successfully adopted in Scandinavia, with hundreds or thousands of CRL's produced and consumed annually to generate energy. [ii]

In operation, the operator collects residues with a crane and places them in the in-feed deck. Four compression rollers pull the material into the bundling unit and perform initial packing. Behind the feed rollers, two sets of compaction frames alternate grasping and sliding to move the compacted bundle through a wrapping unit. The bundles are simply wrapped with standard bailing twine at selected intervals in one continuous string. [ii]

In the Swedish study, biomass bundling with the continuous feeding design produced 30-40 CRL's per productive hour. While biomass bundling is proven technology in Europe, its performance in North American conditions needed to be evaluated. [ii]

Slash arrangement is a critical issue that effects operation and slash density effects the feeding time. If the slash is scattered, the travel time while making a bundle could become significant. 20 tons per acre will have half the travel time per bundle of 10 tons per acre. Good conditions would be about 2.29 minutes per bundle (26 bundles per hour).[ii]

Cost

The suggested retail price for the Timberjack 1490D Slash Bundler[iii] is $450,000.00. Using standard machine rate calculations, the hourly owning costs would be approximately $58/scheduled machine hour (SMH). This assumes a 5-year life; 14% interest, insurance, and taxes, and 20% salvage value. Operating costs include fuel, lube, repair and maintenance, chainsaw, and twine. Each bundle uses about 270 ft of bailing twine. At 20 bundles per hour, twine cost would be about $5 per productive machine hour (PMH). With other consumables, total estimated operating costs would be about $50 per SMH. Adding labor would bring the total cost to around $130 per SMH. [ii]

Transportation

Several problems were apparent with hauling on a quad bunk short log trailer; the loose material from the dry residue bundles was falling from the load, low payload with limited bunk space, and marginal support with the bunk spacing that was available. [ii]

Technical Feasibility

Materials ranging from small limbs and tops to whole trees were effectively wrapped and secured. There were some important exceptions, including problems bundling excessively brittle residues or short, large diameter pieces. [ii]

Analysis of productivity data indicates the importance of using biomass bundling as part of an integrated system of forest management. Simply using a bundling machine to "clean up the mess" from other operations is not productive. However, if the stand treatment is planned to include biomass recovery, then felling and processing operations can place residues and tops in aligned, concentrated piles. [ii]

Bundling residues greatly improves extraction to roadside. Forwarding bundles will result in less soil disturbance than skidding loose residues. [ii]

Assuming a potential production rate of 20 bundles per machine hour (8 bdt), the cost of collecting biomass and creating CRL's would be about $16 per bdt. Forwarding is estimated to cost $5 per bdt based on 4 loads per productive hour. With a hauling cost of $0.10 to $0.20/ton-mile, a 50-mile haul would add $5 to $10 per bdt. Finally, chipping at the energy facility may incur an additional $3 per bdt. Thus, the total cost to deliver chipped hog fuel from CRL's would be about $29 to $34 per bdt. Nearly half the total delivered cost is due to bundling function. [ii]

Forest Residue Bundling Charts

Bundle Dimensions and Density [ii]

Site	Species	*Green/Dry*	Length (ft)	Weight (lbs)	Mean Density (lb/ft^3)	Mean Weight (Bdt)	Moisture Content %
Bonners	DF/WLWRC	Dry	12	768	17.1	0.30	
Bonners	DF/WL/WRC	Dry	14	985	15.5	0.38	
Idaho City	PP	Green	10	860	19.0	0.33	
Stevensville	PP	Green	14	1,176	18.1	0.45	
Medford	Mixed Conf.	Dry	10	772	17.9	0.31	25.1
El Dorado	Mixed Conf.	Green	8	1,023	26.5	0.32	58.1
Bend 1	PP/LP	Green	15	1,774	26.1	0.69	28.9
Crooked River	WJ	Dry	10	518	14.1	0.23	11.3
Crooked River	WJ	Green	10	1,000	21.3	0.36	

Species Definitions			
DF	Douglas Fir	WJ	Western Juniper
LP	Lodge Pole Pine	WL	Western Larch
PP	Ponderosa Pine	WRC	Western Red Cedar

Bundling Cycle Elemental Time Study Results [ii]

Element	Bonners	Idaho City	Stevensville	Site Medford	Bend 1	Bend 2	Crooked River
Move bundle (min)	0.01	0.15	0.43	0.00	0.19	0.13	0.05
Arrange slash (min)							
Align	0.50	0.35	0.06	0.00	3.06	1.05	0.00
Density	1.04	0.00	0.00	0.00	0.81	1.06	0.31
Rocks/Dirt	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Feed (min)	1.88	1.39	2.39	2.25	4.72	2.36	1.92
Wait (min)	0.03	0.14	0.96	0.16	0.45	0.05	0.18
Travel (min)							
Cutting	0.00	0.00	0.00	0.00	0.01	0.01	0.03
Bundling	0.00	0.00	0.00	0.04	0.02	0.00	0.08
Moving	0.85	0.31	0.67	0.14	1.46	0.58	0.61
Looking	0.00	0.00	0.03	0.00	0.08	0.00	0.00
Clear bundler (min)	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Rotate (min)	0.15	0.07	0.34	0.09	0.74	0.13	0.05
Cut bundle (min)	0.12	0.12	0.21	0.45	0.21	0.17	0.18
Total time (min)	4.66	2.52	5.09	3.13	11.76	5.53	3.42
Move dist. (ft)	54.6	25.2	-	14.5	161.5	61.5	96.5
Swings/bundle (n)	5.1	3.2	3.9	4.3	6.3	4.5	4.3
Bundles/hr	13	24	12	19	5	11	18
Bone dry tons/hr	3.9	7.9	5.4	5.9	3.5		4.1

Logging Residue Policies of Major Landowners in the Great Lakes Region

Michigan

Federal:

Hiawatha National Forest: There is currently no policy on the utilization of logging residue.

Huron-Manistee National Forest: On fuel reduction timber sales the material that is less than a 4" top is bid in a separate category as part of the lump sum sale process. An average assigned minimum price is $1/cunit or roughly $0.53/ton.

Ottawa National Forest: On sites with poorer soils, leaving logging residue is required. On other sites, logging residue can be utilized as part of the normal timber sale contract and would be included in the lump sum sale price. On all other timber sales, utilization standards are to a 4" top and the utilization of smaller material is not allowed.

State: Lump sum sales are the primary sale method. Bidders purchase the entire tree, therefore no additional stumpage rates will apply because the purchaser already has the option to use the entire tree.

County: There is only one substantial County Forest in Michigan, which currently does not have a stumpage policy on biomass.

Industrial: Varies from owner to owner, many have not addressed the issue at this point, several ownerships are in flux and there are not firm policies as of yet with those ownerships.

Private Non-Industrial: Commercial Forest Reserve Act (CFA) covers both private and industrial land and there is no severance tax on these properties and there is really no need to oversee biomass usage as there is in Wisconsin under the Managed Forest Law (MFL). Many private landowners prefer to have all of the logging residue removed for a more park-like appearance and in many cases, do not receive any additional stumpage for it. In other cases, landowners actually pay to have the logging residue removed.

Minnesota Policies of Major Landowners

Federal:

Chippewa National Forest: Logging residue removal has not been a major issue at this point and a policy regarding logging residue removal is not in place.

Superior National Forest: They are currently working on putting a policy together. They are actively engaged in a partnership with several entities using a USFS grant to identify issues and opportunities in regard to biomass utilization from the Superior National Forest.

State: The current stumpage rate being assessed to logging residue as of September 2005 is $2/ton on state timbersales. Minnesota Forest Resources Council (MFRC) guidelines require the retention of some coarse woody debris and snags for wildlife habitat purposes.

County: Policy is variable from county to county. One county has assigned stumpage rate of $2/ton while most counties have not addressed this issue.

Industrial: Varies from owner to owner, many have not addressed the issue at this point, several ownerships are in flux and there are not firm policies as of yet with those ownerships.

Private Non-Industrial: Many private landowners prefer to have all of the logging residue removed for a more park-like appearance and in many cases, do not receive any additional stumpage for it. In other cases, landowners actually pay to have the logging residue removed. Extracting biomass residue off state timbersales is a relatively new process that is being developed, but there are instances of a stumpage rate of $2/ton being assessed on logging residue on some current state timbersales. Additionally, the Minnesota Forest Resources Council (MFRC) guidelines recommend that some coarse woody debris and snags be retained for wildlife habitat purposes.

Wisconsin Policies of Major Landowners

Federal: On the Chequamegon-Nicolet National Forest (the only National Forest in Wisconsin), all timbersales are done on a lump sum basis, with a utilization requirement to a four-inch top. This means that anything smaller than the four-inch top remains in the ownership of the National Forest. To date, there has been no demand for doing chipping on the National Forest; consequently, there is no system in place for addressing what the cost per ton would be for the removal of this material. There is nothing within the forest plan that forbids this from happening except on poor sites (i.e. coarse sand soil type).

State: Timber sales are bid to variable top diameters. Contractors bid based on their utilization standards. The total sale bid is the determining factor as to which contractor will get the sale.

County: There are 29 County Forests in Wisconsin. Logging residue utilization policy varies tremendously between the 29. In some counties, it has not even surfaced as an issue so there is no policy, while in others, they use the same policy as is aforementioned in state sales. On scaled sales, several counties use a percentage addition to the timbersale volume to account for biomass. For Example: if a sale were cruised at a 1,000 cords to a four-inch top utilization, 20% would be added on to come up with 1,200 cords total for this sale. A contractor who was going to utilize the whole tree would put a per cord bid on the 1,200 cords and a contractor who was only going to use the four-inch top would put in a per cord bid on the 1,000. The totals of each bid would then be compared to determine the high bid).

Industrial: This has not been addressed by most of the industrial landowners at this point. In one instance, where the whole-tree chips are going into a pulpmill, the same stumpage price is paid regardless of whether it is to a four-inch top or what is traditionally considered 'logging residue'. In regards to traditional logging residue, there seems to be very little set policy on the part of the major industrial landowners.

Private Non-Industrial: Approximately 20% of all private forestland is under the Managed Forest Law (MFL), and for this program, stumpage rates for fuelwood in the 12 areas of the state range from $5/cord to $13.53/cord. For basswood, the stumpage rates ranges from $2.60/cord to $9.66/cord. The landowner has to pay a 5% severance tax. Based on these rates per ton, these severance tax rates would be approximately $0.11 to $0.29/ton for fuelwood and $0.06 to $0.21/ton for basswood. (Basswood is used as an example because, historically, this species in the pulpwood size class has been hard to market and could potentially be an excellent biomass fit.)

For individuals not under the Managed Forest Law (MFL) many of them prefer to have all of the logging residue removed for a more park-like appearance and, in many cases, do not receive any additional stumpage for it. In other cases, landowners actually pay to have the logging residue removed.

Summary: Issues and Potential Solutions

Potential Factors Deterring Biomass Removal

There can be instances where removing logging residue is viewed as detrimental to either the site or the management prescription; these would include, but are not limited to:

- Poor soil conditions (biomass removal could cause both too much surface heat as well as nutrient depletion).
- High deer population densities (where natural regeneration is a concern, if all of the logging residue is removed, the tree seedlings will not be sheltered from browsing.
- For certain conifer species (i.e. jack pine), removing the tops would also mean removing the cones retaining seeds which might be part of the management prescription for managing the site.

In addition, the economics at specific logging sites might make biomass fuel production impractical; these factors may include:

- Trucking distance is cost prohibitive.
- Stumpage price of logging residue is excessive.

Reasons for Biomass Removal

- Many landowners prefer the "park like" appearance that this practice creates.
- In areas of high fire danger, this is a definitive way of reducing fuel load in both logging residue and in unmerchantable trees that would have been an expense to remove.
- Local economic development is stimulated by more jobs being created by producing energy within the community rather than importing fossil fuels.

Chippers

For many logging operations involved in biomass production, a chipper is a piece of machinery that is used on a sporadic basis, with an investment that can range anywhere from $20,000 - $250,000+. If this equipment is left sitting, it is a liability.

A potential solution would be to either lease a chipper or have an independent chipping crew that went from job to job solely doing the chipping.

Cut-to-Length – Mechanized

With this becoming the main timber harvesting system in the Lake States, extracting logging residue from these operations in an economical fashion will become critical. Forwarding the residue with a conventional forwarder is very inefficient because the amount of space that the residue takes up compared to its weight adds considerable cost to the process.

Potential solutions would be:

- A forwarder with a larger capacity bunk specifically for residue extraction. This, however, creates other issues such as size of equipment for operating in selective cut areas and the expense of having another piece of equipment.
- In-woods forwarder mounted chipping systems (a forwarder with both a chipper mounted on it as well as a separate chip bin) would position the weight of the logging residue into more concentrated areas and would eliminate the high mass low weight issue. However, this could create a situation where the chipper would not be functioning for most of the time and would just be additional weight on the forwarder.
- Bundler systems currently need very specific situations where it would prove to be economical. This could change drastically, however, with the increase in the price of alternative fuels, where the price of chipping would no longer be a prohibitive cost.

Lower Moisture Content Chips

Currently, in most cases, a logger actually is paid less for a having a lower moisture content product because payment is by the ton, not the Btu value.

A potential solution would be the development of a payment system that would be based both on tons and moisture content. This, of course, would involve the development of an effective way to determine moisture content at the biomass plant.

GLOSSARY	
Cut-to-length (CTL)	Trees are processed in the woods (at the stump)
Logging Residue	Tops and branches not used for traditional forest products. Can also include unmerchantable whole trees that are either too small or do not meet mill standards.
Submerchantable	Is not big enough to produce an eight foot pulpstick with a 4" diameter
Unmerchantable Tree	It meets the diameter specification to produce traditional timber products, but other issues such as rot, defect, or excessive curves render it unusable.
Whole Tree Harvesting	Trees are processed at the landing

REFERENCES

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[ii] Rummer, Bob; Len, Dan; and O'Brien, Obie; *Forest Residues Bundling Project: New Technology for Residue Removal*, May 2004. Southern Research Station, Auburn, Alabama

[iii] The use of trade names or references to specific companies or products in this publication does not imply endorsement; they are intended only as an aid to the reader.