Harvesting Woody Biomass

A SMALL BUSINESS GUIDE

By Steven Bick

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Harvesting Woody Biomass: A Small Business Guide

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About this Book

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"Give me six hours to chop down a tree and I will spend the first four sharpening the axe."

Abraham Lincoln
boyhood logger (presidential adult)

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PREFACE

The term 'woody biomass' means different things the at policy, market and operations levels. While sustainability, carbon neutrality and levels of subsidy are debated in public forums, prices and markets drive harvesting decisions. For loggers, woody biomass is just another group of products – something they can produce if it is profitable or ignore if it is not. This book describes small business considerations for loggers thinking of adding the production woody biomass to their work.

This publication is for information purposes only and its use is at the discretion of the reader. Examples, prices and analysis of costs are intended to illustrate points and show how to make comparisons. Readers are encouraged to make calculations and comparisons using data that is relevant to their own businesses and operations.

Woody biomass stumpage rates are intentionally left out of this publication's examples and discussions. The example prices used are net figures, less any stumpage that might be paid. While some landowners might forego stumpage on woody biomass production from tops that were previously unused, others may be selling roundwood into biomass uses and will certainly be expecting payments. In the end, market forces will sort this out.

Photographs and tables are used to illustrate points and to make this book more enjoyable to read. Photos from dangerously close angles and distances were in fact shot with a Bushnell trail camera, without risk of life or limb. Most photos are original work. A few photos were supplied by Wendy Farrand, Dominick Maio, Dan Prokupets Sarah Smith and various Forest Service publications. I am especially indebted to those loggers who allowed me to photograph their work and equipment, including Francis VanAlstine, Bob and Roy Aden, Paul and Mary Mitchell, Paul Mitchell Jr., John, Linda, John II, Dan and Jerry Levi, Sam Hull, Mike Fahey, Tom Donnelly and Craig Thomas.

A great number of people shared their insight in helping move this project along and some will undoubtedly escape mention here. Lew McCreery, Ed Cesa and Steve Milauskas of the Forest Service's Wood Education and Resource Center were very helpful. I appreciate the help of my friends at PERC, where some of the book was written. Colleagues on the Innovative Forest Operations Research (iFOR) team (Jeff Benjamin, Rene Germain, Sarah Smith and Paul Frederick) all helped me repeatedly. I tapped an extensive number of people for interviews and feedback on portions of the book, including Mark Bourgeois, Pat Curran, Shelby Jones, John Levi, Paul Mitchell, Dale Greene, Brooks Mendell, John Auel, Adam Sherman, Bill Kropelin, Sam Hull, Mike Fahey, Howard Pope, Lee Berry, Scott Barrett, Collin Miller, Bob Coscomb, and Tom Donnelly.

SECTION 1: BIOMASS BASICS

Introduction

New ventures and expensive equipment require a leap of faith at times, but an old saying cautions “look before you leap”. This publication provides information for loggers who are considering expanding their production to include biomass products. Biomass markets are mature in some areas and just emerging in others. With over thirty years of biomass production history in some parts of the northeastern US, there is a great deal to look at and vast experience to draw from.

Major business decisions in a logging enterprise are seldom easy. Loggers work on very tight margins, making the right decisions critical to the business’s very survival. Independent control of their operations is one of the most appealing aspects of a logger’s work, but sometimes they must step outside of their world to explore opportunities. Changes can be hard to make without outside interactions. Loggers undoubtedly understand their operations and cash flows well, but must sometimes explain and demonstrate them to others, especially in the financial world. The material presented here can help investigate biomass harvesting options, explore operational changes and prepare business plans and loan applications.

The book is divided into in several sections, including introductory material about woody biomass, operations, business considerations, biomass harvesting options and advice and finally a collection of useful resource material.

Woody Biomass Products & Markets

What is woody biomass? Definitions abound and there are many opinions on what wood products are considered biomass and what ones are not. From a logger's prospective, reaching an agreement on a definition isn't as useful as finding a home for the products they make. This section begins with exploration of woody biomass from policy, market, and operational viewpoints, and then turns to a thorough discussion of the in-woods products made from woody biomass and the markets that demand them.

Operations
Harvesting trees and then creating and delivering wood products are the primary work of loggers, with everything else they do supporting of these functions. The collection of machinery and the processes that comprise this work are labeled harvesting systems. In the northeast, logging operations often defy the neat categories of logging systems seen in other locations. The variety of timber types, ownerships, markets and personalities has lead to mix-and-match equipment sets. With this in mind, operations chapters will deal separately with the following functions: felling, skidding, processing and delivery.

Each chapter describes the range of options available when harvesting woody biomass. The chapters present alternatives and offer relevant points of comparison and financial analysis. The merits of different equipment models or manufacturers are left to discussions with equipment dealers and other loggers. The operations chapters serve as a starting point toward further investigation of the best mix of equipment for a logger's individual purposes.

Small Business Information

Expansion of an existing logging business very often leads to a search for financing. This section explains credit and how it is built. Various types of lenders are described. One chapter shows the important financial measures lenders use in judging credit worthiness and calculations loggers should use in analyzing their business decisions. An outline presents the essential elements of a business plan. An example plan shows how one logger is pursuing an expansion into biomass and the financial calculations that prove to himself and his lender that it is worthwhile.

Biomass Harvesting Options and Advice

This section explores realistic and unrealistic possibilities for getting into harvesting woody biomass. One example traces the cash flow it would take to start from scratch and purchase all of the equipment necessary for full time production of wood chips. A second looks into an existing logging business expanding into biomass production as a sideline. A descriptive chapter shows the wide spectrum of logging companies that supply woody biomass markets – everyone from part time cooperators who team up with large suppliers right up through those who have made it their main focus and even created value-added facilities (building their own markets!). Finally, a capstone chapter features sound advice from proven sources in the forest products community.

Resource Chapters

This section is a catchall for useful discussions of woody biomass related topics. Such material helps analyze the potential fit of biomass to individual operations. Those who want a greater understanding of how the world uses forest biomass will find a description of processes for consuming it. There is information about machine rates and understanding the role of equity and deprecation in a business. Firewood is an important biomass production that merits it's own discussion. Guidelines for harvesting woody biomass are emerging in various locations. These guidelines are summarized and suggestions are made for implementing them in logging operations.

What is Woody Biomass?

Defining Woody Biomass

Finding a commonly accepted definition of woody biomass is difficult, as there are a number of ways to define it, from the policy level to the forest and on to the end users. While each definition is important, markets ultimately shape investments in harvesting equipment and the products that are created.

Forest Products Extension Specialist: *"It's all biomass, everything from the roots to veneer. Markets will decide how it gets merchandized."*

The definition offered above is one of the most accurate. Utilization quickly excludes about 33% of the tree, because the roots and the stump will be left in the woods. While there is a general agreement that woody biomass comes from trees, more specific definition seem to vary based on the source.

The US Departments of Agriculture, Energy and the Interior put their heads together and agreed to define woody biomass as follows:

"The trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the by-products of forest management."

This is a broad definition of the material involved. Some would prefer to substitute the word co-products for by-products. There are cases where the growing of woody biomass is the primary management objective – fast growing willow plantations, for example.

As a parallel to this definition, these departments defined woody biomass utilization as:

"The harvest, sale, offer, trade, or utilization of woody biomass to produce bioenergy and the full range of biobased products including lumber, composites, paper and pulp, furniture, housing components, round wood, ethanol and other liquids, chemicals, and energy feedstocks."

This definition seems to embrace all utilization of wood. The federal government can define anything it chooses to, but ultimately it is markets that give true labels to wood products. Loggers who have always supplied traditional markets for logs and pulpwood tend to think of woody biomass as material that is not consumed by these markets, but instead put to the range of other uses described above.

The State of Maine's woody biomass retention guidelines define it as follows:

"Woody biomass, defined from a forest operations perspective, is comprised of logging residues, previously un-merchantable stems, and other such woody material harvested directly from the forest typically for the purposes of energy production."

For the purposes of this book, woody biomass products are any wood products that are chipped or ground by the logger and roundwood that is used to produce energy. Loggers commonly make regular distinctions of this type when they sort materials.

A broader label might be woody biomass and related products. This distinction is important in examining opportunities for loggers – new markets to supplement existing ones and, in some cases, to supplant those that have been lost to mill closures or sagging demand.

Mill Residues
Forest Products Consultant: *"There are no unused mill residuals."*

In-woods woody biomass products have competition. Much of the wood that is delivered to sawmills ends up in a biomass product. The cubic recovery ratio (CRR) of a sawmill refers to the percentage of wood passing through the mill that actually becomes lumber. This varies by logs size and efficiencies within the mill, but the cubic recovery ratio for most hardwood mills tends to be in the 50-60% range. Softwood mills often have lower CRR's because they finish lumber on site, while hardwood is often shipped rough and green.

What happens to the rest of the wood, the other 40-50%? Consider a sawlog, for example. After removing the bark, the slabs are cut off to square up a cant for sawing. These thick slabs are sent to the chipper, along with any edgings sawn to square up boards. As boards are sawn, a great deal of sawdust is created. Somewhere in the supply chain, either at the sawmill or at a secondary processor, many boards are planed or shaped, and shavings are created.

Not so long ago, most or all of the wood at the mill that didn't become lumber was thought of as waste. "*We used to put it out in back and hope it would blow away*", as one mill owner put it. Then uses were found for this material, both by mills themselves and by others. Mill waste became known as residues, residuals and byproducts. Some mills were said to break-even on lumber and make their profit on residues (this old saying may be more fanciful than true). Today some refer to this material as a co-product. Mills are sometimes asked if they can "up production" by customers for this material (note: sawmills prefer to make more lumber and less sawdust and chips, if they can).

Co-product, byproduct or residue, these materials are often the chief competition for in-woods biomass. Mill residues are often more consistent in their make up and the supply chain from mill to user is often more streamlined than those from the nomadic factories operated by loggers. It is often a lack of these materials that cause people to turn to in-woods sources.

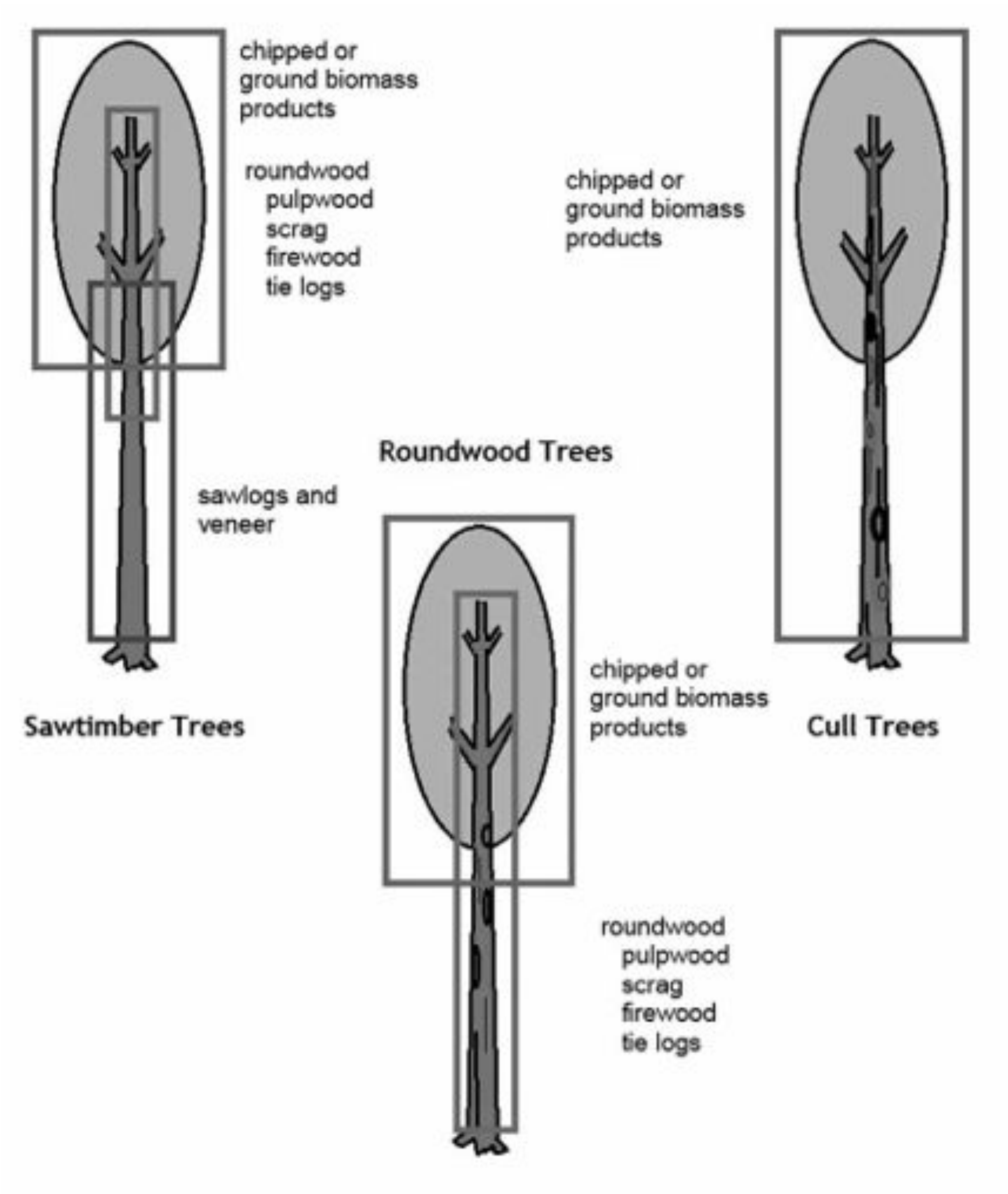
Woody Biomass Products from the Woods
Another way of defining woody biomass is to identify it by its source. Logging residues are commonly identified as biomass. These are the portions of trees that are handled or could be handled in harvesting, but are not utilized (if this same material is being utilized, it is no longer a residue, but instead a co-product). Other sources include standing dead trees, wind thrown trees, small diameter trees and trees that are otherwise not destined for higher value products. Overstocking of stems that are undesirable from a timber or fire management standpoint are potential sources of woody biomass. Dedicated energy crops such as willow are another source.

Woody biomass is a tree or a portion of a tree that is used as feedstock for other products in which the end user isn't always aware of the ingredients. Instead of lumber for homes and furniture, or pulpwood for paper, this wood is an input in the production of heat or electricity, or it's broken down to produce useful chemicals, or perhaps it's consumed in farming or gardening or even spread at playgrounds.

Roundwood

Roundwood is also a biomass product. Roundwood preserves a lot of utilization options and can be sent to a variety of markets. Buyers of roundwood might convert it to firewood or chip it for other uses. A variety of distinctions are possible in roundwood – particularly with regard to size. Often there are minimum and maximum acceptable diameters and lengths. This roundwood was cut with a circular slasher from tree length stems, with all the sawlog material having been sorted out.

In most cases, buyers prefer clean roundwood. Dirt is a problem. It dulls chains and blades and wears out machinery. Dirt is not removed by burning. In some cases, it sticks with the wood all the way to consumer products, such as pellets, where it is extremely unpopular with end users.


chipped or
ground biomass
products
roundwood
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scrag
firewood
tie logs
sawlogs and
veneer
Sawtimber Trees
Roundwood Trees
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products
roundwood
pulpwood
scrag
firewood
tie logs
chipped or
ground biomass
products
Cull Trees

Tree Utilization

Tree utilization depends on available markets, but some broad distinctions are possible. The diagram on the facing page separates trees into three categories and shows the utilization possibilities for each.

Sawtimber Trees

Sawtimber-quality trees in strong market areas have a wide range of utilization opportunities. The largest portion of the stem, provided it meets size and defect requirements, can be used for sawlogs and might also yield an occasional veneer log.

The upper portion of the stem can be expected to be much smaller and contain many knots. This material is suitable for a variety of roundwood products, including scrag logs for pallets, tie and flooring logs, firewood and pulpwood. These roundwood categories are not interchangeable due to the differing specifications each have for size and soundness. There is considerable overlap in how the upper portion of the stem could be merchandised into different roundwood products. This, coupled with narrow price differences, can make operational efficiency the deciding factor in which products are made from this part of the stem.

The remainder of the tree stem can be chipped or ground into biomass products or it can be left in (or returned to) the woods.

Roundwood Trees

Trees that are too small or have too many defects to produce sawlogs will often have their stems allocated into roundwood products. Often these low vigor or suppressed trees, or trees of undesirable species, are removed as part of the harvesting prescription.

The entire stem will be used for one or more roundwood products. Price and the proximity to the market determine how to best utilize these stems.

As before, the tops can be chipped or ground into woody biomass products, if they are used at all.

Cull Trees

The third scenario is one in which the entire harvested tree is chipped or ground into biomass products. In some cases, these trees will have too much rot to be used for roundwood products.

The entire stem can be chipped or ground into a single product, or further sorting is possible. Some chip markets require very low stick and bark content, so the bole is chipped separately from the top.

Grindings

Grindings are a common woody biomass product. Wood grindings that come from landing sites are typically made from materials too small, misshapen or dirty to be handled and delivered in any other way. Grindings are perhaps the lowest quality biomass product in that they usually have a high bark content and also contain dirt. They have many of the same uses as wood chips when burned for heat or electricity, but they tend to be less desirable than chips. The material itself is less suited to many of the conveyance systems used in burning applications and they must often be mixed with wood chips in order to be used.

Wood Utilization Forester: *"Most of the grindings end up in the mulch business. You can cover a litany of sins with aged mulch."*

This material is well-suited for use as mulch in landscaping. It can be dyed to various colors, or can be left to darken with age.

"Dirty" Chips

So-called dirty chips come from both whole and partial trees and are synonymous with woody biomass for many people. The "dirty" label implies that these chips are likely to contain bark and leaves, in addition to wood fiber. Occasionally small pieces of a stick will make it through the chipper intact.

In some operations whole trees will be placed into the chipper and in other operations just the tops are chipped. Depending on the market opportunities, the upper third of the tree stems containing sawtimber might be chipped or be sorted out for a roundwood product.

Apart from the portion of the tree that is chipped, a further step in the sorting might be in limiting the content to desirable species or restricting it to either hardwoods or softwoods. Some buyers insist upon chips that come from the tree bole and can accept only a very limited amount of topwood. In this case, stems and tops might be chipped separately for different markets.

"Clean" Chips

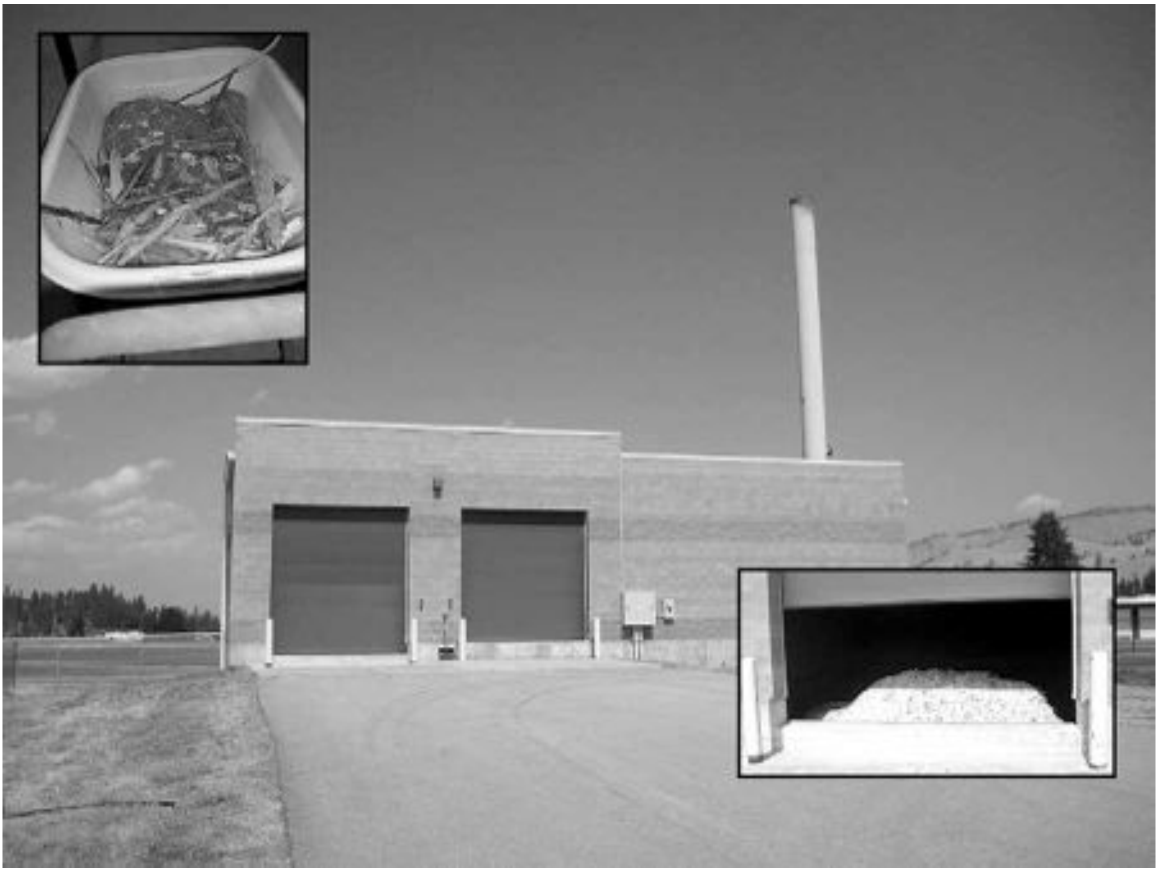
Clean chips have all of the desirable material that might go into dirty chips, but little or none of the impurities (bark, leaves, sticks, dirt, etc.). They are created in a two-step process. First, a flail chain removes all of the bark. Next, a chipper creates chips that are fairly uniform in size.

These higher quality clean chips have multiple uses. Most are used in papermaking. As an energy feedstock the consistency of the material is very desirable for the feed systems in some boilers. Some are co-fired with coal to bring emissions down to acceptable levels. Clean chips are an excellent raw material in making wood pellets as well as rayon for clothing.

Electrical Utility Markets
Stand-alone wood-fired electricity plants like this plant in Vermont are one of the largest consumers of woody biomass. Many accept large enough volumes to be the primary markets for individual loggers. Chips from both whole trees and tops alone tend to meet their quality standards, meaning they can take a larger range of wood than most institutional heating boilers.

An argument can be made that these higher demand utility markets support the harvesting capacity that is necessary for smaller specialty markets to flourish as a sideline. The number of businesses engaged in supplying these plants allows smaller consumers to benefit (both in price and level of service) from a level of competition that wouldn't otherwise exist.

All markets should be recognized and explored by potential suppliers and are discussed in this book. The main thrust of most examples and comparisons found here are on supplying biomass for electricity facilities.



Heating Markets

Many colleges and schools in the Northeast and some western states have installed wood-fired boilers to replace oil-fired heating systems. Experience tells us that the conveyance of chips to the boiler can be somewhat complicated and uniform chips work best in these systems. The low bark content in clean chips ensures a smaller amount of residual ash is produced. This alleviates the facility's disposal concerns. Advanced designs in conveyance systems for boilers allow them to remove any sticks that make it through the chipper.

Satisfying and retaining institutional customers requires attention to chip quality and having these acceptable chips available on short notice. These exacting needs, coupled with relatively small quantities mean that the wood chips usually sell for considerably more per load than those sold to the electrical utilities.

Playground Chips
Playgrounds are a relatively small market for biomass products, but they can be an important niche for some suppliers. One logger who focuses on supplying chips for school boilers in the winter shifts to supplying chips for playgrounds in the summer.

As a retail product, playground chips are sold by the cubic yard at prices that are significantly higher than most other biomass products. On the other hand, this product is is sold in small quantities to a geographically scattered collection of customers. Loggers historically do not sell into the retail market.

Shavings
Roundwood is also used to produce wood shavings used for animal bedding. The shavings themselves are very thin (to facilitate drying) and uniform in size (for easy handling) Customers seem to prefer lighter colored woods. Lower valued species are usually used to produce wood shavings. Consumers range from large farms to small hobbyists with only a few animals.

While there are certainly many large commercial shavings mills in existence, there are also opportunities for small scale and sideline producers. Shavings probably aren't practical as an in-woods product, but loggers who have a steady, reliable, and nearby demand for them have an opportunity to add value to some of the timber they harvest by supplying this market.

Firewood

Firewood is considered by some to be the first and most enduring woody biomass product. Firewood logs may be sold from the landing, delivered as roundwood, or further processed into blocks or split wood. Drying increases its value.

Split firewood might be the only retail product that loggers can produce on their harvesting site. While it may sometimes be inconvenient to cut and split wood on the landing, when it can be done the added expense of a second handling is saved. When sold as a retail product, firewood has many buyers and the producer can often dictate the price, payment and delivery terms.

Firewood consumers tend to stack it, store it, dry it and then use it up. As one logger put it – *"the nice thing about firewood is that they use it up and then next year they want more."* Retail level consumers of other forest products, such as lumber, don't tend to have that on-going annual need.

Firewood is a true biomass product, but it involves a different level of investment and emphasis than the production of wood chips and related products. While much of the material here focuses on chipping, a supplemental chapter is dedicated entirely to firewood.

SECTION 2: OPERATIONS

Felling

Introduction

This chapter provides an overview of the many felling options available for harvesting woody biomass. The full range of options can be seen in real-world biomass operations – everything from hand felling to high-production feller-bunchers. A narrower subset of these options has emerged due to their high productivity, cost effectiveness and smooth integration with other links in the production chain.

Think of the felling options presented here as a menu from which a selection can be made to fit into a larger production system. These choices also represent an evolutionary path that many loggers have followed over the course of growing their businesses. Lower cost machines with lower production levels have proven to be an effective way to build the credit, reputation and experience necessary to move an operation toward higher production.

Photos of various makes and models of felling machines are included here for the sake of convenience. No attempt is made to discuss the merits of or endorse any particular manufacturer or specific model.

Hand Felling

Hand felling is done with a chainsaw – the least expensive piece of equipment for severing trees. It is also the least productive approach to felling. Chainsaws replaced hand tools some time ago. While most rightly consider the chainsaw to be an indispensable part of the equipment mix, they aren't suited to be the primary means of felling for biomass harvesting, where a large number of low-value stems are typically cut.

Chainsaws are best used when a harvesting site contains an area that is too difficult to reach with larger feller-bunchers. They are also useful in felling stems that are too large for this equipment.

Small Drive-to-Tree Feller Bunchers

The small skidsteer pictured above is equipped with a feller-buncher head. It uses a shear to sever small stems up to 16” in diameter. While this machine clearly isn’t suited to all types of terrain and sizes of timber, it does have its advantages. This is a multi-purpose machine that may be used in other types of operations. The enclosed cab allows for the safe handling of stems such as the limby Scots pine shown in the photo.

This particular biomass harvesting operation handles occasional timber stand improvements, cutting and bunching low quality stems. A larger chipping contractor comes in later (between moves to larger job sites) to skid and chip the bunched materials.

As seen above, a small wheeled feller-buncher cuts and piles a tree for skidding. From the time the tree in this photo is first grasped, then bunched, 22 seconds have elapsed. While these machines must travel to each stem, they have a smaller footprint and greater maneuverability than larger mechanized tree-to-tree felling options. One biomass harvesting pioneer summed up these machines this way:

"I've harvested biomass with everything from hand tools to helicopters. These small feller-bunchers are the best low cost approach to mechanized felling – not the best and not the most efficient, but the best lower cost mechanized way to do it."

Forester to logger: *"You need a bigger feller-buncher."*
Logger to forester: *"I need a bigger income."*

Compact and maneuverable, this wheeled machine presents a combination of advantages and drawbacks. Somewhat prone to tipping, it is equipped with doors on both sides to prevent the operator from being trapped inside. Steel safety bars and the cutting head itself obscure the operator's view of what is in front of him.

The rear wheel is essentially a large caster, spinning as needed and often seen off the ground.

The small tracked feller-buncher pictured above handles steep slopes better than the wheeled version (this same principle holds with larger machines). While the tracked machine is slower, it climbs much better. The added weight of the tracks increases the amount of tree weight the machine can balance as well. The cutting head is the same chainsaw bar used in the wheeled version. These machines can grasp multiple stems that are close together, but cannot simultaneously carry one stem and cut another.

Large Drive-to-Tree Feller Bunchers

Larger drive-to-tree feller-bunchers are essentially front end loaders equipped with harvesting heads. Most heads are circular "hot" saws, though some are equipped with shears. The overall weight and larger cutting heads of these machines allow them to cut larger stems and carry more stems at once than the smaller models. Moving trees with these machines is a balancing act and requires a great deal of operator skill.

Many think of these machines as best suited to clear cuts, patch cutting, shelterwood harvests and plantation thinnings. They are less well suited to selective cutting or lower intensity harvests where the residual stems may be exposed to damage due to the larger footprint of these machines.

Tracked Feller-Bunchers

As the name implies, feller-bunchers both sever the stem and bunch stems together so that they may be skidded to the landing site. Ideally these bunches are no larger than the skidding machine can pull. Tightly packed bunches make it easier to grab them with a grapple. The feller-buncher operator should make sure the large ends are close to the trail and point in the direction of skidding.

Communication between the operators of feller-bunchers and skidders is important – both for efficiency and safety. Two-way radios in these machines are quite common.

Tracked feller-bunchers with continuously turning saw heads (often called hot saws) are generally considered the most productive means of cutting and bunching in biomass harvesting. Operators of these machines become highly skilled over time. These machines do much in the implementation of a harvesting plan, cutting out the main skid trails and then aggregating hitches of wood to be skidded to the landing. Radio communication with the operator is important and the onus is on others to let the operator know when they are nearby.

The cab of this machine spins 360 degrees. Track wear is minimized by harvesting all of the target trees within the radius of the machine's reach before moving. These machines have a noticeable blind side, as the photo shows. Some operators have noticed that this causes them to favor working toward the other side, resulting in slightly uneven track wear.

Productivity is subject to the limits of the stocking and removal level. These machines typically sever hundreds of stems in a day, but can top one thousand under the right conditions.

The reach of these machines varies with their size, but are generally in the 25-30 ft. range. The *effective* reach is dictated by the weight of the stems being severed, as balanced against the weight of the machine. The longer the machine's reach, the less movement of the tracks is necessary.

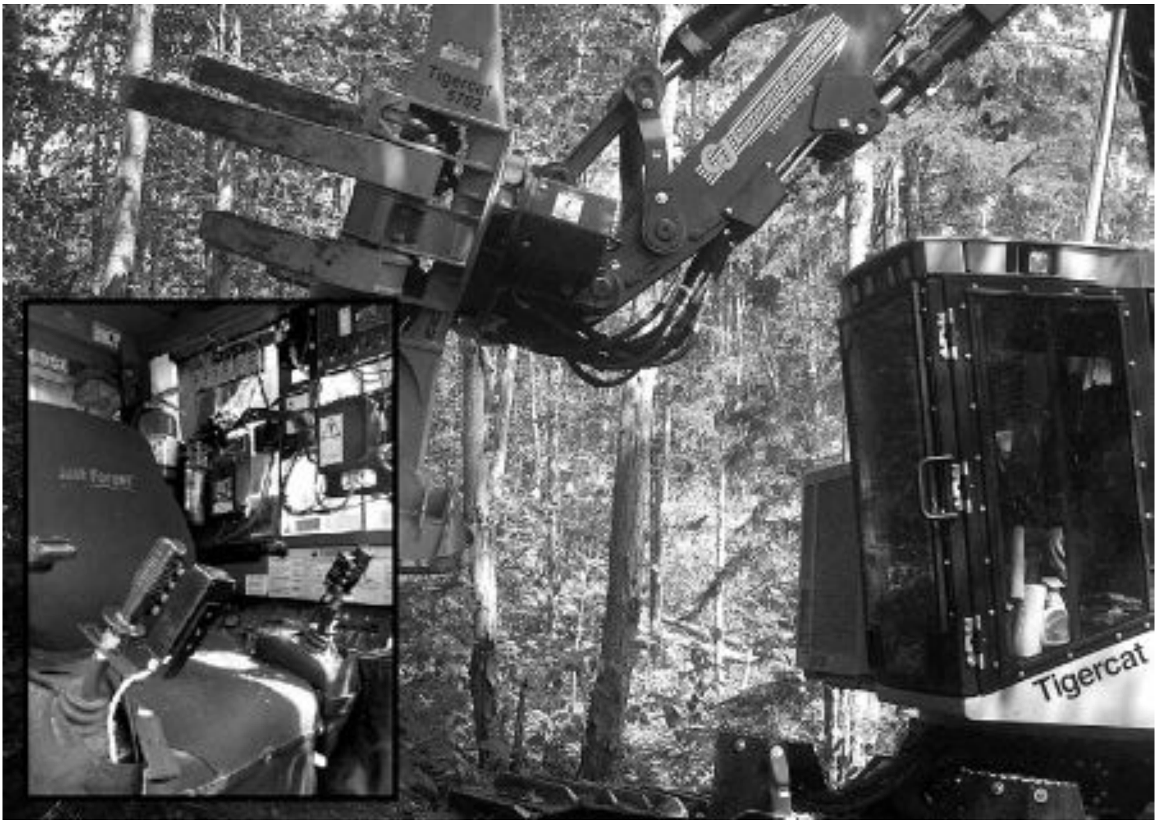
The self-leveling capacity of these machines is a great help on steep slopes. The operator safety and comfort that results from this contributes to higher productivity. It is important for an expensive mechanized-felling option to be able to cover as much of the anticipated harvesting terrain as possible.

A close up look at the cutting head at the top of the facing page shows that the lower side of the blade is not covered. The upper side has a guard that serves as a shelf to bear some of the weight of severed stems. This allows the machine to grasp some stems while cutting others. In this way a number of stems can be aggregated before placing them in a bunch with others to be skid. All of this serves to reduce the amount of motion required and increases productivity.

A close up look at the cutting head above shows the cover on the upper side (discussed previously). Each tooth on the blade has four sides. Teeth are manually rotated when they become dull. Cutting with dull teeth causes a notable decrease in productivity.

The tree size this machine will cut is limited by the opening in the front and the depth of the cover over the blade. Some operators will cut trees that are larger than this by making multiple cuts in the stem from different sides.

Note the chain hook welded to the right side of the frame. Just the sort of thing a logger is bound to find a use for.



The cab of a feller-buncher (previous page) is a sophisticated work site. Heavy reinforcement is necessary for the safety of the operator. As powerful and expensive as these machines are, they are no more productive than their operator. Most operators believe that they become significantly more productive after they gain some experience with the machine. Operating these machines requires skill, experience, and a tolerance for repetition.

A comfortable, intuitive layout of the work space is necessary. A controlled climate, supportive seat and easily accessible controls all contribute to ensuring the operator works at his best. Many operators enjoy music or talk radio as they work. Owner-operators may even field work calls from their cabs.

Wheeled Feller-Buncher

Some wheeled feller-bunchers of this type are used in the northeast. They have a big advantage over tracked machines in terms of ground speed. This can be important when the harvest is a light thinning or a partial harvest where the spacing between harvestable stems is greater. They are at a disadvantage on steep hillsides. Despite their climbing ability, it is difficult for these machines to move safely across slopes (the cab will not level in all directions).

When working in winter or on rough ground, tracks can be used to join the tires. Tracks provide for better traction and a smoother ride. Mounting and removing tracks can be done in about the same amount of time as skidder chains – some even find it easier to do. In some areas, these tracks are required at all times.

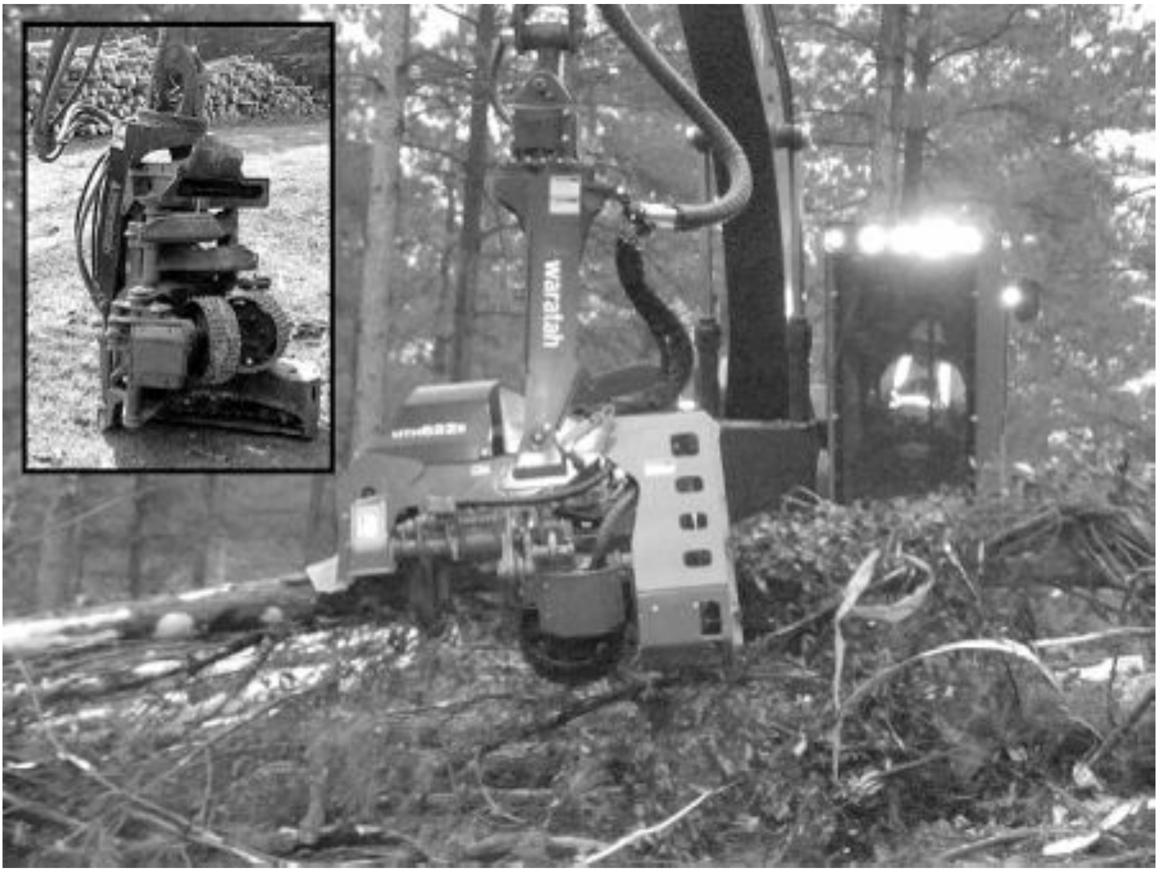
These machines can be fitted with several types of heads, from hot-saws to CTL systems. Fuel consumption will vary accordingly. While replacement tire costs have risen considerably in recent years, they are still less expensive than tracks. While this is the major cost difference between wheeled and tracked machines, a thorough analysis of costs and suitability to the available work will help in deciding between the two.

Harvesting Head Alternatives
Two alternatives to the hot saw style of cutting head are pictured above - the intermittent saw head (upper) and chainsaw bar (lower). In both cases, the tree is grasped before the cutting head starts turning and is extended to sever the stem. Both of these options use less fuel than the continuous head, but are probably better suited to situations that involve fewer, larger stems rather than the larger numbers of small stems typically seen in biomass harvests.

Hydraulic shears were common in first generation mechanized felling machines and a few companies still produce them today. The most common use of these heads has been by drive-to-tree feller-bunchers, but they are occasionally mounted on the boom of larger machines. Some heads simply shear the stem, while others grasp it and allow the operator to accumulate multiple stems.

The opening of the jaws limits the size of the trees they will fell. Recovery time between cuts can be ten times longer than head saws, so they are clearly less productive. The jaws themselves are simpler and require a bit less caution in the snow, on rocky ground or in cutting low stumps. When closed, the jaws can be used for pushing bunched stems and the occasional rock.

Used small drive-to-tree feller-bunchers with shear heads remain in circulation and are seen by some as entry-level machines in biomass harvesting. Loggers working in small diameter softwood stands have found them to be a good fit for their work.



Cut-to-Length Harvesters

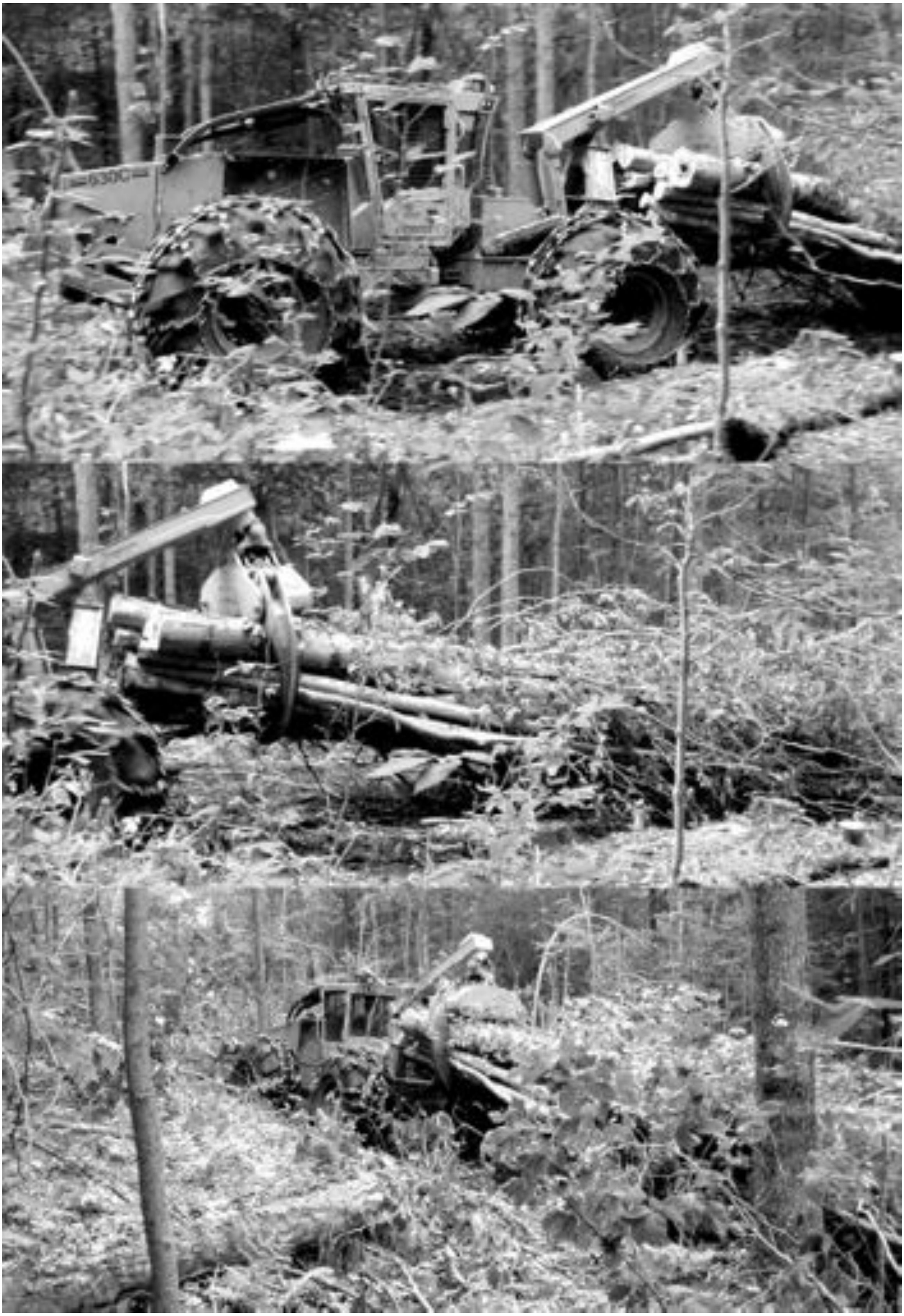
Cut-to-length (CTL) harvesters are essentially feller-bunchers equipped with a more sophisticated processing head. The following page uses two-part photography to show the movement of one of these machines. The trees are severed with a chainsaw head. Stems are then processed on-site by delimbing them and then cutting the stem at desired lengths. A measuring wheel on the processing head (seen above) is tied to a computer in the cab to determine exact lengths before the chainsaw bar cuts the stem into bolts of the desired lengths. The machine then piles the bolts along the trail to be taken to the landing for loading. With the processing completed on-site, this wood is carried out with a forwarder, rather than skidding. Sorting becomes a two-step process – partially completed by the way they are piled for removal and then finished when the forwarder unloads at the landing.

CTL systems aren't generally thought of as biomass harvesting systems. Like most systems they are generally part of integrated harvesting of multiple products. On the other hand, they are an excellent way of providing clean bolewood for further processing into products such as firewood, high quality fuel chips, pellet feedstock and paper grade chips.

Skidding

Introduction

Felled trees have to be brought to the landing for processing. The skidding process is perhaps the most straightforward step in production. There are relatively few options in skidding relative to other aspects of production - machines either drag tree stems or portions of stems to the landing or they carry them. This chapter discusses some of the skidding options and talks about considerations in choosing among them.



Grapple Skidders

Grapple skidders are the primary workhorses in biomass harvesting operations. While there are only a few options in skidding, the widespread use of grapple skidders demonstrates their suitability to the work.

The facing page shows three consecutive photos of a grapple skidder passing by with a full hitch. The feller-buncher operator bunches wood in piles that the skidder can back up to and grasp. Ideally these bunches would be of nearly equal weight each time and comprise the optimum weight for a machine of this size to pull. Reality often doesn't come in perfect bunches. The diameter and length of the trees, ground conditions and even the distance to the landing might dictate different sizes.

The skidder operator will sometimes have to collect two or more bunches to fill out the hitch. Scattered wood might mean smaller bunches. Occasionally stems fall out and must be collected again on future trips. A great deal of pressure is on the operator to be thorough. Radio communication between all operators helps ensure that all of the felled and bunched wood is skidded to the landing.

Additional pressure comes when there are people on the landing waiting to process and load wood. At some point every producer finds themselves in a situation where they are held up by a lack of wood on the landing. A good balance among the felling, skidding and processing phases of production can be elusive when the stocking, terrain and trail layout varies from one job to the next.

A skidder can pull up to about 40% of its weight. Depending on the size of the grapple skidder it can pull from 5 to 10 tons of woods in a hitch. The number of stems is limited by their size and what will fit in the grapple.

In general, large skidders can pull more weight. The longer the skidding distance, the more cost effective it is to pull more weight. For example, the smaller model may cost $85 per hour to operate, but delivers 12 tons per hour. The skidding cost per ton is then $7.08 ($85 ÷ 12 tons). The larger model is more expensive to operate, at $100 per hour, but delivers 20 tons per hour. In this case, the cost of skidding is $5.00 per ton ($100 ÷20 tons). While larger machines can clearly be more productive, they are not suited to all sites and harvesting goals.

At the landing, the skidder has to deliver the wood in such as way that it can be processed. Here the skidder delivers the stems with the butts facing the loader and then pushes them up onto the pile to leave room for the delivery of the next hitch. Landing layout and communication between the slasher operator and the skidder operator are essential parts of the production process.

This six-wheeled grapple skidder has tracks on the rear wheels for greater traction and weight displacement. Operators report that they can pull 50% more weight with this machine than a small four-wheeled grapple skidder.

The tracks allow this larger machine to work on wet ground without having as great an impact on the trail. It is also much better at climbing steep terrain than a four-wheeled skidder.

A larger machine costs more to own and operate, but may make up for this in its results. Suppose that this machine costs $100 per machine hour and a somewhat smaller four-wheeled model costs $75 per machine hour. A 25% increase in cost is potentially yielding 50% greater results. This represents an excellent return on the increased cost. This particular machine is new enough to the market that its true costs of repairs and maintenance are still being determined.

Cable Skidders

While cable skidders are synonymous with logging in many places, they are not well suited to be the primary means of skidding in a biomass harvest. Gathering a hitch of stems for a cable skidder takes far more time than it does with a grapple skidder, even if the stems have been bunched. One advantage the cable skidder has is the ability to drop a hitch at a difficult spot, move through it and then winch the hitch forward to the machine.

In some operations, roundwood biomass products that are part of an integrated harvest are skidded using these machines. Some occasional whole tree skidding is done, often when a subcontractor will be brought in to chip a limited amount of topwood. Many loggers got their start with a cable skidder. They like to keep an older cable skidder on hand for specific jobs or occasions when their grapple skidder breaks down.

Clam-bunk Skidders

Clam-bunk skidders, as shown here, carry the butts of the trees over their rear axles. Most have loaders that allow the operator to accumulate a full hitch from multiple locations. These machines are larger than grapple skidders and can pull more weight. Some of these machines are essentially modified versions of forwarders, while others follow a more conventional skidder design. Both types are shown above.

Hauling more wood with each turn is their primary advantage, which is particularly useful when skidding longer distances.

Forwarders

Forwarders carry wood rather than skid it. They are most often coupled with a cut-to-length harvesting system. They are an excellent way to carry roundwood out of the forest for biomass products because they keep the wood much cleaner than skidding. Firewood log customers in particular quickly learn to favor forwarded wood over wood that has been skidded. Similarly, roundwood handled in this way is better for pellet production because it is cleaner.

Some mechanized loggers started to utilize tree tops for biomass (contingent on markets) because they were pulling them to the landing anyway. Other loggers examined this whole-tree dilemma and decided a forwarder is a good way to avoid handling material that could not be sold. These machines are not a cost effective way of getting tree tops to the landing.

As mentioned in the felling section, forwarding is part of a significant system-level departure from conventional logging in that the stem is processed in the woods, rather than at the landing.

Forwarders carry a greater amount of usable wood per trip to the landing than grapple skidders, but they are also much slower. For example, a forwarder might carry 15 tons (all usable), but need 45 minutes per round trip, while a skidder might pull half this weight in half the time. The difference some of the skidded wood is unusable. Such comparisons are useful for roundwood harvesting, but are far less applicable when whole tree skidding is the goal.

WHOLE TREE GREEN WEIGHT
Combined Hardwoods - TONS

DBH	Total Tree Height in Feet					
	15	30	50	65	80	95
4	0.03	0.05	0.08	0.10		
5	0.05	0.03	0.12	0.16	0.19	
6	0.07	0.11	0.18	0.22	0.27	
7	0.09	0.15	0.24	0.30	0.37	0.43
8	0.11	0.20	0.31	0.37	0.48	0.57
9	0.14	0.25	0.39	0.50	0.61	0.72
10	0.17	0.30	0.48	0.62	0.75	0.89
11	0.20	0.36	0.58	0.74	0.91	1.07
12	0.23	0.43	0.69	0.88	1.08	1.28
13	0.27	0.50	0.81	1.04	1.27	1.50
14	0.31	0.58	0.93	1.20	1.47	1.73
15	0.35	0.66	1.07	1.38	1.68	1.99
16		0.75	1.21	1.56	1.91	2.26
17		0.84	1.37	1.76	2.16	2.55
18			1.53	1.97	2.42	2.86
19			1.70	2.20	2.69	3.19
20				2.43	2.98	3.53
21				2.68	3.28	3.89
22					3.60	4.26

Tree Weights

Knowing the amount of weight being skidded is an essential part of any comparison between machines. This table shows average hardwood tree weights by size for northern hardwood species. For example, if a hitch contains ten stems that average 50' long and an average of 10" in diameter at breast height, it would weigh about 4.8 tons (10 stems x 0.48 tons).

Table adapted from:

Montieth, D.B. 1979. Whole Tree Weight Tables for New York. Syracuse, NY: Applied Forestry Research Institute. 64 p.

WHOLE TREE GREEN WEIGHT
Combined Softwoods - TONS

DBH	Total Tree Height in Feet: 15	30	50	65	80	95
4	0.04	0.05	0.06	0.07		
5	0.06	0.08	0.11	0.13	0.15	
6	0.08	0.11	0.16	0.19	0.23	
7	0.10	0.16	0.22	0.27	0.32	0.37
8	0.13	0.20	0.29	0.36	0.43	0.50
9	0.16	0.25	0.37	0.46	0.56	0.65
10	0.19	0.31	0.46	0.58	0.69	0.81
11	0.23	0.37	0.56	0.70	0.84	0.98
12	0.26	0.43	0.66	0.83	1.01	1.18
13	0.30	0.50	0.78	0.98	1.18	1.39
14	0.34	0.58	0.90	1.14	1.37	1.61
15	0.39	0.66	1.03	1.30	1.58	1.85
16		0.75	1.17	1.48	1.80	2.11
17		0.84	1.31	1.67	2.03	2.38
18			1.47	1.87	2.27	2.67
19			1.63	2.08	2.53	2.98
20				2.31	2.80	3.30
21				2.54	3.09	3.64
22					3.39	3.99

Some biomass harvesting operations take place in softwood plantations or in natural stands with a dominant softwood component. This table gives average whole tree weights for a combination of softwood species found in the northeast and can be used to calculate skidding weights. For example, if a hitch contains 15 stems that are sixty five feet tall and average 8” in diameter at breast height, it weighs about 5.4 tons (15 stems x 0.36 tons).

While tree heights tend to be uniform within stands, they do not always fall into conveniently into categories found in the table. Averaging can be used to determine weights for trees that fall between weight categories. For example, a softwood tree that is 40’ in height and 14” in diameter at breast height weighs about 0.74 tons ((0.58 + 0.9) ÷ 2 = 0.74).

Table adapted from:
Montieth, D.B. 1979. Whole Tree Weight Tables for New York. Syracuse, NY: Applied Forestry Research Institute. 64 p.

Sorting and Processing

Introduction

Processing of the harvested wood that arrives at the log landing creates and loads the products that leave. Landings are complicated production sites that involve a great deal of sorting, cutting and handling in the creation of a wide variety of products that might come from any given mix of the tree species being harvested.

Biomass harvesting is often done in connection with the harvesting of other products. The logger has the challenging task of creating a new landing or production site each time he sets up in a new location. Processing must facilitate the interface of incoming trees with outgoing trucks and provide storage and handling - all as efficiently as possible. Most loggers have evolved a general series of steps for creating a landing that they fine tune for each new location. To the extent that biomass production is usually a sideline to the other production goals, chipping or grinding must be sandwiched into everything else that is going on.

This chapter describes machinery used for processing biomass and as general procedures that are followed to create these products and load them onto trucks.

Slashing

When whole trees reach the landing, processing begins with cutting and sorting. The sorts depend both on the type and quality of trees being harvested and the intended products. Sawlog material is removed. The remaining roundwood may be separated and cut to length if it will leave the landing in this form. Sometimes roundwood is processed on the landing separately from tops and other times they are processed together.

A loader and slasher are used to divide the whole tree into intended products or sections that will be chipped. Circle saw slashers are faster, more expensive and consume more fuel. A less expensive (and less productive) alternative is a mechanized sawbuck with a chainsaw bar.

Stroke Delimbing
This stroke delimber lifts the stem and then shears off all the branches by moving the mechanism along the shaft. This machine can cut stems into sections as well.

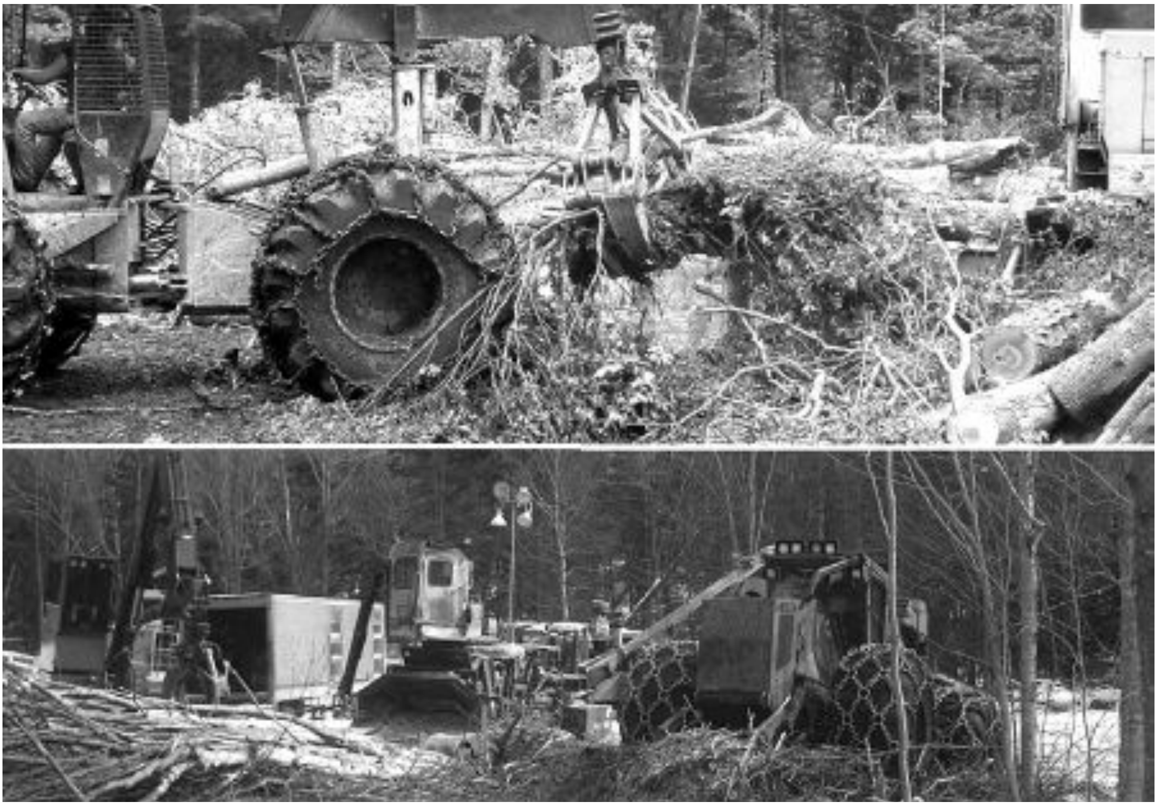
Delimbing is an important process in biomass harvesting when the product is roundwood or higher quality chips that may contain only minimal bark. Paper and pellet grade chips can be made from the stem. Some heating markets, such as smaller school boilers, require chipped stem wood as well.

These machines are essential in many whole tree harvesting operations that weren't utilizing the entire tree or where using tops and limbs for grinding. As markets have allowed utilization of whole trees, many of these machines have been removed from the production process. If there is no need to remove all of the limbs, there is no need for this machine.

Pull-through Delimbing

This pull-through delimber shears all the limbs from a tree as the loader pulls it through. These machines work well on softwood. Hardwood can be delimbed in this way, but it is often more difficult. Sheared limbs and tops can be put in a grinder or returned to the woods.

This type of a delimber is a lower cost option than the stroke delimber. It is also far less productive. Pull-through delimbing is best suited to situations where only a portion of the production must be delimbed. If every stem must undergo this process, this lower production approach quickly becomes a bottleneck.

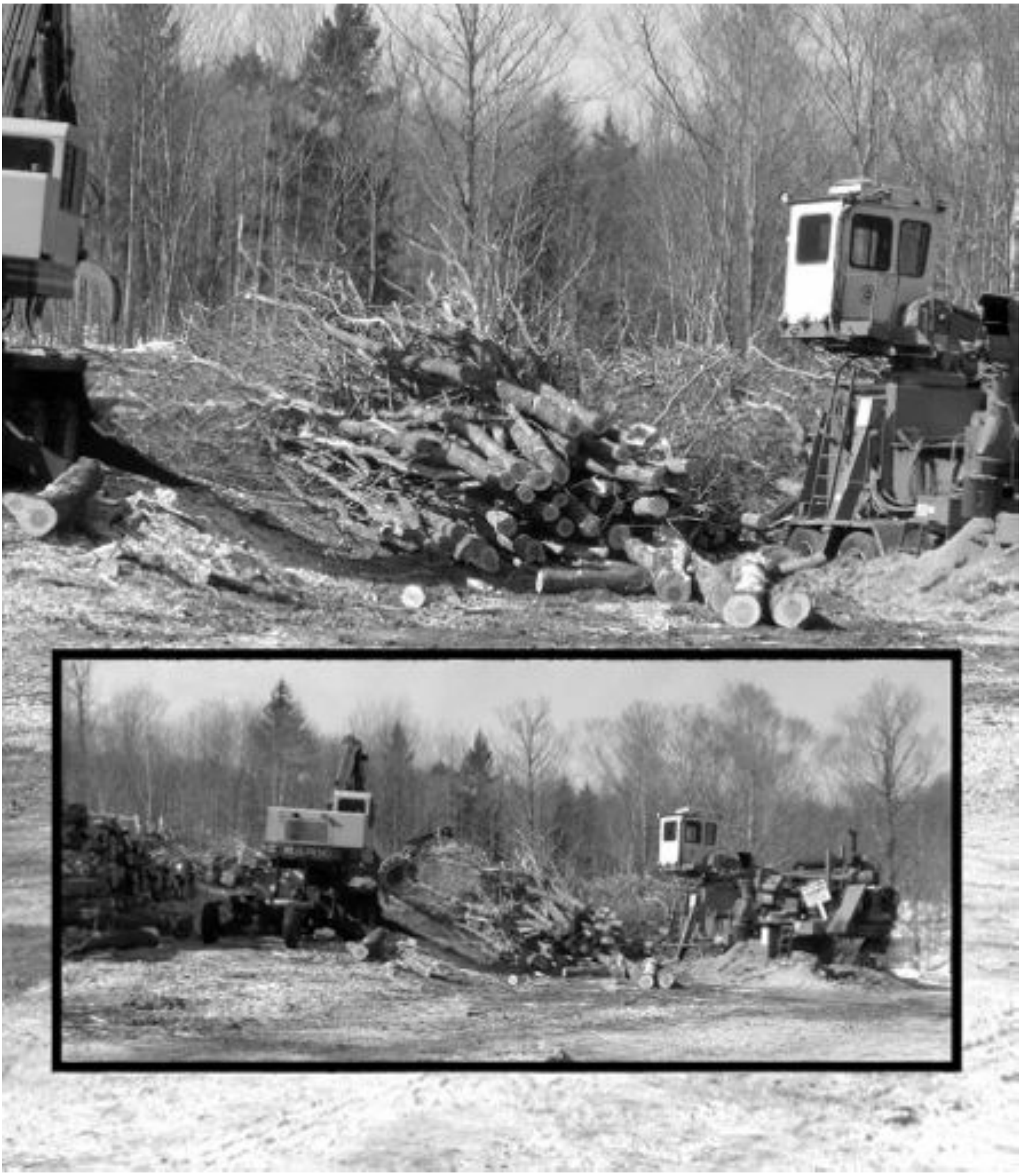


Returns

Some portion of topwood is inevitably unusable. While some whole tree operations do not use any of it, even those that chip or grind it will need to use some to fill soft spots on skidder tails. Some tops are too muddy to put into the chipper and other are too small to feed into it. Grinders are better able to handle this type of wood, but aren't employed on all operations.

Returning topwood to the woods falls to the grapple skidder operators, who routinely carry material from a sorted pile on the landing back to the woods (upper scene).

In flail chipping operations, an additional step is required. Flail debris flies out of the chipper and lands on the ground across a wide area. This skidder operator must push it up into a pile to consolidate enough to lift and carry some of it away with the grapple (lower scene).



Sorting
A load of topwood sits within easy reach of the chipper in the photograph on the facing page. The inset image shows the position of the slasher and other roundwood products, with room for loading trucks in front of these machines. A close look at this pile reveals that some roundwood is included. Utilization depends on markets and trucking distances.

Depending on the chipper, larger wood will fill a chip van sooner, meaning less fuel consumption per ton. The previous step of slashing up whole trees is quicker (again, less fuel) when fewer products are sorted.

This topwood was cut with a slasher and set aside as part of a two-part chipping process. When a market such as a heating plant is available for bolewood chips, it makes sense to separate the wood in this way. Some portion of the stems has gone into creating the bolewood chip. Just enough roundwood is left in this pile to facilitate feeding this wood into the chipper. The wood shown in this pile will go to an electrical utility.

The higher bark and stick content that will be part of a load of wood chips from this source will not be a problem for a larger facility. Most electrical plants pass all of their wood material through a hog grinder or hammer mill before it reaches the conveyors taking it to the burning stage.

Moisture Content

Biomass products delivered from the woods usually have a high moisture content, comprising 40% or more of their delivered weight. Few facilities actually want this water in the product and some actually base payments on a calculation of the dry weight of the wood. If a cost effective way of partially drying the wood before it leaves the landing is developed, higher value loads will result. This serves to lower trucking costs. Some producers have toyed with finding ways of drying wood using the exhaust heat from equipment they are already running. Drying represents a value-added opportunity.

One proven means of partially drying wood is to fell and bunch it wood several months prior to processing. Cutting the trees six to eight months in advance can reduce the moisture content to 20%. If payment is based on dry weight, reducing moisture content from 40% to 20% increases the value of each load by 25%.

Separating felling from the rest of harvesting by several months requires a great deal of planning. This operation incurs expenses that are not recouped until much later. Despite the hurdles involved, the potential of this value-added approach is certainly worth investigating.

Disk Chippers

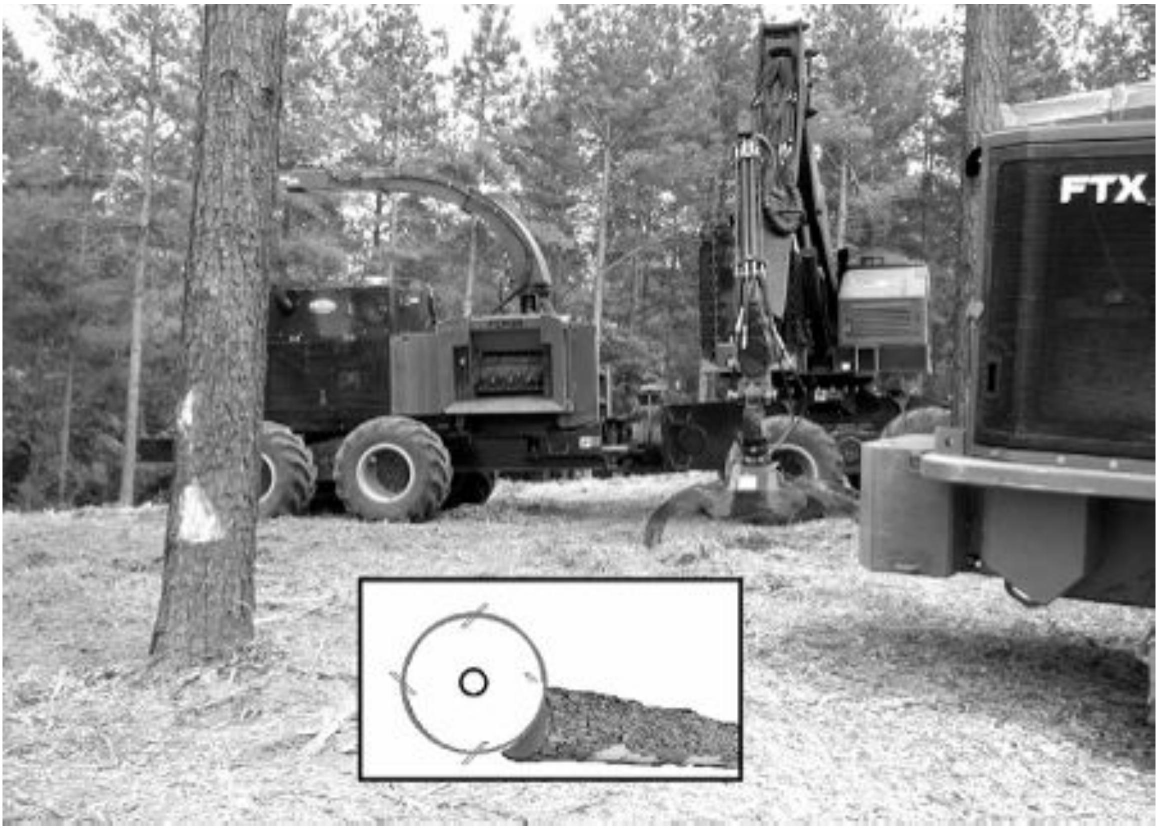
Disk chippers are probably the most common type in operation throughout the northeast. This inset photo shows a closer look at the spot where the feeding roller conveys the wood to the spinning disk.

Wood is fed against the turning knives on the disk where the chipping takes place. Disk chippers can chip whole trees and tops alike, with tree size limited only by the intake. These machines consume a great deal of fuel, putting them at a disadvantage when only tops are chipped.

The chipper shown is self-loading. Other models are available without a loader. In many cases, operators find it most convenient to feed it with a larger loader. The longer reach of larger loaders and their central purpose on the landing site often make this more convenient. Convenience comes at a price - using two machines when chipping increases the processing costs.

Tracked Chipper

This tracked chipper is self-propelled. It can maneuver itself into a greater variety of places than a wheeled chipper. The tracks become a disadvantage when it comes to moving the machine from one job site to the next, since it must travel on a trailer, rather than be towed.



Drum Chippers

Drum chippers are making inroads in biomass harvesting operations. The primary advantage of newer models of drum chippers is their lower fuel consumption than disk chippers. Prudent operators have sifted through manufacturers' claims about fuel consumption and have field tested chippers to make their own comparisons. It is realistic to expect these chippers to use half the fuel of the older disk chippers they are replacing.

Taking current fuel prices into account, fuel can account for over a third of the hourly cost of operating a chipper. Cutting fuel consumption in half would drop this cost to under 25%. If a drum or a disk chipper were interchangeable in all cases, this factor alone would make the decision between them easy. Unfortunately, decisions usually are not that simple.

Drum chippers have smaller size limits and are generally considered best for chipping topwood. If whole trees or a large portion of the stem is going to be chipped, a disk chipper may be a necessity.

Flail Chippers

Flail chippers debark wood with a series of spinning chains. The bark and any dirt or other debris is beaten off with the chain and ejected from the machine. The clean wood then advances to a disk chipper. The resulting product is very clean and suitable for making pulp, wood pellets and even rayon for clothing. It is also a high quality heating chip that produces very little ash.

This chipper combines the two functions of flailing and chipping. Other operations accomplish the same result with two separate machines, one serving as a flail debarker and the second as a conventional disk chipper. The single machine approach seems best suited to high production for certain markets for this clean chip product. The two machine approach has an advantage for smaller producers in that they can employ the flail only when they have a market for the clean chips and produce conventional chips the rest of the time.

Horizontal Grinders

Horizontal grinders have a large intake that conveys the wood into the grinder. While these machines can handle whole trees, they are more often used to grind tops or flail debris that cannot be used for other purposes. Grinders have served as the entry for many whole tree operations into biomass production. Grindings are perhaps the lowest value biomass product. For some they serve as a means for cleaning up jobs sites. Operators find that as long as they can break even on grindings, there is benefit in using them for clean up purposes.

Grinding topwood requires feeding the grinder with a second machine. Most of the time this is the loader, but grapple skidders have been used for this purpose as well. Dedicated grinding operations will sometimes modify the loader with a debris head that allows them to do a more efficient job of picking up material.

Alternatively, grinders have been used to create value added products such as mulch, but this usually isn't part of the processing done on the landing. Dying and storage are often part of that process and landing sites are not well suited for these activities.

Example purchase price premiums for decreasing fuel consumption by 50%

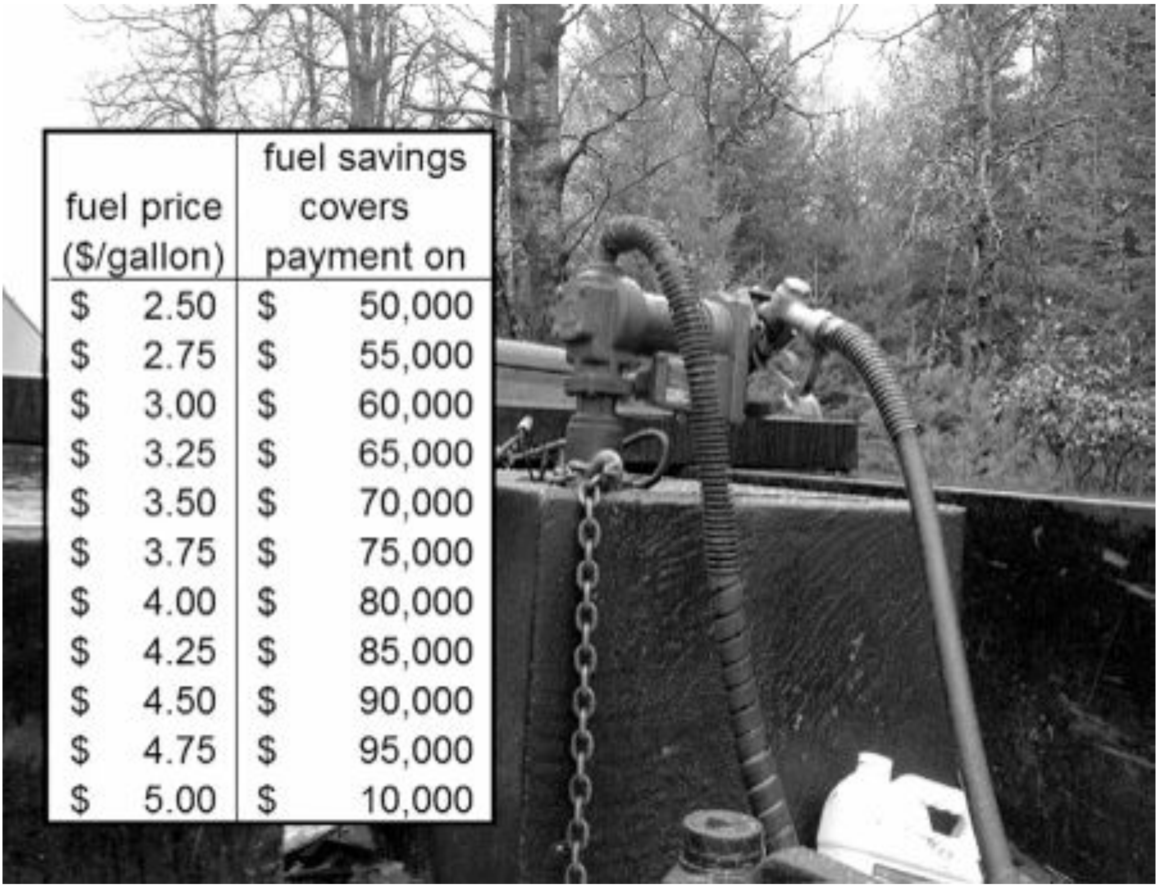
fuel price ($/gallon)	5 year ownership price premium	10 year ownership price premium
$ 2.50	$ 52,000	$ 69,000
$ 2.75	$ 57,000	$ 76,000
$ 3.00	$ 63,000	$ 83,000
$ 3.25	$ 68,000	$ 90,000
$ 3.50	$ 73,000	$ 97,000
$ 3.75	$ 78,000	$ 104,000
$ 4.00	$ 84,000	$ 111,000
$ 4.25	$ 89,000	$ 118,000
$ 4.50	$ 94,000	$ 125,000
$ 4.75	$ 99,000	$ 132,000
$ 5.00	$ 105,000	$ 139,000

Fuel Efficiency Comparison

Fuel efficiency is a major selling point for drum chippers. All other things being equal, how much more is one of these chippers worth if it use 50% less fuel than a comparable disk chipper? The comparison above shows how much more can be spent for a more fuel efficient chipper while still retaining an operating cost advantage. Both five and ten year scenarios are shown for a wide range of average fuel prices. Interest rates, labor costs, utilization and repairs and maintenance were all kept equal in this comparison, with fuel consumption being the only difference.

Significant price premiums are justified for the more fuel efficient chipper, even at lower fuel prices. Over five years of ownership (depreciating 60% of the purchase price), a logger can pay $5-6,000 more for each $0.25 increase in fuel price. Over ten years of ownership (depreciating 90% of the purchase price), a logger can pay about $7,000 more for each $0.25 increase in fuel price.

Suitability of the machine for a logger's work is a prerequisite to any comparison of this sort. PATH or other machine rate software allows these evaluations. Input both machines with all of the same information, altering the fuel consumption rates accordingly. Increase the purchase price of the more efficient chipper until the hourly costs are equal to determine how much more the machine is worth.



fuel price ($/gallon)	fuel savings covers payment on
$ 2.50	$ 50,000
$ 2.75	$ 55,000
$ 3.00	$ 60,000
$ 3.25	$ 65,000
$ 3.50	$ 70,000
$ 3.75	$ 75,000
$ 4.00	$ 80,000
$ 4.25	$ 85,000
$ 4.50	$ 90,000
$ 4.75	$ 95,000
$ 5.00	$ 10,000

Some loggers prefer to make comparisons in terms of differences in payments for financed equipment. A logical question is, will the fuel savings make up for the larger payment on the more fuel-efficient chipper? In many cases, they will. The table above shows the amount in annual payments that could be made up by the fuel savings for a range of fuel prices.

In this case, the less expensive chipper that used twice as much fuel was assumed to sell for $250,000, financed at 4.5% interest over 5 years. Annual fuel savings were assumed to be 4,500 gallons (22.5 gallons per day x 200 days).

To make this comparison, determine how much fuel each option would use each year. Multiply this by the fuel prices. Use an amortization spreadsheet to determine the annual payments associated with financing both machines. If the difference between the two annual payments is no more than the fuel savings, the results are positive.

This measure alone is not enough to make the decision between two machines, but it should be part of the analysis.

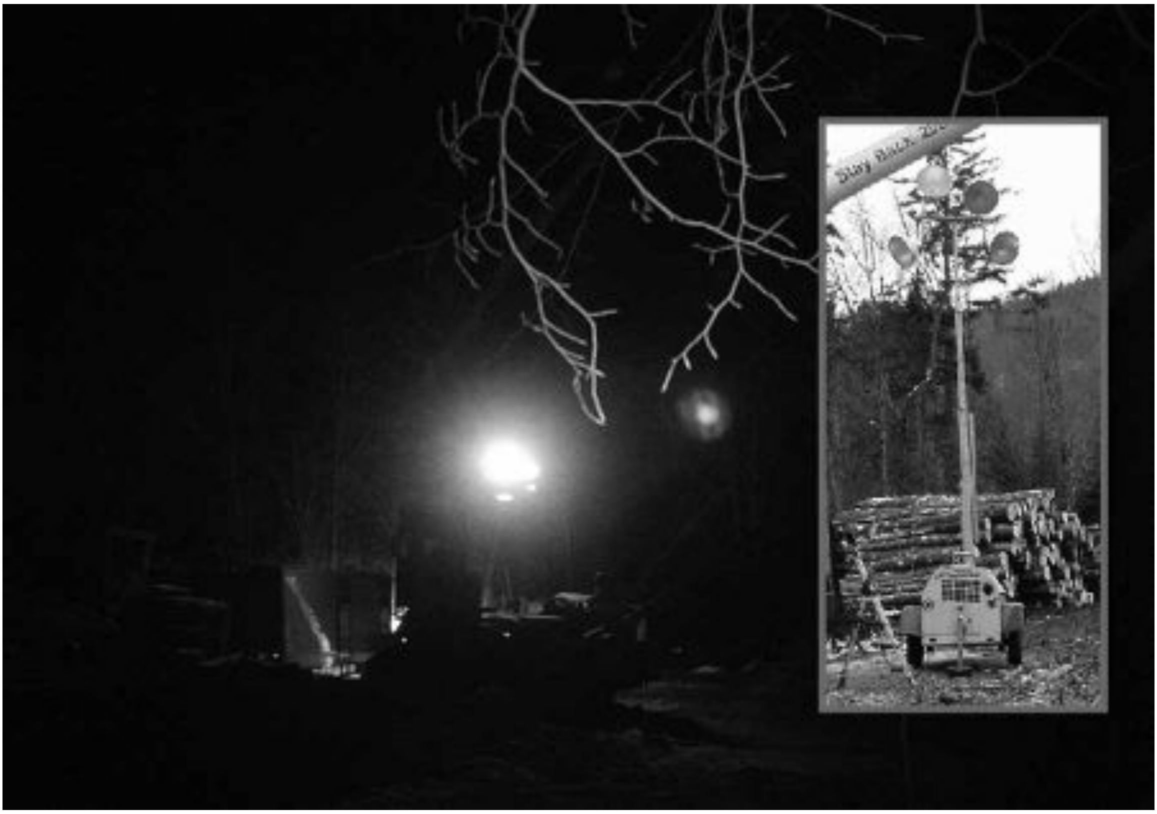

Loading

Chipping and grinding (above) both integrate loading into the process. Chips are either blown into a van from an opening in the back, or are deposited in from the top. Top loading requires more assistance from the truck driver than back loading, where the van remains parked in place. Top loaders begin at the front of the van. As the van fills, the driver pulls forward a bit at a time, until the van is full. Once full, a long tarp is rolled out over the load. This both ensures that chips do not fly out on the road and protects the load from contamination with dirt or road salt.

When most of the chip material is hardwood it is sometimes possible to overload vans because they can hold more than a legal limit. Fines can easily wipe away thin profit margins so it is important to be conscious of load weights.

Support

Service trucks have become essential to most logging operations. Service and repairs to machinery are a daily occurrence. Having a compressor, welder, generator, spare parts and a wide range of tools on hand helps minimize lost production time. This is especially true when loggers work a long distance from home. These trucks tend to become better equipped over time as recurring repairs dictate that new items are added to the collection. A truck of this type is not a substitute for a larger shop, but it does help keep an operation producing.



Supplementing Daylight
Daylight is often in short supply during the prime of a logger's winter production time. Mid January provides just over 9 hours of daylight each day for much of the northeast.

A portable light such as the one shown here can be a great help on a landing, especially for making repairs, performing early morning maintenance and positioning a truck for the first load of the day. These lights were originally made for construction sites, but innovative loggers are not afraid to adopt good ideas from other industries.

Transport & Delivery

Weighing

Biomass is quantified by weight. Quantities of wood chips are almost always calculated in green tons. Payments may be made based on green or dry weights, but the starting point in determining how much wood is on a load is weight scaling. Truckloads of wood are weighed upon arrival with a drive-on scale. After the wood has been unloaded, the truck is weighed again before departing. The green wood weight is the difference between the arrival and departure weights.

Some scales are staffed by the facility to ensure that trucks are properly positioned for weighing. Others are more automated and may have railings to ensure proper positioning of the load (i.e. completely on the scale).

Smaller heating plants will seldom have their own weight scales. Weighing may be done on off-site scales at nearby stone facilities. In other cases, an average load weight is established through a series of weights from loads that have been sent to other facilities. Reasonably consistent load weights make this possible.

Unloading

Hydraulic dumpers like those shown on the facing page secure the trailer and then lift it, allowing the wood chips to fall from the back of the trailer. Unloading times vary from one facility to the next. Gravity allows the wood to fall from the van, but the speed with which the vans can be elevated for the chips to fall out depends on the next step in the process.

The upper photo shows a rail yard facility where the chips are dumped onto a concrete platform and then moved by a front end loader. With the scale positioned directly in front of the dumper, this facility consistently weighs and unloads the trailers in 5 to 7 minutes. In this case, the load can be continuously elevated until all of the chips fall out, with no need or reason for slowing down. This ensures a reasonably quick turnover time, even when many trucks are waiting in line. Since this is a high volume facility, it has two scales and dumpers.

When some of the chip processing occurs as the trailer is unloaded it will lengthen the unloading time. As the chips fall from the trailer in the lower photo, they are fed into a hog grinder and then conveyed into a pile. Chips must be dumped out slowly, with the dumper elevated gradually to control the rate at which they fall out. Unloading can take up to 30 minutes, often after a long wait for the unloading of the trucks that came in earlier.

Unloading times can be significant enough that they should be accounted for in costs calculations. Idling trucks and drivers increase the logger's production costs.

Driver Responsibilities
The truck driver has several responsibilities in the unloading process. These duties will vary from one facility to the next. Communication with the operator is needed so the load is recorded properly. Most loggers have some internal recording to keep track of their loads and match up deliveries with payments. Opening the van gates and unhitching the truck are common duties. Driver safety should be important to everyone. Drivers should comply with all of the facilities requirements in this regard.

While the logger will have a direct relationship with the plant's wood buyer, the relationship the trucker has with the facility is important as well. Often the only impression the facility staff has of a logger is through the truck drivers. Drivers should represent their employers well. This might pay off in the form of added quota or other considerations

Long waits for unloading are not uncommon. Respect for their peers should guide drivers to be cooperative with other trucks who are in line to unload.

Quality Standards
This producer topped off this load with some loose sticks from branches that didn't make it into the chipper. This efficient use of the resource also helps clean up the landing area. While these sticks might be a problem in a smaller heating application, most electrical utilities pass all of their wood supply through a hog grinder or hammer mill that takes care of such irregularities.

It's always best to stay in the good graces of those who run the facility. Be sure to find out if the type of material in this load is acceptable to them. Facilities specify allowable content in supply contracts and may include penalties for sub-standard loads. Sticks, stones, dirt, and chain all pose difficulties to the end user. Giving the customer the quality they want will helps keep a supplier in operation during the inevitable periods of low demand.

Self-Dumping

A self unloading truck like this one has its advantages. While tractor-trailers at some facilities may wait an hour or more to unload, this one is able to back up to the pile, dump its load and be on its way. Trucking small loads like this can hardly be considered efficient for longer distances, but a convenient location and a sort distance may make it cost effective, especially if it shortens the unloading time significantly.

This particular supplier added a seldom-seen level of utilization by carrying some additional chips to the plant in five gallon pails that rode in the cab.

From a veteran supplier:

"When it comes to these specialty markets, what I've learned is that they expect the quality and quantity they want, on short notice and all delivered as quickly as possible."

Supplying Specialty Markets

When markets for wood chips come from outside the traditional forest products realm, there is no reason to expect buyers to understand the peculiarities of timber harvesting and wood supply. These facilities are accustomed to simply ordering items and materials and having them delivered. When it comes to energy, the more expensive fossil fuels all come in a more convenient fashion than wood and require far less storage. Natural gas and electricity are continuously supplied by dedicated lines. Oil and propane are delivered by truck to storage tanks, with little or no participation by the facility in the unloading and storage. One of the roles of suppliers to these specialty markets is to remove some of the inconvenience and anxiety that can come from relying on wood. Limited storage means that it's possible to run out. Quick and consistent responses to phone calls for help distinguish a supplier from the competition. Chip quality suitable for the conveyance and burning conditions are further ways to satisfy customers. A positive relationship between truck drivers and the facility staff is also helpful.

Self-Unloading

A live-deck, self-unloading trailer is necessary for delivery of wood chips to some facilities. Heating plants in particular seldom have any means of unloading trailers. The deck of this trailer moves slats back and forth, shifting the chips forward until they fall out the back.

A live deck adds more weight to the load, reducing in the amount of chips that can be carried. This is one more of the specialty factors that goes in supplying heating markets, making them a custom market distinctly different from commodity transactions that makes up the bulk of the wood chip market.

Heating chip supplier:

"A lot of guys out there with a chipper, they'll make chips, but they don't have the big infrastructure to back it up. We can guarantee supply."

Heating Plants

Supplying heating plants often means delivering into tight spots. Sometimes delivery times are restricted because of other activities at the facility. Most biomass heating plants were added to existing facilities – places where the original designers never anticipated delivery of trailer loads of wood chips. Storage in these plants is nearly always less than ideal, meaning they will require regular deliveries on short notice. A live floor unloads the chips here and then the staff uses the tractor to clean up any chips that didn't make it into the bay. Having a driver who can get along well the operators of these plants is a great asset to a supplier.

The supplier of this facility solved the storage dilemma by finding a nearby warehouse that allows him to stockpile a significant inventory of wood chips. The near endless supply of wood for the boiler that resulted endeared them to the physical plant operators.

Most heating plants of this type have included heating oil or some similarly expensive fuel to account for 5-10% of their heating budget. This is a practical reality where wood heat is concerned – a back up system just in case. A conscientious supplier can help make a meaningful dent in this budget, adding more cost savings.

SECTION 3: BUSINESS

Credit

There are five C's involved in credit – character, capital, capacity, collateral and conditions. Each of these plays a role in a lender's decision to extend credit to a borrower. A lender will view an ideal candidate as one who meets acceptable standards in each of these five areas. This is often too much to expect from logging firms in various stages of growth and development. A logger's largest assets – equipment – are also highly depreciable. Building a high net worth is difficult.

Over the course of a logging career each of these five C's will play out and develop, limiting growth for some and providing abundant opportunities for others. Young loggers without an established credit history or reputation will need time to build these. Skilled lenders have an eye out for good prospects and will approach them. It is worthwhile for a logger to talk with these lenders, even when they are unable to make a loan. The lender's job is to make secure loans. With this in mind, a lender can offer advice on how to build credit, in the hopes of gaining a customer in the future.

Character

Character is a measure of the borrower as an individual. Proven character can help in overcoming deficiencies in other areas. The number of years in business combined with a solid credit history will speak well of a logger as a potential loan risk. An individual's credit history is readily available to all lenders.

Everyone has a reputation within the industry. A few well placed phone calls and conversations will reveal a great deal about anyone. Skilled lenders know how to make discreet inquiries into someone's reputation. Two excellent sources of information that lenders use are fuel dealers and repair shops. Most loggers have an established history of interaction with these types of firms. A record of on-time payment is, of course, a good indicator of character. Beyond that, it's important to find out how a logger may have handled things when cash flow caused on time payments to be very difficult. A record of being proactive and approaching his creditors to work out a payment schedule is far better than one of past due accounts and no communication.

Most small businesses within the forest products industry operate completely under the radar of the general public. As a result, a logger may have to carefully explain how challenges were overcome in their business. The logger himself may well be the only source of this kind of information – though backing it up with an income tax return or other records can help put an exclamation point on the story.

	Current Situation	Loan Amount	Proposed Situation
Assets	$ 410,000	$ 180,000	$ 590,000
Debts	$ 115,000	$ 180,000	$ 295,000
Net Worth	**$ 295,000**		**$ 295,000**
NW to Asset Ratio	**72%**		**50%**

Net Worth = Assets - Debts

NW to Asset Ratio = Net Worth / Assets

Maximum Loan Amount Maintaining 50% or more NWA = Net Worth - Debts

Capital
Capital is a logger's net worth and liquidity. Building a company's net worth establishes proof to a lender that the logger is risk-worthy and can do what is necessary to pay off a loan. Actual net worth and the ability to draw on it (liquidity) can serve as security for the loan. It can also help show the wherewithal to get through difficult times when cash flow may be stunted. This is reassuring to lenders, who do not want to loan money to someone who might prove unable to pay it back.

Net worth is simply the difference between the value of someone's assets and the amount of their debt. For example, if a logger has assets worth $410,000 and debts totaling $115,000, his net worth is $295,000 ($410,000 - $115,000). Net worth is an important measure to lenders. Those who understand the logging business realize how difficult it is to build up net worth, as much of a logger's debt is accrued in purchasing equipment that depreciates rapidly.

Lenders prefer to see a **net worth to asset ratio (NWA**; sometimes called equity ratio) that remains 50% or more after the loan is made. This is calculated by dividing net worth by the value of assets. For example, in the situation above, this ratio is equal to 72% ($295,000 ÷ $410,000). With this in mind the most a logger can borrow (provided NWA is already 50% or more), without additional conditions, will be equal to the difference between net worth and total debts. In the example above, the most this logger can borrow without dropping his NWA below 50% is $180,000 ($295,000 - $115,000).

A loggers net worth may remain the same before and after a loan, because the debt incurred is equal to the value of the asset acquired, but there can be a dramatic difference in NWA Keeping NWA above 50% reassures a lender that the borrower has the financial ability to make it through the difficult times that can happen to a business.

Capacity

Capacity is the ability to generate the necessary cash flow to make payments and show a profit. Equipment that is being financed should make a substantial contribution to capacity. Records from past years, such as production totals and tax returns should demonstrate current and past capacity. Informed lenders will understand the production potential contained within various mixes of logging equipment.

A careful explanation or a detailed business plan may be necessary to show how new equipment would enhance capacity. The business plan should demonstrate sufficient market demand to keep financed equipment utilized at a high level. It is essential that financed equipment be put to work.

Guaranteeing loan payment

Co-signer

Additional collateral

Timber sale contracts proving you have work

How will this loan be employed to generate profits?

Conditions

Conditions are those further terms the lender deems necessary to make a loan viable. The magnitude of the item or project being financed, weighed against the previous items (character, capital, capacity and collateral) will come together in specifying the conditions of the financing. Apart from the term and interest rate, additional considerations may apply.

Conditions that will give the lender the sense of security they need to make the loan may include life insurance (specifying loan payoff with proceeds), a co-signer and additional collateral. Proof of sufficient work for the equipment being purchased is another condition – one that may be satisfied by supplying the lender with timber sale or production contracts.

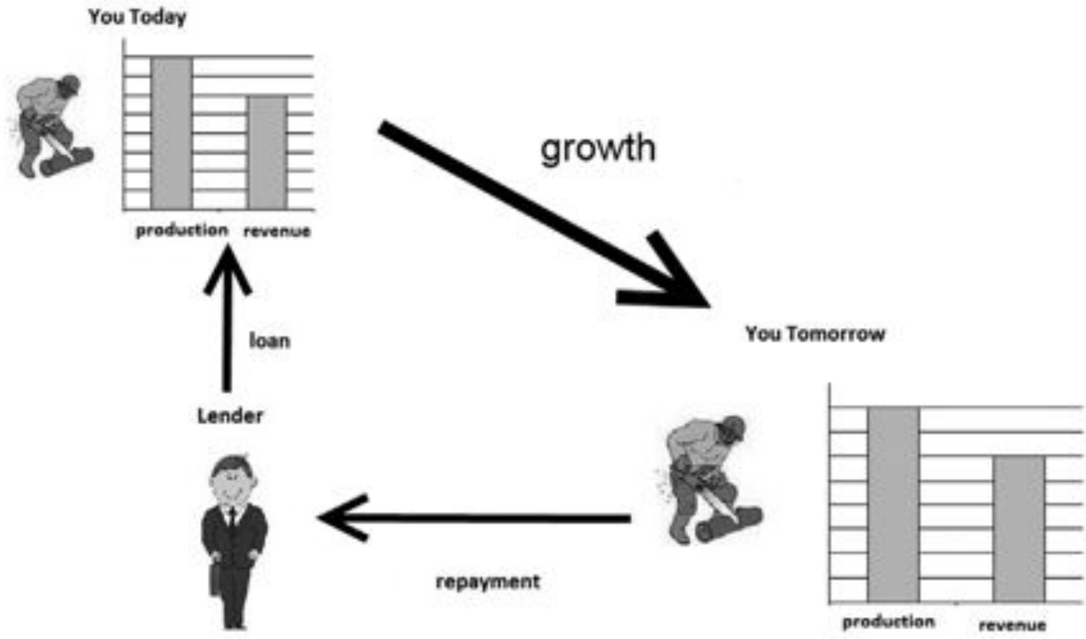
Collateral
Collateral is the material security supplied to guarantee the loan. A new piece of equipment will usually serve as the collateral for its own financing. In the absence of a substantial down payment, further collateral may be necessary. Loggers will often use other pieces of equipment that they own outright as this further collateral.

A line of credit for operating expenses (such as funds to buy stumpage) is often backed up with a line of equipment as collateral. Real estate, such as a repair shop, can serve as collateral – but some lenders are hesitant to secure loans with this type of property. A logger's large garage is often a purpose-built building in a rural location. This isn't the sort of property there is a large market for in the event of a foreclosure. Timberland, on the other hand, has much better potential to serve as collateral.

Additional Security

Lenders sometimes ask that borrowers use a home or land as security for a business loan. A logger who has worked hard to built equity in these assets and doesn't consider them to be a part of his business will naturally be reluctant to do this. As a bargaining point, the borrower can offer to include a "no pledge" agreement as a condition of the loan.

The ability to offer a no pledge agreement is a negotiating point in helping qualify for a loan. Other assets can demonstrate the presence of a safety net if things don't go quite as planned in a business. A no pledge agreement guarantees that the borrower will not take out a loan secured by these other assets over the term of the business loan. This reassures the lender that the borrower does have some security to fall back on in the event that an additional loan is necessary. If an additional line of credit is needed to help the business succeed, collateral is available to secure this loan.



Business Plans
A business plan shows how the logger intends to put a loan to work in growing a business. It should describe the logger's current situation and explain how the financing of new equipment or other purchases will allow business growth to a position that produces more wood products and more revenue. This plan should combine an outline of assumptions, description of intentions, and provide a detailed analysis of the cash flows that will result. The plan isn't complete unless it clearly identifies the risks involved and explains strategies for addressing them.

A well-written plan is no substitute for a solid business idea. Instead it should be viewed a means of helping the lender understand how a business will operate. Future chapters focus on business plans and provide a detailed example of one logger's plan to grow a business by adding biomass production.

Leasing

Leasing equipment can be a good entry level strategy, both for operations and for building a good credit history. Leasing typically costs more than a financed purchase. If a logger's credit history rules out financing an equipment purchase, leasing may be the only option.

Lenders typically respond to risk (or perceived risk) by requiring a greater rate of return. Leasing is one way for them to realize this greater return. The upside for the logger is an opportunity to demonstrate a history of on-time payments. This shows character and demonstrates the capacity to produce the necessary revenue. The downside for the logger is that lease payments entitle the the business to nothing more than the use of the machine – with no residual equity in the end.

Some lease terms are written in such a way that the logger can purchase the machine at the end of the lease for a set price – the higher the payments have been over the course of the lease, the lower this purchase amount may be. In this case, the logger can build equity, but it has come at a higher cost than if it had been a traditional financed purchase.

Leasing has some significant downsides. Loggers sometimes enter periods of financial stress that might result in missed lease payments. Leasing companies are rigid in their payment schedules and will not reschedule payments. In most cases, payments that are 90 days late will cause the leasing company to repossess the equipment and turn the matter over to attorneys for collection.

Lenders

Business loans have traditionally been handled by banks. Logging businesses are often more difficult for such institutions to understand. Lenders associate things they don't understand with risk, and greater risk means higher interest rates and stricter lending terms. In some cases, the easy answer to perceived high risk is simply to deny a loan.

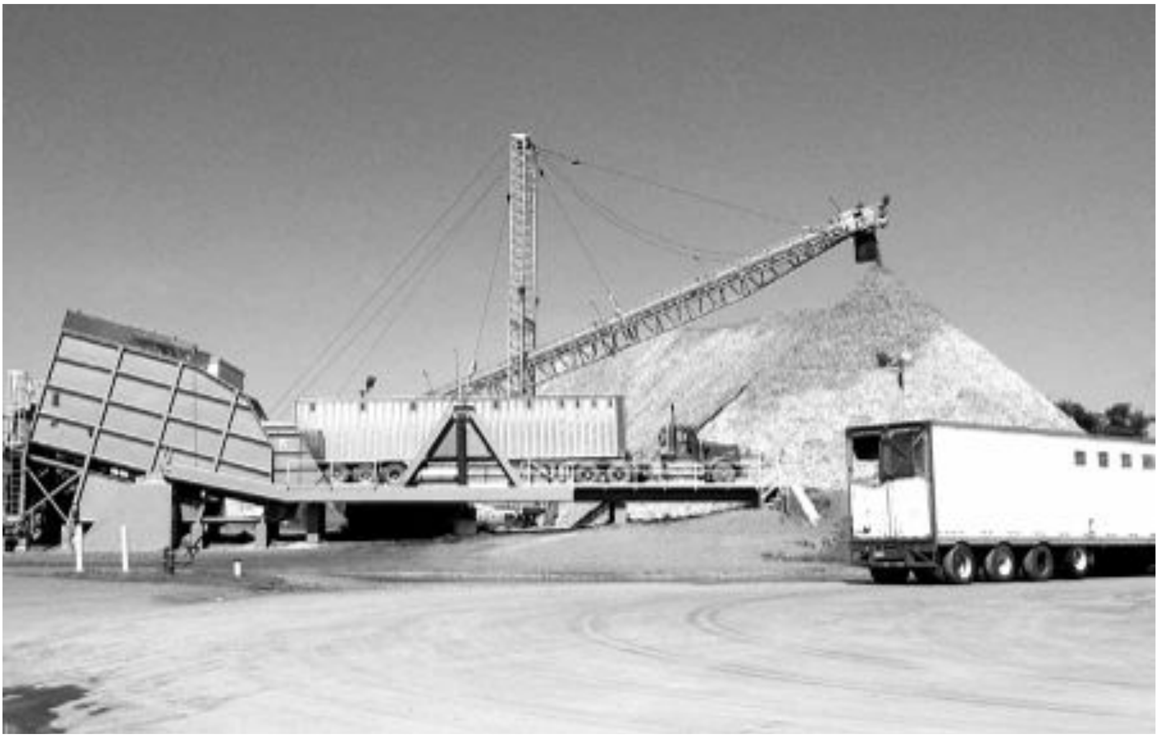
Some specialized lenders have evolved over time to serve loggers. Institutions such as Farm Credit have a sound understanding of rural enterprises, in part because they are cooperative institutions that are owned by their borrowers. The specialized expertise they have developed allows them to accurately assess the risks involved in logging, as well as the resource-dependent business cycles.

Advanced discussion of your credit-worthiness with a bank places a logger in a better position to negotiate for the purchase of equipment.

Dealer Financing
Equipment dealers and manufacturers are another source of loans. Generally this type of credit is extended only to new equipment purchases, though terms may be tailored around the seasonal needs of a logging business. This financing option can be a good approach for building sufficient credit to qualify for more traditional credit sources in future purchases. It is important to discover if a lender of this type reports information to credit bureaus. If it does not, a logger cannot build a credit history using this particular route.

The downside to financing through an equipment dealer is the difficulty in sorting out the details of the deal in traditional terms. With outside financing a logger can focus on price and delivery date in striking a deal (perhaps even building some other concessions such as delivery location or a small supply of commonly replaced parts). When the seller controls the interest rate and terms they are at a distinct advantage when it comes to closing the deal.

In most cases dealers are looking only at the sale of an individual piece of equipment, rather than at the business as a whole. They have less incentive to work with the borrower in times of financial stress. Their preferred response is to work out a trade and replace one sales contract with another for a different machine.



Customer Financing
Wood purchasing facilities sometimes become involved in extending credit to suppliers to finance equipment purchases. Short-term loans of working capital have often been extended and then worked off through delivered wood products. This has been a beneficial relationship for both parties in many cases. Uninterrupted production helps both businesses.

Large loans for equipment can be a slippery slope. These loans may be a good solution for younger businesses lacking the credit history needed to build the production capacity they would like. This arrangement may also be a good strategy to ensure market access in times when limited supply quotas are available. Suppliers that owe the facility money are usually the last ones cut off when inventories are high.

Equipment loans from customers come with the expectation of repayment over time through delivered wood products. Sometimes the terms of the loan specify that the facility has right of first refusal on all production from such machines. Biomass products are generally commodities and the suppliers are price takers. The only leverage the supplier has in determining price is by withholding supply. When the buyer is also the banker, this option is essentially ruled out.

If a mature firm with good credit has a business plan for expansion that doesn't meet the financial criteria for a traditional loan, this should be a red flag about the viability of this business idea. Prices have to be sufficient for an idea to lead to profits. If the lack of available financing is an obstacle to the logging capacity needed to feed a particular mill, prices and reliable demand levels are probably the culprits. While logging is widely regarded as a lifestyle choice, no one goes into this business simply hoping to break even.

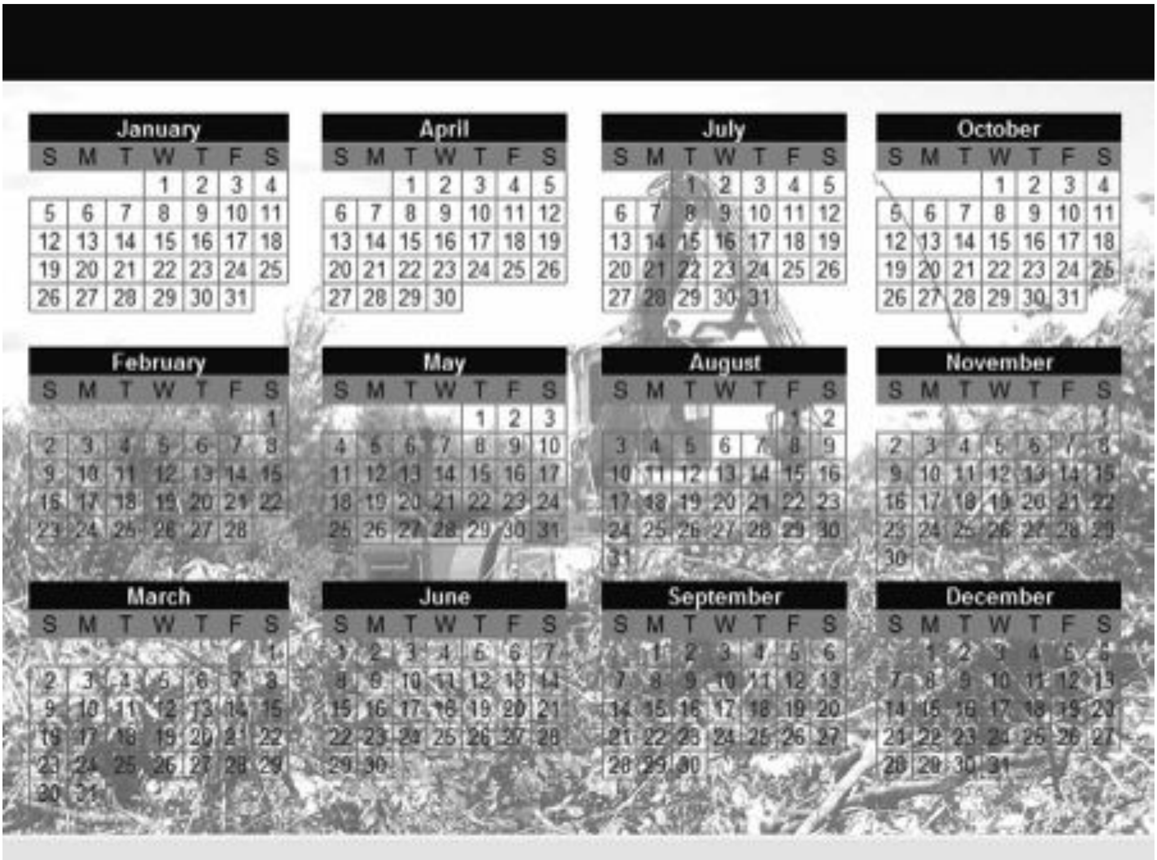
Financial Calculations

Important Financial Calculations

In most cases when a logger becomes involved with biomass production it represents an extension or shift within their existing business. The business has already had some level of success if the owners are sticking with it and looking to invest in new production. When biomass is seen as supplementing existing production, consider analyzing the financial end of it as if it were a project. The equipment has a useful life, so this is the natural project time frame. Fixing the project in time allows a close look at payback period and returns. Then compare the findings with the next best alternative for this capital and effort (which may well be doing nothing different than what has been done up to that point).

There are several important financial calculations that can inform decision-making about whether or not to pursue biomass harvesting opportunities. These include the payback period, rate of return, net present value, and internal rate of return. These measures can help determine if an opportunity is worthwhile.

Beyond a logger convincing himself of the worthiness of a business opportunity, he will most likely also need to convince a lender. There are a number of important financial ratios that inform a lender about the potential of a project and the logger's ability to pull it off. Among these are the blended capital debt term, profitability ratios, financing & leverage ratios, liquidity ratios, and capital cost & acquisitions ratios. Most can be calculated from information contained in a federal income tax return.



Payback Period = Cost of the expansion ÷ Annual Cash Inflow resulting from expansion

The annual cash inflow is a net number, calculated after accounting for the on-going costs of operation (e.g. fuel, additional labor, etc.). For example, a $250,000 investment that resulted in annual cash inflows of $100,000 would have a payback period of 2.5 years ($250,000 ÷ $100,000).

Accounting Rate of Return = (Annual Cash Inflows – Depreciation) ÷ Initial Investment

This is a measure of the return on an investment, taking capital recovery through depreciation into account. If the $250,000 investment mentioned above that resulted in $100,000 annual cash inflows also had $50,000 in annual depreciation, the accounting rate of return would be 20% (($100,000 - $50,000) ÷ $250,000).

Payback Production Table – $100,000 Loan

Interest Rate	Total of Payments	Tons @ $40/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $35/ton	# of 40 ton loads	# of 30 ton loads
3.0%	$ 107,812	2,695	67	90	3,080	77	103
3.5%	$ 109,150	2,729	68	91	3,119	78	104
4.0%	$ 110,499	2,762	69	92	3,157	79	105
4.5%	$ 111,858	2,796	70	93	3,196	80	107
5.0%	$ 113,227	2,831	71	94	3,235	81	108
5.5%	$ 114,607	2,865	72	96	3,274	82	109
6.0%	$ 115,996	2,900	72	97	3,314	83	110
6.5%	$ 117,397	2,935	73	98	3,354	84	112
7.0%	$ 118,807	2,970	74	99	3,394	85	113

Interest Rate	Total of Payments	Tons @ $30/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $25/ton	# of 40 ton loads	# of 30 ton loads
3.0%	$ 107,812	3,594	90	120	4,312	108	144
3.5%	$ 109,150	3,638	91	121	4,366	109	146
4.0%	$ 110,499	3,683	92	123	4,420	110	147
4.5%	$ 111,858	3,729	93	124	4,474	112	149
5.0%	$ 113,227	3,774	94	126	4,529	113	151
5.5%	$ 114,607	3,820	96	127	4,584	115	153
6.0%	$ 115,996	3,867	97	129	4,640	116	155
6.5%	$ 117,397	3,913	98	130	4,696	117	157
7.0%	$ 118,807	3,960	99	132	4,752	119	158

Interest Rate	Total of Payments	Tons @ $20/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $15/ton	# of 40 ton loads	# of 30 ton loads
3.0%	$ 107,812	5,391	135	180	7,187	180	240
3.5%	$ 109,150	5,458	136	182	7,277	182	243
4.0%	$ 110,499	5,525	138	184	7,367	184	246
4.5%	$ 111,858	5,593	140	186	7,457	186	249
5.0%	$ 113,227	5,661	142	189	7,548	189	252
5.5%	$ 114,607	5,730	143	191	7,640	191	255
6.0%	$ 115,996	5,800	145	193	7,733	193	258
6.5%	$ 117,397	5,870	147	196	7,826	196	261
7.0%	$ 118,807	5,940	149	198	7,920	198	264

This table shows the total of payments necessary for a five year loan of $100,000. It also shows the total biomass production levels necessary to produce this revenue. For example, if wood chips are selling for $30 per ton and the loan is at 5% interest, it requires 94 loads (40 tons each) of chips to produce the necessary cash inflow to make the payments. If the loan were for $500,000, the necessary production is 470 loads (94 x 5).

Note that this table only shows production levels equal to payments. Payments represent a large portion of the fixed costs of owning equipment (principal and interest), but do not reflect the production necessary to cover other operating costs. This table is meant only to serve as starting point guideline for judging the feasibility of a given market.

Payback Annual Production Table – $100,000 Loan

Interest Rate	Annual Payments	Tons @ $40/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $35/ton	# of 40 ton loads	# of 30 ton loads
3.0%	$ 21,562	539	13	18	616	15	21
3.5%	$ 21,830	546	14	18	624	16	21
4.0%	$ 22,100	552	14	18	631	16	21
4.5%	$ 22,372	559	14	19	639	16	21
5.0%	$ 22,645	566	14	19	647	16	22
5.5%	$ 22,921	573	14	19	655	16	22
6.0%	$ 23,199	580	14	19	663	17	22
6.5%	$ 23,479	587	15	20	671	17	22
7.0%	$ 23,761	594	15	20	679	17	23

Interest Rate	Annual Payments	Tons @ $30/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $25/ton	# of 40 ton loads	# of 30 ton loads
3.0%	$ 21,562	539	13	18	862	22	29
3.5%	$ 21,830	546	14	18	873	22	29
4.0%	$ 22,100	552	14	18	884	22	29
4.5%	$ 22,372	559	14	19	895	22	30
5.0%	$ 22,645	566	14	19	906	23	30
5.5%	$ 22,921	573	14	19	917	23	31
6.0%	$ 23,199	580	14	19	928	23	31
6.5%	$ 23,479	587	15	20	939	23	31
7.0%	$ 23,761	594	15	20	950	24	32

Interest Rate	Annual Payments	Tons @ $20/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $15/ton	# of 40 ton loads	# of 30 ton loads
3.0%	$ 21,562	539	13	18	862	22	29
3.5%	$ 21,830	546	14	18	873	22	29
4.0%	$ 22,100	552	14	18	884	22	29
4.5%	$ 22,372	559	14	19	895	22	30
5.0%	$ 22,645	566	14	19	906	23	30
5.5%	$ 22,921	573	14	19	917	23	31
6.0%	$ 23,199	580	14	19	928	23	31
6.5%	$ 23,479	587	15	20	939	23	31
7.0%	$ 23,761	594	15	20	950	24	32

This table shows the annual payments necessary for a five year loan of $100,000. It also shows the annual biomass production levels necessary to produce this revenue. For example, if wood chips are selling for $25 per ton and the loan is at 6% interest, it requires 23 loads (40 tons each) of chips to produce the necessary cash inflow to make the payments. If the loan were for $400,000, the necessary annual production is 92 loads (23 x 4).

Payback Weekly Production Table – $100,000 Loan

Interest Rate	Total of Payments	Tons @ $40/ton	# of 40 ton loads/week	# of 30 ton loads/week	Tons @ $35/ton	# of 40 ton loads/week	# of 30 ton loads/week
3.0%	$ 21,562	539	0.34	0.45	616	0.39	0.51
3.5%	$ 21,830	546	0.34	0.45	624	0.39	0.52
4.0%	$ 22,100	552	0.35	0.46	631	0.39	0.53
4.5%	$ 22,372	559	0.35	0.47	639	0.40	0.53
5.0%	$ 22,645	566	0.35	0.47	647	0.40	0.54
5.5%	$ 22,921	573	0.36	0.48	655	0.41	0.55
6.0%	$ 23,199	580	0.36	0.48	663	0.41	0.55
6.5%	$ 23,479	587	0.37	0.49	671	0.42	0.56
7.0%	$ 23,761	594	0.37	0.50	679	0.42	0.57

Interest Rate	Total of Payments	Tons @ $30/ton	# of 40 ton loads/week	# of 30 ton loads/week	Tons @ $25/ton	# of 40 ton loads/week	# of 30 ton loads/week
3.0%	$ 21,562	539	0.34	0.45	862	0.54	0.72
3.5%	$ 21,830	546	0.34	0.45	873	0.55	0.73
4.0%	$ 22,100	552	0.35	0.46	884	0.55	0.74
4.5%	$ 22,372	559	0.35	0.47	895	0.56	0.75
5.0%	$ 22,645	566	0.35	0.47	906	0.57	0.75
5.5%	$ 22,921	573	0.36	0.48	917	0.57	0.76
6.0%	$ 23,199	580	0.36	0.48	928	0.58	0.77
6.5%	$ 23,479	587	0.37	0.49	939	0.59	0.78
7.0%	$ 23,761	594	0.37	0.50	950	0.59	0.79

Interest Rate	Total of Payments	Tons @ $20/ton	# of 40 ton loads/week	# of 30 ton loads/week	Tons @ $15/ton	# of 40 ton loads/week	# of 30 ton loads/week
3.0%	$ 21,562	539	0.34	0.45	862	0.54	0.72
3.5%	$ 21,830	546	0.34	0.45	873	0.55	0.73
4.0%	$ 22,100	552	0.35	0.46	884	0.55	0.74
4.5%	$ 22,372	559	0.35	0.47	895	0.56	0.75
5.0%	$ 22,645	566	0.35	0.47	906	0.57	0.75
5.5%	$ 22,921	573	0.36	0.48	917	0.57	0.76
6.0%	$ 23,199	580	0.36	0.48	928	0.58	0.77
6.5%	$ 23,479	587	0.37	0.49	939	0.59	0.78
7.0%	$ 23,761	594	0.37	0.50	950	0.59	0.79

This table shows the annual payments necessary for a five year loan of $100,000. It also shows the weekly (assuming 40 weeks of production/year) biomass production levels necessary to produce this revenue. For example, if wood chips are selling for $20 per ton and the loan is at 4% interest, it requires 0.35 loads (40 tons each) of chips per week to produce the necessary cash inflow to make the payments. If the loan were for $600,000, the necessary production is 2.1 loads per week (0.35 x 6).

Net Present Value

This formula determines the present value of the investment by adding the discounted annual cash flows that result. Specify the amount of the initial investment (Co), the discount rate (r) and the number of years (T). This calculation can be tedious and complicated when done by hand and is well-suited to a spreadsheet. A net present value that is higher than the initial investment demonstrates that a project is worthwhile. Investments are not made in the hope of breaking even or losing money.

Calculations should be made for a variety of assumptions, representing a reasonable range of production and prices. The discount rate used should be the rate for the next best alternative use of funds. In most cases, secure alternative rates of return for average investors are very low.

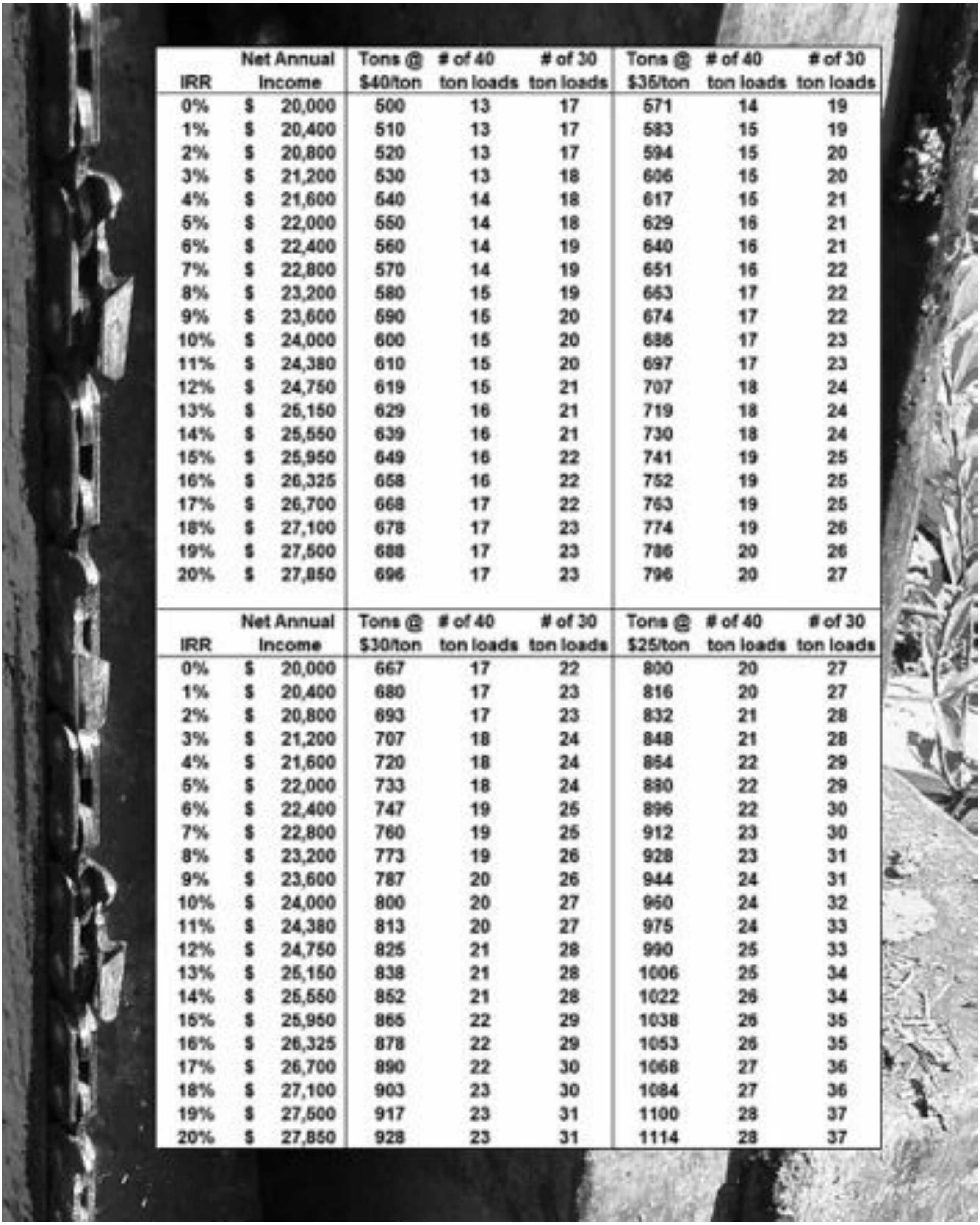
Internal Rate of Return

Internal rate of return (IRR) is a complicated series of calculations requiring several iterations to reach an answer. Fortunately, these calculations are readily done in a spreadsheet. The IRR for a project is the interest rate that makes the net present value of a project equal to zero.

As the word "return" in its name implies, an IRR view of the cash flow stream is essentially an investment view: money will be paid out and compared to returns. Instead of a simple ratio between inflows and outflows (as with Return on Investment), the IRR compares returns to costs by asking: "What is the discount rate that would give the cash flow stream a net present value of 0?" The interest rate that answers that question is the IRR for the cash flow stream.

The higher the IRR the better – the implication is that the logger would have to have an alternative use for capital that yielded this interest rate before it would be a superior use of these funds than the project under consideration.

IRR Profit & Production Requirements per $100,000 of Investment



IRR	Net Annual Income	Tons @ $40/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $35/ton	# of 40 ton loads	# of 30 ton loads
0%	$ 20,000	500	13	17	571	14	19
1%	$ 20,400	510	13	17	583	15	19
2%	$ 20,800	520	13	17	594	15	20
3%	$ 21,200	530	13	18	606	15	20
4%	$ 21,600	540	14	18	617	15	21
5%	$ 22,000	550	14	18	629	16	21
6%	$ 22,400	560	14	19	640	16	21
7%	$ 22,800	570	14	19	651	16	22
8%	$ 23,200	580	15	19	663	17	22
9%	$ 23,600	590	15	20	674	17	22
10%	$ 24,000	600	15	20	686	17	23
11%	$ 24,380	610	15	20	697	17	23
12%	$ 24,750	619	15	21	707	18	24
13%	$ 25,150	629	16	21	719	18	24
14%	$ 25,550	639	16	21	730	18	24
15%	$ 25,950	649	16	22	741	19	25
16%	$ 26,325	658	16	22	752	19	25
17%	$ 26,700	668	17	22	763	19	25
18%	$ 27,100	678	17	23	774	19	26
19%	$ 27,500	688	17	23	786	20	26
20%	$ 27,850	696	17	23	796	20	27

IRR	Net Annual Income	Tons @ $30/ton	# of 40 ton loads	# of 30 ton loads	Tons @ $25/ton	# of 40 ton loads	# of 30 ton loads
0%	$ 20,000	667	17	22	800	20	27
1%	$ 20,400	680	17	23	816	20	27
2%	$ 20,800	693	17	23	832	21	28
3%	$ 21,200	707	18	24	848	21	28
4%	$ 21,600	720	18	24	864	22	29
5%	$ 22,000	733	18	24	880	22	29
6%	$ 22,400	747	19	25	896	22	30
7%	$ 22,800	760	19	25	912	23	30
8%	$ 23,200	773	19	26	928	23	31
9%	$ 23,600	787	20	26	944	24	31
10%	$ 24,000	800	20	27	960	24	32
11%	$ 24,380	813	20	27	975	24	33
12%	$ 24,750	825	21	28	990	25	33
13%	$ 25,150	838	21	28	1006	25	34
14%	$ 25,550	852	21	28	1022	26	34
15%	$ 25,950	865	22	29	1038	26	35
16%	$ 26,325	878	22	29	1053	26	35
17%	$ 26,700	890	22	30	1068	27	36
18%	$ 27,100	903	23	30	1084	27	36
19%	$ 27,500	917	23	31	1100	28	37
20%	$ 27,850	928	23	31	1114	28	37

This table shows annual profit requirements for various Internal Rates of Return for a $100,000 investment over a five year term. It also shows the annual production levels beyond the break-even point necessary to achieve these profit levels for several prices. Suppose a logger is investing $300,000 in new equipment in order to produce biomass products that will sell for $30 per ton. He hopes to realize an IRR of 6%. The net annual income necessary is $22,400 per $100,000 in investment, $67,200 in total. The number of tons beyond the break-even point in production is 2,241 (3 x 747). The annual number of 40 ton loads to reach this level is 57 beyond the break-even point (19 x 3).

This table is meant only to serve as starting point guideline for judging the feasibility of investing to supply markets at the given price points. The target IRR should be equal to or greater than the rate next best use of the logger's time and effort.

Blended Capital Debt Term = Total Term Debt ÷ Current Portion of Term Debt
This measure determines how long it would take to get out of debt, based on the current rate of payment. The current portion of debt term is the amount of debt principal that must be paid in the coming year. As a general range, no more than 3.5 to 5 years is desirable. For example, if $50,000 is required in the current year on a loan totaling $200,000, the blended capital debt term is four years ($200,000 ÷ $50,000).

Profitability Ratios

Gross Margin on Sales = Gross Profit ÷Net Sales

Return on Sales (%) = Net Operating Income ÷ Net Sales

> Net operating income excludes non-operating income and all interest expenses (to remove differences between different types of firms)

Return on Assets (%) = Net Operating Income ÷ Total Assets

Return on Equity (%) = Equity ÷ Total Assets

Financing and Leverage Ratios

Equity Ratio = Equity ÷ Total Assets

How much of the business does the logger own and how much is owned by creditors? Lenders prefer that the borrower have over 60%. This is also sometimes called Net Worth to Assets ratio (NWA).

Fixed Assets/Equity = (Total Assets – Current Assets) ÷ Equity

The lower the ratio the better, as this indicates the owner has the cash flow available for normal operations.

Current Liabilities/Equity = Current Liabilities ÷ Equity

This is a measure of short term debt to equity. A ratio above 0.8 is not considered healthy.

Debt Equity = (Long-term Debt + Current Liabilities) ÷ Equity

Times-Interest-Earned = (Net Operating Income + Interest Expense) ÷ Interest Expense

This ratio determines what portion of income must be devoted to meeting interest expenses. The larger this ratio, the better able the logger is to meet the interest expenses.

Liquidity Ratios
Current Ratio = Current Assets ÷ Current Liabilities

This ratio demonstrates how much working capital is available to meet debts that are due within the year ahead.

Quick Ratio = (Current Assets – Inventory) ÷ Current Liabilities

In many cases loggers do not carry an inventory as a part of their business, which means this ratio will be identical to the current ratio that preceded it here.

Debt Service Coverage Ratio = Net Annual Operating Income ÷ Total Annual Debt Service

This ratio determines if the business has sufficient current income to cover most or all of the proposed debt. A ratio of one (1) or higher indicates positive cash flow.

Capital Cost and Acquisition Ratios

Cost of Capital = Interest Expense ÷ (Long-Term Debt + Short Term Debt)

This is a measure of the average cost of all indebtedness.

Asset Additions = Asset Additions ÷ (Total Assets – Current Assets)

This measure shows what percentage of value a new fixed asset adds to current fixed assets.

Asset Additions/Depreciation = Asset Additions ÷ Depreciation

A measure how new assets are replacing those that have been depreciated.

Asset Additions/Net Sales = Asset Additions ÷ Net Sales

This ratio shows the value of new investments in assets in relation to net sales.

Business Plans

Introduction

Business planning means looking ahead in a formal and structured way. Most loggers have an informal plan for their business. Unwritten and informal plans abound – loggers know what they are doing and what they intend to do, and so they often don't think that there is much reason to record it for others. Varying levels of analysis probably went into each of their major strategy implementations or equipment purchases. A good bit of this analysis often involves back of the envelope calculations, promises from landowners, encouragement from mills and flat out trial-and-error.

Suppose a lender tells a logger that before a loan can be approved, a business plan with be required. Never having developed a formal business plan before, how does this logger go about getting it done? Do-it-yourself templates and software are available, or the logger can hire a consultant to do it. Either way, the logger is intimately involved in the process. A template or a computer program requires the logger to fill in the blanks and provide explanations – just as a consultant would be asking the right questions. Loggers know their business and intentions best. The rest is a matter of answering the right questions and doing a complete and useful analysis. The financial analysis is a very good place to start, as this should determine if it is really worth pursuing the idea any further .

View this formal written business plan requirement as an opportunity rather than a burden. The days are gone when someone can write a business plan in order to get a check mark in an application box and then file it away forever. A lender that forces objective quantification of some of the hard realities about a business will help the logger make better decisions. Revisiting a business plan to see how real-world results have matched up with written expectation takes a further level of discipline.

One logger had this observation about loggers and business planning:

"They don't have the time to do it. They're so busy just making it happen."

True enough. It's probably not a bad thing that outside forces impose some disciplined planning on loggers as a condition of financing equipment.

As a general rule, a formal business plan will contain a description of the business, a description of the products and services offered, a marketing plan, source of raw materials, management explanation, and a financial plan. An executive summary, written last, will serve as a preface for the entire document.

Description of Existing Business

Lenders understand small businesses, but it would be a mistake to assume they know the specifics of any individual business. The *Description of Existing Business* section of the business plan should include the business name, the company's legal structure (LLC, Corporation, etc.) and a listing of the business owners. An existing business should detail the number of years in business and provide details about past growth and any related accomplishments. This section tells the story of the company, its origin and got to the present day. It explains the things a logger does and provides details of daily and yearly routines.

The company's legal structure is an important part of protecting a business and those who own it. Many logging companies start out as sole proprietorships. From a management standpoint, they often stay this way. From the standpoint of protecting assets, it is very important to build some distance between the business and its related liability and the individual owner and their family. Adopting the legal structure of a Limited Liability Company (LLC) or Corporation can be a good means of accomplishing this.

Description of Products and Services
Logging companies often offer both products and services. Both should be described in detail in the *Description of Products and Services* section. A logger who is expanding to include biomass products should explain the advantages of this, both in offering services to landowners and filling market needs for products. Pricing for biomass products should be addressed in this section as well.

What's the source for the material that will go through the proposed chipper? Perhaps this material is simply the tops of trees that are already being handled by the logger. In other cases, production from roundwood may be shifted to a somewhat more finished product (e.g. pellet grade chips or specialized heating chips). Perhaps the acquisition of the chipper opens an opportunity for the logger to work on lands with a higher concentration of low grade timber.

In most cases, loggers are the seller and are paid directly for the biomass products they produce. Sometimes the landowner will be the seller and the logger will assume the role of service provider, being paid to produce and deliver wood chips. In either case, loggers are typically price takers – there is very little opportunity for a logger to set the price of the chips produced (except in specialized heating markets such as school boilers). Presenting a historical range of the prices that have been paid is a good idea. Later financial analysis should not be built around best case price scenarios.

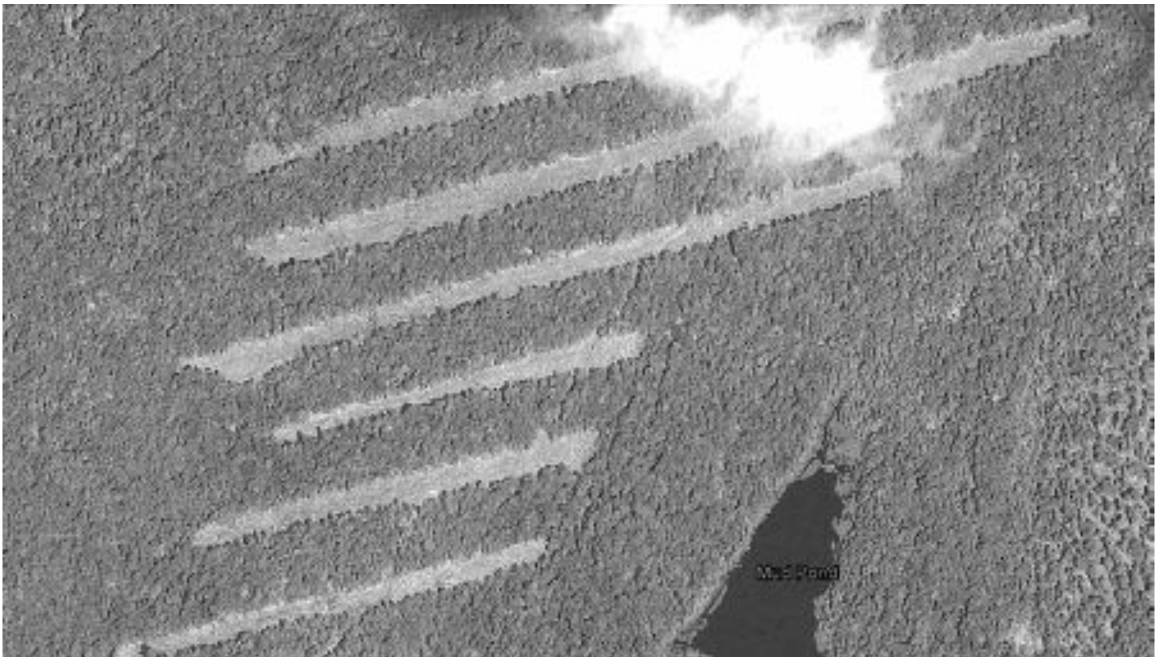
Marketing Plan

The Marketing Plan is the section where industry conditions are described the logging business's place in the forest products supply chain is explained. Within this framework, this section contains an explanation of the benefits expanded production will offer to the market – both to landowners and to biomass consuming facilities. With a modest number of markets for biomass products, the logger must demonstrate how the business can acquire the necessary timber and cost-effectively produce and transport wood chips.

There are a number of ways in which loggers market themselves, but nothing is better than having established a good track record. A company's reputation for maintaining reliable levels of production and producing quality products are items of great importance to mills and other wood consuming facilities.

In marketing a logging business to landowners who will either sell stumpage or hire to them produce, there is a range of ways distinguish the company from competitors. Adherence to best management practices for water quality is one, as is attention to aesthetics and prompt attention to landowner concerns. Successful completion of all relevant logger training programs is another positive indicator to landowners.

As in any small business, prompt responses to existing and potential customers are an important part of marketing. The logging community has been quick to adopt mobile phones, making them more available than they have ever been in the past. Some have embraced email and texting, recognizing that these things are important to some of their customers.



Sources of Raw Materials

The purpose of this section is to demonstrate that sufficient raw materials exist to justify the production capacity proposed in the business plan. Often a logger's suppliers will be his customers – those who are paying him to produce and deliver wood products. In most parts of the eastern US, the timber supply itself is not in question. The amount that might be available to an individual firm, however, it is far less certain.

Carefully explain the type of timber being harvested and how it is acquired. It may be contract work for timber that has been procured by a sawmill, it could be production work for a TIMO or other large landowner, or perhaps it is timber that has been purchased directly from individual landowners. Often loggers get their supply from a combination of these sources. It is important for a lender to understand that the logger has realistic expectations of sufficient timber to meet production goals.

Subcontractors

If the operation relies on other businesses to complete some of the work necessary for production of wood products (or in support of this work) this is the place to explain the nature of this relationship. Some logging operations have a strong reliance on subcontractors while others have none. Nearly any aspect of timber harvesting and delivery could be (and has been) handled through subcontractors.

Subcontracting of some or all of a firm's trucking is common. Often a logging company will own the number of trucks that it can keep fully busy and will supplement this number as necessary with subcontractors.

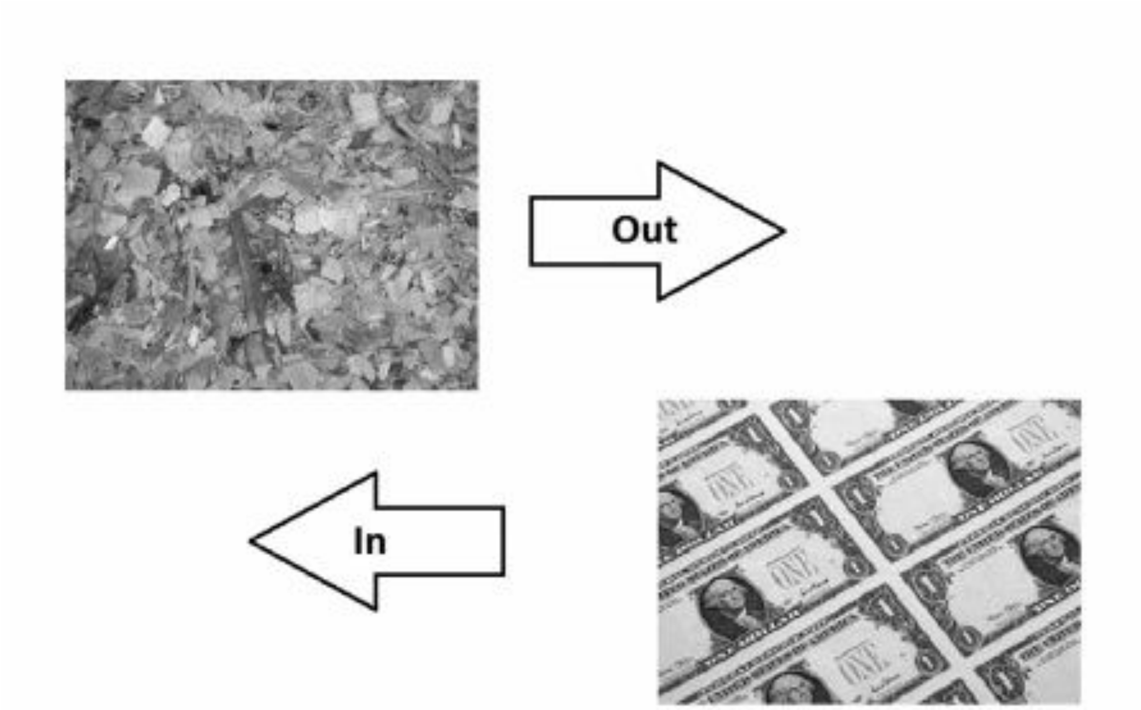
No one wants to bear the expense of extra equipment that might sit idle for much of the time. A company that makes few moves in a year might use an outside trucking company and low-boy trailer to move equipment. Others will subcontract for road building and cleanup work that is done with excavation equipment. There are many valid reasons for relying on subcontractors. Be sure to explain them here.

Management

The *Management* section in a business plan describes the responsibilities of key personnel. Each person is named and their duties are described. Management relationships and responsibilities often evolve in a business until a comfortable and productive level of existence is reached. Many loggers have never thought about creating an organizational chart or producing written job descriptions. Chances are if a company is running smoothly everyone has well-defined responsibilities and they understand what is expected of them.

Any specialized training certificates or degrees that the owner or any of the team have obtained should be included here. College degrees, technical training certificates, and even a listing of specialized workshops attended should all be mentioned here, along with logger training programs. Completion of training programs is a way to demonstrate that the workforce possesses a range of needed skills and also shows that the logger is serious enough about his profession to have made the effort to look beyond just work experience for additional skills and knowledge.

All of the company's important responsibilities should be accounted for in the management section of the business plan – and indeed, in the actual running of the company. Responsible people often find that their duties have become second nature, so listing them doesn't always come naturally. It's important to take a step back from the day-to-day realities and make sure all of the necessary work has been fully assigned across the personnel within the business plan.



Financial Plan

The Financial Plan addresses questions about how capital will be raised and allocated in the startup or expansion of the business. Clearly state the total cost involved in the expansions and how much of this is in hand as well as how much must be financed. List the equipment or other needs for this capital. Show the financial statements of profit and loss from previous years and then make financial projections about the future of the business. Important financial projections include the payback period, rate of return, net present value, internal rate of return , blended capital debt term and debt service coverage ratio. All of these ratios were addressed earlier in this book.

Lenders use several significant financial ratios to judge the logger's credit worthiness and business plan. The ratios are calculated from information found in a tax return or other business records. These ratios measure profitability, financing and leverage, liquidity and capital costs in ways that can be compared to acceptable industry averages.

Supporting documents such as year-end financial statements and income tax returns (primarily Form 1040 Schedule C) should accompany the plan. Documents from the previous three to five years may be required.

Executive Summary
The business plan begins with an *Executive Summary.* While the executive summary appears first in the plan, it is best to write it last because the information needed to write it won't be available until the rest of the plan is completed. The executive summary binds the entire document together.

The business plan will probably be circulated among a number of people from the lending team. The executive summary should be thorough enough to satisfy those who won't review the entire document, while also enticing them to read further. It's best to think of this section as having the job of representing each of the following sections with just a few sentences. Following a reading of the executive summary, the reader should know who the applicant is, what the businesses intentions are, how much this will cost, and the expectations for a return on this investment.

Veteran logger: *"We look at our business model that we threw together and it doesn't look at all like our reality model that we look at today."*

Stumped?

Recall that this chapter started by addressing how to get a business plan done. Whether using a business plan template or a consultant, the logger will always prove to be the source of most of the information contained in the plan. The owner knows the business, knows its place in the market, and is the one who's mapping the company's intended direction. A solid financial analysis can reveal if the idea is feasible. It's almost guaranteed that things will not go exactly as planned, just as the logger quoted above observed.

There is no standard price for a business plan. Shopping around will probably produce a range of prices. Getting solid, useful information and meeting the lender's requirements is more important than saving a few dollars. Most lenders can suggest a consultant who understands the logging business and this might help avoid the need to re-invent the wheel.

Larger projects such as financing a pellet mill or district wood heating system will require a great deal more analysis. There are a number of firms that specialize in this work. The US Forest Service's Wood Education & Resource Center is a good place to look for preliminary advice on a project of this nature.

Example Business Plan

This chapter contains an example business plan for an existing logging company that plans to add the equipment necessary to expand into whole tree chipping.

Plentywood, LLC Biomass Expansion Business Plan

Executive Summary

Plentywood, LLC is a successful logging company owned by logger Chip Perman. Working as a mechanized operation, Plentywood produces and delivers sawlogs and pulpwood for a variety of landowner clients, including Global Financial Fund and North Star Hardwoods. The company currently has no debt. The next phase in the growth of the company is expansion of the product line to provide whole tree chips from wood that the company is already harvesting. Plentywood will sell these chips to Bright Spark Electric and other facilities.

Plentywood is one of a shrinking number of logging companies in the region. We provide harvesting services to sawmills and large landowners and occasionally buy timber from private landowners. The opening of the Bright Spark facility in Cold River in 2002 provided another market for low-grade timber and especially for tree tops that had not been used in the past. This facility will be the primary customer for Plentywood's expanded production. While other logging companies represent competition for sales quota, we do not anticipate increased competition for timber as we will be using wood we already handle, but have been unable to sell without adding new processing equipment. We anticipate production of 30 tons of wood chips per day, totaling 5,000 to 6,000 tons annually.

This expansion will require an investment of $401,000 to purchase four pieces of equipment. Plentywood has $76,000 in cash towards this investment. A loan of $325,000 will be necessary to accomplish the expansion. Annual revenues of $140,000 to $168,000 are expected and should be sufficient to repay the loan and turn a profit.

Description of Business

Plentywood, LLC is a logging business that was started in 1995 and has undergone continuous growth and operation since that time. Chip Perman owns the company. Prior to starting this company, Mr. Perman worked as a logger for Ragged Mountain Timber Harvesting for five years.

Plentywood is currently a mechanized harvesting operation, producing sawlogs, pulpwood and firewood. The company began operation with a cable skidder and a chainsaw, with the owner subcontracting to larger operations. In the second year of operation a loader, log truck and trailer were added to the equipment profile along with an employee. Several years of buying private stumpage and contract logging for North Star Hardwoods followed.

From 2002 to 2007 the company grew to its current size when a tracked feller-buncher, slasher, grapple skidder, bulldozer, second truck and two new employees were added, along with a pole-barn garage and equipment yard. Over half of the company's current production is now contract logging on the Global Financial Fund's properties.

Plentywood is ready for the next phase in its growth. The addition of a used whole tree drum chipper, two chip vans and a new grapple skidder will allow the company to increase production. The current mechanized operation is handling whole trees and then returning tops to the woods. The chipper will allow for greater utilization of material that is already being handled.

Description of Products and Services

Plentywood produces sawlogs for sawmills, pulpwood for a pulp & paper mill and firewood logs for families. The business will expand to produce whole and partial tree chips as hog fuel for an electric utility and occasional bole chips for heating a college campus.

In some cases, Plentywood purchases stumpage from landowners and then sells the products we produce into various markets. In other case, the company is paid by the landowner to produce and deliver wood products.

Productive loggers who have achieved logger training certification are in demand. The abundance of low quality timber in the resource base will make our updated equipment mix attractive to landowners who are making long-term improvements to their forest resources.

Production of these wood products involves providing a service for landowners and occasionally for mills. The updated equipment mix will be well-suited to harvesting low grade timber for Global Financial. Our company needs a continuous supply of timber and the Global Financial holdings are well-stocked with this material.

In general, prices for our products and services are set by others. Rates we are paid for delivered products are industry average prices. Delivered prices for pulpwood and chips are set by the mill. These are raised and lowered based on supply. Sawlog prices for wood we produce from private stumpage are more competitive and we have the ability to shop around for the best price. We also set the price for firewood logs and have some ability to command a bit more than the industry average by controlling quality and delivery.

Marketing Plan

Plentywood has largely relied on our reputation for marketing up to this point. The steps involved in building a good reputation include productive work, careful site clean up, attendance at logger training classes and annual participation in the Log-a-Load for Kids program.

Expansion of the business involves securing two supply contracts. Our reputations has garnered us tentative approval of these contracts, pending acquisition of the new equipment. The first contract is to supply whole tree chips to the Bright Spark Electric company's 20 MW plant in Cold River. We hope to supply one load per day during our operating season (averaging 200 days per year). The historic average delivered price for these chips over the last ten years has been $28 per ton.

The second contract is to supply heating chips to Steuben College on an occasional basis, as a subcontractor to Roberts Logging. We anticipate supplying 20-30 loads per year, for $40 per ton.

As opportunities arise, we hope to shift as much of our wood chip production from the utility to the higher-paying heating markets as possible.

Industry Description

Plentywood operates as part of the larger forest product industry. Within our region, the forest resource supports a supply chain extending to consumers that embraces everything from furniture manufacturing to paper production to heat. There is less secondary processing here than there was in the past, but similar harvesting levels. Timber harvesting has become less labor intensive and more capital intensive. The current pattern of land ownership in the region has most of the acreage controlled by institutional investors with the remainder belonging to families, clubs, and associations.

Within the timber harvesting segment of this industry, the emphasis has been on efficiency. Operating cost increases have been disproportionately higher than increases in production rates or wood products prices. Inefficient operators are unable to remain in business.

There are significant barriers to entry for new comers in this business. High equipment costs mean newcomers must start small to build up their credit and capital. Businesses enter this industry in the same way we did – gaining experience through employment, starting small and then growing in response to market opportunities. Most growth comes in the form of added equipment and the employees needed to operate it. Added equipment might mean more of the same kind of production or an expanded operation accessing a wider range of terrain or forest types. Similarly, increased production can mean more of the same products or additional product lines, such as wood chips.

Plentywood is a mature business from the standpoint of conventional production. We have the equipment and personnel to operate the various types of woodlands in the region. Our current size is a strategic response to the production work available to us. As price takers, we have few options to expanding the business. The addition of whole tree chipping would allow us to realize an additional revenue stream from timber we are already handling.

Customers

Plentywood has two types of customers – landowners and sawmills we provide with timber harvesting services and mills we supply with wood products.

Institutional investors hire us to harvest trees, produce intermediate wood products and deliver them to mills and concentration yards. Sawmills hire us to harvest standing timber and deliver sawlogs from timber they have purchased. As a service provider, we are expected to be productive, observe best management practices for water quality, protect residual forest stands and maintain our training certification. With our payment based on production at a set rate, we have ample incentive to produce as much as we can as efficiently as we can. The timberland investment management organizations prefer loggers who are steady producers and who don't have extended breakdown periods.

When Plentywood purchases stumpage privately, our customers are the mills that we purchase our wood products. Careful attention to detail and aesthetics are important when purchasing private stumpage. Word of mouth and on-going relationships with small landowners help us in purchasing timber. This work is more difficult to obtain than contract logging and it is more lucrative. Carefully merchandising of products is necessary to get the best return. Carefully bucking sawlogs and sorting out export quality material is necessary.

Roughly 65% of our work is contract logging for Global Financial Timberlands, with an additional 10% for Wellborn Forest Fund. Contract logging for sawmills accounts for 15% of our work (10% with North Star Lumber and 5% with occasional jobs for Nelson Lake Lumber). Our most lucrative work is purchasing stumpage from private landowners, though this accounts for just 10% of our production.

In contracting logging for investment firms, both sawlogs and pulpwood are included in the contract terms. We are able to purchase some firewood logs as stumpage. We have a commitment from GFT to sell us stumpage on tree tops for chips at $3 per ton. In contracting logging for sawmills, we purchase the stumpage for the pulpwood and firewood and similar arrangements are available for chip wood.

Tree chipping would allow us another revenue source in our everyday contract work and provide us with a competitive advantage in purchasing private stumpage. We would be able to provide additional revenue to the landowners and a cleaner appearance in the forest. Not all of our competitors can do this.

Competition

Within the region there is sufficient contract logging work for all of the other businesses out there, with room for growth. Competition is greatest for the more-desirable harvesting tracts, for work in the slower seasons (wet portions of spring and fall) and in purchasing private stumpage.

Our company has built a good niche in contract logging for large landowners and has had sufficient work for our current business size and equipment mix. Our proposed expansion would allow us to produce more revenue from the wood we are already handling. This expansion appeals to our large landowner customers, as they will experience additional revenue streams as well. We expect to harvest more desirable tracts as a result.

Competition in selling the wood chips is currently limited to two markets. The 20 MW Bright Sparks power plan has been running at less than full capacity and is expecting to expand. This will require an additional 150 tons of wood chips per day. We propose to supply 30 tons daily for much of the year.

Our second market is as a backup supplier of heating chips to Steuben College. We would be subcontracting to their main supplier (Roberts Logging) for occasional loads to the college. The college uses three loads of wood chips per day in the heating season and has limited storage room. While Roberts Logging is a large producer, they need backup suppliers they can call on to fill in during breakdowns or other contingencies. These wood chips must be of slightly higher quality than those produced for Bright Sparks (more stem wood and less limb wood) and the delivery schedule is restricted to limited hours. The trade off is that these chips sell for 42% more than the others.

Logging firms we compete with range from much larger companies that produce much more than we will to a few smaller firms with older equipment. While we will not be among the larger suppliers of wood chips, we expect to be a reliable supplier. Our reliability will stem from a record of minimal down time for repairs and our reputation for good work in the woods that keeps us supplied with timber.

Advertising and Promotion

Advertising and promotion within the timber harvesting sector of the forest products industry differs from traditional approaches. There are a relatively small number of customers for the services we offer. The timberland investment management organizations and sawmills are already aware of our business. As our production capacity is expanded, we will make them aware that we can now produce wood chips and potentially use a wider variety of timber types and quality. Interaction with these customers typically takes place during site visits, in phone calls or emails and during industry meetings and training sessions.

There is occasional turnover among the larger land ownerships. As new owners and representatives enter the region, we will contact them and invite them to see some of our current and past job sites.

Our best advertising is through word of mouth and the promotion of our business comes primarily from doing good work. Good job performance is measured by productivity, adherence to water quality best management practices, and responsiveness to customer concerns.

Apart from on-site timber harvesting performance, product quality is the other indicator of doing good work. We adhere to purchaser standards for pulpwood and chips, do a careful job of bucking out quality sawlogs, and deliver clean firewood logs to customers.

The other aspect of advertising and promotion is reaching more potential small landowners who will sell us stumpage. We sometimes pay referral fees to landowners we have worked for in the past who find us additional work with friends, neighbors and family members. Past experience has shown that the key to securing private stumpage involves prompt responses to inquiries, a willingness to show other examples of our work and cash advances.

Success in our advertising and promotion will be measured in the amount of work it generates. Most new customers tell us who referred them. We have a small group of industry colleagues who consistently refer customers to us. We are particularly responsive when any of these people need something from us.

Location

Our business is mobile – we move from one production site to the next. Most timber harvesting sites are within 50 miles of our home base. We will occasionally travel up to 100 miles for work, if the site is productive or if we do not have closer work.

Our location can be thought of as the broader region. Our region has abundant timber resources and close proximity to the wood-using markets discussed earlier in this document.

Suppliers

The timber supply is controlled by those who own it. In most cases, we are working directly for these owners – they supply the timber and we harvest it.

Current suppliers include Global Financial Timberlands, Wellborn Forest Fund, North Star Lumber and Nelson Lake Lumber. There are a number of other sawmills who purchase a modest amount of standing timber in the region who are potential suppliers. There are other timberland investment management organizations in the greater region, though they are on the fringe of our operating area.

We are dependent on these suppliers who are our customers. Historically, timberlands in the region have been operated at the current harvesting levels, with some occasional fluctuations.

Management

Chip Perman is the owner and manager of this business, which he founded in 1995. He oversees day-to-day operations and strategic planning.

Bea Perman is the company bookkeeper. She handles payroll, pays bills and tracks production to ensure payments. She serves as clerk of the works.

Bum Perman (Chip's brother) is a key employee who oversees production when Chip is not on site.

In addition to these key people, there are two employees in the woods and one truck driver. The proposed expansion would include adding a half-time mechanic.

Other aspects of the management of this company are handled by outside professionals. Financing and accounting services come through General Credit Corporation. Harvester's Mutual Coporation supplies our insurance. A local attorney is called upon, as necessary.

Financial Plan

The proposed expansion will require an investment of $401,000 for the following pieces of equipment:

1	2002 Morbark 30/36 450 HP Wood Chipper	$115,000
1	2012 Tigercat 610C Grapple Skidder	$250,000
1	Used Spec Tech Live Floor Chip Van Trailer	$30,000
1	Used Wabash Chip Van	$6,000
	Total Investment	$401,000

The prices above include all taxes and delivery charges. Plentywood has $76,000 in cash to be put towards this investment, leaving $325,000 to be financed. This loan will be repaid over five years.

Additional capital beyond what is needed for the equipment purchases is not necessary. This equipment will be put into operation right away. Revenue from the expansion will begin almost immediately after production starts. There will be between two and three months of non-productive time each year, but cash flow from productive periods should be sufficient to take care of the loan obligation during these times.

A 5% interest loan amortized over five years will require monthly payments of $6,604.93, or just over $79,000 per year.

Annual operating expenses for the expansion will be as follows:

Chipper	$20,000
Skidder	$15,000
Additional Labor	$8,000
Total	$31,000

Note that equipment costs include fuel and other variable costs, as well as insurance. The skidder costs are those attributed to wood chip production, as determined by increased hours of use over existing operations. Labor costs are those directly attributed to chip production.

Net annual income from the expansion is as follows:

Wood chip sales (net, less stumpage)	$140,000
Operating expenses	($31,000)
Loan repayment	($79,000)
Net income	$30,000

These projects are based on conservative assumptions and do not include any potential revenue from higher-valued heating chips.

The payback period for this expansion is 2.5 years.

The accounting rate of return for this expansion is 20%, assuming gross revenue and five years of straight-line depreciation with no salvage value. When ten years of deprecation and a salvage value of $50,000 are used, the accounting rate of return is 31%.

The net present value of the project is $99,672. This assumes a discount rate of 4%, an initial cash outlay of $401,000 and then annual revenue in excess of production expenses of $109,000 ($140,000 wood chip revenue - $31,000 operating expenses)

The internal rate of return (IRR) for this expansion is 18.2%. This assumes an initial cash outlay of $401,000 and then annual revenue in excess of production expenses of $109,000 ($140,000 wood chip revenue - $31,000 operating expenses)

The company currently has a blended capital debt term of zero, with no outstanding loans. Borrowing $350,000 for this expansion will create the blended capital debt term of 5 years (the anticipated loan term).

The company currently has no debts. This expansion will create a debt service coverage ratio of 1.08. This is ratio is based on average net operating income of $85,000 (past three years) and proposed annual debt service of $79,000 ($85,000 / $79,000).

Summary of Financial Calculations – Plentywood Biomass Expansion Plan

Payback Period	2.5 years
Accounting Rate of Return	20%
Net Present Value (4% discount rate)	$99,672
Internal Rate of Return (IRR)	18.2%
Blended Capital Debt Term	5 years
Debt Service Coverage Ratio	1.08

Allocation of Funding

Item	Cost	Funding Source
2002 Morbark Chipper	$115,000	Plentywood ($40,000); loan ($70,000)
2012 Grapple Skidder	$250,000	loan
Spec Tec Live Floor Van	$30,000	Plentywood
Wabash Chip Van	$6,000	Plentywood

Supporting Materials

Plentywood LLC Year-End Financial Statements: 2010, 2011, 2012

Chip Perman IRS Form 1040, Schedule C: 2008, 2009, 2010, 2011, 2012

SECTION 4: BIOMASS HARVESTING OPTIONS AND ADVICE

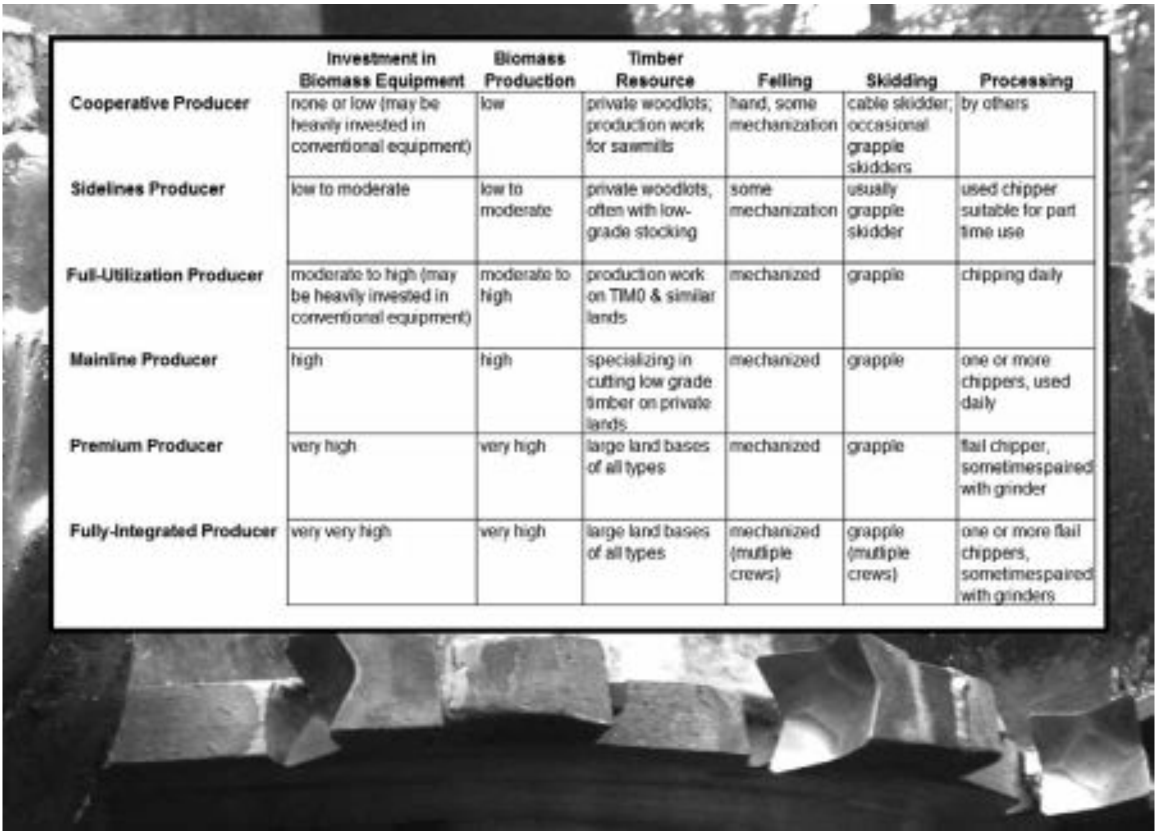
Types and Roles In Woody Biomass Harvesting

Introduction

It is easy to think of loggers as all being alike, but they aren't. Some loggers harvest woody biomass and others do not. Some harvest whole trees with the intention of full or nearly full utilization. Others harvest whole trees but return the tops to the woods. Some loggers have a primary focus on woody biomass while others produce it as a sideline to their main operation.

This chapter looks at the full spectrum of biomass harvesting within the logging community and explains some of the small business and operational behavior that is taking place. The emphasis on woody biomass will naturally vary from one operation to the next – as well as from one harvesting job to the next for these individual businesses.

Woody biomass producers come in a wide range of sizes. This is especially evident in areas with multiple biomass markets. In places where there is only a single option to sell wood chips, some of the producer types shown here will be scarce or absent.



	Investment in Biomass Equipment	Biomass Production	Timber Resource	Felling	Skidding	Processing
Cooperative Producer	none or low (may be heavily invested in conventional equipment)	low	private woodlots; production work for sawmills	hand, some mechanization	cable skidder; occasional grapple skidders	by others
Sidelines Producer	low to moderate	low to moderate	private woodlots, often with low-grade stocking	some mechanization	usually grapple skidder	used chipper suitable for part time use
Full-Utilization Producer	moderate to high (may be heavily invested in conventional equipment)	moderate to high	production work on TIMO & similar lands	mechanized	grapple	chipping daily
Mainline Producer	high	high	specializing in cutting low grade timber on private lands	mechanized	grapple	one or more chippers, used daily
Premium Producer	very high	very high	large land bases of all types	mechanized	grapple	flail chipper, sometimespaired with grinder
Fully-Integrated Producer	very very high	very high	large land bases of all types	mechanized (mutiple crews)	grapple (mutiple crews)	one or more flail chippers, sometimespaired with grinders

Biomass Producer Spectrum

This table categorizes the wide range of logging companies that harvest woody biomass. Individual operations will not always neatly fall into one of the six categories described here. Some loggers have made the transition from one end of the spectrum to the other – first by dipping a toe into biomass and then ending up as one of a handful of premium producers or facility owners through growth and specialization. Other loggers have played a number of the roles shown here, eventually settling into the one best suited to their circumstances.

In areas with overlapping markets for woody biomass, the full range of producers types are present. Single market areas tend to have only sideline and cooperative producers.

Loggers find their niche based on the timber available to them, their own talents and interests and subject to the markets for their products and services. The following pages describe each of these producer types. The purpose is to provide an overview of what others have done and show the range of business growth that is available.

Cooperative Producers
Conventional logging companies sometimes find themselves in harvesting situations where whole tree removal is advantageous. These loggers may not have the interest or opportunity to process or sell biomass products themselves, but they occasionally have the appropriate resource arriving at their landing. Cooperative transactions have long been a staple within the logging community.

Some larger chipping contractors have one or more spare chippers that they can set up and operate on another contractor's landing site. Others try to coordinate these collaborations between moves from their own jobs. The host contractor provides the whole trees or tree tops and the cooperator takes it from there. Both loggers share in the proceeds from the wood chips – with 50-50 splits and similar ratios being common.

Working in a cooperative arrangement with a larger producer is a good way to investigate the possibilities of expanding into biomass production on a more involved basis. This opportunity can provide the logger with a look at how adding a chipper to their equipment mix and handling whole trees would alter their current operation.

Sideline Producers
Some conventional logging companies add biomass harvesting as a sideline portion of their business, chipping tops from sawtimber harvests and filling out their work year with low grade harvests when other work is unavailable. This approach does not justify a large capital investment in equipment. Often the only addition to the existing mix is a used chipper and a chip van. A smaller investment means the operator is justified in ruling out biomass removal on some harvesting sites.

The operation shown here is harvesting large sawtimber along with a mix of lower grade tree stems. Most of the tops and roundwood from the upper portion of the stems are chipped. In the absence of a nearby pulpwood market, this is often the most viable utilization option.

The delivered chips have the same value, whether the productive capacity behind them comes from a multi-million dollar investment or a collection of older machines that were fully depreciated by previous owners.

Full Utilization Producers

Full utilization suppliers see biomass production as a natural extension of the whole tree harvesting they are already doing. Low margin work requires high productivity. Pursuit of efficient production in an environment where skilled employees are hard to retain or recruit from other industries has led to increased mechanization in logging. Felling and skidding without putting feet on the ground is safer and faster. This means whole tree harvesting.

Landscapes that are characterized by a great deal of low grade timber and large tracts under investment ownerships have another feature that encourages loggers to look into full utilization whenever possible. Service work is the bulk of what is available to these loggers. A land management firm usually markets the sawlogs and the pulpwood is often bound by a supply contract connected to the land. The harvesting rates paid to logging contractors are modest enough to motivate them to look into any additional sources of revenue that could come from their work.

Some loggers who have pursued this route report that they get the same return regardless of what goes out on a load – sawlogs, pulpwood or chips. With this in mind, the prospect of realizing a return from wood that is already being harvested makes a great deal of sense.

Mainline Producers

Mainline producers of biomass products place the majority of their emphasis on producing whole tree chips, usually for electrical facilities. Most of these facilities have a solid core of these businesses among their suppliers, often relying on them for half or more of their supply. These loggers made a conscious choice to focus on biomass and have become very good at reliably producing a supply of wood chips that facilities depend on. The sheer volume these operations produce make them the most reliable suppliers for the scarce but more lucrative heating chip markets.

In areas where long standing pulpwood markets have disappeared, shifting production capacity into biomass is a logical step. While pulpwood prices are generally higher than wood chip prices, long trucking distances often significantly erode this difference.

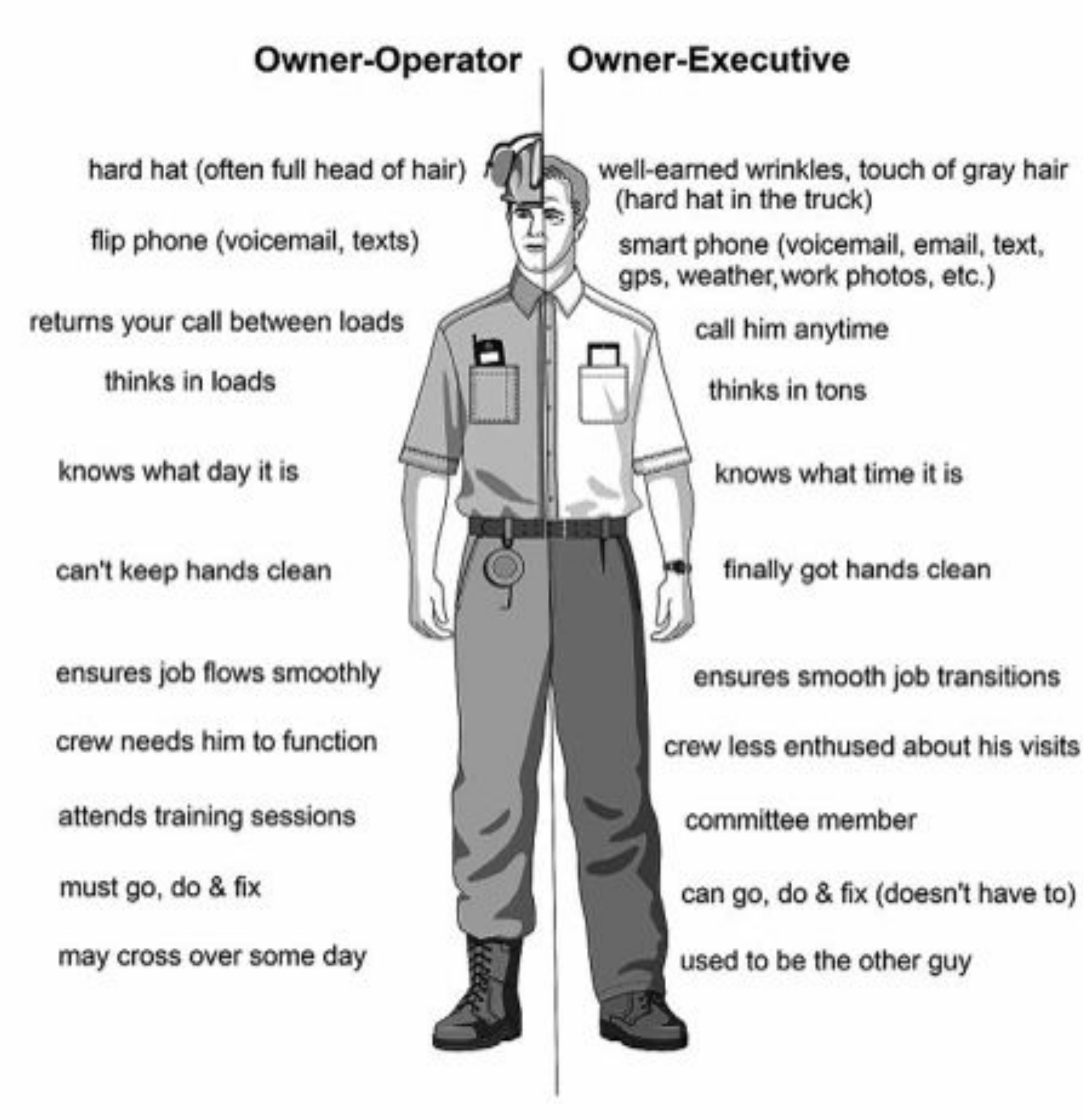
Businesses that place an emphasis on low grade timber often have more opportunities outside of production contract work. This lower value timber may be more readily available from private landowners and, in some cases, on public lands. Competition for this resource comes from similar operations, rather than sawmills. Reliable contractors are often sought out by consulting foresters for timber stand improvement work.

Premium Producers

Premium producers create large quantities of the higher value biomass products such as clean wood chips. These premium suppliers have the highest investment in productive capacity of any biomass producers. A flail chipper is required to produce clean, uniform chips with very little bark content. These investments are justified only by high production levels (i.e. more equipment, more trucks, more labor).

Most of these suppliers came into being to supply clean debarked bole chips to paper mills. It's not surprising to learn that few actually regard their product as "biomass". Often a paper mill was the core customer that made the initial investment in an operation like this possible. Emerging markets and the producer's natural desire for diversification have resulted in more customers. Pellet mills, institutional heating plants and even rayon producers have sought out this product. A co-product from these producers is lower quality wood grindings, using the tops and flail debris that are left over.

Finding sufficient timber to feed these operations, supporting and coordinating production, and maintaining all the moving parts requires a dedicated owner executive – or ownership team. People skills are a must, as is a high tolerance for risk. A number of loggers have made this jump – one that takes them out of the comfort zone many have in working in the woods. This has given rise to a new type of logger.



Rise of the Owner Executive

While this example may be a gross simplification, illustrating the full range of possibilities seen within the logging community is difficult. In one sense this image captures some of the evolution present in many logging careers, as an owner grows from the guy doing the job to the guy that makes sure the job happens. Growth of this sort almost always comes with a huge increase in productive capacity – more equipment and employees and more problems to solve. While most loggers get into the business with the intention of being an owner-operator, some find they are well suited to stepping into a larger role.

Success in the logging business doesn't necessarily mean a transition out of operations. A worthwhile livelihood and satisfaction with one's work can come in any size business.

Fully Integrated Producers
In past generations, some loggers took the leap into value-added processing by opening their own sawmills. In the biomass world, a few large wood chip producers have taken a similar leap along the supply chain to start their own wood pellet operations. Some found that their capital investment in productive capacity was far too significant to rely on a single large market for their production. Creating their own market solves this problem. Others saw an opportunity in the quality control they could exercise over their supply for such a mill.

Significant leaps like this into value-added production aren't for everyone. There is a great deal of risk involved. By their nature, loggers seem to have a high risk tolerance and, for some, the risk isn't the deterrent so much as is shifting their emphasis away from the harvesting work with which they are most comfortable.

Starting from Scratch: Building a Business Around Harvesting Woody Biomass

A veteran logger shares some insight:

"The cost of operating a logging company has gone way beyond what anybody understands."

This chapter takes a close look at a hypothetical example of a logging company starting out purchasing equipment and producing wood chips. What combination of volume and prices would justify such an investment? Most loggers arrive at a biomass focus or sideline as a natural part of the life cycle of their business and the changes in markets for wood products. Can someone start from scratch and go into harvesting woody biomass? A project approach reveals some interesting things about the return from such a business. Five year returns will be examined.

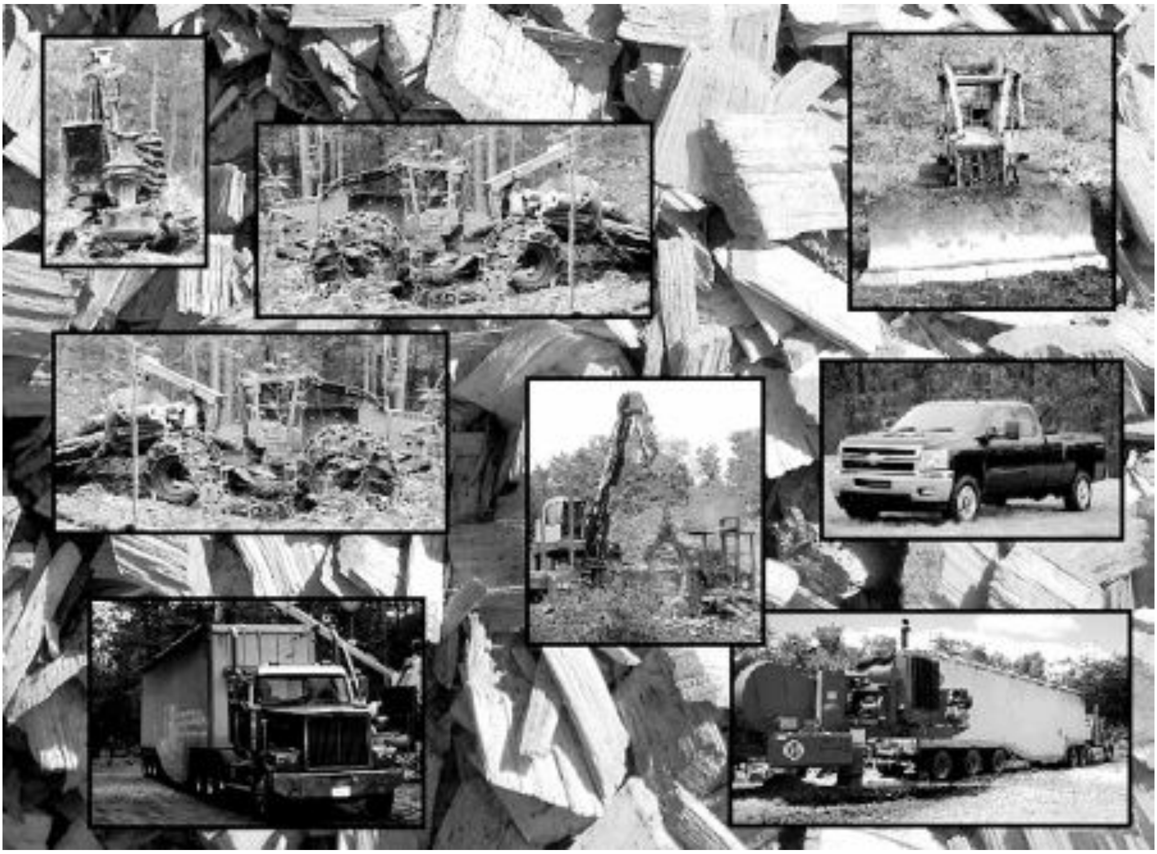
As a baseline assumption, this example will consider the owner of this business to be an experienced logger who has operated equipment for other logging companies, but hasn't yet purchased any of his own equipment. Is this realistic scenario? Probably not. But it is eye-opening. Think of this as a look at what it would take to buy a turn-key business, rather than build through equity as most logging companies do. The numbers are informative.

Markets Come First

Markets for wood chips are a prerequisite for investing in biomass harvesting equipment. Assume there is wood burning electrical utility that will take most of the production. A secondary bit of encouragement will be an opportunity to supply occasional loads of wood to a nearby college heating plant, as a subcontractor to their primary supplier.

In the absence of a nearby pulpwood market, roundwood not suitable for logs will be chipped.

While this company will focus on wood chips, production of some logs is inevitable. Assume this company is paid to produce 200 MBF annually. These logs are loaded on the landing and bring in $120 per MBF.



Equipment

Examining the markets available and the timber supply, this entrepreneur decides to take a close look at the following mix of equipment:

Disk Chipper (New)
Tracked Feller-Buncher (New)
Grapple Skidder (New)
Second Grapple Skidder (New)
Loader with Slasher (New)
Bulldozer (Used)
Tractor & Trailer (New)
Tractor & Trailer (Used)
Pickup Truck (New)

Shop
From a large-scale producer:

"I believe if you are mechanized with a feller-buncher and trying to do any volume mechanically, you have to have your own shop. The reason being, the equipment dealers that sell this stuff cannot take care of you to the level you need to be taken care of."

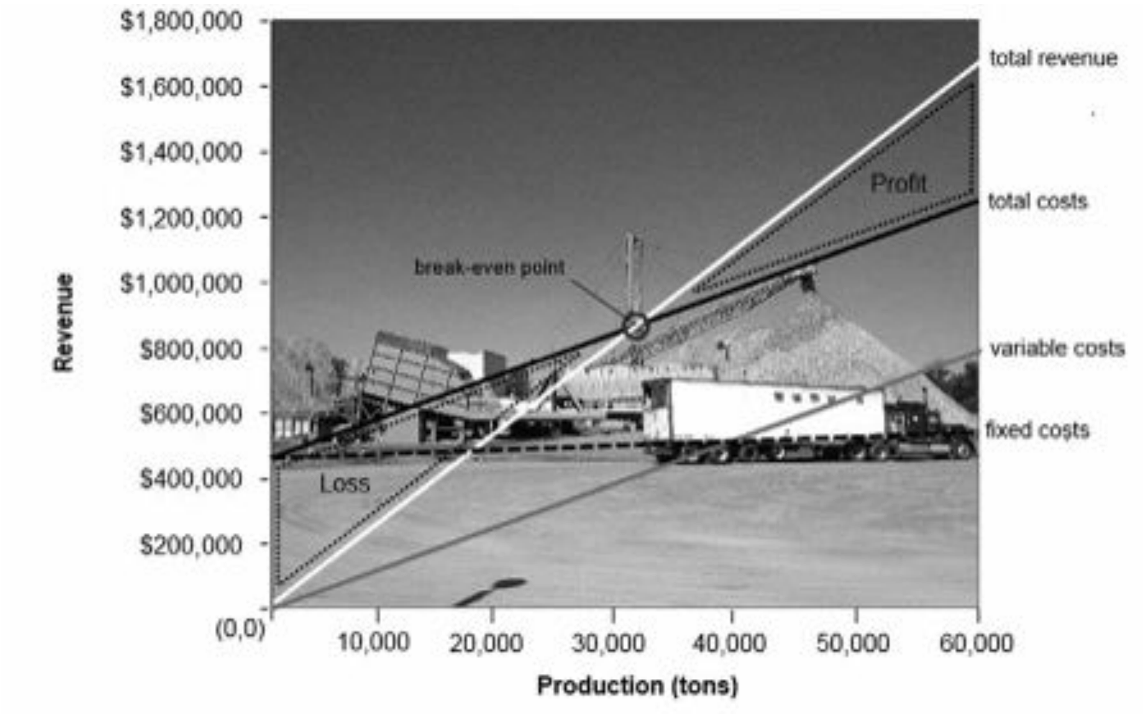
A mobile factory of this type has a lot of moving parts. Logging equipment requires a great deal of maintenance and repairs are inevitable. An operation of this size needs a well equipped shop for repairs and maintenance. Assume that a pole barn style building can be placed on a heated slab in a rural area and then fully equipped (welder, compressor, hand tools, hoist, jacks, etc) for $250,000. While shorter time frames will be used with the equipment, a 20 year mortgage will be used for this investment in a repair shop.

Overhead

This logger will obviously need equipment and a well-equipped shop. What else is needed? While it's tempting to focus only on the physical work involved, a significant amount of administration will be necessary. Books must be kept, payroll met, records maintained and so on. All of this can be thought of as overhead to the production function. While this cost may be minor in the larger scheme of things, it is perilous to ignore it. Assume that one family member will serve as a half-time employee in filling this function.

Additional Expenses
What other expenses is this start-up likely to experience? It is possible to simplify things by assuming everything that isn't a direct equipment cost is overhead, but it's important to be sure to include everything that belongs in this catch-all category. The purpose of all these expenses is to support the productive portion of a business that creates revenue. Among the support expenses that a business like this incurs are some of the following (above).

- Insurance, licenses, & related fees
- Pick up truck
- Wages for support staff
- Wages paid during unproductive periods (e.g. a skidder operator turns a wrench during spring break up)
- Property taxes



Breaking Even

The total annual operating costs for this business come to $983,050. Annual sawlog production incidental to the chipping operation of 200 MBF was assumed earlier. At $120 per MBF, this brings in $24,000 annually. Subtracting this minor revenue leaves $959,050 to be covered in order for the business to break even. What level of production is necessary to accomplish this? At what price? The table on the next page holds some answers.

If wood chips are selling for $30 per ton, this business would have to produce 31,968 tons to break even. This amounts to 799 forty-ton loads. If the business is able to produce 200 days each year, this amounts to four loads of wood chips each day.

Are these realistic annual and daily production levels for this business, with this collection of harvesting equipment? Possibly. What if the price were $20 per ton and an average of 6 loads per day was necessary to break even?

This type of analysis cannot determine realistic production levels. Instead, this project approach allows calculation of break-even production levels. The decision to pursue the project may hinge on an individual's judgment of how realistic these production goals are.

Would a logger make this sort of investment just to break even? It seems like a very expensive way to purchase a job. Profits are the residual claim to capital. How much would this logging company have to produce in order to have something left over in the form of profit? Read on for further calculations.

price* per ton ($)	break-even production (tons)	# of 40 ton loads (#)	loads per day** (#)
20	47,953	1,199	6.0
21	45,669	1,142	5.7
22	43,593	1,090	5.4
23	41,698	1,042	5.2
24	39,960	999	5.0
25	38,362	959	4.8
26	36,887	922	4.6
27	35,520	888	4.4
28	34,252	856	4.3
29	33,071	827	4.1
30	31,968	799	4.0
31	30,937	773	3.9
32	29,970	749	3.7
33	29,062	727	3.6
34	28,207	705	3.5
35	27,401	685	3.4
36	26,640	666	3.3
37	25,920	648	3.2
38	25,238	631	3.2
39	24,591	615	3.1
40	23,976	599	3.0

** assumed to be net price, less any stumpage*
*** 200 productive working days are assumed*

price* per ton ($)	5% profit production (tons)	additional 40 ton loads (tons)	loads per day (#)	10% profit production (tons)	additional 40 ton loads (tons)	loads per day (#)
20	2,458	61	0.3	4,915	123	0.6
21	2,341	59	0.3	4,681	117	0.6
22	2,234	56	0.3	4,468	112	0.6
23	2,137	53	0.3	4,274	107	0.5
24	2,048	51	0.3	4,096	102	0.5
25	1,966	49	0.2	3,932	98	0.5
26	1,890	47	0.2	3,781	95	0.5
27	1,820	46	0.2	3,641	91	0.5
28	1,755	44	0.2	3,511	88	0.4
29	1,695	42	0.2	3,390	85	0.4
30	1,638	41	0.2	3,277	82	0.4
31	1,586	40	0.2	3,171	79	0.4
32	1,536	38	0.2	3,072	77	0.4
33	1,489	37	0.2	2,979	74	0.4
34	1,446	36	0.2	2,891	72	0.4
35	1,404	35	0.2	2,809	70	0.4
36	1,365	34	0.2	2,731	68	0.3
37	1,328	33	0.2	2,657	66	0.3
38	1,293	32	0.2	2,587	65	0.3
39	1,260	32	0.2	2,521	63	0.3
40	1,229	31	0.2	2,458	61	0.3

price* per ton ($)	15% profit production (tons)	additional 40 ton loads (tons)	loads per day (#)	20% profit production (tons)	additional 40 ton loads (tons)	loads per day (#)
20	7,373	184	0.9	9,831	246	1.2
21	7,022	176	0.9	9,362	234	1.2
22	6,703	168	0.8	8,937	223	1.1
23	6,411	160	0.8	8,548	214	1.1
24	6,144	154	0.8	8,192	205	1.0
25	5,898	147	0.7	7,864	197	1.0
26	5,671	142	0.7	7,562	189	0.9
27	5,461	137	0.7	7,282	182	0.9
28	5,266	132	0.7	7,022	176	0.9
29	5,085	127	0.6	6,780	169	0.8
30	4,915	123	0.6	6,554	164	0.8
31	4,757	119	0.6	6,342	159	0.8
32	4,608	115	0.6	6,144	154	0.8
33	4,468	112	0.6	5,958	149	0.7
34	4,337	108	0.5	5,783	145	0.7
35	4,213	105	0.5	5,617	140	0.7
36	4,096	102	0.5	5,461	137	0.7
37	3,985	100	0.5	5,314	133	0.7
38	3,880	97	0.5	5,174	129	0.6
39	3,781	95	0.5	5,041	126	0.6
40	3,686	92	0.5	4,915	123	0.6

Profit

Breaking-even allows a logging company to persist in business, if not to declare the business a success. How much additional production beyond the break-even point is necessary for this start up business to achieve various levels of production? The table on the facing page has some answers.

If wood chips are selling for $30 per ton, an additional 3,277 tons beyond the break-even point in production would be required to realize a 10% return (holding the annual costs constant at the level stated earlier). This requires an average of 0.4 additional loads per day in the 200-day year.

Biomass producers are largely price takers. The facility sets the price and the producer can supply chips or (hopefully) shift production into something else. Once the investment has been made in a chipping operation, there are few options but to accept the prices being offered for as long as the business had debts to repay.

This price-taking reality underscores the need for a close look at the production levels needed to make it all worthwhile. Choose realistic price ranges that acknowledge the reality that prices are bound to fluctuate.

Expanding to Produce Biomass: Case Study Example

Woody biomass harvesters don't simply materialize – most come into being as a result of the conscious expansion of a conventional logging operation. These expansions start with a market opportunity – someone to buy the chips. With a market in place there are reasons for loggers to add biomass to their product line. It has become increasingly difficult to find timber to produce higher value products and so some choose to focus on harvesting low grade timber.

Other loggers were already harvesting whole trees, but were not utilizing the tops (often carrying them back for dispersion on site). If there is a market for more of the tree, it only makes sense to consider supplying it. For these loggers, the felling and skidding functions remain largely unchanged, but the processing on the landing is shifted to create a new product.

Starting from Strength

Suppose a firm is in a strong equity position with no debt. This firm currently has a track record of success in conventional logging. Over time it grew into a mechanized operation, with plenty of contract work for a large firm managing pension fund lands. A family member handles bookkeeping and many administrative details and the company has a well-equipped shop and work yard.

The current operation includes a tracked feller-buncher, slasher, grapple skidder, stroke delimber, bulldozer, and two trucks for delivering logs and pulpwood. Two employees work in the woods and another drives one of the trucks. The owner runs the landing, slashing logs and pulpwood and loading trucks. Most days end with him delivering a load using the older truck. On a very good day, this crew produces four loads. Most days it is three and often enough something goes wrong and it is only two loads. As a general rule, they are producing two or three loads of pulpwood for every load of logs.

The only thing that has prevented this crew from using more of the tree is the lack of a market. They watched as a public utility opened an electrical generation facility powered with wood. After several years of successful operation, the owner thinks the time is right to become a supplier. How does he go about taking a closer look at this opportunity?

Equipment and Investment

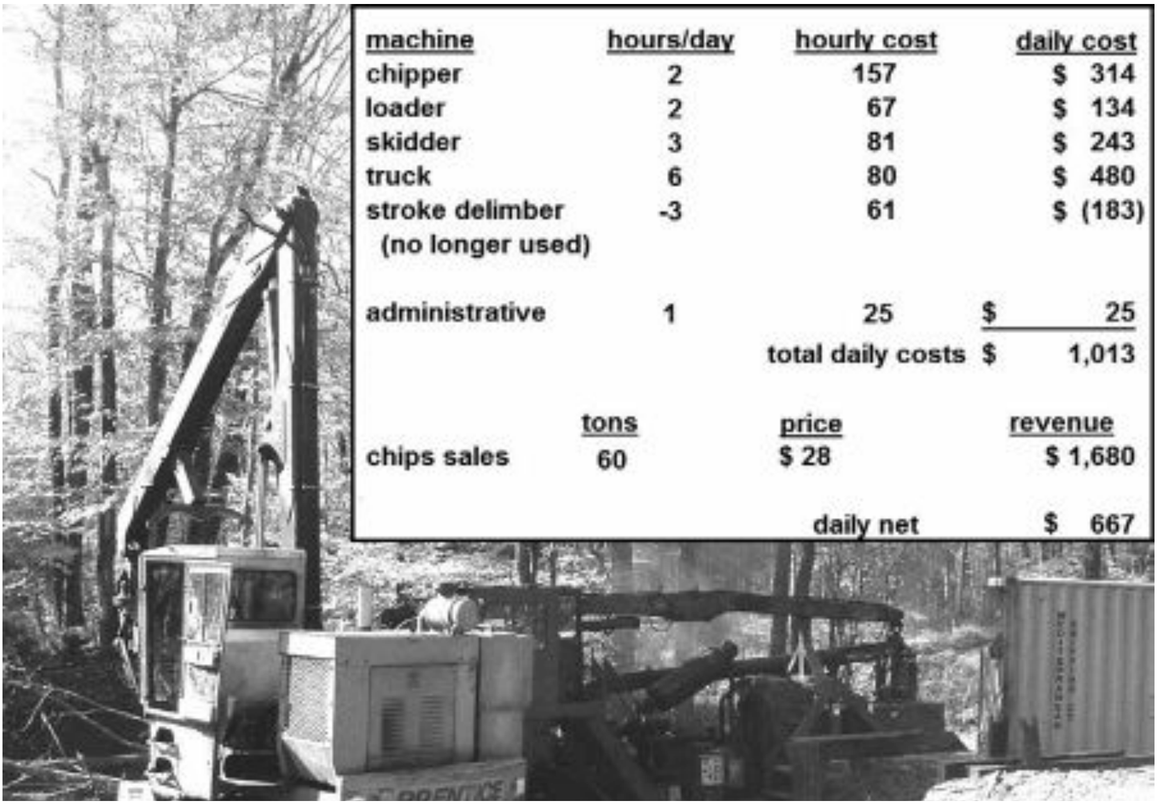
The first step in figuring out the costs of expanding into biomass production is determining the equipment that must be added to add to the current mix. A chipper is the most obvious item, but what else will be needed? Delivery of chips will require a chip van trailer. The existing skidder is getting old and adding another will increase productivity and allow use of the older machine for fewer hours. There might be some addition to be made by subtraction if the stroke delimber is sold. This machine is paid for and it might make sense to keep for a while and see how the new operation works out.

What would this expansion cost? A used 2002 chipper could be had for $119,000. A new grapple skidder will cost $255,000. A used chip van is available for $6,000. The total initial investment comes to $380,000. Assume that the owner's past hard work has enabled him to put together 25% of this amount, or $95,000. This means that there is $285,000 to finance.

In addition to equipment and financing, additional labor will be needed. Everyone on the current crew already has a full plate. While the lines of responsibilities are sometimes blurred and one or more of them shifts to operating other equipment from time to time, there really is no way to add another product line without acquiring more help. The owner anticipates needing another full time truck driver (freeing him up for more time on the landing) and more help in the woods driving the new skidder.

Changes
As a point of departure from the existing operation, this logging company will now be using more of the whole trees that are brought out to the landing. Instead of delimbing most stems and returning the top material to the woods, they will remove the pulpwood and logs with the slasher and set the tops aside to chip. Exceptionally muddy tops won't be chipped and some of this material will still be needed to shore up trails. In general, they will need a larger landing and may have to reposition the loader and chipper one or more times each day.

A logical goal for this retooled operation is to maintain the current level of pulpwood and sawlog production and to produce two 30-ton loads of biomass chips each day.



machine	hours/day	hourly cost	daily cost
chipper	2	157	$ 314
loader	2	67	$ 134
skidder	3	81	$ 243
truck	6	80	$ 480
stroke delimber (no longer used)	-3	61	$ (183)
administrative	1	25	$ 25
		total daily costs	$ 1,013
	tons	price	revenue
chips sales	60	$ 28	$ 1,680
		daily net	$ 667

Calculating Daily Production

This company is contemplating new equipment, additional labor, and an altered production process - all to sell some wood that they were already handling. With these thoughts in mind, the next step is to calculate the potential income and costs and analyze the return they bring.

Looking at it first on a daily basis, calculating the additional revenue is a straightforward process. Suppose they plan to produce 60 tons of biomass chips each day. Assume the chips will sell for $28 per ton (net, with stumpage removed). This brings in $1,680 in revenue. Examine the other costs on an hourly basis to help calculate daily costs. The chipper will run for two hours each day. If it is fed with the loader this will run for an additional two hours as well. If each load takes three hours (round trip) to deliver, this is an additional 6 hours of trucking each day. Some of the added skidder's time can be attributed to biomass production (3 hours each day). Additional administrative costs, though small, are inevitable. Book work and communication with the chip buyer are an essential part of the mix.

Some savings are realized when the stroke delimber is no longer used (assume it ran for three hours a day before). Some increased skidding efficiency is realized as well because the crew is not carrying tops back into the wood as often. The gains from this are difficult to calculate.

Daily costs come to $1,013. Subtracting these costs from the $1,680 in daily revenue results in a net profit of $667 per day, if all goes well.

Cautious Optimism

If all goes well (pretty bold assumption, right?) and this company averages two loads per day for the entire productive year (180 days), this means $120,060 in new annual profit. The major premise of this example is that this is a well-established logging company. Experienced loggers don't make business decisions based on best-case scenarios, so some further analysis is in order. What could go wrong to alter this production schedule? There are two types of trouble – delays on the logger's end and changes in the market.

Unexpected break downs, poor weather, changes in landowner plans, exceptionally muddy wood, contract delays – any of these things can cost productive time that will never be regained. As a result, annual chipping production might be significantly less than the potential.

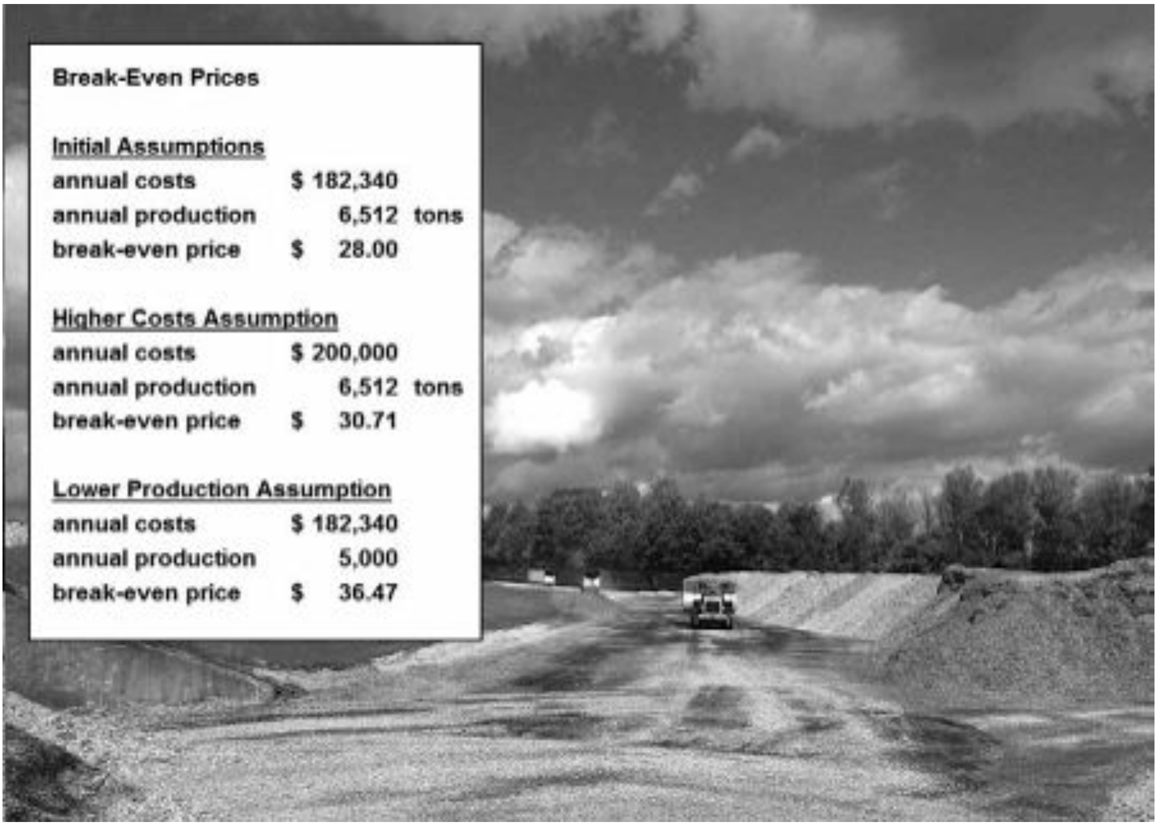
The market can harm the logger's efforts in two ways – a drop in price or a drop in the amount they can sell. Price drops have an obvious impact on the return. What about break downs at the buyer's plant? If the plant loses productive time, the logger does as well. Larger picture market forces such as delays in power supply agreements between a facility and a utility are beyond this logger's control and can certainly impact production.

Total Annual Costs	$ 182,340	Price per ton	$ 28
Break-Even Production	6,512 tons	(Total Costs / Price)	

Break-Even Production
This is a perfect situation for break-even calculations (background calculations were explained in an earlier chapter). What level of production is needed to break-even on production for a given price? Alternatively, what price allows this logger to break-even for a given level of production? Having done the math necessary for the initial analysis, it's not too difficult to take it a step further and make these calculations. Free software such as PATH can help in this work.

Assuming the price for wood chips is fixed at $28 per ton, the break even point in production for the example is 6,512 tons. This works out to 217 30-ton loads. Assuming this logger can produce 180 days each year, 1.2 loads of chips per day are needed to break even. If his goal is to produce 2 loads of chips each day is realistic, this looks like a worthwhile endeavor.

Perhaps the least certain piece of information in this analysis is the number of days this logger can work each year. Given the weather and the work available, 180 days could certainly happen, but this number is far from certain. Every day lost reduces the opportunity to turn a profit. Reducing the number of production days to 160, the new break even point rate of production becomes 1.4 loads per day. This still leaves room for profit, but it's clear that the margin for doing so shrinks with each lost day.



Break-Even Prices

Initial Assumptions		
annual costs	$ 182,340	
annual production	6,512	tons
break-even price	$ 28.00	
Higher Costs Assumption		
annual costs	$ 200,000	
annual production	6,512	tons
break-even price	$ 30.71	
Lower Production Assumption		
annual costs	$ 182,340	
annual production	5,000	
break-even price	$ 36.47	

Break-Even Price

An alternative analysis looks at the break even price for the product. Make one or more assumptions about the production level and determine what price is necessary to cover costs. Note that in these examples, prices are assumed to be net, after stumpage has been deducted.

The calculations shown above were done in PATH. As previously determined, a production level of 6,512 tons annually will break even on expenses if the price is $28 per ton. Altering assumptions about both the annual expenses and the production level reveals more about the range of possibilities.

If expenses increase to $200,000 annually and production is kept at 6,512 tons, a price of $30.71 is necessary to break even. If expenses are held constant ($182,340), but production drops to 5,000 tons, a price of $36.47 per ton is needed to break even.

A good practice in an analysis of this type is to make one best set of accurate assumptions about expenses, production and prices and then alter them by 30% in either direction to examine a wider range of possibilities. This is called sensitivity analysis. Next, the logger can judge if there are cost circumstances within this set of possibilities that encourage or discourage the investment.

Making a Decision

Should this logging company expand into biomass production? The type of analysis shown here can be an important part of this decision. Positive numbers all rest on assumptions. The assumptions the logger makes about himself are those that are most certain. Experienced loggers have proven to themselves that they can borrow money and produce enough to pay back loans and earn a livelihood.

It is the assumptions about things outside a logger's control that they have to be comfortable with before plunging ahead. A thorough loan officer is going to force a borrower to question all of these things before lending the money. When financing is done by non-traditional lenders, a logger should be sure to keep this lenders overriding motives (such as selling a piece of equipment or guaranteeing supply) in mind.

Selecting the right equipment has often been done through trial and error. Careful loggers benefit from the experience of those who have gone before them. Most loggers are happy to discuss equipment and its performance. Dealers and manufacturers are open to field testing machines.

Is the timber resource needed available to be harvested? Under what terms? Can stumpage be purchased or is service work all that is available? Sometimes a lower end product such as biomass can be purchased as stumpage even within the context of a service agreement. This is especially true when it would otherwise be unused.

A logger must be comfortable with the demand level for the product. Can enough of it be sold to turn a profit, or is there an oversupply on the market? Is the end-user likely to stay open? How will the abundance of inexpensive natural gas impact the target market? There are no easy answers, but significant investments in facilities and upgrades are a positive sign. In the end, there are no iron-clad assurances.

Fuel prices have been one of the industry's greatest concerns for some time now. Steep rises in price that aren't counterbalanced by product price increases can quickly eliminate all of the profit margin in logging. Fuel prices impact so many other aspects of the economy that the forest products industry isn't the only one that has been hurt by this. Time will tell where the chips will fall.

Insight & Advice

"The people who need the chips need a certain amount of stability in the market." **Eric Johnson**, Northeastern Loggers' Association

Stability is elusive in the logging business. Johnson was quick to add that the people producing the chips have so much invested in it that they need stable markets as well. New ventures such as biomass production may pile further risk on an already difficult job. Continued growth might be the key to stability, as long as market demand for wood products continues. The fact remains that many loggers have taken up chipping and have persisted in it. This is evidence enough that biomass production can be a worthwhile and profitable for loggers.

Those loggers who have the opportunity to produce and sell woody biomass can benefit from the advice of others in and around this industry. This chapter contains observations and insight from a variety of experienced sources.

Commodity Pricing

"In other areas of business, they raise the price. What does the logger do? He doesn't have any recourse. He can work all the harder, I guess." **John Levi**, biomass harvesting pioneer.

"The price is market driven. You can claim that you're not making money until the cows come home, but unless they have to compete, price wise, it doesn't matter." **Paul Mitchell**, logger

Most biomass products are commodities. As producers, loggers must do their best to control costs because the price side of the equation is beyond their control. Loggers are price takers, with individual businesses having very little influence over how much they are paid per unit. The only leverage the logger has is to withhold the product, either by sending it elsewhere (if there is an alternative market) or by stopping production. If the logger is not a major supplier, this tactic usually has no impact. If the logger is still paying off loans on the equipment bought to produce the product, he really has no leverage at all, as even a suboptimal cash flow might keep his loan payments current.

Recognize that this sort of price structure is the nature of low-value products. Only a shortage will spur price increases. This in part explains why some loggers have only dabbled in biomass as a sideline or as cooperative producers. If fuel prices and chip prices are at advantageous levels, the logger can make money selling wood chips. If not, chip production can cease until conditions improve. Large volume producers have little choice in the short run but to accept the price the buyer offers.

Supplier Competition

"In the surrounding region, if it has on-going development, oftentimes the guys that are land clearing are willing to sell their chips at a very low rate, so it drives the market downward. The prices that these biomass plants are willing to pay is not high enough to support a strictly chipping operation." **Mike Fahey**, NE Timberland Investments LLC

Discussions of biomass energy have moved past the early "free wood" myth, in which investors dreamed of supplying facilities with feed stocks that contractors and municipalities were eager to deliver to them and expect nothing in return. Despite this progress, the reality is that in most places, there are non-forestry sources of wood chips and grindings from land clearing and municipal waste. This material can be had at a lower cost because the suppliers were either paid to remove it or are avoiding or mitigating a disposal cost.

Nearly all electrical facilities get a portion of their supply in this manner. If a large portion of supply arrives in this way, it will certainly exert a downward pull on the price the utility has to pay get wood. Some facilities are unfairly demonized for their pricing policies. Prices serve as a faucet for supply. If all of their supply needs are met at a given price, there is no reason to increase it.

Suppliers can either send in chips or stop producing them. Stopping production is a hard thing to do with financed equipment. Potential suppliers have a different choice – they look at the types of financial calculations outlined in earlier chapters and decide whether historical price trends merit an investment in producing biomass products.

Been There, Done That

"It's nothing new to these guys......they have been harvesting biomass since I was watching Sesame Street. They have either already done it, they've considered it, tried it, dropped it, or they have considered it and they're not going to do it at all." **Jeffrey Benjamin**, University of Maine

Woody biomass markets are just emerging in some areas and long established in others. Not only is there an abundance of used biomass harvesting equipment in circulation, there is a great wealth of practical experience to draw from as well. Logging companies that are considering adding biomass to their harvesting mix should inform their decisions by taking a good look at what others have done. The logging community tends to be one of friendly competition, bonded in the mutual respect that comes from shared experiences. It is a small world as well, even across state lines. Reach out to colleagues to ask about equipment, operations, pitfalls and successes.

Loggers are problem solvers. Most would gladly provide sound advice in order to spare their peers from the pitfalls they experienced. Who hasn't built on the work of others in innovating systems that work best for them? Site visits, equipment tests, chance encounters at trade shows and even shared stories in hunting camps have inspired the business decisions of many loggers.

Buy-In & Build

"Owners forget just how scary it is to talk to them. Crew members are more apt to support something that they help build, which strengthens the company. The owners can tell them they are thinking of adding a new piece of equipment and ask "what's your take?" and then have a healthy discussion about it. To me, transparency is power. Incorporate people into the decision." **Wendy Farrand**, forest industry consultant & originator of the How to Build a Kick-@$% Crew approach to logging

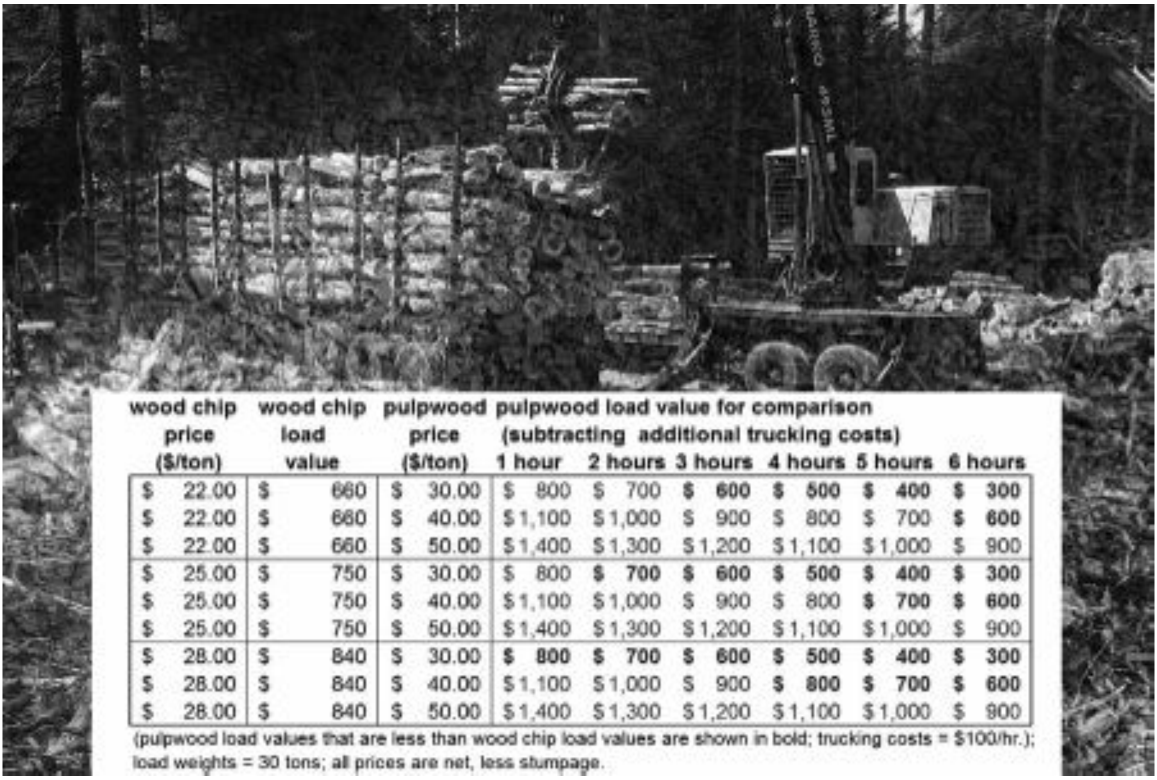
Change can be difficult for people. Changing a logging operation to incorporate biomass will mean new duties and demands for a crew. Equipment will not run itself. Engaged employees are the difference between profitable levels of production and going through the motions. Bear in mind that harvesting operations are far more than a collection of the right equipment to do the job. As one logging crew member put it "*I'm just a link in the chain.*" Cooperation among the crew is what sends loads of wood to the mill. Seek advice from all the links in the chain when it comes to bringing in new equipment, staff and product lines.

True Costs

"Our equipment sales are dependent on the financial success of the forestry contractor. Too many are forced to produce a product for the mill at a price that is not financially sustainable long term. During these cycles the contractor maintains operation by reducing the equity in his owned equipment. Who is subsidizing who here?" **Mark Bourgeois**, CJ Logging Equipment

The ability to produce wood chips and the desirability of producing them are two different questions. Loggers have the proven ability to harvest trees and make wood products. They understand the work. Solving the "how to?" problem is a fun exercise for them. The harder question to answer is "should we make wood chips?" Answering this question requires figuring out if this operation can be profitable.

Determine break-even prices and production levels in the manner described in earlier chapters. Is the production level required to make money truly within the company's ability? Does the prevailing wood chip price cover costs and allow a logger to make a profit? A lengthy discussion of equipment equity and prices is included in the resource section at the end of the book.



wood chip price ($/ton)	wood chip load value	pulpwood price ($/ton)	pulpwood load value for comparison (subtracting additional trucking costs) 1 hour	2 hours	3 hours	4 hours	5 hours	6 hours
$ 22.00	$ 660	$ 30.00	$ 800	$ 700	**$ 600**	**$ 500**	**$ 400**	**$ 300**
$ 22.00	$ 660	$ 40.00	$1,100	$1,000	$ 900	$ 800	$ 700	**$ 600**
$ 22.00	$ 660	$ 50.00	$1,400	$1,300	$1,200	$1,100	$1,000	$ 900
$ 25.00	$ 750	$ 30.00	$ 800	**$ 700**	**$ 600**	**$ 500**	**$ 400**	**$ 300**
$ 25.00	$ 750	$ 40.00	$1,100	$1,000	$ 900	$ 800	**$ 700**	**$ 600**
$ 25.00	$ 750	$ 50.00	$1,400	$1,300	$1,200	$1,100	$1,000	$ 900
$ 28.00	$ 840	$ 30.00	**$ 800**	**$ 700**	**$ 600**	**$ 500**	**$ 400**	**$ 300**
$ 28.00	$ 840	$ 40.00	$1,100	$1,000	$ 900	**$ 800**	**$ 700**	**$ 600**
$ 28.00	$ 840	$ 50.00	$1,400	$1,300	$1,200	$1,100	$1,000	$ 900

(pulpwood load values that are less than wood chip load values are shown in bold; trucking costs = $100/hr.); load weights = 30 tons; all prices are net, less stumpage.

From a Distance
"Do I use that truck to move a lesser product when it could have been moving a higher value one?" **Paul Mitchell**, logger

Adding a biomass product line can interfere with the other products and deliveries. Mitchell's point is a good one – shifting resources from your core business to a sideline might undermine the operation. In the short run, the supply of trucks is limited and a company should employ them to their best advantage.

Trucking distance is a limiting factor in biomass production – but it also limits other wood products. Distance can be the difference between utilizing all the wood harvested and returning tops to the woods. Some biomass-using facilities are located to take advantage of market voids where pulp and paper mills used to operate. How far can a logger be from a pulpwood market before it is no longer an option? Should this logger chip roundwood that could be pulpwood? A price comparison helps answer these questions.

Pulpwood prices are almost always higher than biomass prices, but trucking costs can erode this difference to the point where the effective price for wood chips is higher. If the biomass market is closer, subtract the difference in trucking costs between the two to compare load values. The table above shows that wood chips can be more valuable than pulpwood under several conditions. When prices are close, convenience and truck availability are often the determining factors.

Guarantees

"I've never had a long-term contract with anybody." **Pat Curran**, Curran Renewable Energy.

Supply contracts with wood using facilities really are not that hard to come by – this in itself is an indicator of how valuable they are. There are no guarantees. Mills and facilities will issue contracts to loggers if it helps them in securing equipment financing, but they readily admit these agreements are one-sided and subject to cancellation without much cause. Mills buy wood when they need inventory and stop buying it when they have enough. There is nothing new or surprising in this.

Loggers most often work without a safety net when they invest in equipment. While long-term contracts are not possible, look to customers for the same sort of guarantee they can observe in loggers – a willingness to invest in productive capacity. Biomass plants and other facilities are expensive to build and are created with the expectation of long-term viability. A logger's investments signal to buyers that they are serious about production. Goodwill can be in short supply in this industry, but good intentions are evident in investments.

Opportunities
"Opportunity is missed by most people because it is dressed in overalls and looks like work."
Thomas Edison

Will woody biomass provide cost-effective energy on a wide spread scale and create far ranging opportunities for loggers? While there are increases in biomass uses and expanding markets for it, after thirty years of hype it's hard for loggers too see biomass as anything more than just another product. Biomass will serve as a core emphasis for a dedicated few, provide entry to other timber opportunities for some and will endure as a worthwhile sideline for many.

Loggers should explore biomass market and production opportunities. A few may have the opportunity to take it several steps further into value-added production opportunities with pellet and heat facilities, much in the same way some loggers expanded into sawmilling in past generations. This book is meant to help loggers think about biomass as a business opportunity and do their homework in finding out if it is a good fit for their operations. Many have taken a close look at biomass and decided it doesn't contribute to their goals. If a logger can make a profit or somehow enhance his business by producing woody biomass, then this may be the right choice.

SECTION 5: ADDITIONAL RESOURCES

Processes for Using Woody Biomass

Woody biomass becomes a variety of end products, but what conversions does it undergo along the way? There are a variety of different processes that change woody biomass into compounds or items that meet or contribute to consumer demands. This brief chapter outlines the processes and relates them to the products that come from the forest.

Combustion

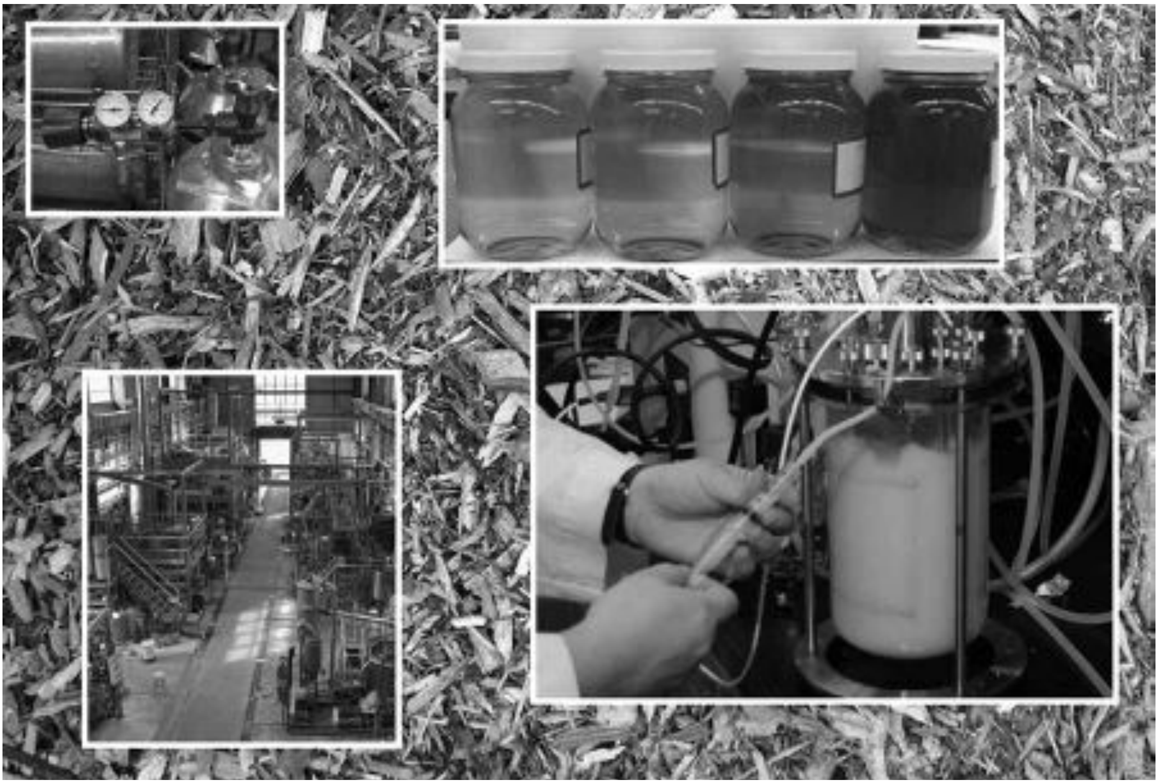
Combustion is the oldest and most common use of woody biomass. Wood is burned to heat homes and has a foothold in the heating market for large buildings such as schools, college campuses, and commercial facilities. Many homes and smaller buildings heat with cordwood. The combustion of wood pellets is similarly used in heating buildings in this smaller size range. Larger heating loads are typically fueled by wood chips. It's not surprising that wood residues have long been used to heat the wood processing facilities where they were created.

Radiant heat from combustion is quite common at the household level. More sophisticated systems capture and distribute the heat in hot water (think of a typical outdoor wood boiler) and in others steam is created. The steam may be used for heat or to power an electrical generation turbine or both.

Gasification

Gasification is a process in which wood is heated to high temperature under conditions of very low oxygen in order to extract syngas, which is then burned with oxygen in a separate chamber. While the process itself is capable of powering automobiles and generators (search "wood gasification" on youtube.com to view this) its most common and practical use has been in heating. The photo above shows the burn chamber of a wood gasification boiler. A fan blows the syngas and superheated air into this chamber, where it burns much more cleanly than the fire seen in combustion. Heating refractory bricks in close contact with a water-filled jacket creates hot water that can be distributed through pipes.

Think of gasification as an improvement on combustion, being more thorough and efficient. The same heating and electrical generation applications are possible with gasification, with the only real difference being that wood is converted to gas before it is burned and the emissions from the process are cleaner than those from combustion.



Biochemical Conversion

Biochemical conversions such as fermentation and anaerobic digestion make the extraction of useful chemicals and pharmaceuticals from woody biomass possible. Fermentation uses microbes such as bacteria and yeast to extract ethanol. Anaerobic digestion produces biogas, which is a mixture of carbon dioxide and methane and smaller quantities of other compounds. In both cases, fuel for power and heat are possible end uses.

From a practical standpoint, such facilities are likely to be co-located with existing wood consuming facilities. After chemicals have been extracted from wood, the bulk of the material remains suitable for direct combustion or gasification, or as feedstock for wood pellets.

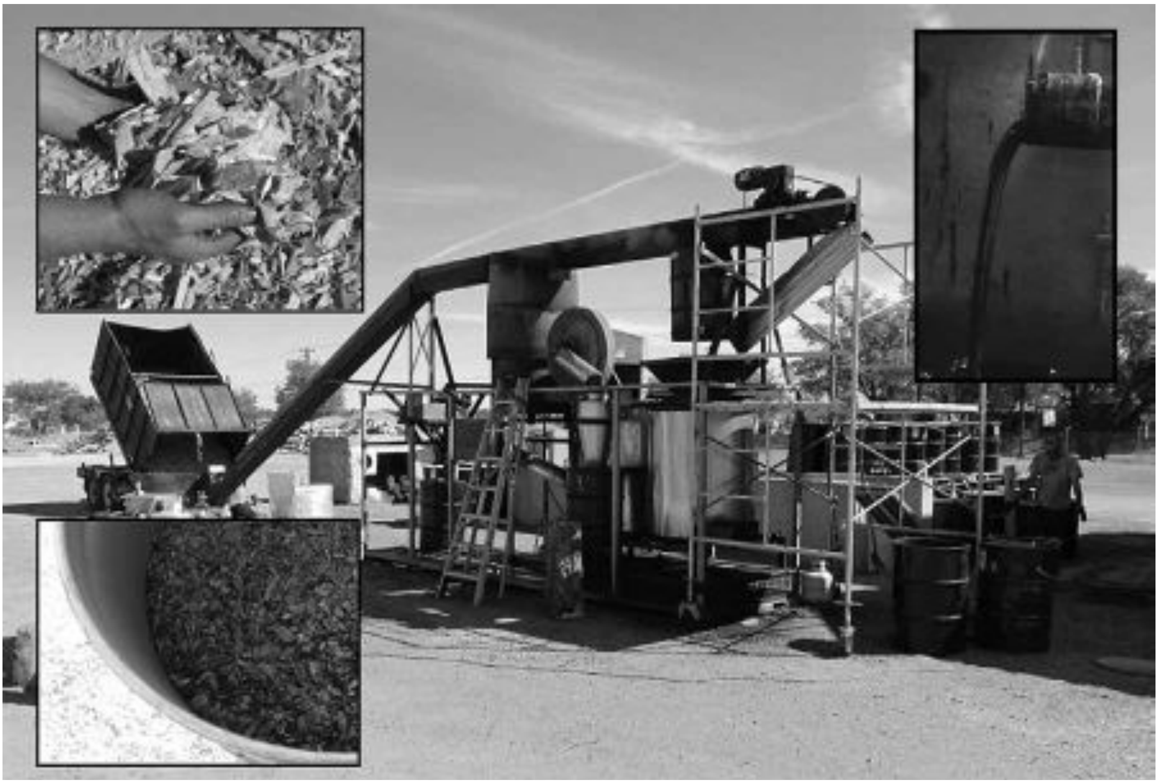
This process is more likely to yield secondary markets for existing woody biomass consumers than it is to be a direct purchaser of in-wood products.

Pyrolysis
Pyrolysis is a process for breaking down wood at a high temperature in the absence of oxygen in order to produce useful products. Torrefaction is a form of pyrolysis that occurs at the lower end of the temperature range and is discussed next.

Pyrolysis at the higher end of the temperature range produces a form of charcoal known as biochar, as well as a number of gases. Some portion of these gases can be used to create a liquid fuel sometimes called bio-oil. Biochar can be used as a soil additive, burned to create heat and electricity, or can be refined into other products.

Bio-oil can also be burned as a fuel or refined into superior forms of transportation fuel. At present, these transportation fuels are extremely expensive to manufacture from woody biomass. Unfortunately, extremely expensive fuels simply cannot compete with our current petroleum fuels, which are only very expensive.

Large scale wood processing facilities built around this concept have been “just around the corner” for close to fifteen years at this point. Only small scale research facilities and mobile units like the one shown here exist at this point. If this use of woody biomass does take off on a commercial scale, it has the potential to use extremely large quantities of wood.



Torrefaction

Torrefaction is a form of pyrolysis that involves the roasting of wood in a low oxygen environment in order to produce an energy-dense, waterproof pellet. Some have referred to this as green coal, as it has a similar application in burning to produce heat and electricity. Torrefied wood chips and pellets cannot presently compete with fossil coal on price alone, although they have a significant advantage over coal in terms of carbon and sulfur emissions. Co-firing to meet emissions standards in coal-using facilities is one possible use for torrefied wood. This use arises from a regulatory market created by imposing renewable energy standards.

Decay

Decay is a natural process for woody biomass that is typical of agricultural and ornamental purposes. The process of decay isn't the intention so much as it is a consequence of the uses for this material. In most cases, processing is minimal and may involve dying, mixing with other materials, and bagging. For uses other than animal bedding the consumer puts it on the ground and replaces it after it decays past the point of its intended purpose. Grindings, chips, and shavings are all sometimes used in this manner.

Few consider these uses to be part of the woody biomass spectrum. For the purpose of discussing the harvesting of woody biomass, this distinction is unimportant. The same expensive harvesting equipment is used to supply makers of playground chips and bedding as is to provide heating fuel for large scale wood boilers.

Pulping

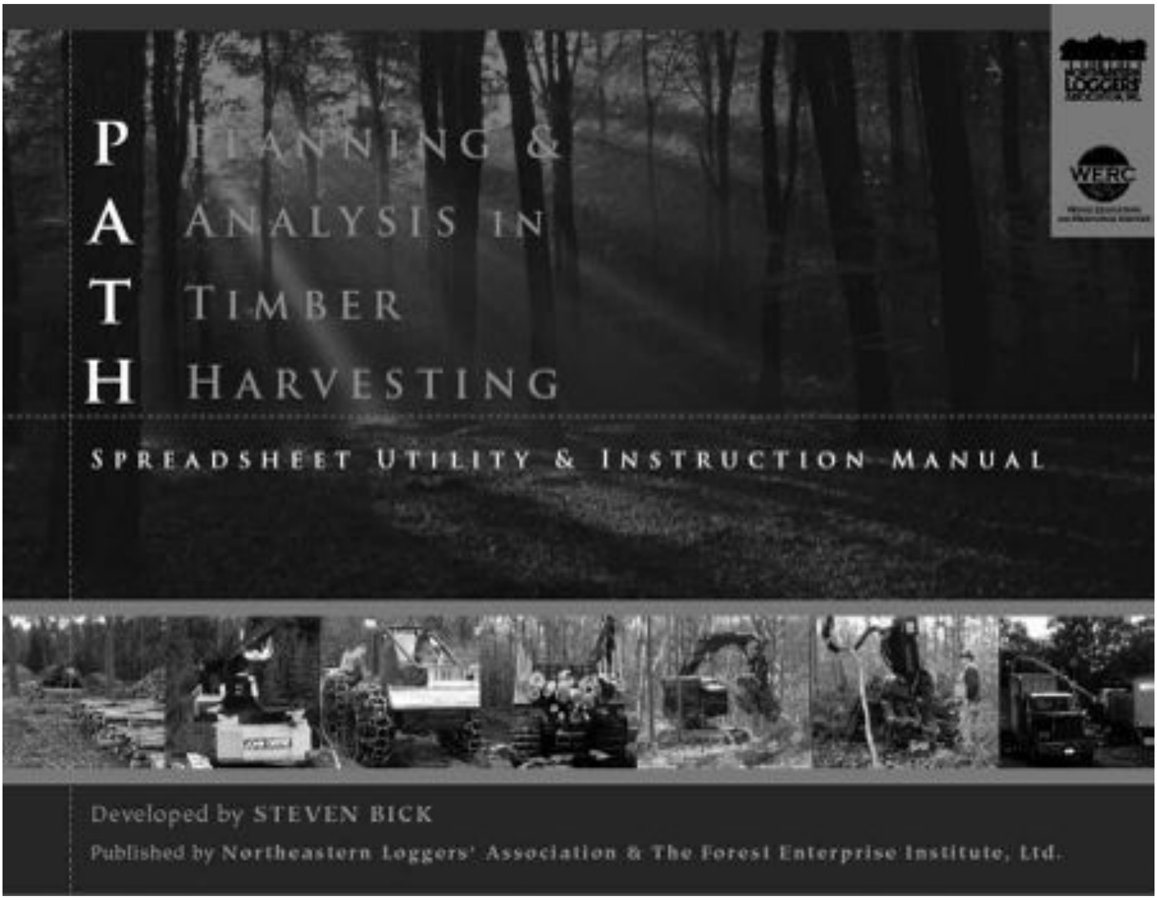
Pulping can be a chemical or mechanical process that degrades wood fiber into a uniform material used to make paper and other useful products such as clothing fiber. The harvesting of pulpwood for pulp and paper mills has long been one of the most significant parts of the forest product industry. A more recent development is the in-woods production of paper-grade wood chips for these markets. In effect, the earliest stage of pulp production has been shifted to the woods. Wood is debarked with a flail chipper and then chipped to acceptable sizes.

Paper chips generally aren't considered to be a biomass product, but this distinction becomes less important at the harvesting level. The same chips produced to make paper are also suitable for use in making wood pellets, co-firing with coal and burned in wood boilers at schools.

Understanding Machine Rates

Calculating hourly machine rates is a common practice in determining logging costs. The ownership and operation of expensive machinery comprises the greatest portion of costs in a logging business. This chapter will show how to estimate hourly costs for equipment.

There are several types of costs that must be accounted for when calculating a machine rate. These include depreciation, interest, insurance, repairs and maintenance, labor, and fuel. Most of these costs are easily calculated on an annual basis and can then be quickly converted to hourly rates. Each of these costs is examined in turn and then they are combined into a single hourly machine rate.



Planning & Analysis in Timber Harvesting (PATH)
Machine rate calculations can be tedious when done by hand. PATH is a free spreadsheet utility that allows users to compile machine rates for a large collection of equipment and then compare them to the costs for alternative equipment mixes. PATH automates calculations that are detailed in this chapter.

Beyond machine rates, PATH allows for estimates of the overall costs for an operation and then determines break-even points in both production and pricing. Once armed with a good estimate of a cost structure, logging companies can better estimate production costs for individual harvesting jobs. This program works for biomass harvesting and conventional logging alike.

PATH comes bundled with a detailed user manual. Its development was funded by the USDA Forest Service's Wood Education & Resource Center and can be downloaded from their website. A quick Internet search of "Planning & Analysis in Timber Harvesting" will locate links to the download site.

Depreciation
Depreciation is the loss in value of a piece of equipment as it is used and worn out over time. The first step in calculating depreciation is to determine the anticipated useful life of the machine. Next, estimate the salvage value of the machine at the end of that time.

For example, suppose a logger purchased a grapple skidder for $200,000 and intends to use it for seven years. If the machine is estimated to be worth $60,000 at the end of this time then the depreciation over its useful life is $140,000 ($200,000 - $60,000). "Straight-line" depreciation spreads this depreciation equally over its useful life. Dividing the $140,000 by 7 years will show the annual depreciation to be $20,000.

Loggers have a tendency to hold on to equipment for long periods of time – especially if it has worked out well for them. It is instructive to look at the experience of peers and consider the intended usage in determining the useful life of a particular machine.

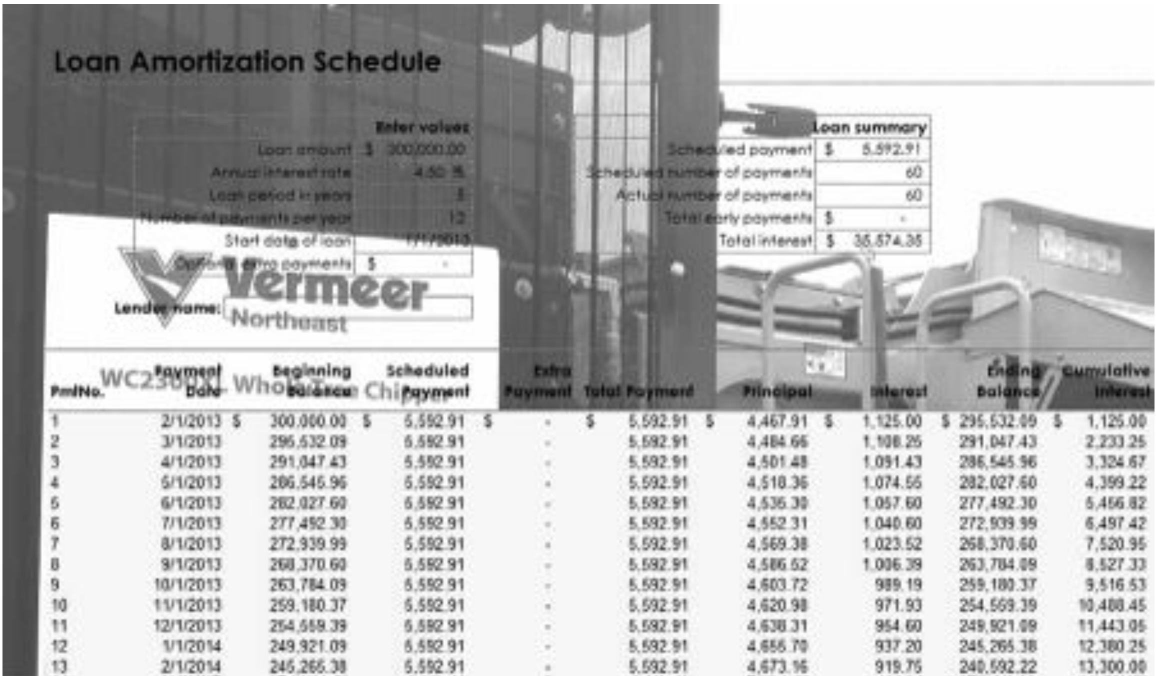
Salvage values can be determined by looking at listings for used equipment. Actual salvage values are somewhat less than retail values of used machines.

Insurance

Insurance is a common requirement in loans for new equipment. Loggers who are able to purchase new equipment outright should not overlook this important safeguard just because no one is requiring it of them.

Insurance costs for new equipment are often said to range from 1% to 3% of the equipment's value. Using a number from within this range can be handy for a quick analysis, but it is really no substitute for the actual cost. A phone call to an insurance agent should be all it takes to obtain a quote to insure a particular piece of equipment.

Once an annual insurance cost is determined, it is added to the annual depreciation that was calculated earlier.



PmtNo.	Payment Date	Beginning Balance	Scheduled Payment	Extra Payment	Total Payment	Principal	Interest	Ending Balance	Cumulative Interest
1	2/1/2013	$ 300,000.00	$ 5,592.91	$ -	$ 5,592.91	$ 4,467.91	$ 1,125.00	$ 295,532.09	$ 1,125.00
2	3/1/2013	295,532.09	5,592.91	-	5,592.91	4,484.66	1,108.25	291,047.43	2,233.25
3	4/1/2013	291,047.43	5,592.91	-	5,592.91	4,501.48	1,091.43	286,545.96	3,324.67
4	5/1/2013	286,545.96	5,592.91	-	5,592.91	4,518.36	1,074.56	282,027.60	4,399.22
5	6/1/2013	282,027.60	5,592.91	-	5,592.91	4,535.30	1,057.60	277,492.30	5,456.82
6	7/1/2013	277,492.30	5,592.91	-	5,592.91	4,552.31	1,040.60	272,939.99	6,497.42
7	8/1/2013	272,939.99	5,592.91	-	5,592.91	4,569.38	1,023.52	268,370.60	7,520.95
8	9/1/2013	268,370.60	5,592.91	-	5,592.91	4,586.52	1,006.39	263,784.09	8,527.33
9	10/1/2013	263,784.09	5,592.91	-	5,592.91	4,603.72	989.19	259,180.37	9,516.53
10	11/1/2013	259,180.37	5,592.91	-	5,592.91	4,620.98	971.93	254,559.39	10,488.45
11	12/1/2013	254,559.39	5,592.91	-	5,592.91	4,638.31	954.60	249,921.09	11,443.05
12	1/1/2014	249,921.09	5,592.91	-	5,592.91	4,655.70	937.20	245,265.38	12,380.25
13	2/1/2014	245,265.38	5,592.91	-	5,592.91	4,673.16	919.75	240,592.22	13,300.00

Interest

Interest is the cost of using money for purchasing a machine. Most often this is loan interest. If a logger purchases equipment outright, it can be thought of as opportunity cost - the return realized from the next best alternative use of these funds. Most low risk rates have been extremely low in recent years, but the fact remains that there are alternative uses for capital. If equipment is financed, the interest rate is used to create an amortization schedule. While this amount will vary from one year to the next, payments themselves are equalized. For convenience, use the average annual amount of interest over the term of the loan. This is consistent with using the straight-line deprecation approach outlined earlier. To calculate average annual loan interest, simply multiply the loan payment amount by the number of payments to calculate the total payout. Subtract the original purchase price from the total payout to determine the cumulative interest. Divide this cumulative interest by the number of years of the loan to calculate annual interest.

For example, a five year loan with 60 payments of $2,000 would have a total payout of $120,000. Subtracting the purchase price of $100,000 reveals that the cumulative interest is $20,000 ($120,000 – $100,000). Dividing this figure by the five-year term shows that average annual interest is $4,000 ($20,000 ÷ 5 years).

Once annual interest has been determined, it is added to the depreciation and insurance costs calculated earlier.

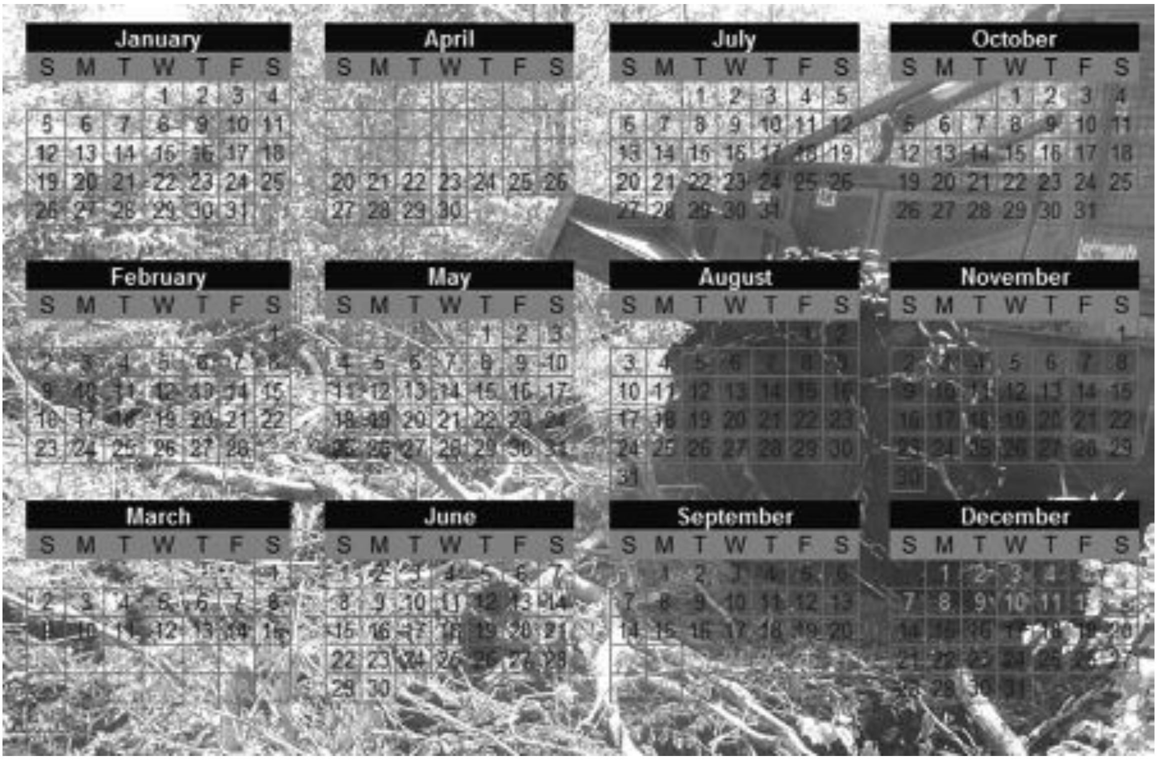
Repairs & Maintenance
Repairs and maintenance expenses are inevitable costs of owning and operating equipment. Rates for these costs are particularly high – and unpredictable – for logging equipment.

The best source of this information is actual costs. Past performance can be a good predictor, whether it comes from personal experience or from a peer. Many expected costs from replacing commonly worn out parts do not correspond neatly with the calendar year.

In the absence of good sources of repairs and maintenance costs, there are guidelines available for various pieces of logging equipment. Costs for repairs and maintenance are often estimated as a percentage of depreciation. Two tables showing suggested rates are shown at the end of this chapter.

For example, if the repairs and maintenance rate for a tracked feller-buncher is 60% and the annual depreciation is $40,000, expected repairs and maintenance are $24,000 ($40,000 x 60%).

Once annual repairs and maintenance costs have been estimated, they are added to the depreciation, insurance and interest costs calculated earlier.



Annual Hours

The four costs discussed over the previous pages (depreciation, interest, insurance, repairs & maintenance) were all calculated on an annual basis. To express them on an hourly basis, determine how many hours the machine is scheduled to work each year (scheduled hours vs. productive hours are addressed later in this chapter).

Determining the number of annual hours can be difficult. It is possible to look at the hour meter for a machine and determine how many hours it was used in past years. For new machines, start with the number of days it is expected to work each year. For example, if a company typically produces180 days each year, this is a starting point. While machines may be on-hand all day, every day, the number of hours the logger will use it will probably vary for each machine (more on this later). Suppose that a logging company schedules a skidder for 8 hours each day. Based on a 180 day schedule, this means the skidder has been scheduled for 1,440 hours annually (180 days x 8 hours).

Suppose annual costs of $37,000 are determined for the machine - $20,000 (depreciation), $3,000 (insurance) $4,000 (interest), and $10,000 (repairs & maintenance). Dividing this annual cost by 1,440 scheduled hours results in an hourly cost of $25.69 ($37,000 ÷ 1,440 hours). This represents the fixed cost per hour of owning this machine.

Fuel & Lubrication
Fuel costs are a significant portion of the total cost of owning and operating machines. Fuel often accounts for more than 25% of hourly costs – and sometimes considerably more than that. Calculating hourly fuel costs is straightforward, even if the results themselves tend to be unpleasant.

Hourly fuel costs are determined by multiplying the hourly consumption rate by the fuel cost per gallon. For example, if a machine uses 5 gallons of fuel per hour and fuel costs $4 per gallon, the hourly cost is $20 (5 x $4).

Fuel prices are readily available from fuel dealers or a logger's records. Accurate consumption rates are a bit more difficult to reference. The best measure is actual performance. This is easy enough to do by tracking the fuel consumption against the hour meter on the machine in order to come up with the average number of gallons it uses per hour.

For machines a logger is considering buying, other loggers who already own this model may be the best source of this information. Sometimes dealers will let loggers field test a machine and so they can make this calculation. Be skeptical of manufacturer's claims about fuel consumption.

Hourly lubrication costs can also be determined from actual practice. Determine the cost of the daily lubrication routine for a machine and then divide it by the number of scheduled hours per day to arrive at an hourly cost. While less significant than other costs, this shouldn't be overlooked. If $16 per day is spent lubing a machine, the hourly cost is $2 ($16 ÷ 8 hours).

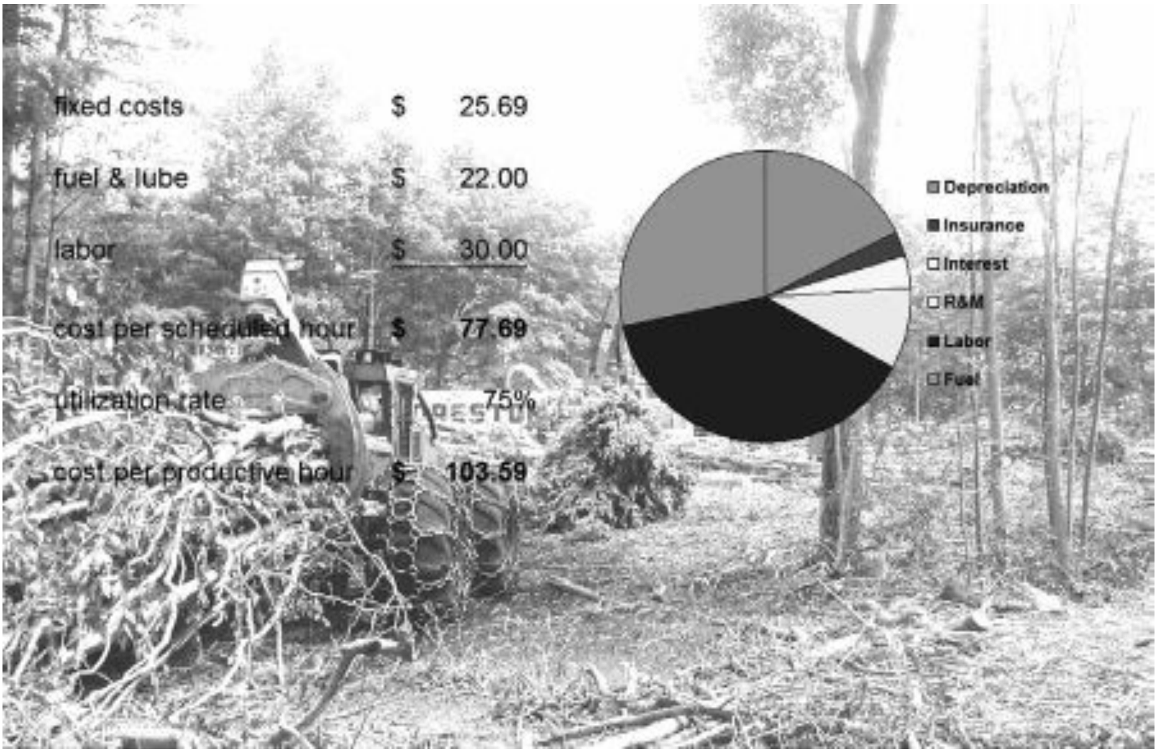
Hourly fuel and lube costs are added together and then incorporated into the hourly machine rate. In the example shown here, the cost is $22 ($20 + $2).

Labor

Labor represents a significant portion of hourly machine costs. Equipment cannot run without an operator. Skilled operation of machinery makes a significant impact on productivity. It can also have a big impact on the costs of repairs and maintenance.

Labor costs are easy to express on an hourly basis, as most equipment operators are paid by the hour. Payroll records are the best source of this information. As a general rule of thumb, actual costs are usually about twice the nominal hourly rate. This accounts for various payroll taxes and insurance costs borne by the employer, along with the costs of any benefits. With this in mind, an employee making $15 per hour is probably costing the employer about $30 per hour.

Hourly labor costs are added to other costs in compiling the machine rate for an individual piece of equipment.



Machine Rates – Scheduled & Productive

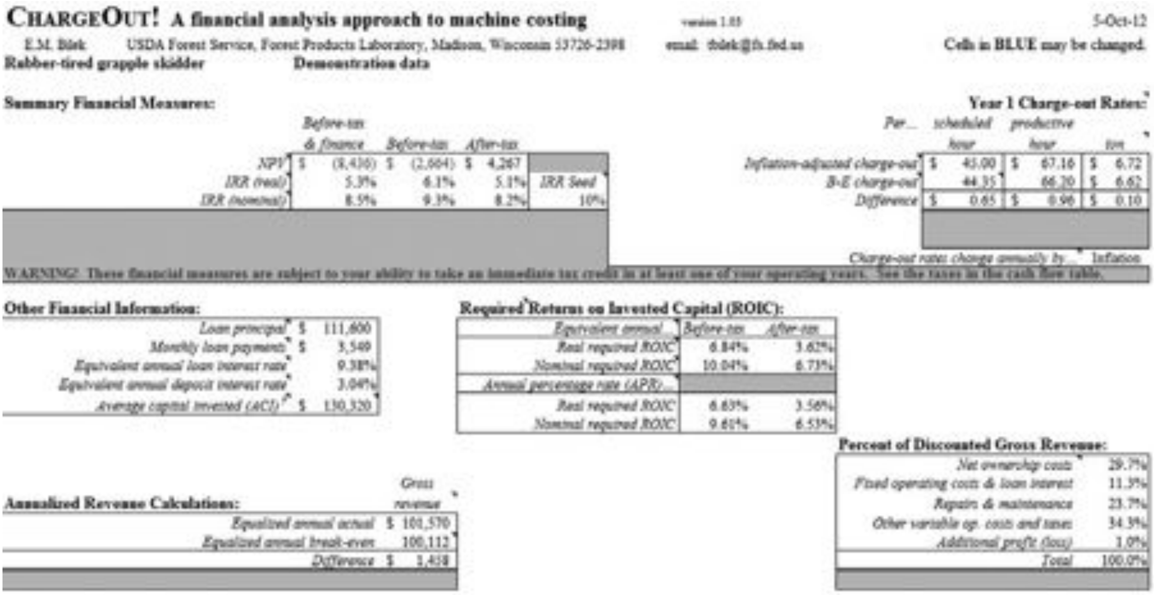
The fixed hourly costs are added to the variable hourly costs to arrive at the cost per scheduled hour for the machine. An earlier example determined the fixed costs for a particular machine to be \$25.69. Adding the \$22 in fuel and lube costs and the \$30 in labor costs shows the cost per productive machine hour for this example skidder is \$77.69 (\$25.69 +\$22.00+\$30.00).

A further distinction can be made to take a more accurate look at costs. While most pieces of logging equipment are present and available for the entire work day on a job site, they simply aren't run all day long. The utilization rate is the portion of the work day they actually run. For example, if a skidder is operated for 6 hours out of an 8 hour day, its utilization rate is 75% (6 ÷ 8).

The cost per productive hour for a machine is determined by dividing the hourly rate by the utilization rate. In our example, the cost per productive hour for operating the skidder is \$103.59 (\$77.69 ÷ 75%).

This hourly machine rate forms the basis for much of the analysis used throughout this publication.

It's informative to look at what portion of the cost of owning and operating a machine is attributed to the different cost items. The pie chart above illustrates this for the example skidder.



ChargeOut! A financial analysis approach to machine costing version 1.03 5-Oct-12

E.M. Bilek USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin 53726-2398 email: tbilek@fs.fed.us Cells in BLUE may be changed.

Rubber-tired grapple skidder **Demonstration data**

Summary Financial Measures:

	Before-tax & finance	Before-tax	After-tax	
NPV	$ (8,430)	$ (2,004)	$ 4,267	
IRR (real)	5.3%	6.1%	5.1%	IRR Seed
IRR (nominal)	8.5%	9.3%	8.2%	10%

Year 1 Charge-out Rates:

Per...	scheduled hour	productive hour	ton
Inflation-adjusted charge-out	$ 45.00	$ 67.16	$ 6.72
B-E charge-out	44.35	66.20	$ 6.62
Difference	$ 0.65	$ 0.96	$ 0.10

Charge-out rates change annually by... Inflation

WARNING! These financial measures are subject to your ability to take an immediate tax credit in at least one of your operating years. See the taxes in the cash flow table.

Other Financial Information:

Loan principal	$ 111,600
Monthly loan payments	$ 3,540
Equivalent annual loan interest rate	9.38%
Equivalent annual deposit interest rate	3.04%
Average capital invested (ACI)	$ 130,320

Required Returns on Invested Capital (ROIC):

Equivalent annual...	Before-tax	After-tax
Real required ROIC	6.84%	3.62%
Nominal required ROIC	10.04%	6.73%
Annual percentage rate (APR)...		
Real required ROIC	6.63%	3.56%
Nominal required ROIC	9.61%	6.53%

Annualized Revenue Calculations:

	Gross revenue
Equalized annual actual	$ 101,570
Equalized annual break-even	100,112
Difference	$ 1,458

Percent of Discounted Gross Revenue:

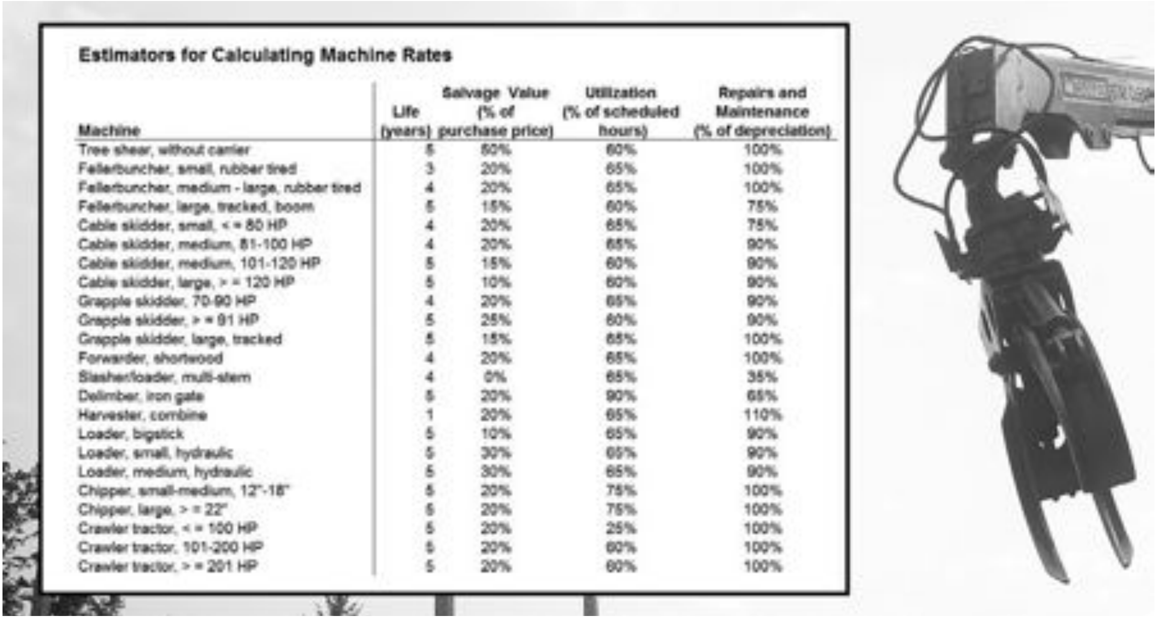
Net ownership costs	29.7%
Fixed operating costs & loan interest	11.3%
Repairs & maintenance	23.7%
Other variable op. costs and taxes	34.3%
Additional profit (loss)	1.0%
Total	100.0%

Machine Rate Alternative

A very good alternative to the traditional machine rate approach to examining the cost of owning and operating a machine is the ChargeOut! financial analysis approach to machine costing. This discounted cash flow approach is considered to be more accurate than machine rates – though the calculations themselves may be more difficult to follow.

ChargeOut! calculates the break-even charge-out rate that will return a user-specified after-tax real rate of return over the life of the machine. Negotiated rates can be used to calculate the net present values and real and nominal rates of return for various before and after-tax scenarios.

This free spreadsheet and accompanying instruction manual were created by the USDA Forest Service Forest Products Laboratory. A quick Internet search of the Forest Products Lab and ChargeOut! search terms will bring up links to the download site.



Estimators for Calculating Machine Rates

Machine	Life (years)	Salvage Value (% of purchase price)	Utilization (% of scheduled hours)	Repairs and Maintenance (% of depreciation)
Tree shear, without carrier	5	60%	60%	100%
Fellerbuncher, small, rubber tired	3	20%	65%	100%
Fellerbuncher, medium - large, rubber tired	4	20%	65%	100%
Fellerbuncher, large, tracked, boom	5	15%	60%	75%
Cable skidder, small, < = 80 HP	4	20%	65%	75%
Cable skidder, medium, 81-100 HP	4	20%	65%	90%
Cable skidder, medium, 101-120 HP	5	15%	60%	90%
Cable skidder, large, > = 120 HP	5	10%	60%	90%
Grapple skidder, 70-90 HP	4	20%	65%	90%
Grapple skidder, > = 91 HP	5	25%	60%	90%
Grapple skidder, large, tracked	5	15%	65%	100%
Forwarder, shortwood	4	20%	65%	100%
Slasher/loader, multi-stem	4	0%	65%	35%
Delimber, iron gate	5	20%	90%	65%
Harvester, combine	1	20%	65%	110%
Loader, bigstick	5	10%	65%	90%
Loader, small, hydraulic	5	30%	65%	90%
Loader, medium, hydraulic	5	30%	65%	90%
Chipper, small-medium, 12"-18"	5	20%	75%	100%
Chipper, large, > = 22"	5	20%	75%	100%
Crawler tractor, < = 100 HP	5	20%	25%	100%
Crawler tractor, 101-200 HP	5	20%	60%	100%
Crawler tractor, > = 201 HP	5	20%	60%	100%

Repairs & Maintenance Estimators

The estimators shown above are helpful in calculating machine rates using the steps outlined earlier. The useful lives of machines shown here are probably shorter than commonly experienced in the northeast. One way to compensate for a longer life is to decrease the salvage value. A common practice for machines that are kept longer is a reinvestment of additional funds for major overhauls that exceed things that are commonly considered routine repairs and maintenance.

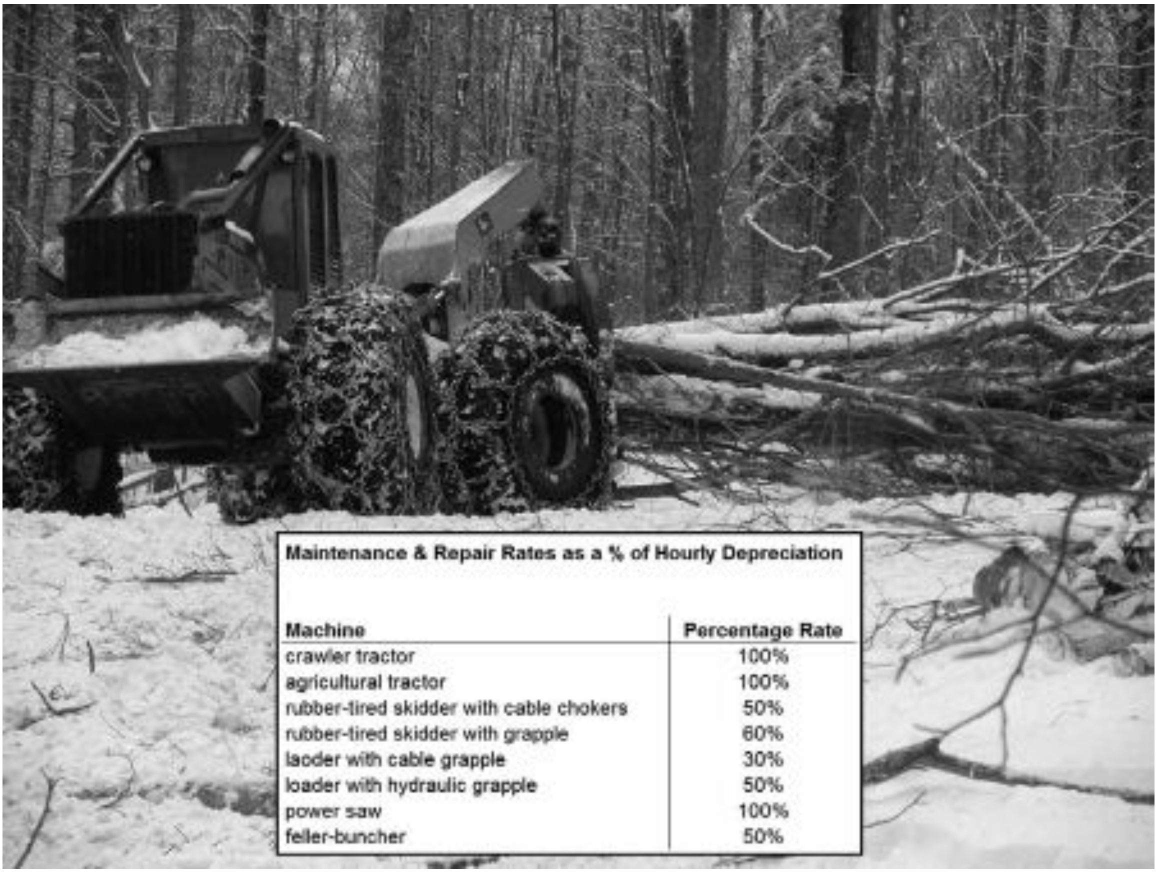
The table referenced above comes from a publication that is an excellent source of information on machine rates. It is available for free download from a number of online sources.

Sources:

Cubbage (2), Hypes and Stuart (4), Miyata (8), Warren (13) and authors.

Compiled from the above stated sources by Brinker, etal, presented in:

Brinker, RW; Kindard, J; Rummer, B; Landford, B. 2002. Machine Rates for Selected Forest Harvesting Machines. Circular 296. Auburn, LA: Alabama Agricultural Experiment Station 29 p.



Maintenance & Repair Rates as a % of Hourly Depreciation

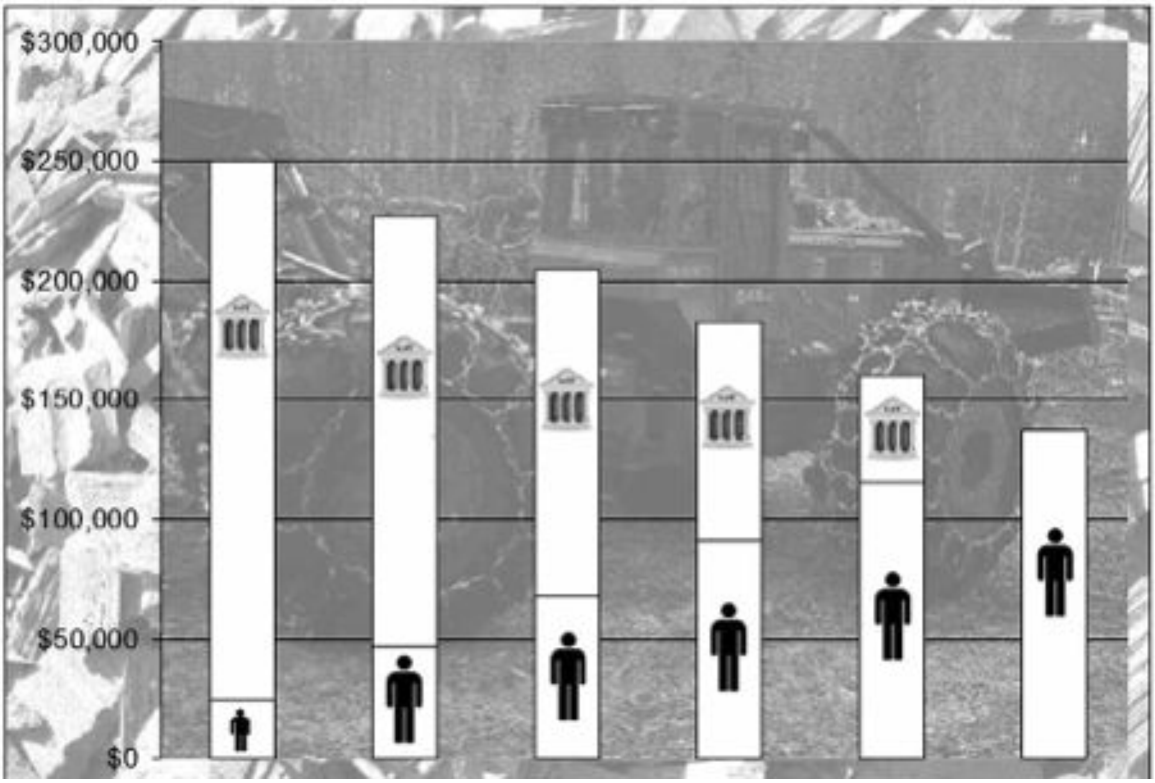
Machine	Percentage Rate
crawler tractor	100%
agricultural tractor	100%
rubber-tired skidder with cable chokers	50%
rubber-tired skidder with grapple	60%
laoder with cable grapple	30%
loader with hydraulic grapple	50%
power saw	100%
feller-buncher	50%

The rates shown here are another good source of assistance in determining repair and maintenance rates for logging equipment. For example, suppose the annual depreciation on a grapple skidder is $27,000. Using the rate of 60% shown above, repairs and maintenance of $16,200 would be expected.

While exact repairs and maintenance costs are difficult to predict, they should be expected and seen as inevitable. Brand new machines will of course tend to have lower costs in the first year or two of use and higher rates in successive years. In the absence of actual records, these rates allow for good estimates that average these costs over several years.

Source:
Cost Control in Forest Harvesting and Road Construction. 1992. (Volume 99) United Nations Food and Agricultural Organization. 106 p.

Equity and Ownership

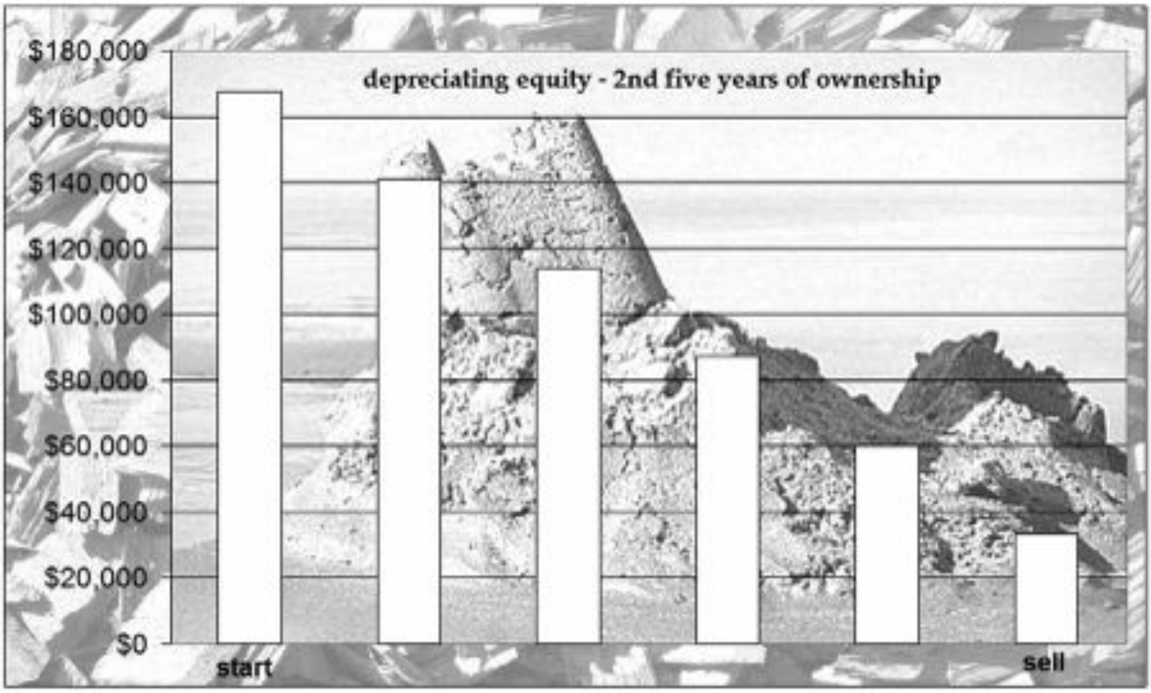


Who owns the machine in the background of this chart? Does it belong to the logger who bought it? Most purchases of new logging equipment are financed with loans. Suppose a logger bought this skidder new for $250,000. This amount may well have been more than he had lying around that week, so he went to a friendly banker and secured a loan. This banker is generous and thoughtful, but still asked the logger to put down 10% of the purchase price, in order to ensure he has a stake in making sure this machine is used to produce revenue to repay the loan.

Initially the logger owned 10% of the machine and the bank owned the other 90%. Bankers have no use for skidders, so over the course of 5 years the logger repays the loan with interest (4% in this case). Each year the amount of equity the logger has in the machine increases until he owns 100% of it.

Despite spending $273,623 over five years to own this machine outright, the value of the equity at this point is only about $137,500 (assuming straight line depreciation over ten years). The rest of the equity was consumed in operating the machine.

Building equity in a logging business is difficult because most of the money it tied up in equipment. Logging equipment is highly depreciable. It's as if a logger is building an inventory of sand castles. They can be repaired only a limited number of times before he needs to start over with a new one.

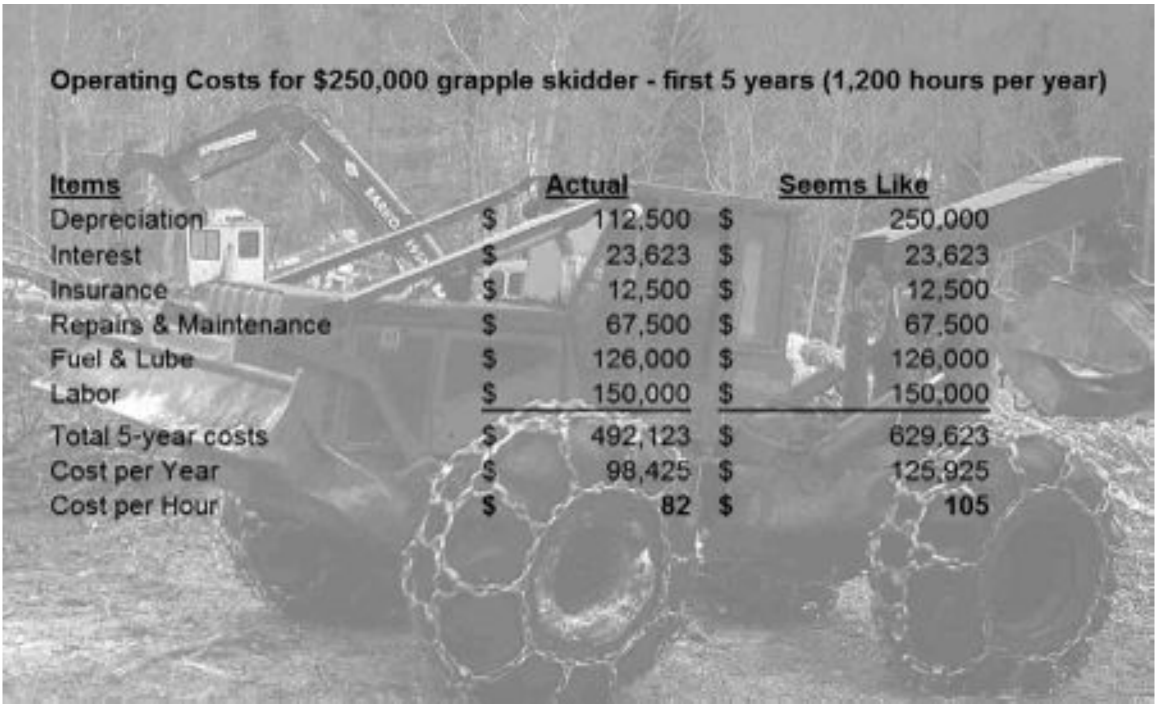


Highly Depreciable Business Assets

Suppose a logger purchased this machine with the intent of using it for ten years. After financing it for five years and paying it off, he is left with outright ownership of a machine worth about $137,500. Even with careful routine repairs and maintenance, chances are that after five years of front line work, some major repairs will be necessary. Assume he spends $30,000 on these repairs (sort of like scooping up the old sand to repair an eroding sand castle), making his new equity total in the machine $167,500. Taking it a step farther, the logger plans to depreciate 80% of this value over the next five years.

For the first five years, the depreciation was obvious because the logger was handing it over to the banker almost as quickly as he was building equity. This logger spent a total of $250,000 for the machine, consuming $112,500 ($250,000 - $137,500) of its value through depreciation. Look at it this way, the company pre-paid for $137,500 worth of inevitable depreciation going forward - $167,500 when the recent major repairs are counted.

From this point on, the pre-paid nature of this depreciation means he will be consuming it in a less obvious way over the next five years, but it will be just as spent once it is gone.



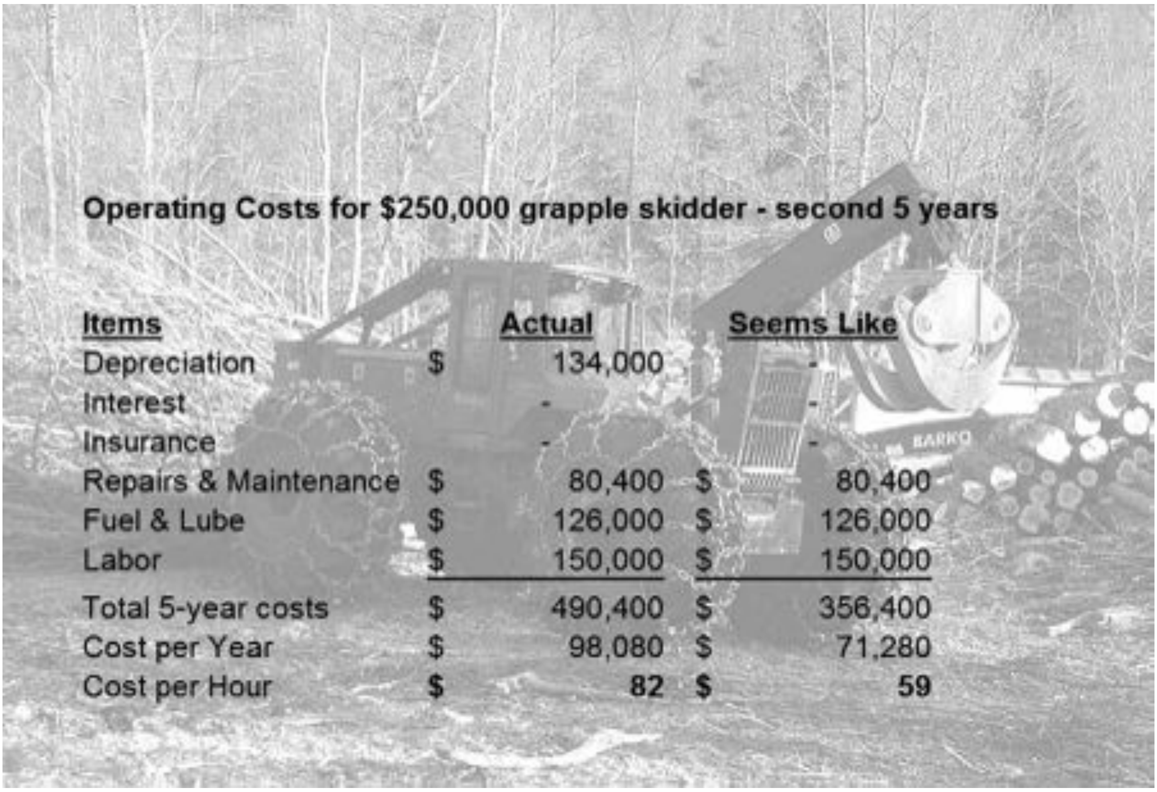
Operating Costs for $250,000 grapple skidder - first 5 years (1,200 hours per year)

Items	Actual	Seems Like
Depreciation	$ 112,500	$ 250,000
Interest	$ 23,623	$ 23,623
Insurance	$ 12,500	$ 12,500
Repairs & Maintenance	$ 67,500	$ 67,500
Fuel & Lube	$ 126,000	$ 126,000
Labor	$ 150,000	$ 150,000
Total 5-year costs	$ 492,123	$ 629,623
Cost per Year	$ 98,425	$ 125,925
Cost per Hour	$ **82**	$ **105**

First Five Years of Ownership

Consider what it costs to operate the machine over the first five years of ownership, assuming 6,000 hours are put on it. The interest is based on a five year loan of $225,000 at 4% interest. Insurance is $2,500 annually. Repairs and maintenance are calculated as 60% of depreciation. Fuel is based on consumption of 6 gallons per hour at $3.50 per gallon. Labor is based on $25 per hour. Actual depreciation is $112,500 over this five year period, but it seems like the full $250,000 purchase price because of the cash flows involved in repaying the loan.

While the true costs of owning and operating this skidder were $82 per hour, they seemed liked $105 per hour due to actual cash flows. The difference of $23 per hour is the cost of building equity in this machine. When the costs for the next five years are examined, the situation is reversed.



Operating Costs for $250,000 grapple skidder - second 5 years

Items	Actual	Seems Like
Depreciation	$ 134,000	-
Interest	-	-
Insurance	-	-
Repairs & Maintenance	$ 80,400	$ 80,400
Fuel & Lube	$ 126,000	$ 126,000
Labor	$ 150,000	$ 150,000
Total 5-year costs	$ 490,400	$ 356,400
Cost per Year	$ 98,080	$ 71,280
Cost per Hour	$ **82**	$ **59**

"Funny how falling feels like flying…..for a little while." **Stephen Bruton** & **Gary Nicholson**

Second Five Years of Ownership

In the second five years of owning this machine the actual costs seem lower than they really are. Without a monthly payment (with interest) and no insurance requirements, there is certainly less direct strain on cash flow. The difference is this logger is now consuming some of his equity through depreciation. He doesn't pay this out monthly or yearly – it just happens in the woods as he runs the skidder and it continues to lose value. While it may seem like this machine costs $59 per hour to operate, the true cost is $23 per hour more, at $82.

Conjured examples are understandably open to second guessing– rates and costs that seem reasonable in one location may be excessive in others. In this example, one can alter fuel prices, labor costs and repair rates in any direction, but the underlying cause of the difference between the actual costs and cash flows remains the same. Real depreciation occurs every time the skidder is used. Producing at rates lower than the true costs of a machine is known as "running on equity."

A single piece of equipment in a biomass harvesting operation is just one link in a production chain. Assessing how equity relates to costs and production is probably best done at a higher level that includes the entire operation. While anyone can calculate costs for single pieces of equipment, allocating portions of total revenue to them is much more difficult. A logger needs each piece of equipment to do the job or he probably wouldn't have it.

Equity

Equity is the total value of current assets, less debt. If a logger has kept good business records, he can easily reference this value. If not, this is another reminder of how important it is to keep good records.

In general, it is desirable to have an equity ratio in a business of 60% or more (or be under loan terms leave the business in this position when they are repaid). This is especially true during tough times, when fuel costs soar and wood prices shrink. One veteran biomass harvester summed it up this way:

"To do it productively and profitably, you know, you can squeak through bad times, if they're not forever. Somewhere you've got to make up for what you haven't been. You use your resources and your equity. You use up your equity, to survive. If you have no equity, you're in trouble."

As shown here, a logger is using up equity even in the best of times. Leaning on this equity in hard times means producing wood at rates that do not compensate for the depletion of this equity. Knowing what these rates are is essential to the health of a logging business. Failure to account for the consumption of equity will leave a business worse off over the long run.

A common dilemma for loggers is finding that their competitors do not understand true costs and the uncompensated depletion of their equity. The unwitting willingness of some to produce at below cost rates drives down prices for everyone.

The Sum of its Parts?

Isolating a single piece of equipment to analyze costs is easy, but ultimately it doesn't reveal very much. A logging business is a collection of harvesting equipment, directed by a leader, operated by labor and supported by off-site resources. Taking a close look at an entire business is a better way to understand the dynamics of equity and ownership and the inevitable erosion from depreciation.

Consider a ten-year period in a logging firm's existence divided into two five-year windows. Assume that the firm has $1,000,000 in assets. Suppose this firm has annual costs of $100,000 in overhead, $10,000 in equipment insurance, $50,000 in repairs and maintenance, and $312,593 in variable operating costs (fuel, labor, etc).

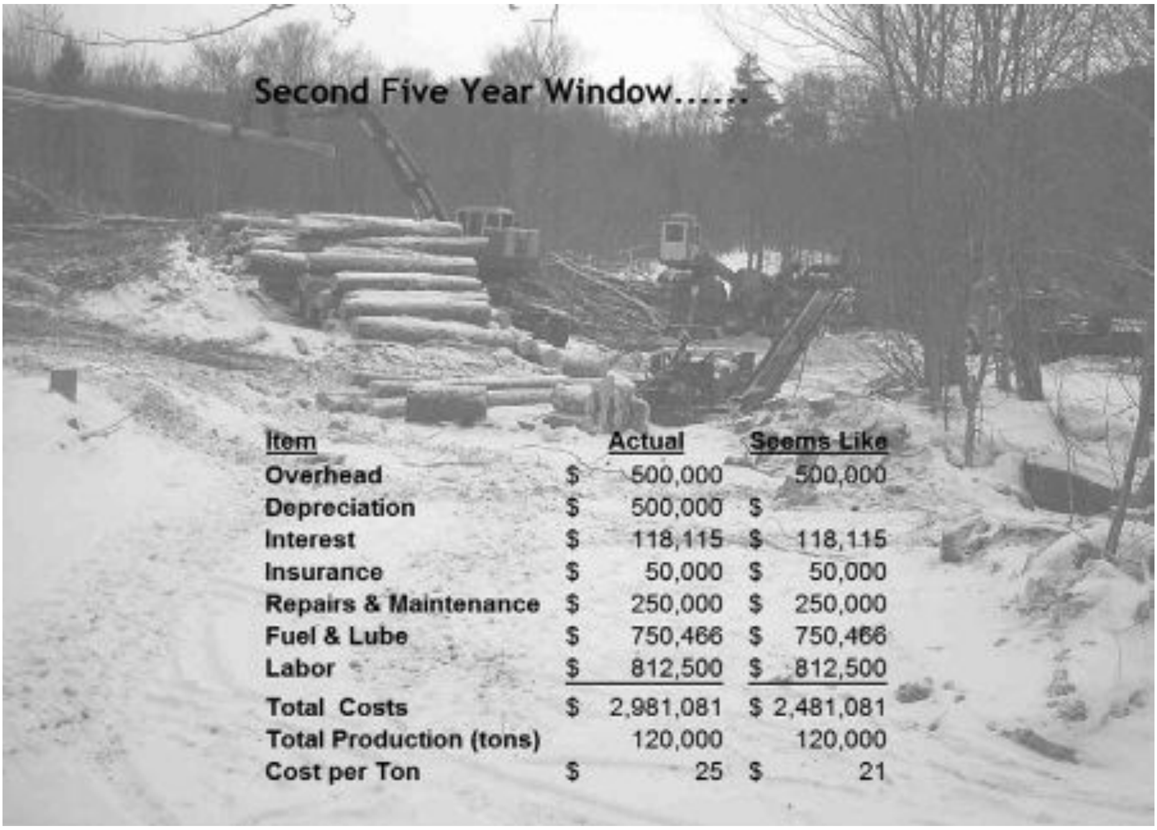
Assume the firm starts the first five-year window with 50% equity in the company, with loans to be retired over this time period. The interest on this loan amounts to $118,115 over its life.

For simplicity, this example will depreciate all of the assets at an equal rate over ten years, making annual depreciation $100,000.

Item		Actual		Seems Like
Overhead	$	500,000	$	500,000
Depreciation	$	500,000	$	500,000
Interest	$	118,115	$	118,115
Insurance	$	50,000	$	50,000
Repairs & Maintenance	$	250,000	$	250,000
Fuel & Lube	$	750,466	$	750,466
Labor	$	812,500	$	812,500
Total Costs	$	2,981,081	$	2,981,081
Total Production (tons)	$	120,000	$	120,000
Cost per Ton	$	25	$	25

First Five Years
In the first five years, the actual costs for production are identical to the cash flows. The loan is paid off in a way that matches the depreciation exactly. The true costs per ton are the same as the amounts this small business is paying out.

Real world examples aren't nearly as prone to neat numbers as seen here. Businesses are not static for five year periods. The general principle still holds, however. As long as loan payments are more or less equal to depreciation, the business is living the true costs of production day in and day out.



Second Five Years

Things look a bit darker in the second five-year window. In the absence of payments (including both repayment of principle and the interest), the true costs are difficult to see. In this cash flow, it appears that it costs $21 per ton of production. When the reality of equipment depreciation is taken into account, it's actually costing $25 per ton. At first glance a $4 difference might not seem like much. When the cumulative effect over a year is considered, however, it amounts to $96,000. Failure to recover these costs in revenue may well mean that a logger is unable to afford replacement equipment when his current equipment is worn out.

When a logger's livelihood depends on depreciable assets, he can realize a return on them only while their productive capacity is intact. Cash flows don't always neatly match up to costs. Knowing true costs will help tell the difference between flying and falling.

Firewood

Firewood is one of several competing uses for roundwood. Wood suitable for cutting up and splitting to burn is inevitably good pulpwood as well. A portion of the wood that might otherwise be used as firewood could also go into other products. Pallet lumber, pellets, OSB, flooring and various wood chip markets could all reach into the firewood pile under the right conditions.

"It's the only thing I make that I get to set the price of."

As one logger observed, the difference between firewood and other products is that it might be the only consumer product that a logger makes. Instead of a handful of large facilities that get to set the terms of the sale, firewood can be sold to many people. Another logger proudly talks of *"supplying heat for 100 families last year."*

Firewood sales are a mixed bag of advantages and disadvantages. The consolidation and contraction within the paper industry over the past generation has meant fewer pulpwood markets and, for many, longer trucking distances. Firewood logs can often be sold for the same nominal price as pulpwood, but the trucking costs are less. The delivery might be closer, but it can be difficult to unload or dump logs at someone's home in a way that's acceptable to all parties. Collecting payment for pulpwood is an automatic process in which the logger waits for a check to arrive. Collecting payment for firewood can be more stressful, though payments are often in cash. Some loggers are better suited than others to the customer service aspect of these transactions.

While few loggers have been able to shift their entire low grade production into firewood, some have cultivated enough markets to devote a substantial portion toward it. There are many do-it-yourself homeowners who want to cut and split firewood from roundwood. There are a also a significant number of retail cordwood producers who need a reliable supply of roundwood for their processors. These buyers may be a bit more demanding in terms of species content, size and overall quality, but they can make up for it by being a steady fixed location to sell wood.

This chapter is a general overview of firewood production possibilities for loggers. A collection of operations types, technical information and example calculations are presented.

Processing
The father and son team shown here produces and delivers split firewood one or two days each week. A larger accumulation of sawdust might be a problem on some worksites, but they have turned it into a co-product, supplying neighbors with horse bedding. While the processor can be run by a single person, they find the occasional support from a second person makes things more productive. The father breaks away from other nearby duties to load the deck with logs, position trucks for loading and keep the sawdust out of the way.

Like many firewood operations, this is a sideline to a logging business. The home yard is a convenient place to stockpile roundwood and then process it later. Stockpiling roundwood up to a year in advance allows them to achieve partial drying of their wood before they process. One of their goals is to handle the wood as few times as possible.
Having stationary productive capacity as a fill-in when they are not harvesting timber has proven to be a very good business choice for many loggers. As with any other biomass product, having markets within a reasonable distance is a prerequisite to production. While there are many ready markets for firewood in the rural landscape, there are locations where the population is too sparse and the competition to great to make firewood a meaningful opportunity.

Many firewood processors are equipped with a chainsaw bar for blocking up the wood. The block then falls in front of the wedge and is pushed through it with a ram. Note the small guide on the end of the block. This tells the operator how far to advance the log in order to cut the block to the desired length.

Like any chainsaw, this one must be kept sharpened and oiled. Dirty wood means more frequent sharpening. Frozen mud on the logs is particularly hard on the chain and causes frequent work stoppages. Loggers have a bit of an advantage in supplying their own roundwood, with greater control over the species mix, size and how clean the wood is.

A processer costing $25,000 and depreciated over ten years would have to produce just 17 cords annually at $150 each (net, less stumpage and trucking) in order pay back the purchase price. Alternatively, production of 167 cords would pay off the entire machine.

Part of the reason that firewood processing has been an appealing sideline for many loggers is the low capital investment in comparison to other equipment. Firewood has consistently provided a value-added product potential that builds on the large capital investments that are already sunk into harvesting operations.

High Production

A firewood processor with a headsaw is shown on the facing page. These processors are more productive than those that use a chainsaw bar. There is far less time spent sharpening them and they are much better at cutting dirty wood. This increased productivity comes at a higher cost – both up front and in operation. These processors are more expensive to purchase and use more fuel than other models.

These high productivity processors are well-suited to businesses that bring in roundwood, but have limited control over quality. When size and dirt content in the wood can't be controlled, a producer can mitigate these factors with a processor that handles such wood.

Mobile Production

This operation integrates split firewood production into the processing done on the landing. Clean roundwood that is manageable in size is sorted for processing into firewood. Three times a day, in between other duties, wood is blocked, split and then loaded onto pickup trucks with a conveyor. Each load comprises two to three face cords and takes approximately 15 minutes to produce. This diesel-powered splitter has a four-way splitting head so that each block can be fully split in a single pass. While this work is obviously tough on a logger's back, the conveyor does the hardest part of the loading.

Wood that might otherwise have been chips or pulpwood and sold in the $20 to $40 per ton range is worth over $80 per ton as split firewood. While very few loggers have the opportunity to shift the majority of their production to this higher-value product, it is a worthwhile part of the production mix in many locations.

If there is a ready market for split firewood, this level of production can be a very good way of adding revenue without taking on a major investment in equipment. It can also serve as a way to allow employees to supplement their income. For many small businesses, this is an important means of retaining good employees.

Conveyors

A conveyor (sometimes called a wood elevator) is an essential time and labor saving machine in split firewood production. These conveyors are wheeled into place and the elevation is adjusted to suit the truck being loading. Positioned as this conveyor is directly behind the splitting wedge, it collects split wood with minimal human effort and then carries it up to the back of the truck. The conveyor shown is hydraulic, while other models are powered with small engines.

Loading is perhaps the most strenuous aspect of producing split firewood. A well maintained conveyor replaces this labor without talking back or causing flair ups of back pain. As with any machinery, it is not without a certain amount of down time, but many firewood producers have a clearly-stated preference for a conveyor over an employee.

Suppose a firewood producer purchased a conveyor for $6,000, intending to run it just 200 hours per year. Depreciating this machine over 5 years and taking fuel consumption and repairs and maintenance into account, it costs about $15 per hour to own and operate. A conservative comparison might call this machine twice as productive as a laborer in loading wood. Realistically, the alternative isn't hiring someone an hour here and there for loading. Instead, loading by hand would mean shifting an employee from something else they are doing. If firewood is being produced on a log landing, the operation almost certainly has something more important for that person to do.

Annual cordwood production needed to pay back 5 year loans at 5% interest.

loan amount	total of payments	$150/cord	$175/cord	$200/cord	$225/cord	$250/cord
$ 10,000	$ 11,323	15	13	11	10	9
$ 15,000	$ 16,984	23	19	17	15	14
$ 20,000	$ 22,645	30	26	23	20	18
$ 25,000	$ 28,307	38	32	28	25	23
$ 30,000	$ 33,968	45	39	34	30	27
$ 35,000	$ 39,630	53	45	40	35	32
$ 40,000	$ 45,291	60	52	45	40	36
$ 45,000	$ 50,952	68	58	51	45	41
$ 50,000	$ 56,614	75	65	57	50	45
$ 55,000	$ 62,275	83	71	62	55	50
$ 60,000	$ 67,936	91	78	68	60	54
$ 65,000	$ 73,598	98	84	74	65	59
$ 70,000	$ 79,259	106	91	79	70	63
$ 75,000	$ 84,921	113	97	85	75	68
$ 80,000	$ 90,582	121	104	91	81	72
$ 85,000	$ 96,244	128	110	96	86	77
$ 90,000	$ 101,905	136	116	102	91	82
$ 95,000	$ 107,566	143	123	108	96	86
$ 100,000	$ 113,227	151	129	113	101	91

Payback Production

This table shows the annual production levels needed to retire firewood processor loans over a five-ear period (5% interest). Production levels are based on a range of full cord prices. Five years of production at these levels would be necessary to pay back the entire loan, including interest. The production levels shown leave enough room for the additional production that will be necessary to cover operating costs and turn a profit.

To create a similar annual payback table based on face cord prices, divide the annual payment amounts by the face cord prices to determine the annual production levels.

Firewood processing scale comparison assumptions:

Small				
	bar processor:	$25,000	used truck:	$ 15,000
	useful life:	7 years		5 years
Medium				
	bar processor:	$60,000	used truck:	$ 25,000
	useful life:	7 years		5 years
Large				
	headsaw processor:	$60,000	used truck:	$ 30,000
	useful life:	7 years		5 years
Labor: $25 per hour		Fuel:	$4/gallon	

Comparing Scales

A convenient generalization about firewood processing operations involves dividing them into small, medium and large scales. Many factors go into determining the ideal size of an operation, including the availability of roundwood and labor, along with the local firewood demand. There are many examples of profitable operations in all of these size classes.

The table shows a general set of assumptions used to make a comparison of three potential operations. Option 1 calls for a small scale bar saw processor costing $25,000 and a used dump truck costing $15,000. Option two calls for a mid-sized bar saw processor costing $60,000 and a used dump truck costing $30,000. Option three calls for a large head saw processor costing $100,000 and a used dump truck costing $30,000. A useful life of 7 years (25% salvage value) is assumed for each processor and 5 years for each truck. Labor is set at $25 per hour. Production is assumed to be the equivalent of 200 eight-hour days each year and the utilization rate is 75%. Fuel consumption was factored in at appropriate rates and a cost of $4 per gallon.

The comparison on the facing page shows the break even production levels for three potential firewood processing operations. The price shown ($100 per cord) is intended to be a net that excludes the cost of roundwood.

Altering the price within the PATH worksheet will change the break-even level of production. While the numbers shown here are in full cords, calculations can be made in terms of face cords as well.

Based on the production ratings for each of these machines, an average of about three hours of production each day, or 600 hours each year, would be necessary to break even. This leaves room to turn a profit on production that exceeds this level. The equivalent of 200 eight hour days is a best case scenario, but as long as all of the remaining 1,000 hours above the break-even point are not lost to inevitable setbacks that plague all jobs and machinery, a profitable operation is possible.

This example assumes that each of these operations are full-time, year-round endeavors. While there are some full-time year-round producers, the seasonal nature of this business means the workload will often be less even, especially for smaller producers. More than half of firewood demand comes in the fall, concentrating much of the production into a shorter time frame.

If a producer can cut, split and load firewood when orders come in, this means that the split wood is usually only handled once, loading it as it is produced. A more or less constant year-round production level means that some of the wood will be stockpiled until there is an order for it. Handling wood twice raises the production costs.

Stockpiled wood can be stacked to dry and sold for a premium over green wood, but there are costs involved. Heaped piles do not dry particularly well, but stacking is labor intensive. When all of the production costs except delivery are borne months in advance it can tie up a substantial amount of money before the wood is sold.

Loading large quantities of stockpiled wood involves either a lot of handling or a significant investment. A machine with a bucket can load wood if it is stored on a concrete pad and there is a walled loading bin.

PATH *Planning & Analysis in Timber Harvesting*

Company Name:

Wood Energy Co. 10/10/2012 12:32

Print Report

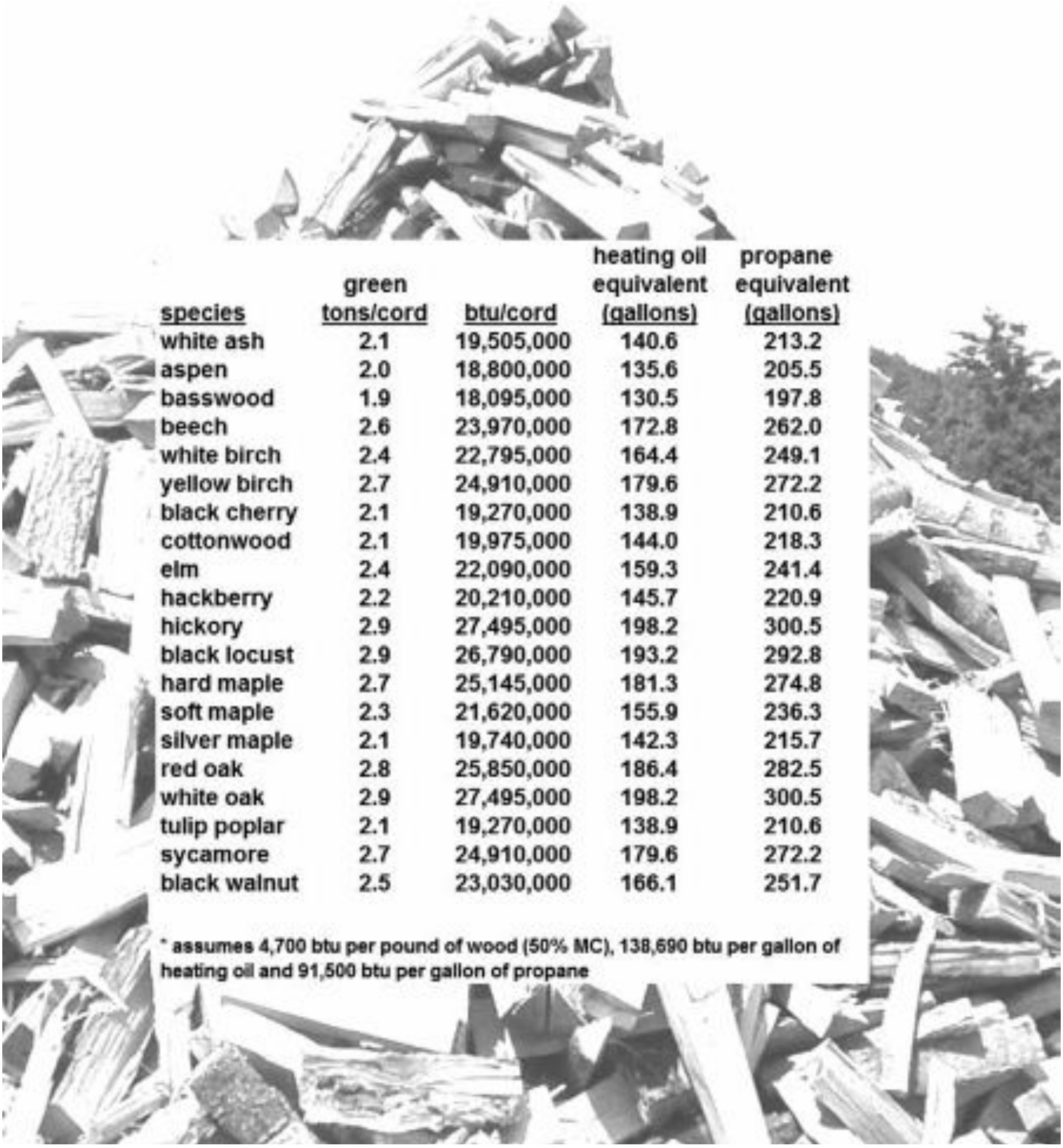
Comparison Report for Alternative Equipment Configurations

Please enter the following information to allow comparisons:

	Annual Overhead	Total Annual Cost	Productive Days/Year	MBF, Tons or Cords	Price Received
Option 1	$ 6,000	$ 82,472	200	Cords	$ 100
				(select MBF, Tons or Cords)	(per Unit)
Option 2	$ 12,000	$ 122,720	200	Cords	$ 100
				(select MBF, Tons or Cords)	(per Unit)
Option 3	$ 18,000	$ 166,523	200	Cords	$ 100
				(select MBF, Tons or Cords)	(per Unit)

Break Even Production Level Required for Each Option

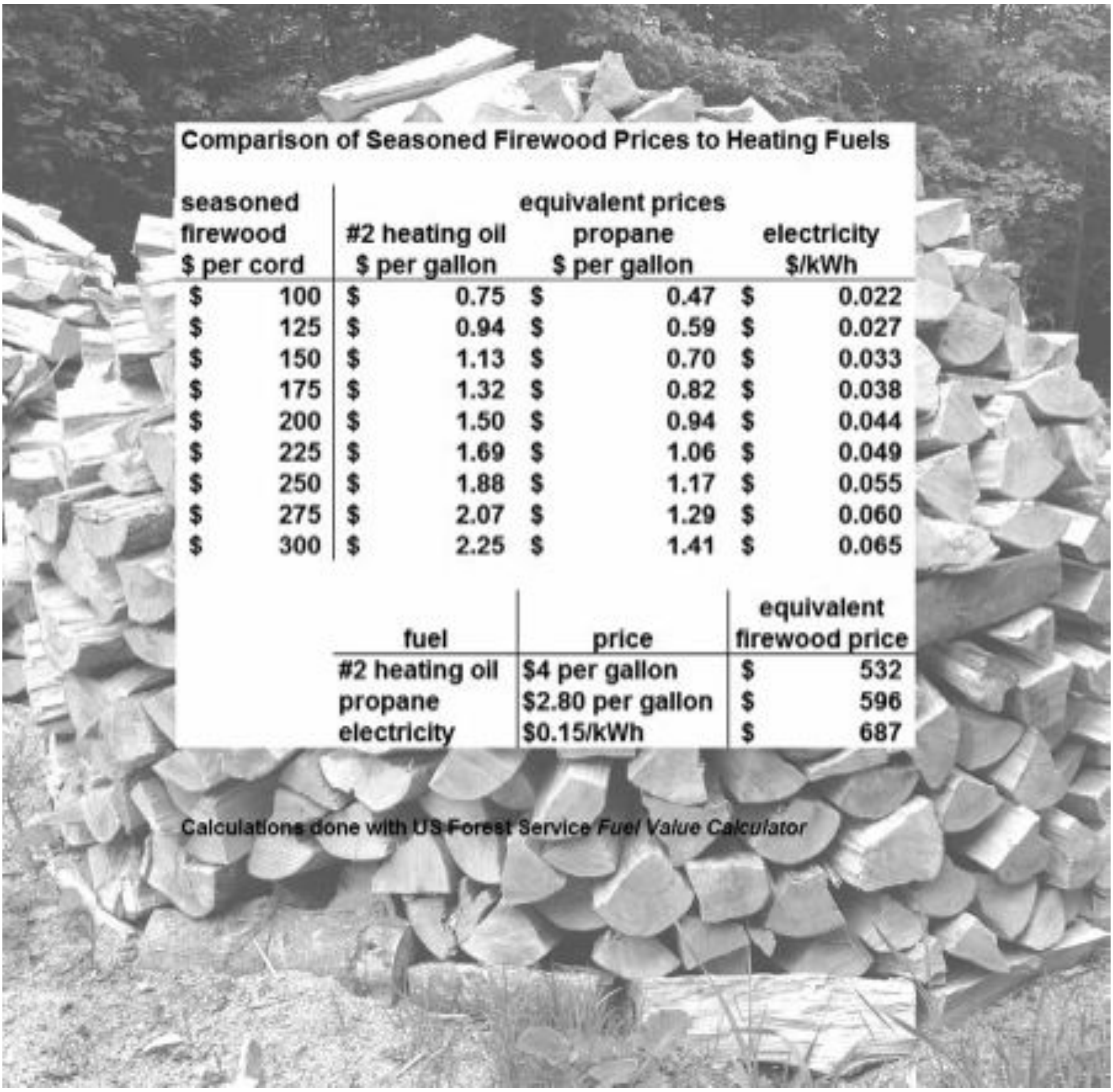
	Annual	Weekly	Daily	
Option 1 Low	825	20.6	4.1	Cords
Option 2 Medium	1,227	30.7	6.1	Cords
Option 3 High	1,665	41.6	8.3	Cords



species	green tons/cord	btu/cord	heating oil equivalent (gallons)	propane equivalent (gallons)
white ash	2.1	19,505,000	140.6	213.2
aspen	2.0	18,800,000	135.6	205.5
basswood	1.9	18,095,000	130.5	197.8
beech	2.6	23,970,000	172.8	262.0
white birch	2.4	22,795,000	164.4	249.1
yellow birch	2.7	24,910,000	179.6	272.2
black cherry	2.1	19,270,000	138.9	210.6
cottonwood	2.1	19,975,000	144.0	218.3
elm	2.4	22,090,000	159.3	241.4
hackberry	2.2	20,210,000	145.7	220.9
hickory	2.9	27,495,000	198.2	300.5
black locust	2.9	26,790,000	193.2	292.8
hard maple	2.7	25,145,000	181.3	274.8
soft maple	2.3	21,620,000	155.9	236.3
silver maple	2.1	19,740,000	142.3	215.7
red oak	2.8	25,850,000	186.4	282.5
white oak	2.9	27,495,000	198.2	300.5
tulip poplar	2.1	19,270,000	138.9	210.6
sycamore	2.7	24,910,000	179.6	272.2
black walnut	2.5	23,030,000	166.1	251.7

* assumes 4,700 btu per pound of wood (50% MC), 138,690 btu per gallon of heating oil and 91,500 btu per gallon of propane

BTU Comparison
This table shows the btu content for various species of hardwood. Calculations are based on 4,700 btu per pound of green wood (50% MC). It also shows the equivalent gallons of heating oil and propane per cord, based on btu content. While firewood is clearly a less expensive source of btu's than these other fuels, it is also less convenient. Realizing all of the btu's in firewood requires quite a bit of handling, drying and efficient burning.



Comparison of Seasoned Firewood Prices to Heating Fuels

seasoned firewood $ per cord	#2 heating oil $ per gallon	propane $ per gallon	electricity $/kWh
	equivalent prices		
$ 100	$ 0.75	$ 0.47	$ 0.022
$ 125	$ 0.94	$ 0.59	$ 0.027
$ 150	$ 1.13	$ 0.70	$ 0.033
$ 175	$ 1.32	$ 0.82	$ 0.038
$ 200	$ 1.50	$ 0.94	$ 0.044
$ 225	$ 1.69	$ 1.06	$ 0.049
$ 250	$ 1.88	$ 1.17	$ 0.055
$ 275	$ 2.07	$ 1.29	$ 0.060
$ 300	$ 2.25	$ 1.41	$ 0.065

fuel	price	equivalent firewood price
#2 heating oil	$4 per gallon	$ 532
propane	$2.80 per gallon	$ 596
electricity	$0.15/kWh	$ 687

Calculations done with US Forest Service *Fuel Value Calculator*

Price Comparison to other Fuels

Firewood commonly sells for far less than alternative fuels such as heating oil, propane and electricity when comparisons are made on a btu basis. This table compares a range of prices for seasoned firewood to equivalent prices for alternatives. It also shows equivalent prices per cord to the actual prices commonly paid for these fuels in recent years. The differences are eye opening. Home owners usually figure out these savings on their own, but firewood producers should be familiar with these comparisons as part of marketing the product.

Dump Box Loose Cord Firewood Hauling Capacity

cubic yards	loose full cords	cubic yards	loose full cords	cubic yards	loose full cords
1	0.15	15	2.25	33	4.95
1.5	0.23	16	2.40	34	5.10
2	0.30	17	2.55	35	5.25
2.5	0.38	18	2.70	36	5.40
3	0.45	19	2.85	37	5.55
3.5	0.53	20	3.00	38	5.70
4	0.60	21	3.15	39	5.85
4.5	0.68	22	3.30	40	6.00
5	0.75	23	3.45	41	6.15
6	0.90	24	3.60	42	6.30
7	1.05	25	3.75	43	6.45
8	1.20	26	3.90	44	6.60
9	1.35	27	4.05	45	6.75
10	1.50	28	4.20	46	6.90
11	1.65	29	4.35	47	7.05
12	1.80	30	4.50	48	7.20
13	1.95	31	4.65	49	7.35
14	2.10	32	4.80	50	7.50

1 cubic yard = 27 cubic feet; 128 cubic feet = 1 stacked cord; 180 cubic feet = 1 loose thrown cord

Hauling Capacity – Full Cords

Firewood is commonly delivered in dump boxed trucks or dump trailers. Much of this time the wood is loose – tumbled in off a conveyor or (gulp) tossed in by hand. Customers like to know how much wood they are buying and prices are often quoted on a cord basis.

This table shows the hauling capacity of various dump box sizes, expressed in cubic yards. One cubic yard is equal to 27 cubic feet. The State of Maine defines a loose cord as the wood occupying 180 cubic feet. Multiple thrown cord studies have supported this definition. Thrown cords were stacked to measure actual cords – 128 stacked cubic feet being the definition of a full cord. The numbers shown in the table above apply to firewood 16 inches in length.

Dump Box Loose Face Cord Firewood Hauling Capacity

cubic yards	loose 16" face cords	cubic yards	loose 16" face cords	cubic yards	loose 16" face cords
1	0.5	15	6.8	33	14.9
1.5	0.7	16	7.2	34	15.3
2	0.9	17	7.7	35	15.8
2.5	1.1	18	8.1	36	16.2
3	1.4	19	8.6	37	16.7
3.5	1.6	20	9.0	38	17.1
4	1.8	21	9.5	39	17.6
4.5	2.0	22	9.9	40	18.0
5	2.3	23	10.4	41	18.5
6	2.7	24	10.8	42	18.9
7	3.2	25	11.3	43	19.4
8	3.6	26	11.7	44	19.8
9	4.1	27	12.2	45	20.3
10	4.5	28	12.6	46	20.7
11	5.0	29	13.1	47	21.2
12	5.4	30	13.5	48	21.6
13	5.9	31	14.0	49	22.1
14	6.3	32	14.4	50	22.5

1 cubic yard = 27 cubic feet; 128 cubic feet = 1 stacked cord; 180 cubic feet = 1 loose thrown cord
1 stacked cord = 3 face cords

Hauling Capacity – Face Cords
In some areas consumers are most comfortable with face cords. A face cord is all of the wood stacked eight feet wide and four feet high. The actual portion of a full cord this represents depends on the length of the wood. If the wood is 16” long, three face cords equals one full cord.

This table shows the number of 16” face cords held by various sizes of dump boxes.

Woody Biomass Harvesting Guidelines

Many biomass harvesting and related guidelines have been developed in recent years. Most are voluntary guidelines, published by the state's natural resource agency. In some cases, development of these guidelines was required by statute. In addition to these state-level guidelines, there are some guidelines suggested by non-profit groups and others.

Other states have taken a wait-and-see approach to issuing guidelines, and some, such as New Hampshire, have decided they are an unnecessary addition to existing guidelines for timber harvesting.

Woody biomass harvesting, as used in these guidelines, is something of a misnomer. People have been harvesting woody biomass for heat in most of these areas for centuries. In many places, whole tree harvesting has been done for a generation or more (usually pre-dating the term "biomass"). Harvesting for biomass use often means utilization of bolewood and in particular the upper portions of stems. The focus of these guidelines is on harvesting of topwood. In reality, these guidelines are for whole tree harvesting, or, far less commonly, subsequent harvest of downed tops in a second operation.

Common Themes in Biomass Harvesting Guidelines

Existing guidelines provide us with a great deal of information about how to safeguard harvesting sites and the rationale for doing so. A common thread through all of them is a concern for soil, water quality, and site-level biodiversity. While these are concerns on any timber harvesting site, there is a greater potential impact on all of these resources when bigger equipment makes more frequent trips in and out of the woods and is used to remove a larger volume of material than in a conventional harvest.

While some guidelines do a better job of conveying information than others, there are some good recommendations in all of them. Most have some questionable direction in the form of arbitrary retention standards, with very little in the way of practical advice on how to accomplish them. Some guidelines stray into items that either should not be lumped in with practical considerations or detract from the core message of how to protect on-site resources. Other guideline inclusions represent someone's wish list for all forest management activities.

Loggers should be aware of the guidelines that are applicable to them. These guidelines may be state mandated or guidelines that are specified or referred to in a timber sale or harvesting contract. Some guidelines are clearly the responsibility of the logger, while others may be the landowner or forester's responsibility. When guidelines are voluntary, emphasize those that protect on-site resources.

Responsibilities

Responsibilities for following the many recommendations in biomass harvesting guidelines are usually undefined. While the logger is the most obvious party when it comes to a harvesting operation, there are others in the background. Some responsibilities might logically fall to the forest owner, forester, or the logger. Ideally, these would be shared responsibilities. Planning, site investigation and determination of whether or not whole tree harvesting is appropriate for a situation should be done in advance of selection of the logging contractor. It is not logical to put a mechanized biomass harvesting crew on a site and then leave them to determine whether they can use their full array of equipment and practices.

In situations where the logger has purchased the timber directly from a landowner and there is no oversight from a forester, the onus is upon the logger to investigate the type of harvesting that is appropriate. The costs of following harvesting guidelines will usually be felt in productivity.

When a forester has been engaged by the landowner (or, in the case of many of the large land owning companies, a forester is an employee) the forester should review the guidelines applicable to a site to determine where, when, and under what circumstances whole tree harvesting is allowable. These realities can then be reflected in how the timber is advertised for sale or what type of logging contractor is selected to do the work.

Soil

Soil is one of the main focuses of biomass harvesting guidelines. There are several considerations, including productivity, erosion and protection of soil properties.

Soil productivity is perhaps the most important and least agreed upon aspect of harvesting guidelines. Removal of large quantities of fine woody material has the potential to deplete soil nutrients, especially on poorer sites.

Erosion is a concern in any harvesting operation, so increased site traffic and skidding of whole trees might increase erosion potential. Site layout and timing are important considerations in avoiding erosion.

The physical properties of soil and its compaction by heavy equipment are a concern as well. Compaction of main skid trails is inevitable. Compaction across the entire harvesting site must be addressed at the site level.

The biological properties of soil can be altered by heavy equipment traffic and overstory removal. Soil temperatures and water availability may change after a harvest.

Water

Protecting water is an important issue on any harvesting site. Water quality is one of the primary focuses of woody biomass harvesting guidelines because these harvests often involve large equipment, more passes by this equipment, and removal of a greater volume of wood. Greater risk and the perception of greater risk mean more attention to water quality safeguards is warranted. Following existing water quality Best Management Practices (BMPs) should be sufficient to protect water in most cases.

When working on lands managed by foresters, a good approach to BMPs is to ask them to identify specific water quality protection concerns for individual harvesting sites. Select the appropriate time of the year to meet the harvesting goals in advance of the work. Review the layout of trails and landing areas and designate any areas that are off limits to equipment. Successful protection of water quality is a shared responsibility of the landowner, forester and timber harvester.

Biodiversity

Biodiversity concerns for any individual harvesting site is one aspect of larger biodiversity concerns at the ownership and landscape levels. A general awareness of biodiversity does not require maximizing it on each individual harvesting site. Biodiversity is a policy and management level concern that should be addressed in any planning that ultimately culminates in timber harvesting on a site

Site-level biodiversity concerns that have not been addressed by overriding management plans, policies and regulations can be investigated by looking into natural heritage inventories. Many states have posted enough natural heritage information to allow initial inquiries to be completed online. Interactive maps can help determine if there are species of special concern known to be on a particular site. If so, further inquiries to the state regarding management considerations and strategies may be necessary.

Stumps and Roots

Though seldom if ever contemplated by loggers, removal of both stumps and roots are universally presented as undesirable during biomass harvesting. In addition to the obvious physical impact this would have on the soil, it would deprive the site of the nutrients that are released as this below-ground portion of the tree slowly decays. Most woody biomass harvesting guidelines are presented as a good faith effort to cover all bases. With this in mind, a number of obvious safeguards are listed.

Stump and root removal is common when land is cleared for development, but this can hardly be considered a timber harvesting activity. Land use policy and related safeguards are beyond the scope of individual timber harvesting site considerations.

Fine Woody Material

Fine Woody Material (FWM; occasionally called Fine Woody Debris or FWD) has a variety of definitions in woody biomass harvesting guidelines, but generally refers to tree and shrub branches and tops six inches and less in diameter. This material is typically left behind in conventional hand harvesting and cut-to-length harvesting, but may be removed in biomass harvesting (as well as some mechanized harvesting that handles tree length material, even when no products are produced from the tops).

Various guidelines call for leaving or returning 10%, 20% and 30% of this material on the harvesting site. Others guidelines, such as Maine's retention standards, are less prescriptive and simply point out the highest concentration of nutrients for cycling back into the soil is found in this portion of the tree.

A risk-averse approach to the issue of how much FWM to retain or return is that the greater the concern about loss of soil productivity, the more FWM should be left. With this in mind, thinner, less productive soils may warrant greater retention of FWM.

It should be noted that this portion of the tree has the least valuable material for woody biomass products and in some cases, it is suitable only for grindings. It is also the portion of the tree most likely to collect dirt. Dirt wears out machinery and reduces the quality of the product for the end-user.

Coarse Woody Material

Coarse Woody Material (CWM; alternatively, Coarse Woody Debris or CWD) refers to stems and branches that are six inches in diameter or larger. Most biomass harvesting guidelines call for retaining all of the existing CWM on a harvesting site. This has less to do with soil nutrients than wildlife habitat and biodiversity.

While this is an excellent guideline, there is no reason it must be followed in every single instance. For example, a recently wind-thrown sawtimber tree that still has merchantable value could certainly be harvested. Less commercially valuable trees may have more immediate wildlife value if cavities or decay is already present.

Snags

Snags should be retained and not cut down on woody biomass harvesting sites. These trees often provide cavities for nesting by a variety of birds and mammals and serve as hosts for a wide variety of other organisms.

An exception to this guideline is made when the snag should be brought down for safety reasons. If the tree is cut, it should be left on the ground as CWM. Loggers should be aware of OSHA regulations regarding hazard trees and how they pertain to retention of snags.

Any individual action in pursuit of these guidelines is subject to safety considerations. If there is an unreasonable risk of injury, the action should be foregone. If the action involves retention of CWM or FWM, there are usually many opportunities to compensate for it somewhere else on the harvesting site.

Operational Considerations For Following Guidelines

Lacking in the various guidelines for biomass harvesting and retention are practical suggestions for implementation. It's one thing to be aware of the rules and another to figure out how to incorporate them into harvesting operations and the existing cost structure of a business. This chapter makes observations and suggestions about how to incorporate common items from biomass harvesting guidelines and retention standards into everyday whole tree harvesting operations.

Safety

Any individual site level activity conducted in pursuit of these guidelines should be foregone if, in the reasonable judgment of the people involved, they pose an undue risk of death or injury or create a hazard for subsequent workers or visitors to the site.

<u>Suggestions</u>

- Incorporate discussion and identification of potential safety hazards related to following guidelines into any pre-harvest logging crew safety meetings.

Planning
In planning the harvest, conduct a site level assessment of the risks of harming soil productivity, water quality, site level biodiversity and the residual stand in implementing the desired prescription. Some sites or portions of sites may be ruled out for whole tree harvesting while others may be viable only with particular ground conditions (e.g. dry, frozen or snow covered).

Common site review items

1. Soil Type and Slope
2. Natural Heritage Review
3. Presence of High Conservation Value (HCV) Forest
4. Equipment Mix and Harvesting Practices

<u>Suggestions</u>
- Retain sufficient FWD for soil type and productivity (poorer soils = more retention)
- Do not conduct whole tree harvests in HCV Forests
- Do not conduct whole tree harvests in known habitats for threatened or endangered species, unless this will enhance the habitat for them

Water Quality Best Management Practices

Best management practices for water quality should be followed on any timber harvesting site. In many cases, the standard practice of following water quality BMPs addresses many of the concerns expressed about whole tree harvesting. The intensity of the harvesting operation, coupled with the site conditions, will dictate the specific practices necessary.

Suggestions

- Review the BMP guide after initial site inspection and plan necessary implementation of BMPs
- A well laid-out trail system can concentrate equipment traffic on a smaller area.
- Stream crossings must be adequate to handle the weight and traffic levels of the equipment involved.
- Depending on the amount of soil disturbance that occurs, a greater number of post-harvest water diversions may be necessary.
- Harvesting prescriptions should leave an adequate number of trees in riparian zones to prevent changes in stream temperatures.

Soil & Litter Layer

Equipment can cause soil compaction that will require time for the soil to recover. Movement of the litter layer can also alter soil temperature and increase susceptibility to erosion. Therefore, it is good practice to minimize the disturbance to the litter layer of the soil, except where soil scarification is a planned result.

Suggestions

- Schedule harvests for portions of the year that will minimize impact – leaving the sites with the most potential for damage for harvesting at the time of the year when they are most protected.
- Lay out harvesting operations in a manner that minimizes ground exposure to equipment and skidded tops. Often this will mean planning high impacts on small areas. High impact areas may need post-harvest safeguards, consistent with BMPs.

Stumps & Roots
There is a significant amount of both coarse and fine woody debris in the ground in the form of stumps and roots. Removal of stumps and roots will harm biological and physical soil properties and may contribute to erosion. While it is very seldom contemplated, stumps and roots should not be removed.

<u>*Exception*</u>
Occasionally a logger will have a request for one from a specialty woods craftsperson. Removal of one or two stumps from a low-risk site is permissible.

Coarse Woody Material

Course Woody Material provides habitat for many wildlife species, so leave most CWM on-site. Downed material should be left in place. Standing snags should be left alone, unless they must be cut down for safety reasons. Any such trees cut down for safety reasons should be left on site.

Exceptions

Salvage harvests of wind thrown or insect damaged stands.

Isolated individual sawtimber trees that have recently been wind thrown and remain merchantable.

Suggestions

- Identify any variations to standard practices for CWM in the harvesting plan and make all felling and skidding personnel aware of them.

Fine Woody Material
Retain sufficient FWM on-site to protect soil productivity. There is no current scientific basis for universal retention standards. Sites with low soil productivity (thin and wet soils, for example) will need a greater amount of FWM than more productive sites. Partial harvests will require less retention if whole trees are removed than late stage shelterwood, seed-tree or clear cut harvests.

Suggestions

- Leave on site any tree tops that are likely to cause unacceptable levels of damage to residual trees when they are moved.
- If cutting trees less than six inches in diameter is part of the prescription, leave some of these trees laying down on site.
- Mechanized harvesting systems can often cut small diameter, unacceptable growing stock during normal operations without much disruption in machine productivity. Cut these stems as the machine passes them and leave them on-site.
- In larger stands, some types of feller-bunchers are able to safely cut off tree tops prior to severing the remaining part of the stem, placing these stems apart from bunched whole trees.
- Return some of the tree tops that have been taken to the landing back to the harvesting site and spread them around. Often the smallest and muddiest material that is least suited to chipping is the best material to return to the site. Some site conditions and large skidders make it impractical to do this without causing damage to the soil and to the residual stand. Avoiding damage to the residual stand is more important than meeting an arbitrary retention standard.
- Following the very practical suggestions in the State of Maine's retention standards, leave as much FWM as possible on the following sites: low-fertility sites, shallow-to-bedrock soils, coarse sandy soils, poorly drained soils, steep slopes, and other erosion-prone sites.

Protection of Residual Stand

Trees in the residual stand should be protected in any harvest. In most cases, one of the goals of the harvest is to enhance the growth of the residual stand. Much of the benefit of this increased growth rate can be negated the residual stem are devalued in their most valuable sections. Whole tree harvesting has greater potential to scar trees in the residual stand because of the wider area covered by the trees travelling behind the skidder. Sites where a relatively small percentage of the trees are being removed may not be suitable for whole tree harvesting.

Suggestions

- Trees harvested with a feller-buncher should be grouped in locations that minimize the potential to damage the residual stand when they are skidded.
- Individual tree tops that cannot be removed without causing unacceptable levels of damage to valuable stems should be left in place.
- Trees along main skid routes can be protected by leaving low quality stems to serve as bumper trees to bear the brunt of skidding damage. These trees are then harvested last. If a second entry is planned in the stand within 20 years or so, leave these bumper trees to be harvested at that time (unless aesthetic considerations rule this out).
- If leaving whole bumper trees in place for a subsequent harvest is too inefficient to the production process, consider leaving high stump (4-5') bumpers in strategic locations.

Invasive Species

Investigate the potential of a planned harvest to introduce or spread invasive plant species and take steps to mitigate or avoid this, if necessary. Site disturbance is often a contributing factor in the spread of invasive species. Whole tree harvesting is a site disturbance. While little is known about any connection between whole tree harvesting and invasive species, awareness of localized problems can help curb the spread.

Suggestions

- If invasive species are on or near the harvesting site, avoid soil disturbances close to them.
- If invasive species are on or near the harvesting site and deemed undesirable, investigate if they can be eradicated as part of the harvesting operation.
- If moving from a site that had invasive species present, carefully clean any soil or organic material from equipment prior to moving it to the next harvesting site.

The Northeastern Loggers' Association (NELA) is a regional trade group representing members of the Northeast and Lake States' logging, sawmilling, and forest products community. For over sixty years the association has published *The Northern Logger and Timber Processor*-a highly respected monthly magazine that focuses exclusively on our region. NELA also produces training programs, pamphlets, books, and an annual exposition of forest products equipment.

NELA: WWW.NORTHERNLOGGER.COM

The Wood Education and Resource Center (WERC) is administered by the Northeastern Area State and Private Forestry of the Forest Service, U.S. Department of Agriculture. WERC's mission is to facilitate networking and information exchange with the forest products industry, in order to enhance opportunities that sustain forest products production. WERC's programs support managerial and technical innovation that keep businesses competitive, provide training, technology transfer, and applied research. The center consists of offices, training facilities, a rough mill in Princeton, West Virginia, and serves the 35 States in the eastern hardwood region of the United States.

WERC: WWW.NA.FS.FED.US/WERC

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