



Appalachia-Science
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ASPI TECHNICAL SERIES TP 35

SUSTAINABLE LOGGING AND LUMBER PRODUCTION

Few issues are more critical, or more hotly debated, than proper forest management and timber harvesting techniques. The long term health of forests, streams, and wildlife, as well as personal and community economies, is at stake. On a personal level, a landowner may fear excessive damage to their woods by heavy equipment, sloppy logging, over harvesting or under-valuation of their timber. These often valid concerns, coupled with the fact that Kentucky has some of the most diverse, productive hardwood forests in the world, led my wife Beth and I to start **Woodland Farms Modern Horselogging**. As both landowners and loggers, we developed a list of common interests to satisfy our concerns for the forest's health on the one hand, and the need to make a living on the other. The list included the following:

- make use of dead, damaged, or otherwise low quality trees first
- fell timber with as little damage to surrounding trees as possible
- use skidding technology that can reach trees scattered throughout the woods while doing as little damage as possible
- get as much value from the harvested timber as possible
- do all of the above as safely, cheaply, and flexibly as possible

These goals can be achieved, profitably and sustainably, by combining several methods and small-scale technologies currently used successfully in different contexts all across the country. These are:

- management plans based on uneven-aged harvesting through single tree selection (*see TP 34*)
- directional felling of trees
- skidding sawlogs out of the woods using draft horses and a logging "arch"
- sawing of logs on-site for "grade," or highest quality, using an efficient portable bandsaw
- grading the lumber
- kiln-drying the lumber in a solar kiln
- directly marketing green, air-dried, or kiln-dried lumber
- selling slab and trimwood for firewood

Using these methods, a landowner can make up to two times the money per tree, and the logger/sawyer can make up to five times the money per tree, as compared to simply hauling and selling logs. The value of the log is increased two to four times by milling and solar kiln-drying, the woods are minimally disturbed, and less than half of the non-renewable fossil fuels are consumed in the process. The two most exciting results of using these techniques are that the forest remains a forest instead of being reduced to a tree farm or a monoculture, and that timber can be cut on a 15 to 20 year rotation, with each harvest improving the quality of the remaining trees. These are two essential criteria for a truly sustainable logging operation.

The purpose of providing the details of this production system is to encourage others to duplicate all or part of it. However, while this work is profoundly rewarding and can be profitable, it can also be extremely dangerous. Anyone interested in horselogging, or logging in general, yet untrained in using horses or working in the woods, is strongly encouraged to enroll in the Kentucky Master Logger's Program and/or apprentice with a certified logger.

Management Philosophy:

Trees are not cut unless there is a good reason to do so. A "good reason" may be that a tree is dead or dying, has a broken top or is crowding out a high quality tree. A large tree which has reached its growth potential is another excellent candidate for felling. High grade (clear or defect-free) trees of desirable species larger than 16 inches at breast height (*dbh*), but which have good growth potential, are usually left standing for future harvest. Some trees and snags are left for wildlife.

This type of management takes the characteristics of each tree, its potential for growth, and the size, species and quality of the surrounding trees into consideration. All trees which fit the above criteria for harvesting are cut regardless of species. There is no high grading (cutting the best and leaving the rest). Rather, this method is best described by Jason Rutledge of Environmentally Sensitive Logging and Lumber Company as "cutting the worst first." Consistently applied, balanced harvesting using single-tree selection results in improved forest quality with each harvest. This empirical fact contradicts the often heard criticism from professional foresters that single-tree selection results in forests of shade-tolerant species like maple and beach. Enough of the canopy is removed by this approach to allow for the germination and growth of species such as yellow-poplar, oak and cherry. If necessary, several lower quality trees can be removed from one area, resulting in a "group selection" type of management.

One obvious consequence of using uneven-aged management through single-tree selection is the increased skill required by the timber feller. When clear-cutting, the quality of the timber left standing is not an issue. However, when a tree needs to come down, and it is surrounded by smaller, yet higher value trees, the feller needs skill in placing the tree where he wants it so as to ensure that those smaller trees make it to the next harvest cycle. The method of choice, developed by Soren Eriksen and taught in the Kentucky Master Logger's Program, is the open-faced felling technique. Before the first tree comes down, however, a system of skid trails should be cut so as to get the logs out in the most efficient and least destructive manner possible.

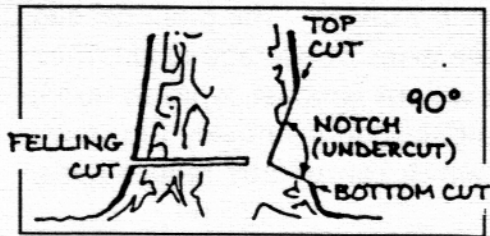
Skid Trails:

Conventional logging operations which use mechanical skidders require logging roads through the forest to get to downed timber. Often bulldozers are needed to build these roads. If the terrain is at all uneven, best management practices (*BMP's*) require these roads to be bermed and, when the job is completed, re-seeded, to lessen the chance of soil erosion. This is time consuming and costly. Thankfully, for horseloggers it is almost always unnecessary.

Skid trails for horses are definitely not like logging roads. They more closely resemble walking paths. A team of horses and the logging arch require a trail only six feet wide compared to a 10 or 20 foot wide road needed by skidders. Trails should be along the contour of hills, not up and down them. This makes life much easier on the horses and lessens the chance for soil erosion. Main trails should be placed strategically to minimize cutting numerous, smaller, feeder trails. Cutting long feeder trails which go only to one or two logs is very inefficient. Finally, it's best to work the timber furthest from the logging yard, or in this system the saw, first. This way trees which fall unpredictably won't block the main trails. Once a main trail is cut, felling can begin.

Directional Felling

Developed and promoted by Soren Eriksen, directional felling using the open face notch and felling wedge is a technique essential for quality logging. It also makes a very dangerous job safer. Often a tree is dropped by first cutting a notch, and then sawing from the outside of the tree inward to the notch. However, the tree can start to fall before the cut is finished. This can result in accidents, and in fiber pull which decreases the value of the log. The proper technique is to cut a notch



as usual, optimally achieving a 90 degree angled "open" face. A felling cut is then made directly behind, and 1 to 2 inches above the notch, leaving a hinge of wood 1 to 1.5 inches thick. The hinge ensures a controlled fall, snapping only when the tree is almost on the ground. This prevents the tree from twisting, sliding, or kicking off the stump as it falls. Wedges are then driven into the felling cut to prevent the chainsaw bar from getting stuck and

to help push the tree in the desired direction. With a 1 to 1.5 inch hinge and a latch in the back, a tree won't fall even in a strong wind. When an escape route has been cleared, the security latch is cut, the saw is shut off and the feller retreats at a 45 degree angle along the escape route, watching for falling limbs. Before felling any tree it is very important to look for dead branches, grapevines in the canopy, or other hazards. This is much easier to do in the Fall and Winter. A tree without leaves causes much less damage as it falls. For these reasons and others, Fall and Winter are the preferred times to fell trees.

Directional felling using the open-face technique helps ensure both the quality of the timber being harvested by reducing fiber pull, and the quality of the timber to be harvested in the future by decreasing damage to those trees left standing. Because directional felling is usually quite accurate, wooden supports cut from the thick limbs or trees cut while making trails are placed on the ground where a tree will fall. This makes getting a chain around the logs much easier and reduces skidding time. Once on the ground and supported, the tree is bucked into sawlog length sections in preparation for skidding. In most cases, all of the slash, or tops, from felled trees is cut to be within two to three feet from the ground. Trees damaged during felling, including spring poles (bent over trees or saplings) are also cut down. These steps take relatively little time, but improve the quality of the woods and make a job look much neater. Leaving damaged trees hurts reputations and future profits.

Skidding with Horses:

Horses and mules are central to, and indispensable for, truly sustainable logging. Those unfamiliar with working horses or mules in the woods may find it difficult to understand their utility, efficiency and practicality. Too often, animal powered skidding is dismissed as old-fashioned and impractical. For well organized operations, however, this is not the case. A major reason for this is that using a logging arch with the horses can double their productivity. The arch gets the front end of the log up off the ground, significantly reducing drag. Half of the log's weight is on wheels and this makes the horse's job much easier. It is also easier on the ground which would otherwise be continually gouged by the front of the log. The teamster can walk next to, or ride on the arch, which again is easier and much safer. But this simple, effective technology doesn't explain by itself the indispensability of horses for sustainable logging.

To believe that mechanical skidding, loading and hauling of logs from decentralized origins to centralized mills for processing can continue indefinitely is to believe that non-renewable fossil fuels will always be plentiful and cheap. This is both illogical and irresponsible. The belief that some other form of energy or technology will come along to solve this problem provides little security and may prove to be ill founded.

Horses are here now, they are relatively inexpensive, and they can get the job done while causing very little damage to the woods. Mechanical skidders commonly bark standing trees as they pull logs past them. The tree continues to grow, but the base of the tree, where the highest quality wood usually is, often rots. Skidding with horses and an arch rarely results in barked trees.

Compaction of the soil along logging roads is an inevitable result of mechanical skidding. Compaction leads to rutting, soil erosion, and reduced soil fertility. This damage is almost totally eliminated when horses are used, especially if skid trails are properly cut.

Horses offer other advantages directly or indirectly related to their role in logging. They can harvest much of their food by grazing and can be used to cut, rake and bale hay. They can be used

to plow, disk, plant, cultivate and harvest the grain they will need while working. The grain needed for a team working hard for 200 days per year can be raised on three acres of average land. Their manure and bedding, typically the sawdust from the sawmill (but not walnut sawdust, which is toxic), can be used to fertilize the hay fields and crop land. Horses, like engines, do eventually run down and die, but thankfully they also reproduce. These are all factors which can greatly reduce costs, increase profits and allow for sustainable forestry (and agriculture).

Aren't horses too slow to be economically practical? The answer is a definite "no", even when selling logs instead of lumber. It is possible for horseloggers to make \$30,000 or more in less than a year. However, selling logs may not be the best option. It is necessary to stop thinking about quantity, and start thinking about quality and adding value to logs. Why invest in technology that requires volumes of 5000 board feet or more per day to pay for itself when more profit can be made off of less volume with lower cost and more environmentally friendly methods? Ultimately, a high net income is more important than a high gross income. The use of horses allows for sustainable management practices on small or large acreages while doing minimal damage and allowing for a decent wage. To get the most economic benefit from the horse's labor, however, it is essential to get as much wood as possible from the logs by milling them on-site with a portable bandsaw.

Bandsaw Milling:

Modern portable bandsaws with hydraulic arms, log turners and clamps like those sold by *Woodmizer* can produce from 1000-3500 board feet of high quality lumber per day. Coincidentally, this is the same volume of wood that a team of horses can skid in one day. In fact, portable bandsaws routinely average 150% of Doyle Rule, so for every 1000 bdft skid to the saw, 1500 board feet of lumber are produced. Instead of loading logs on a truck, hauling them to the mill, and possibly getting underpaid or underscaled, logs are skidded to the mill on-site, often reducing the lengths of skids by half. The logger/sawyer, and therefore the landowner, has 50 percent more of a **higher value product** to sell. Unlike logs, lumber can be stacked and stored without deterioration and sold when markets are highest. In fact its value actually increases, as lumber dried for at least three months often gets up to 10% premiums. Lumber should be painted with end-coating (to prevent checks) and stacked soon after sawing to prevent warp and mold. Stacks should be built on level ground, with stickers on 16 to 24 inch centers between each level of wood. It is important that the ends of each board are supported on stickers also. Cover stacks with shade cloth or metal, and weight them down. Logs are sawn for "grade", which means that the clearest (free of knots, holes etc.) side of the log is chosen with each pass of the saw. This decreases production somewhat, but increases the value of the lumber. (Please refer to chart (p.6) for an example of increased yield and value). Low grade logs are sawn into cross-ties, timbers, or other large dimension cants. Slabwood and trimwood are cut and stacked for firewood.

Lumber is graded using an objective set of standards set by the *National Hardwood Lumber Association* (anyone interested in obtaining a rule book, or lumber grading training manual, can write to NHLA, P.O. Box 34518, Memphis, TN 38184-5018 for prices and availability). For both the logger/sawyer and the landowner, knowing the volume and grade of the lumber reduces the risk of being underpaid and again increases value. Many wholesalers pay premiums for strait shipments of one grade. Boards wider than ten inches can also bring higher prices.

Sawing logs does increase the initial investment, and skills needed by the logger. Sawing one thousand board feet of one inch lumber with a 20 horsepower diesel bandsaw takes 6-8 hours and requires about four gallons of fuel. Maintenance of the saw and blades requires an additional \$30 per day. However, the low cost of operation, increased lumber yield, and decreased hauling bills, more than compensate for the initial costs.

A considerable amount of slab and trimwood is generated with any sawing operation. A conservative estimate is that a tightly stacked cord of slabs and kindling is produced per 2000 Bdft of

sawn lumber. Sold as firewood for \$50 per cord, this represents a potential annual income of \$4500, assuming 180,000 Bdft of lumber are produced each year. In urban areas, prices for firewood are often two to three times as high, providing an even more lucrative marketing option.

Solar kiln drying:

Green lumber or cants can be marketed more flexibly and profitably than logs, and there is less ambiguity regarding quantity and quality being sold. There is little difficulty selling wood to mills or other buyers with established markets. However, to get the highest possible value for rough lumber, kiln drying is required. Kiln-dried lumber can be directly marketed to crafts people, custom cabinet makers, furniture builders, etc. at a considerable profit. Even at wholesale prices, kiln-drying lumber of FAS, #1 common, and #2A grades of most species increases the value by at least 50, and up to 100, percent. Kiln-dried lumber is also significantly lighter than green lumber, making hauling more efficient.

A solar kiln, sufficient for drying 40-75 thousand Bdft per year, need not be very large or expensive. One 8 feet by 24 feet kiln (inside dimensions) costing \$2500 to build, can handle 3-4 thousand board feet per load, with 12 loads, on average, being dried per year. A better idea yet is to use air-dried lumber. Wood having a moisture content of 20 percent or less can be dried in three or four days in the kiln with little or no fear of degradation (surface checking, casehardening, etc.). Wood is quite heavy - three thousand board feet of green oak weighs eight or nine tons. Build a kiln which can be loaded from the outside, with stacked wood on wheels or rollers which can then be pulled or pushed into the kiln. This requires a large door on at least one end of the kiln (minimum 6x6 feet) to accommodate the stack. Detailed construction and operating instructions for owner built solar wood drying kilns are available from: *Dept. of Forest Products, Brooks Forest Products Center, Virginia Tech, Blacksburg, VA 24061-0299*. Consultation is also available. Write to: *Woodland Farms Modern Horselogging, HCR 84 Box 10B, Constantine, KY 40114*.

Summary:

The methods described for harvesting timber and producing green, air or kiln-dried lumber add 2.5 - 4.0 times the value to each tree harvested. The landowner can make up to two times the money for their trees, or cut half as hard and leave more volume for subsequent harvests. The logger/sawyer can make up to six times the money per tree without increasing the total amount of work. Only the variety of jobs, and the skills required to perform them, increases. Logging is hard, and potentially dangerous work requiring skill and experience. If interested in working in the woods, get training from those with experience first.

Horses are a versatile and efficient power source. They are relatively inexpensive (\$2000 - \$4000 per team) and their production rate matches, or slightly exceeds, that of a portable sawmill and small solar kiln. Horses are also economically practical even when working small tracks of timber. Of the estimated 400,000 woodland owners in Kentucky, the average woodlot size is 26 acres. This is a potentially large clientele.

Starting this operation does take money. The essential components are:

- 3 or 4 horses	\$3000 - 5000
- harness, collars and miscellaneous	\$2000
- portable fencing	\$ 180
- logging arch	\$ 500
- portable bandsaw	\$6000 - 18,000
- chainsaws	\$1000
- truck	\$2000
- horse trailer	\$1600
- solar kiln and accessories	\$2250
- training courses	<u>\$ 100</u>

\$18,630 and up

To work most efficiently, one person can work the horses in the woods while another works the saw. This is also a more economical way to get started as each person assumes only half of the initial investment. There are many teamsters around, and over 550 *Woodmizer* sawmills have been sold in Kentucky alone. Experience has shown that there is a very large demand for this type of operation. People are tired of having their land damaged unnecessarily, and of not getting fully paid for their timber. This means job security for horseloggers. Because timber is harvested sustainably, allowing for 15-20 year cutting cycles, job security extends to the horselogger's children.

Potential income depends on many factors. Organization, work ethic, timber quality, horsemanship, terrain and marketing skills all play major roles. A very conservative estimate is that two hardworking people could gross \$30,000 each. A good teamster skidding logs for \$40 per 1000 Bdft can make over \$30,000 a year (about \$120/day) with operating costs of \$15/day or less. Hourly wages for custom sawing with a portable bandsaw are \$18 and up (based on \$0.15/foot). Selling wood is more lucrative than just sawing as a service, so \$18/hour should serve as a conservative base salary. Most custom sawyers are several months behind demand.

For anyone who feels that a bad day in the woods is better than a good day inside, here is a job opportunity. And for anyone truly interested in the long-term health of the forests and forest economies, here is an example of sustainable techniques that have proven their utility and profitability.

ECONOMIC ADVANTAGES OF SELLING LUMBER VERSUS LOGS: INCREASED VOLUME FOR TWO RED OAK LOGS

Red Oak log #	Volume* board feet	Volume by Grade (board feet)				Total
		FAS/1F	1C	2A	3A	
1	72	59.6	22.4	16.5	-	98.5
2	<u>61</u>	<u>49.5</u>	<u>35.4</u>	<u>21.2</u>	-	<u>106.1</u>
	133	109.1	57.8	37.7	-	204.6

*volume measured by the Doyle Log Rule

- 53% of lumber is FAS/1F

- lumber yield: 156% of Doyle rule

- 46% of FAS/1F is 10" or wider
(25% premiums paid for wide boards)

ECONOMIC ADVANTAGES OF SELLING LUMBER VERSUS LOGS: FLEXIBLE DOLLAR VALUES FOR TWO RED OAK LOGS

	<u>log</u>	<u>green graded</u>	<u>kiln dried wholesale</u>	<u>kiln dried retail</u>
Land owner	59 (50%)*	82 (40%)	98 (35%)	113 (25%)
Logger	<u>59</u> (50%)	<u>123</u> (60%)	<u>180</u> (65%)	<u>339</u> (75%)
TOTAL	118	205	278	452
Land owner	1.0 **	1.4	1.7	1.9
Logger	1.0	2.1	3.0	5.7
TOTAL	1.0	1.7	2.3	3.8

* = Dollars (percentage of sales)

** = Ratio of lumber value: log value

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